

Semester:
1 to 8



ALBERTIAN INSTITUTE OF SCIENCE AND TECHNOLOGY

Approved by AICTE, New Delhi, Affiliated to APJAKTU, Thiruvananthapuram

Accredited Programmes in CE, CSE, ECE, EEE, ME ISO 9001:2015 CERTIFIED

**DEPARTMENT OF
ELECTRONICS AND COMMUNICATION
ENGINEERING**

COURSE HANOUT

Program: B.Tech (2019 Regulation)

Vision

“To generate technically competent employable Engineers for the Electronics and Communication industry who will work towards the betterment of society and nation.”

Mission

- Impart knowledge in the field of electronics with ample opportunities for practice, research, innovation and entrepreneurship.
- Adapt to technological advancements by regular interactions with experts from industry and academicians to generate quality professionals.
- Provide value based education to develop socially responsible engineers.

Program Educational Objectives (PEOs)

Graduates of Electronics and Communication Engineering shall

- PEO1. Demonstrate technical aptitude to identify, analyse and design innovative, sustainable and cost-effective solutions for complex engineering problems.
- PEO2. Function effectively as an individual and attune oneself to diverse teams and interdisciplinary ventures.
- PEO3. Apply acquired knowledge and ethical principles for the betterment of the society.

Program Specific Outcomes (PSOs)

Graduates of Electronics & Communication Engineering will be able to

- PSO1. Absorb and apply contextual knowledge of Electronics and Communication Engineering in design, analysis, and development of various electronic systems.
- PSO2. Analyze and synthesize the experimental data from electronic system to validate the design.
- PSO3. Choose and apply modern engineering tools to analyse complex Electronics and Communication engineering problems.

Program Outcomes (POs)

Engineering Graduates will be able to

- PO1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- PO2. **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- PO3. **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
- PO4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
- PO5. **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
- PO6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
- PO7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
- PO8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
- PO9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
- PO10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

- PO11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
- PO12. **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Semester: 1

CONTENTS

SLOT	COURSE CODE	COURSES	L-T-P	HOURS	CREDIT
A	MAT 101	LINEAR ALGEBRA AND CALCULUS	3-1-0	4	4
B	PHT 100	ENGINEERING PHYSICS A	3-1-0	4	4
C	EST 100	ENGINEERING MECHANICS	2-1-0	3	3
D	EST 130	BASICS OF ELECTRICAL & ELECTRONICS ENGINEERING	4-0-0	4	4
E	HUN 101	LIFE SKILLS	2-0-2	4	--
S	PHL 120	ENGINEERING PHYSICS LAB	0-0-2	2	1
T	ESL 130	ELECTRICAL & ELECTRONICS WORKSHOP	0-0-2	2	1

Course Code & Name: MAT 101 LINEAR ALGEBRA AND CALCULUS

1. Prescribed Syllabus

Module	Topic	Hours
1	(Linear algebra) (Text 2: Relevant topics from sections 7.3, 7.4, 7.5, 8.1,8.3,8.4) Systems of linear equations, Solution by Gauss elimination, row echelon form and rank of a matrix, fundamental theorem for linear systems (homogeneous and non-homogeneous, without proof), Eigen values and eigen vectors. Diagonalization of matrices, orthogonal transformation, quadratic forms and their canonical forms.	10
2	(multivariable calculus-Differentiation) (Text 1: Relevant topics from sections 13.3, 13.4, 13.5, 13.8) Concept of limit and continuity of functions of two variables, partial derivatives, Differentials, Local Linear approximations, chain rule, total derivative, Relative maxima and minima, Absolute maxima and minima on closed and bounded set.	8
3	(multivariable calculus-Integration) (Text 1: Relevant topics from sections 14.1, 14.2, 14.3, 14.5, 14.6, 14.8) Double integrals (Cartesian), reversing the order of integration, Change of coordinates (Cartesian to polar), finding areas and volume using double integrals, mass and centre of gravity of inhomogeneous laminas using double integral. Triple integrals, volume calculated as triple integral, triple integral in cylindrical and spherical coordinates (computations involving spheres, cylinders).	10
4	(sequences and series) (Text 1: Relevant topics from sections 9.1, 9.3, 9.4, 9.5, 9.6) Convergence of sequences and series, convergence of geometric series and p-series(without proof), test of convergence (comparison, ratio and root tests without proof); Alternating series and Leibnitz test, absolute and conditional convergence.	8
5	(Series representation of functions) (Text 1: Relevant topics from sections 9.8, 9.9. Text 2: Relevant topics from sections 11.1, 11.2, 11.6) Taylor series (without proof, assuming the possibility of power series expansion in appropriate domains), Binomial series and series representation of exponential, trigonometric, logarithmic functions (without proofs of convergence); Fourier series, Euler formulas, Convergence of Fourier series (without proof), half range sine and cosine series, Parseval's theorem (without proof).	9

2. Text Books (T)

- T1. H. Anton, I. Biven, S. Davis, "Calculus", Wiley, 10th edition, 2015
T2. Erwin Kreyszig, Advanced Engineering Mathematics, 10th Edition, John Wiley & Sons, 2016.

3. Reference Books (R)

- R1. J. Stewart, Essential Calculus, Cengage, 2nd edition, 2017
R2. G.B. Thomas and R.L. Finney, Calculus and Analytic geometry, 9 th Edition, Pearson, Reprint, 2002.

- R3. Peter V. O'Neil, Advanced Engineering Mathematics , Cengage, 7th Edition, 2012
 R4. Veerarajan T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi, 2008.
 R5. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 36 Edition, 2010.

4. Course Objectives

This course introduces students to some basic mathematical ideas and tools which are at the core of any engineering course. A brief course in Linear Algebra familiarises students with some basic techniques in matrix theory which are essential for analysing linear systems. The calculus of functions of one or more variables taught in this course are useful in modelling and analysing physical phenomena involving continuous change of variables or parameters and have applications across all branches of engineering.

5. Course Pre / Co-requisite

A basic course in one-variable calculus and matrix theory.

6. Course Outcomes

After the completion of the course the student will be able to

- CO1: solve systems of linear equations, diagonalize matrices and characterise quadratic forms
 CO2: compute the partial and total derivatives and maxima and minima of multivariable functions
 CO3: compute multiple integrals and apply them to find areas and volumes of geometrical shapes, mass and centre of gravity of plane laminae
 CO4: perform various tests to determine whether a given series is convergent, absolutely convergent or conditionally convergent
 CO5: determine the Taylor and Fourier series expansion of functions and learn their applications.

7. Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes

PO/ CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	H	H	M	L			L	M		M
CO2	H	H	H	H	M	L			L	M		M
CO3	H	H	H	H	M	L			L	M		M
CO4	H	M	H	M	L	L			L	M		M
CO5	H	H	H	H	M	L			L	M		M

8. Justification for CO-PO-PSO Correlation

CO1-PO1	Solutions of system of linear equations can be used to solve complex engineering problems including problems related to Astrophysics.
CO1-PO2	The knowledge of linear algebra can be used to analyse complex engineering problems involving electrical circuits.
CO1-PO3	The concept of linear algebra can be to design complex electronic circuits.
CO1-PO4	The concept of linear algebra can be used in the analysis of advanced electrical systems.
CO1-PO5	Linear Algebra can be useful in solving real life problems by modeling those problems and then find the solutions.

CO1-PO6	The concept of linear algebra can be used to assess societal health, safety and legal issues involved in mixing of chemicals.
CO1-PO9	The knowledge of quadratic forms will help to function effectively in diverse terms.
CO1-PO10	The concept of diagonalization of matrices will help to communicate effectively on the solutions of differential and difference equations.
CO1-PO12	The concept of linear algebra will get awareness about the need for lifelong learning and continuous upgradation of technical knowledge.
CO2-PO1	The knowledge of partial differentiation will help to solve problems arising in engineering
CO2-PO2	Fundamental knowledge of partial derivatives of functions will help to formulate problems with high complexity in Engineering
CO2-PO3	Computation of partial and total derivatives and maxima and minima of multivariable functions are used in the development of solutions for complex engineering problems
CO2-PO4	Knowledge of finding extreme and absolute values of multivariable functions will help in the investigations of certain engineering problems.
CO2-PO5	Various methods for computation of partial derivatives will help to select appropriate techniques in complex engineering activities.
CO2-PO6	The concept of partial differential equations will help to assess the issues related to society
CO2-PO9	Partial derivatives and its applications will help to work effectively as a team member.
CO2-PO10	Understanding of partial and total derivatives and maxima and minima of multivariable functions will help to communicate effectively on complex engineering activities.
CO2-PO12	Practical application of partial derivatives such as maxima and minima of multivariable functions will enhance the lifelong learning process.
CO3-PO1	Evaluation of multiple integrals will help to solve complex engineering problems
CO3-PO2	Theory of multiple integrals will help to analyse problems with high complexity in engineering.
CO3-PO3	The concept of finding area and volume using multiple integrals can be used to design solutions for complex engineering problems.
CO3-PO4	Multiple integrals and their applications can be used to conduct investigations of complex problems involving the synthesis of data to provide valid conclusions.
CO3-PO5	The concept of finding area and volume using multiple integrals can be used to create, select and apply appropriate techniques, modern engineering and IT tools including prediction and modeling to complex engineering activities.
CO3-PO6	Geometric applications of multiple integrals such as finding areas and volumes of geometrical shapes, mass and centre of gravity of plane laminas will help to apply reasoning to the issues and responsibilities relevant to the professional engineering practice
CO3-PO9	The knowledge of multiple integrals and its practical applications will help to perform better in diverse teams and multi-disciplinary settings
CO3-PO10	The concept of finding area and volume will help to communicate effectively on complex engineering activities with the engineering community.
CO3-PO12	The concept of multiple integrals will help to engage in independent and lifelong learning.
CO4-PO1	Basic knowledge of various tests for convergence of series will help to solve problems arising in engineering
CO4-PO2	Fundamental knowledge of tests for convergence of series will help to analyse problems with high complexity in Engineering.
CO4-PO3	Theory of tests for convergence of series are used to design solutions for complex engineering problems

CO4-PO4	Various tests for convergence of series are used to conduct investigation of complex problems
CO4-PO5	Knowledge of various tests for convergence of series will help to select appropriate techniques in complex engineering activities.
CO4-PO6	The concept of tests for convergence of series will help to assess the issues related to society
CO4-PO9	Knowledge of various tests for convergence will help to function effectively as an individual and a member in diverse teams
CO4-PO10	Application of various tests to determine whether a given series is convergent, absolutely convergent or conditionally convergent will help to communicate effectively on complex engineering activities.
CO4-PO12	The knowledge of various tests for convergence of series will enhance the ability to engage in independent and lifelong learning.
CO5-PO1	Fundamental knowledge of series expansion of functions will help to simplify several problems in Engineering
CO5-PO2	Basic knowledge of Taylor and Fourier series expansion of functions and their applications will help to analyse problems with high complexity in Engineering.
CO5-PO3	Concept of Taylor and Fourier series expansion of functions and their applications are used to design solutions for complex engineering problems
CO5-PO4	Knowledge of Series expansion of functions and their applications are used to conduct investigation of complex problems
CO5-PO5	Concept of series expansion of functions and their applications will help to select appropriate techniques in complex engineering activities with the understanding of the limitations.
CO5-PO6	Understanding of series expansion of functions and their applications can be used to assess the issues related to society
CO5-PO9	Application of Taylor and Fourier series expansion of functions will help to function effectively as an individual and a member in diverse teams
CO5-PO10	Concept of Taylor and Fourier series expansion of functions and their applications will help to communicate effectively on complex engineering activities.
CO5-PO12	Knowledge of Series expansion of functions and their applications will help to engage in independent and lifelong learning.

9. Curricular gaps (if any)

Nil

10. Course Enrichment Activities

Nil

11. Internal Assessment mark allocation (as per university curriculum)

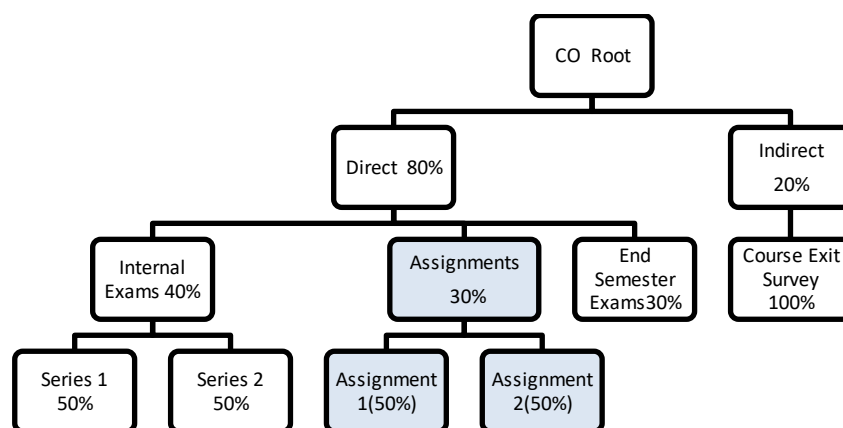
(Provide details as mentioned in syllabus)

Attendance	- 10 marks
Continuous Assessment Test	- 25 marks
<u>Assignment (s)/ Course Project</u>	<u>- 15 marks</u>
<u>Total</u>	<u>- 50 marks</u>

12. Assessment – CO Mapping (Put ‘ x’ if mapping is present)

	Tools		Weightage [#]	CO1	CO2	CO3	CO4	CO5
Direct Assessment Tools**	Internal Exam(s) 40%	Series 1	20%	x	x			
		Series 2	20%			x	x	
	Assignment (s)/ Course Project /Quiz etc. 30%	Assignment 1	15%	x	x			
		Assignment 2	15%			x	x	x
	End Semester Exam		30%	x	x	x	x	x
Indirect Assessment Tool	Course Exit Survey		100%	x	x	x	x	x

13. Assessment Configuration



14. Course Plan

Hour	Topic	Module	Reference(s)	Teaching Pedagogy
1	Systems of linear equations, Solution by Gauss elimination	1	Erwin Kreyszig, Advanced Engineering Mathematics, 10th Edit, John Wiley & Sons	Lecture
2	Row echelon form	1	Erwin Kreyszig, Advanced Engineering Mathematics, 10th Edit, John Wiley & Sons	Lecture
3	Finding rank from row echelon form	1	Erwin Kreyszig, Advanced Engineering Mathematics, 10th Edit, John Wiley & Sons	Lecture
4	Fundamental theorem for linear systems	1	Erwin Kreyszig, Advanced Engineering Mathematics, 10th Edit, John Wiley & Sons	Lecture

5	Eigen values and eigen vectors	1	Erwin Kreyszig, Advanced Engineering Mathematics, 10th Edit, John Wiley & Sons	Lecture
6	Eigen values and eigen vectors	1	Erwin Kreyszig, Advanced Engineering Mathematics, 10th Edit, John Wiley & Sons	Tutorial
7	Diagonalization of matrices	1	Erwin Kreyszig, Advanced Engineering Mathematics, 10th Edit, John Wiley & Sons	Lecture
8	Diagonalization of matrices	1	Erwin Kreyszig, Advanced Engineering Mathematics, 10th Edit, John Wiley & Sons	Tutorial
9	Orthogonal transformation, quadratic forms and their canonical forms.	1	Erwin Kreyszig, Advanced Engineering Mathematics, 10th Edit, John Wiley & Sons	Lecture
10	Orthogonal transformation, quadratic forms and their canonical forms.	1	Erwin Kreyszig, Advanced Engineering Mathematics, 10th Edit, John Wiley & Sons	Lecture
11	Concept of limit and continuity of functions of two variables	2	H. Anton, I. Biven, S. Davis, "Calculus", Wiley, 10th edit, 2015	Lecture
12	partial derivatives	2	H. Anton, I. Biven, S. Davis, "Calculus", Wiley, 10th edit,	Lecture
13	Differentials, Local Linear approximations	2	H. Anton, I. Biven, S. Davis, "Calculus", Wiley, 10th edit,	Lecture
14	Differentials, Local Linear approximations	2	H. Anton, I. Biven, S. Davis, "Calculus", Wiley, 10th edit,	Lecture
15	Chain rule, total derivative	2	H. Anton, I. Biven, S. Davis, "Calculus", Wiley, 10th edit,	Lecture
16	Chain rule, total derivative	2	H. Anton, I. Biven, S. Davis, "Calculus", Wiley, 10th edit,	Tutorial
17	Maxima and minima	2	H. Anton, I. Biven, S. Davis, "Calculus", Wiley, 10th edit,	Lecture
18	Maxima and minima	2	H. Anton, I. Biven, S. Davis, "Calculus", Wiley, 10th edit,	Tutorial
19	Double integrals (Cartesian)- evaluation	3	H. Anton, I. Biven, S. Davis, "Calculus", Wiley, 10th edit,	Lecture
20	Double integrals (Cartesian)- evaluation	3	H. Anton, I. Biven, S. Davis, "Calculus", Wiley, 10th edit,	Lecture
21	Change of order of integration in double integrals	3	H. Anton, I. Biven, S. Davis, "Calculus", Wiley, 10th edit,	Tutorial
22	change of coordinates (Cartesian to polar)	3	H. Anton, I. Biven, S. Davis, "Calculus", Wiley, 10th edit,	Lecture

23	Finding areas and volumes	3	H. Anton, I. Biven, S. Davis, <i>Calculus</i> , Wiley, 10th edit,	Lecture
24	mass and centre of gravity of plane laminas	3	H. Anton, I. Biven, S. Davis, <i>Calculus</i> , Wiley, 10th edit,	Lecture
25	mass and centre of gravity of plane laminas	3	H. Anton, I. Biven, S. Davis, <i>Calculus</i> , Wiley, 10th edit,	Tutorial
26	Triple integrals	3	H. Anton, I. Biven, S. Davis, <i>Calculus</i> , Wiley, 10th edit,	Others
27	Triple integrals	3	H. Anton, I. Biven, S. Davis, <i>Calculus</i> , Wiley, 10th edit,	Others
28	Triple integrals	3	H. Anton, I. Biven, S. Davis, <i>Calculus</i> , Wiley, 10th edit,	Others
29	Convergence of sequences and series	4	H. Anton, I. Biven, S. Davis, <i>Calculus</i> , Wiley, 10th edit,	Lecture
30	geometric and p-series	4	H. Anton, I. Biven, S. Davis, <i>Calculus</i> , Wiley, 10th edit,	Lecture
31	Test of convergence(comparison)	4	H. Anton, I. Biven, S. Davis, <i>Calculus</i> , Wiley, 10th edit,	Lecture
32	Test of convergence(comparison)	4	H. Anton, I. Biven, S. Davis, <i>Calculus</i> , Wiley, 10th edit,	Tutorial
33	Test of convergence(ratio and root)	4	H. Anton, I. Biven, S. Davis, <i>Calculus</i> , Wiley, 10th edit,	Lecture
34	Test of convergence(, ratio and root)	4	H. Anton, I. Biven, S. Davis, <i>Calculus</i> , Wiley, 10th edit,	Lecture
35	Alternating series and Leibnitz test,	4	H. Anton, I. Biven, S. Davis, <i>Calculus</i> , Wiley, 10th edit,	Lecture
36	absolute and conditional convergence	4	H. Anton, I. Biven, S. Davis, <i>Calculus</i> , Wiley, 10th edit,	Tutorial
37	Taylor series, Binomial series and series representation of exponential, trigonometric, logarithmic functions;	5	H. Anton, I. Biven, S. Davis, <i>Calculus</i> , Wiley, 10th edit,	Lecture
38	Taylor series, Binomial series and series representation of exponential, trigonometric, logarithmic functions;	5	H. Anton, I. Biven, S. Davis, <i>Calculus</i> , Wiley, 10th edit,	Lecture
39	Taylor series, Binomial series and series representation of exponential, trigonometric, logarithmic functions;	5	H. Anton, I. Biven, S. Davis, <i>Calculus</i> , Wiley, 10th edit,	Lecture

40	Fourier series, Euler formulas	5	Erwin Kreyszig, Advanced Engineering Mathematics, 10th Edit, John Wiley & Sons	Lecture
41	Fourier series, Euler formulas	5	Erwin Kreyszig, Advanced Engineering Mathematics, 10th Edit, John Wiley & Sons	Tutorial
42	Convergence of Fourier series (Dirichlet's conditions)	5	Erwin Kreyszig, Advanced Engineering Mathematics, 10th Edit, John Wiley & Sons	Lecture
43	Half range sine and cosine series	5	Erwin Kreyszig, Advanced Engineering Mathematics, 10th Edit, John Wiley & Sons	Lecture
44	Half range sine and cosine series	5	Erwin Kreyszig, Advanced Engineering Mathematics, 10th Edit, John Wiley & Sons	Tutorial
45	Parseval's theorem	5	Erwin Kreyszig, Advanced Engineering Mathematics, 10th Edit, John Wiley & Sons	Group Discussion

15. Question Bank

Module 1				
Sl. No.	Question	Marks	CO	BL
1	Determine the rank of the matrix $\begin{bmatrix} 1 & -1 & 0 \\ 1 & 3 & -1 \\ 5 & 3 & -2 \end{bmatrix}$	3	CO1	L1
2	Write down the spectrum of $\begin{bmatrix} -5 & 2 \\ 2 & -2 \end{bmatrix}$	3	CO1	L1
3	Find the eigen values and eigen vectors of $A = \begin{bmatrix} 0.8 & -0.6 \\ 0.6 & 0.8 \end{bmatrix}$	3	CO1	L1
4	Show that the vectors $(1, -1, 0)$, $(1, 3, -1)$ and $(5, 3, -2)$ are linearly dependent.	3	CO1	L2
5	Obtain the matrix of transformation $y_1 = \cos\theta x_1 - \sin\theta x_2$, $y_2 = \sin\theta x_1 + \cos\theta x_2$. Prove that it is orthogonal.	3	CO1	L2
6	Find a matrix C such that $Q = X^T A X$, where $Q = -3x_1^2 + 4x_1x_2 - x_2^2 + 2x_1x_3 - 5x_3^2$	3	CO1	L1
7	Show that the quadratic form $4x_1^2 + 12x_1x_2 + 13x_2^2 = 16$ is positive definite	3	CO1	L1

8	What type of conic section the following quadratic form represent? $Q = 17x_1^2 - 30x_1x_2 + 17x_2^2 = 128$	3	CO1	L2
9	Find the rank of the matrix $\begin{bmatrix} 1 & 2 & -1 & 3 \\ 2 & 2 & 4 & 1 \\ 5 & 6 & 7 & 5 \end{bmatrix}$	3	CO1	L2
10	Find the Eigen values of the matrix $A = \begin{bmatrix} 1 & 2 \\ 0 & 3 \end{bmatrix}$. What are the Eigen values of A^2 , A^{-1} without using its characteristic equation.	3	CO1	L2
11	Find the rank of the matrix $\begin{bmatrix} 3 & 0 & 2 & 2 \\ -6 & 42 & 24 & 54 \\ 21 & -21 & 0 & -15 \end{bmatrix}$	3	CO1	L2
12	Show that the quadratic form $3x_1^2 + 22x_1x_2 + 3x_2^2 = 0$ represents a pair of straight lines by transforming it into principal axes form.	3	CO1	L2
13	Find the rank of the matrix $\begin{bmatrix} 3 & 0 & 2 & 2 \\ -6 & 42 & 42 & 54 \\ 21 & -21 & 0 & -15 \end{bmatrix}$	7	CO1	L2
14	Solve the following system of equation $y + z - 2w = 0$ $2x - 3y - 3z + 6w = 2$ $4x + y + z - 2w = 4$	7	CO1	L3
15	Find the eigen values and eigen vectors of the matrix $A = \begin{bmatrix} -1 & 2 & -2 \\ 2 & 4 & 1 \\ 2 & 1 & 4 \end{bmatrix}$	7	CO1	L2
16	Diagonalize the matrix $A = \begin{bmatrix} -2 & 2 & -3 \\ 2 & 1 & -6 \\ -1 & -2 & 0 \end{bmatrix}$	7	CO1	L3
17	If 2 is an eigen value $\begin{bmatrix} 3 & -1 & 1 \\ -1 & 5 & -1 \\ 1 & -1 & 3 \end{bmatrix}$ without using its characteristic equation, find the other eigen values. Also find the eigen values of $A^3, A^{-1}, A^T, 5A, A - 3I$ & $adjA$	7	CO1	L3
18	What kind of conic section the quadratic form $7x_1^2 - 30x_1x_2 + 17x_2^2 = 128$ represents? Transform it to principal axes.	7	CO1	L3
19	Find the rank, index and signature of the quadratic form $Q = 3x^2 + 5y^2 + 3z^2 - 2xy + 2xz - 2yz$	7	CO1	L3
20	Show that the quadratic form $3x_1^2 + 22x_1x_2 + 3x_2^2 = 0$ represents a pair of straight lines by transforming it into canonical form. Express $X^T = [x_1 \ x_2]$ in terms of the new coordinate vector $Y^T = [y_1 \ y_2]$	7	CO1	L3

21	diagonalize the matrix $A = \begin{bmatrix} 8 & -6 & 2 \\ -6 & 7 & -4 \\ 2 & -4 & 3 \end{bmatrix}$	7	CO1	L3
22	Using Gauss elimination method solve the system of equations $x - y + z = 0$ $-x + y - z = 0$ $10y + 25z = 90$ $20x + 10y = 80$	7	CO1	L3
23	Reduce to row echelon form and find the rank of the matrix $\begin{bmatrix} 1 & 2 & 3 & 4 \\ 2 & 1 & 4 & 5 \\ 1 & 5 & 5 & 7 \\ 8 & 1 & 14 & 17 \end{bmatrix}$	7	CO1	L2
24	Check whether the following matrix is diagonalizable $\begin{bmatrix} 2 & -1 & 3 \\ -1 & 2 & -1 \\ 1 & -1 & 3 \end{bmatrix}$	7	CO1	L2
25	What kind of conic section the quadratic form $1x_1^2 + 84x_1x_2 + 24x_2^2 = 156$ represents? Transform it to principal axes.	7	CO1	L3
26	Show that the equations: $x + y + z = a, \quad 3x + 4y + 5z = b, \quad 2x + 3y + 4z = c$ (i) have no solution if $a = b = c = 1$ (ii) have many solutions if $a = \frac{b}{2} = c = 1$	7	CO1	L3
27	Find the matrix of transformation that diagonalize the matrix $A = \begin{bmatrix} 6 & -2 & 2 \\ -2 & 3 & -1 \\ 2 & -1 & 3 \end{bmatrix}$. Also, find the diagonal matrix.	7	CO1	L3
28	Find the value of λ and μ for which the system of equations $2x + 3y + 5z = 9 \quad 7x + 3y - 2z = 8 \quad 2x + 3y + \lambda z = \mu$ has (a) no solution (b) unique solution (c) more than one solution	7	CO1	L3
29	Solve the following linear system of equations using Gauss elimination method $x + 2y - z = 3$ $3x - y + 2z = 1$ $2x - 2y + 3z = 2$	7	CO1	L3

30	Find the matrix of transformation that diagonalize the matrix $A = \begin{bmatrix} -5 & 2 \\ 2 & -2 \end{bmatrix}$. Also write the diagonal matrix.	7	CO1	L3
31	Solve the following linear system of equations using Gauss elimination method $\begin{aligned} x + y + z &= 2 \\ y + z &= -2 \\ 4y + 6z &= -12 \end{aligned}$	7	CO1	L3
32	Find the eigenvalues and eigenvectors of $\begin{bmatrix} 1 & 1 & 2 \\ -1 & 2 & 1 \\ 0 & 1 & 3 \end{bmatrix}$	7	CO1	L2
33	Solve the following linear system of equations using Gauss elimination method. $\begin{aligned} 2x - 3y - 3z + 6w &= 2 \\ y + z - 2w &= 0 \\ 4x + y + z - 2w &= 4 \end{aligned}$	7	CO1	L3
34	Find the matrix of transformation that diagonalize the matrix $A = \begin{bmatrix} -19 & 7 \\ -42 & 16 \end{bmatrix}$. Also write the diagonal matrix.	7	CO1	L2
Module 2				
Sl. No.	Question	Marks	CO	BL
1	Let $f(x, y) = \sqrt{3x + 2y}$, (a) Find the slope of the surface $z = f(x, y)$ in the x – direction at the point (2, 5). (b) Find the slope of the surface $z = f(x, y)$ in the y – direction at the point (2, 5).	3	CO2	L1
2	If $z = \sin(y^2 - 4x)$, (a) Find the rate of change of z w.r. t x at the point (3, 1) with y held fixed. (b) Find the rate of change of z w.r. t y at the point (3, 1) with x held fixed.	3	CO2	L1
3	Show that the function $f(x, y) = e^{-y} \cos x$ satisfies the Laplace equation $f_{xx} + f_{yy} = 0$	3	CO2	L2
4	Find the derivative of $\omega = x^2 + y^2$ w.r.t t along the path $x = at^2, y = 2at$	3	CO2	L2
5	Find the differential dz of the function $z = \tan^{-1}(x^2y)$	3	CO2	L1
6	If $U = \frac{x^3 + y^3}{x - y}$, find $\frac{\partial U}{\partial x} + \frac{\partial U}{\partial y}$.	3	CO2	L2
7	If $Z = \frac{xy}{x^2 + y^2}$, find $\frac{\partial Z}{\partial x}$ and $\frac{\partial Z}{\partial y}$.	3	CO2	L2
8	Show that the equation $u(x, t) = \sin(x - ct)$, satisfies wave equation $\frac{\partial^2 u}{\partial t^2} = c^2 \frac{\partial^2 u}{\partial x^2}$.	3	CO2	L2

9	Find $\frac{dz}{dt}$ by chain rule ,where $z = 3x^2 y^2$, $x = t^4, y = t^3$	3	CO2	L2
10	If $z = (3x - 2y)^4$ find $\frac{\partial^4 z}{\partial x \partial y^3}$	3	CO2	L3
11	Find the slope of the surface $z = \sqrt{x^2 + 4y^2}$ in the x-direction at the point (1, 2)	3	CO2	L2
12	Prove that $Z_{xy} = Z_{yx}$ where $Z = x^2 y + 5y^3$	3	CO2	L2
13	If $\omega = \log(\tan x + \tan y + \tan z)$, then prove that $\sin 2x \frac{\partial \omega}{\partial x} + \sin 2y \frac{\partial \omega}{\partial y} + \sin 2z \frac{\partial \omega}{\partial z} = 2$	7	CO2	L2
14	Let $\omega = \sqrt{x^2 + y^2 + z^2}$, $x = \cos \theta$, $y = \sin \theta$, $z = \tan \theta$. Use the chain rule to find $\frac{d\omega}{d\theta}$ when $\theta = \frac{\pi}{4}$	7	CO2	L3
15	If $\omega = e^{xy}$, $x = 2u + v$, $y = \frac{u}{v}$. Find $\frac{\partial \omega}{\partial u}$, $\frac{\partial \omega}{\partial v}$	7	CO2	L3
16	Locate all relative extrema and saddle points of $f(x, y) = y^2 + xy + 4y + 2x + 3$	7	CO2	L3
17	Let f be a differentiable function of 3 variables and suppose that $\omega = f(x - y, y - z, z - x)$. Show that $\frac{\partial \omega}{\partial x} + \frac{\partial \omega}{\partial y} + \frac{\partial \omega}{\partial z} = 0$	7	CO2	L3
18	Let $L(x, y)$ denote the local linear approximation to the function $f(x, y) = \frac{1}{\sqrt{x^2 + y^2}}$ at the point $P(4, 3)$. Compare the error in approximating f by L at the point $Q(3.92, 3.01)$ with the distance between the points P and Q .	7	CO2	L3
19	If $\omega = x^2 + y^2 - z^2$, $x = \rho \sin \phi \cos \theta$, $y = \rho \sin \phi \sin \theta$, $z = \rho \cos \phi$. Find $\frac{\partial \omega}{\partial \rho}$, $\frac{\partial \omega}{\partial \theta}$	7	CO2	L3
20	Find the local linear approximation L of $f(x, y) = \ln(xy)$ at the point (1,2). Compare the error in approximating f by L at the point $Q(1.01, 2.01)$	7	CO2	L3
21	Locate all relative maxima, relative minima and saddle points of $f(x, y) = 2xy - x^3 - y^2$	7	CO2	L3
22	If $\omega = 4x^2 + 4y^2 + z^2$, $x = \rho \sin \phi \cos \theta$, $y = \rho \sin \phi \sin \theta$, $z = \rho \cos \phi$. Find $\frac{\partial \omega}{\partial \rho}$, $\frac{\partial \omega}{\partial \theta}$, $\frac{\partial \omega}{\partial \phi}$	7	CO2	L3
23	Find the second order partial derivatives of $f(x, y) = x^2 y^3 + x^4 y$	7	CO2	L2
24	Find the local linear approximation L of $f(x, y) = xyz$ at the point (1,2,3). Compare the error in approximating f by L at the point $Q(1.001, 2.002, 3.003)$	7	CO2	L3
25	A function $f(x, y) = x^2 + y^2$ is differentiable at the point $P(x, y)$. If $L(x, y) = 2x + 4y - 5$ be the local linear approximation to f at P , determine P .	7	CO2	L3

26	Determine the dimensions of a rectangular box, open at the top having a volume of 32 ft^3 and requiring the least amount of material for its construction.	7	CO2	L3
27	Find the local linear approximation of $\frac{4y}{x+z}$ at $(1,1,1)$	7	CO2	L3
28	Find the absolute extrema of the function $f(x, y) = x^2 - 3y^2 - 2x + 6y$ over the square region with vertices $(0,0), (0,2), (2,2)$ and $(2,0)$.	7	CO2	L3
29	Locate all relative extrema of $f(x, y) = x^3 y^2 (12 - x - y)$	7	CO2	L3
30	Locate all relative extrema and saddle points of $f(x, y) = 4xy - x^4 - y^4$	7	CO2	L3
31	The length and width of a rectangle are measured with errors of at most 3% and 4% respectively. Use differentials to approximate the maximum percentage error in the calculated area.	7	CO2	L3
32	If $w = f(P, Q, R)$ where $P = \frac{x}{y}$, $Q = \frac{y}{z}$, $R = \frac{z}{x}$ prove that $x \frac{\partial w}{\partial x} + y \frac{\partial w}{\partial y} + z \frac{\partial w}{\partial z} = 0$.	7	CO2	L2
33	Locate all relative extrema and saddle points of $f(x, y) = 2xy - x^3 - y^2$.	7	CO2	L2
34	The length and width of a rectangle are measured with errors of at most $r\%$, where r is small. Use differentials to approximate the maximum percentage error in the calculated length of the diagonal.	7	CO2	L3
35	Find the local linear approximation L of $f(x, y) = \sqrt{x^2 + y^2}$ at the point $P(3, 4)$. Compute the error in approximation f by L at the point $Q(3.04, 3.98)$.	7	CO2	L3
Module 3				
1	Evaluate $\int_0^1 \int_0^{y^2} \int_{-1}^z z \, dx \, dz \, dy$	3	CO3	L2
2	Use polar coordinates to evaluate the area of the circle $x^2 + y^2 = 4$	3	CO3	L2
3	Find the mass of the square lamina with vertices $(0,0)$ $(1,0)$ $(1,1)$ and $(0,1)$ and density function $x^2 y$	3	CO3	L1
4	Evaluate $\int_0^\infty \int_0^\infty e^{-(x^2+y^2)} \, dx \, dy$ by changing to polar coordinates.	3	CO3	L2
5	Evaluate $\int_0^{\ln 3} \int_0^{\ln 2} e^{x+2y} \, dy \, dx$	3	CO3	L2
6	Find the mass of the lamina with density function x^2 which is bounded by $y = x$ and $y = x^2$.	3	CO3	L2
7	Evaluate $\iint_R y^2 x \, dA$ over the region $R = \{(x, y), -3 \leq x \leq 2, 0 \leq y \leq 1\}$	3	CO3	L2
8	Use double integrals to find the volume of the solid enclosed below the plane $z = 4 - x - y$ and above the rectangle $R = \{(x, y); 0 \leq x \leq 1, 0 \leq y \leq 2\}$.	3	CO3	L2
9	Evaluate $\int_0^3 \int_0^2 \int_0^1 xyz \, dx \, dy \, dz$	3	CO3	L2

11	Find the mass of the square lamina with vertices (0,0) (1,0) (1,1) and (0,1) and density function x^2y	3	CO3	L1
12	Evaluate $\int_0^\infty \int_0^\infty e^{-(x^2+y^2)} dx dy$ by changing to polar coordinates.	3	CO3	L2
13	Evaluate $\int_0^{\ln 3} \int_0^{\ln 2} e^{x+2y} dy dx$	3	CO3	L2
14	Find the mass of the lamina with density function x^2 which is bounded by $y = x$ and $y = x^2$.	3	CO3	L2
15	Evaluate $\iint_R y^2 x dA$ over the region $R = \{(x,y), -3 \leq x \leq 2, 0 \leq y \leq 1\}$	3	CO3	L2
16	Evaluate $\int_1^a \int_1^b x^2 y dx dy$.	3	CO3	L2
17	Use double integral to find the area of the plane region enclosed by the curves $y = \sin x$ and $y = \cos x$ for $0 \leq x \leq \frac{\pi}{4}$.	3	CO3	L3
18	Use double integral to find the area of the region enclosed between the parabola $y = \frac{x^2}{2}$ and the line $y = 2x$.	7	CO3	L2
19	Evaluate $\int_0^\infty \int_x^\infty \frac{e^{-y}}{y} dy dx$ by reversing the order of integration	7	CO3	L3
20	Find the mass and center of gravity of the triangular lamina with vertices (0,0), (0,1) and (1,0) and density function $\delta(x,y) = xy$	7	CO3	L2
21	Evaluate $\int_0^2 \int_{y/2}^1 e^{x^2} dx dy$ by changing the order of integration.	7	CO3	L3
22	Using double integrals prove that the area bounded between the parabolas $y^2 = 4ax$ and $x^2 = 4ay$ is $\frac{16}{3}a^2$.	7	CO3	L3
23	Change the order of integration and hence evaluate $\int_0^4 \int_{\frac{x^2}{4}}^{2\sqrt{x}} dy dx$	7	CO3	L3
24	Evaluate $\iiint_G z dV$, where G is the wedge in the first octant cut off from the cylindrical solid $y^2 + z^2 \leq 1$ and the planes $y = x$ and $x = 0$.	7	CO3	L3
25	Evaluate $\iint_R y dA$ where R is the region in the first quadrant enclosed between the circle $x^2 + y^2 = 25$ and the line $x + y = 5$.	7	CO3	L3
26	Find the volume of the solid bounded by the cylinder $x^2 + y^2 = 4$ and the planes $y + z = 4$ and $z = 0$.	7	CO3	L3
27	Find the area bounded by the x-axis, $y = 2x$ and $x + y = 1$ using double integration.	7	CO3	L2
28	Evaluate $\int_0^a \int_y^a \frac{x}{x^2+y^2} dx dy$ by changing the order of integration.	7	CO3	L3
29	Use spherical coordinates to find the volume of the solid bounded above by the sphere $x^2 + y^2 + z^2 = 16$ and below by the cone $z = \sqrt{x^2 + y^2}$	7	CO3	L3
30	Find the volume of the solid in the first octant bounded by the coordinate planes and the plane $x + 2y + z = 6$.	7	CO3	L2

31	Find the mass and centre of gravity of the lamina in the first quadrant bounded by the circle $x^2 + y^2 = 1$ and the coordinate planes with density function xy .	7	CO3	L3
32	Change the order of integration and hence evaluate $\int_0^1 \int_{x^2}^{2-x} dy dx$	7	CO3	L3
33	Evaluate $\iint_R \frac{\sin y}{y} dA$, where R is the triangular region bounded by the y-axis, $y = x$ and $y = \pi$.	7	CO3	L3
34	Evaluate $\int_0^2 \int_{\frac{y}{2}}^1 e^{x^2} dx dy$ by reversing the order of integration.	7	CO3	L3
35	By converting into polar coordinates evaluate $\int_{-1}^1 \int_0^{\sqrt{1-x^2}} (x^2 + y^2)^{\frac{3}{2}} dy dx$.	7	CO3	L3
36	Find the volume of the solid in the first octant bounded by the coordinate planes and the plane $x + y + z = 1$.	7	CO3	L3
Module 4				
1	Test the convergence of the series $\sum_{k=1}^{\infty} \frac{3^k}{k!}$	3	CO4	L1
2	Test the convergence of the alternating series $\sum_{k=1}^{\infty} (-1)^{k+1} \frac{1}{k}$ using Leibnitz Test	3	CO4	L2
3	Test the convergence of the series $\sum_{k=1}^{\infty} \frac{k^2}{2k^2 - 1}$	3	CO4	L1
4	Test the convergence of $\sum_{k=1}^{\infty} \frac{k}{2k+1}$	3	CO4	L1
5	Test the convergence of $\sum_{k=2}^{\infty} \frac{1}{k^2}$	3	CO4	L2
6	Examine the convergence of $\sum_{k=1}^{\infty} \left(\frac{k}{k+1}\right)^{k^2}$	3	CO4	L2
7	Test the convergence of the series $\sum_{k=1}^{\infty} \left(\frac{k}{100}\right)^k$	3	CO4	L1
8	Does the series $\sum_{k=1}^{\infty} \left(\frac{-3}{4}\right)^k$ converge? If so, find the sum.	3	CO4	L1
9	Examine the convergence of $\sum_{k=1}^{\infty} \frac{1}{k!}$	3	CO4	L1
10	Determine whether the series $\sum_{k=1}^{\infty} \frac{4^{k+2}}{7^{k-1}}$ converges and if so find its sum	3	CO4	L2
11	Determine whether the series $\sum_{k=1}^{\infty} (-1)^{k+1} \frac{3^{2k-1}}{k^2+1}$ is absolutely convergent.	3	CO4	L2
12	Test the convergence of the series $1 + \frac{1.3}{3!} + \frac{1.3.5}{5!} + \frac{1.3.5.7}{7!} + \dots$	7	CO4	L3
13	Test the convergence of $\frac{x}{1.2} + \frac{x^2}{2.3} + \frac{x^3}{3.4} + \dots + \frac{x^k}{k(k+1)} + \dots$	7	CO4	L3

14	Test whether the following series is absolutely convergent or conditionally convergent $\sum_{k=1}^{\infty} \frac{(-1)^k}{\sqrt{k(k+1)}}$	7	CO4	L3
15	Prove that the series $\sum_{k=1}^{\infty} (-1)^{k+1} \frac{(k-2)}{k(k+1)}$ is conditionally convergent.	7	CO4	L2
16	Find the sum of the series $\sum_{k=1}^{\infty} \frac{1}{k(k+1)}$	7	CO4	L2
17	Test the absolute or conditional convergence of $\sum_{k=1}^{\infty} \frac{(-1)^{k+1} k^2}{k^3 + 1}$	7	CO4	L3
18	Test the convergence of the series $1 + \frac{1.3}{1.2} + \frac{1.3.5}{1.2.3} + \frac{1.3.5.7}{1.2.3.4} + \dots$	7	CO4	L3
19	Test the convergence i) $\sum_{k=1}^{\infty} \frac{k(k-1)}{(k+1)(k+2)(k+3)}$ ii) $\sum_{k=1}^{\infty} \left(\frac{k+2}{2k-1} \right)^k$	7	CO4	L2
20	Test the convergence: (i) $\sum_{k=1}^{\infty} \frac{2}{3^k + 5}$ (ii) $\sum_{k=1}^{\infty} (-1)^{k+1} \left(\frac{k}{2k+3} \right)$	7	CO4	L3
21	Test the convergence of the series $\sum_{k=1}^{\infty} \frac{k(k+3)}{(k+1)(k+2)(k+5)}$	7	CO4	L2
22	Test the convergence of the series (i) $\sum_{k=1}^{\infty} \frac{k^k}{k!}$ (ii) $\sum_{k=2}^{\infty} \left(\frac{4k-5}{2k+1} \right)^k$	7	CO4	L1
23	Test the convergence of the series $\sum_{k=1}^{\infty} \frac{1}{\sqrt[3]{2k-1}}$	7	CO4	L2
24	Use ratio test for absolute convergence to determine the convergence of the series $\sum_{k=1}^{\infty} (-1)^k \frac{2^k}{k!}$	7	CO4	L2
25	Test the convergence of the series $1 + \frac{1.2}{1.3} + \frac{1.2.3}{1.3.5} + \frac{1.2.3.4}{1.3.5.7} + \dots$	7	CO4	L3
26	Test the convergence of $\sum_{k=1}^{\infty} \frac{(k+4)!}{4! k! 4^k}$	7	CO4	L2
27	Test the convergence of (i) $\sum_{k=1}^{\infty} \frac{k(k+1)}{(k+3)(k+2)(k+5)}$ (ii) $\sum_{k=1}^{\infty} k^{50} e^{-k}$	7	CO4	L2
28	Test the convergence of the series $1 + \frac{1.3}{3!} + \frac{1.3.5}{5!} + \frac{1.3.5.7}{7!} + \dots$	7	CO4	L2
29	Determine whether the alternating series $\sum_{k=1}^{\infty} (-1)^{k+1} \frac{k+7}{k(k+4)}$ is conditionally convergent or not.	7	CO4	L3
30	Test the convergence of (i) $\sum_{k=1}^{\infty} \frac{[\pi(k+1)]^k}{k^{k+1}}$ (ii) $\sum_{k=1}^{\infty} \frac{1}{(2k+5)^{17}}$	7	CO4	L2
Module 5				

1	Find the binomial series expansion of $\frac{1}{\sqrt{1+x}}$	3	CO5	L1
2	Find the Maclaurin's series expansion of $f(x) = x \sin x$	3	CO5	L2
3	Find the Fourier series expansion of $f(x) = x$ for $-\pi < x < \pi$	3	CO5	L2
4	Find the Fourier half range sine series of $f(x) = e^x$ in $0 < x < 1$	3	CO5	L2
5	Find the half range sine series for the function $f(x) = x$ $0 \leq x \leq \pi$	3	CO5	L2
6	Find the binomial series for $f(x) = (1+x)^{\frac{1}{3}}$ up to third degree term.	3	CO5	L1
7	Find the Maclaurin's series of $f(x) = \log(1+x)$ up to third degree term.	3	CO5	L2
8	Find the Fourier series $f(x) = x^2 - 2$ in the interval $(-2, 2)$	3	CO5	L2
9	Find the Taylor series expansion of $f(x) = \cos x$ about $x = \pi$ up to third degree terms.	3	CO5	L2
10	Find the half range sine series expansion of $f(x) = \pi x - x^2$ in $(0, \pi)$	3	CO5	L3
11	Find the Taylors series for $f(x) = \cos x$ about $x = \pi$ up to third degree terms	7	CO5	L2
12	Find a Fourier series with period 3 to represent $f(x) = 2x - x^2$ in $(0, 3)$	7	CO5	L2
13	Obtain the Fourier series for the function $f(x) = x $, $-\pi < x < \pi$	7	CO5	L2
14	Find the half range sine series of $f(x) = x$ in the interval $0 < x < \pi$. Hence show that $\frac{1}{1^2} + \frac{1}{3^2} + \frac{1}{5^2} + \dots = \frac{\pi^2}{8}$.	7	CO5	L2
15	Expand $f(x) = e^{ax}$ in a Fourier series in the range $(0, 2\pi)$	7	CO5	L2
16	Find the Fourier series of periodic function with period 2 which is given below: $f(x) = \begin{cases} -x & , -1 \leq x \leq 0 \\ x & , 0 \leq x \leq 1 \end{cases}$ Hence prove that $1 + \frac{1}{3^2} + \frac{1}{5^2} + \dots = \frac{\pi^2}{8}$	7	CO5	L2
17	Find the Fourier series for the function $f(x) = \begin{cases} x & , 0 < x < 1 \\ 1-x & , 1 < x < 2 \end{cases}$	7	CO5	L2

18	Find the Fourier series of $f(x) = \begin{cases} -1+x & , -\pi < x < 0 \\ 1+x & , 0 < x < \pi \end{cases}$	7	CO5	L3
19	Find the half range cosine series for the function $f(x) = (x-1)^2$ $0 \leq x \leq 1$	7	CO5	L2
20	Find the half range cosine series for $f(x) = \begin{cases} kx & 0 \leq x \leq L/2 \\ k(L-x) & L/2 \leq x \leq L \end{cases}$	7	CO5	L3
21	Find the Fourier series for $f(x) = x^2$ in the interval $-\pi < x < \pi$. Hence show that $\frac{1}{1^4} + \frac{1}{2^4} + \frac{1}{3^4} + \dots = \frac{\pi^4}{90}$	7	CO5	L3
22	Find the Fourier series of the function $f(x) = x $ in $-1 \leq x \leq 1$	7	CO5	L2
23	Find the Fourier sine series of $f(x) = x \cos x$ in $0 < x < \pi$	7	CO5	L2
24	Find the Fourier series of $f(x) = \begin{cases} 1 + \frac{2x}{\pi}, & -\pi < x < 0 \\ 1 - \frac{2x}{\pi}, & 0 < x < \pi \end{cases}$	7	CO5	L3
25	Obtain Fourier series of e^x the interval $(-1,1)$	7	CO5	L2
26	Find the Fourier cosine series of $f(x) = x^2$ in $0 < x < \pi$.	7	CO5	L2
27	Find the Fourier series expansion of $f(x) = \frac{1}{2}(\pi - x)$ in $0 < x < 2\pi$	7	CO5	L2
28	Find the half range Fourier sine and cosine series of $f(x) = x$ in $(0, \pi)$	7	CO5	L2
29	Find the Fourier series expansion of $f(x) = \begin{cases} \frac{\pi}{2} + x & \text{for } -\pi \leq x \leq 0 \\ \frac{\pi}{2} - x & \text{for } 0 \leq x \leq \pi \end{cases}$. Hence show that $1 + \frac{1}{3^2} + \frac{1}{5^2} + \frac{1}{7^2} + \dots = \frac{\pi^2}{8}$	7	CO5	L2
30	Obtain the half range Fourier sine series of $f(x) = \begin{cases} x, & 0 < x < 1 \\ 2-x, & 1 < x < 2 \end{cases}$	7	CO5	L2

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Course Code & Name: PHT Engineering Physics A

1. Prescribed Syllabus

Module	Topic	Hours
1	Oscillations and Waves: Harmonic oscillations, damped harmonic motion-Derivation of differential equation and its solution, over damped, critically damped and Under damped Cases, Quality Factor-Expression, Forced Oscillations-Differential Equation- Derivation of expressions for amplitude and phase of forced oscillations, Amplitude Resonance-Expression for Resonant frequency, Quality factor and Sharpness of Resonance, Electrical analogy of mechanical oscillators. Wave motion-Derivation of one-dimensional wave equation and its solution, Three-dimensional wave equation and its solution (no derivation), Distinction between transverse and longitudinal waves, Transverse vibration in a stretched string, Statement of laws of vibration.	9
2	Wave Optics: Interference of light-Principle of superposition of waves, Theory of thin films - Cosine law (Reflected system), Derivation of the conditions of constructive and destructive Interference, Interference due to wedge shaped films - Determination of thickness and test for optical planeness, Newton's rings - Measurement of wavelength and refractive index, Antireflection coatings. Diffraction of light, Fresnel and Fraunhofer classes of diffraction, Diffraction grating - Grating equation, Rayleigh criterion for limit of resolution, Resolving and Dispersive power of a grating with expression (no derivation)	9
3	Quantum Mechanics & Nanotechnology: Introduction for the need of Quantum mechanics, Wave nature of Particles, Uncertainty principle, Applications-Absence of electrons inside a nucleus and Natural line broadening mechanism, Formulation of time dependent and independent Schrodinger wave equations- Physical meaning of wave function, Particle in a one-dimensional box- Derivation for normalized wave function and energy eigen values, Quantum Mechanical Tunneling (Qualitative). Introduction to nanoscience and technology, Increase in surface to volume ratio for nanomaterials, Quantum confinement in one dimension, two dimension and three dimension-Nano sheets, Nano wires and Quantum dots, Properties of nanomaterials- mechanical, electrical and optical, Applications of nanotechnology (qualitative ideas)	9
4	Magnetism & Electro Magnetic Theory: Magnetic field and Magnetic flux density, Gauss's law for Magnetic flux density, Ampere's Circuital law, Faraday's law in terms of EMF produced by changing magnetic flux, Magnetic permeability and susceptibility, Classification of magnetic materials-para, dia and ferromagnetic materials. Fundamentals of vector calculus, concept of divergence, gradient and curl along with physical significance, Line, Surface and Volume integrals, Gauss divergence theorem & Stokes' theorem, Equation of continuity, Derivation of Maxwell's equations in vacuum, Comparison of displacement current with	9

	conduction current. Electromagnetic waves, Velocity of Electromagnetic waves in free space, Flow of energy and Poynting's vector (no derivation)	
5	Superconductivity & Photonics: Superconducting phenomena, Meissner effect and perfect diamagnetism, Types of superconductors- Type I and Type II, BCS Theory (Qualitative), High temperature superconductors- Applications of super conductivity. Introduction to photonics-Photonic devices-Light Emitting Diode, Photo detectors -Junction and PIN photodiodes, Solar cells-I-V Characteristics, Optic fibre-Principle of propagation of light, Types of fibres-Step index and Graded index fibres, Numerical aperture –Derivation, Fibre optic communication system (block diagram), Industrial, Medical and Technological applications of optical fibre, Fibre optic sensors- Intensity Modulated and Phase modulated sensors.	9

2. Text Books (T)

T1. M.N.Avadhanulu, P.G.Kshirsagar, TVS Arun Murthy “A Text book of Engineering Physics”, S.Chand &Co., Revised Edition 2019

T2. H.K.Malik , A.K. Singh, “Engineering Physics” McGraw Hill Education, Second Edition 2017

3. Reference Books (R)

R1. Arthur Beiser, “Concepts of Modern Physics ”, Tata McGraw Hill Publications, 6th Edition 2003

R2. D.K. Bhattacharya, Poonam Tandon, “Engineering Physics”, Oxford University Press, 2015

R3.Md.N.Khan & S.Panigrahi “Principles of Engineering Physics 1&2”, Cambridge University Press, 2016

R4. Aruldas G., “Engineering Physics”, PHI Pvt. Ltd., 2015

R5. Ajoy Ghatak, “Optics”, Mc Graw Hill Education, Sixth Edition, 2017 R6.T. Pradeep, Nano:The Essentials”, McGraw Hill India Ltd, 2007

R7. Halliday, Resnick, Walker, “Fundamentals of Physics”, John Wiley & Sons.Inc, 2001

R8. David J Griffiths, “Introduction to Electrodynamics”, Addison-Wesley publishing, 3rd Edition, 1999

R9. Premlet B., “Advanced Engineering Physics”, Phasor Books, 10th edition, 2017 R10. I. Dominic and.

A. Nahari, “A Text Book of Engineering physics”, Owl Books Publishers, Revised edition, 2016

4. Course Objectives

The aim of the Engineering Physics Program is to offer students a solid background in the fundamentals of Physics and to impart that knowledge in engineering disciplines. The program is designed to develop scientific attitudes and enable the students to correlate the concepts of Physics with the core programs

5. Course Pre / Co-requisite

Higher secondary level Physics, Mathematical course on vector calculus, differential equations and linear algebra

6. Course Outcomes

After completion of the course, student will be able to

- CO1. Compute the quantitative aspects of waves and oscillations in engineering systems CO2: Apply the interaction of light with matter through interference, diffraction and identify these phenomena in different natural optical processes and optical instruments.
- CO2. Analyze the behavior of matter in the atomic and subatomic level through the principles of quantum mechanics to perceive the microscopic processes in electronic devices.
- CO3. Classify the properties of magnetic materials and apply vector calculus to static magnetic fields and use Maxwell's equations to diverse engineering problems
- CO4. Analyze the principles behind various superconducting applications, explain the working of solid state lighting devices and fibre optic communication system

7. Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes

PO/ CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	H	M						L	M			L			
CO2	H	M						L	M			L			
CO3	H	M						L	M			L			
CO4	H	L						L	M			L			
CO5	H	L						L	M			L			

8. Justification for CO-PO-PSO Correlation

9.

CO	PO/PSO	Justification
CO1	PO1	Computing the quantitative aspects of waves and oscillations in engineering systems helps to solve complex engineering problems like resonance and related phenomenon
	PO2	The quantitative study of waves and oscillations helps to analyze complex engineering problems
	PO8	Compute the quantitative aspects of waves and oscillations in engineering systems helps to apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice
	PO9	Compute the quantitative aspects of waves and oscillations in engineering systems helps to function effectively as an individual and a member in a diverse teams and multidisciplinary settings
	PO12	Compute the quantitative aspects of waves and oscillations in engineering systems helps to recognize the need for, and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological knowledge
	PO1	Apply the knowledge of interaction of light with matter through interference, diffraction helps to solve complex engineering problems related to optical instruments

CO2	PO2	Study of interference and diffraction helps to formulate, identify and analyze complex engineering problems
	PO8	Apply the interaction of light with matter through interference, diffraction and identify these phenomena in different natural optical processes and optical instruments helps to apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice.
	PO9	Apply the interaction of light with matter through interference, diffraction and identify these phenomena in different natural optical processes and optical instruments helps to function effectively as an individual and a member in a diverse teams and multidisciplinary settings.
	PO12	Apply the interaction of light with matter through interference, diffraction and identify these phenomena in different natural optical processes and optical instruments helps to recognize the need for, and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological knowledge
CO3	PO1	Analyze the behaviour of matter in the atomic and subatomic level through the principles of quantum mechanics help to solve complex engineering problems related to electronic devices.
	PO2	Knowledge of nanoscience and technology helps to design complex engineering problems and design system components
	PO8	Analyze the behaviour of matter in the atomic and subatomic level through the principles of quantum mechanics to perceive the microscopic processes in electronic devices helps to apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice
	PO9	Analyze the behaviour of matter in the atomic and subatomic level through the principles of quantum mechanics to perceive the microscopic processes in electronic devices helps to function effectively as an individual and a member in a diverse teams and multidisciplinary settings
	PO12	Analyze the behaviour of matter in the atomic and subatomic level through the principles of quantum mechanics to perceive the microscopic processes in electronic devices helps to recognize the need for, and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological knowledge
	PO1	knowledge of properties of magnetic materials and apply vector calculus to static magnetic fields and use Maxwell's equations will help to solve complex engineering problems. Engineering problems.
	PO2	Classify the properties of magnetic materials and apply vector calculus to static magnetic fields and use Maxwell's equations help to formulate and analyze complex engineering problems
	PO8	Classify the properties of magnetic materials and apply vector calculus to static magnetic fields and use Maxwell's equations to diverse engineering problems and it enables the students to apply ethics and responsibilities of engineering practice.
	PO9	Maxwell's equations to diverse engineering problems enable the students to function effectively as an individual and a member in diverse teams and in multi-disciplinary settings.

PO12	Maxwell's equations to diverse engineering problems helps the students to develop lifelong learning.
PO1	Analyze the principles behind various superconducting applications, explain the working of solid-state lighting devices and fibre optic communication system can be utilized to solve various complex engineering problems.
PO2	Analyze the principles behind various superconducting applications and enables the students to analyze complex engineering problems.
PO8	Analyze the principles behind various superconducting applications, explain the working of solid-state lighting devices and fibre optic communication system and this helps the students to apply ethical principles and commit to professional ethics and responsibilities.
PO9	Analyze the principles behind various superconducting applications, explain the working of solid-state lighting devices and fibre optic communication system and helps to function effectively as an individual and member in diverse teams.
PO12	Analyze the principles behind various superconducting applications, explain the working of solid-state lighting devices and fibre optic communication system and helps the students to develop lifelong learning.

9. Curricular gaps (if any)

Nil

10. Course Enrichment Activities*

Sl No	Description	Proposed Activities **	Relevance to POs and PSOs
1	To better attainment of PO's	Expert talks	Better understanding of the relevance of the topic.

11. Internal Assessment mark allocation (as per university curriculum)

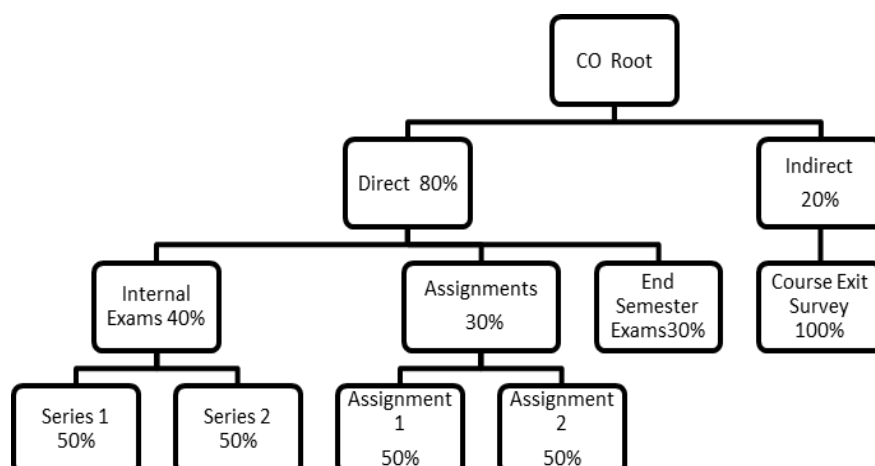
(Provide details as mentioned in syllabus)

Attendance	- 10 marks
Continuous Assessment Test	- 25 marks
Assignment (s)/ Course Project	- 15 marks
<u>Total</u>	<u>- 50 marks</u>

12. Assessment – CO Mapping (Put 'x' if mapping is present)

	Tools		Weightage [#]	CO1	CO2	CO3	CO4	CO5
Direct Assessment Tools**	Internal Exam(s) 40%	Series 1	20%	x	x			
		Series 2	20%			x	x	x
	Assignment (s)/ Course Project /Quiz etc. 30%	Assignment 1	15%	x	x			
		Assignment 2	15%			x	x	x
	End Semester Exam		30%	x	x	x	x	x
Indirect Assessment Tool	Course Exit Survey		100%	x	x	x	x	x

13. Assessment Configuration



14. Course Plan

Hour	Topic	Module	Reference(s)	Teaching Pedagogy
1	Harmonic oscillations, Damped harmonic motion-Derivation of differential equation and its solution.	1	T1, T2	Lecture
2	Over damped, critically damped and Under damped Cases, Quality Factor-Expression	1	T1, T2	Lecture
3	Forced oscillations-Differential Equation-Derivation of expressions for amplitude and phase of forced oscillations,	1	T1, T2	Lecture
4	Amplitude Resonance- Expression for Resonant frequency, Quality factor and Sharpness of Resonance,	1	T1, T2	Lecture
5	Electrical analogy of mechanical oscillators	1	T1, T2	Lecture
6	Wave motion- Derivation of one-dimensional wave equation and its solution,	1	T1, T2	Lecture
7	Three-dimensional wave equation and its solution (no derivation)	1	T1, T2	Lecture
8	Distinction between transverse and longitudinal waves.	1	T1, T2	Lecture
9	Transverse vibration in a stretched string, Statement of laws of vibration	1	T1, T2	Lecture
10	Interference of light-Principle of superposition of waves, Theory of thin films - Cosine law (Reflected system),	2	T1, T2	Lecture
11	Derivation of the conditions of constructive and destructive Interference	2	T1, T2	Lecture

12	Interference due to wedge shaped films	2	T1, T2	Lecture
13	Determination of thickness and test for optical planeness	2	T1, T2	Lecture
14	Newton's rings	2	T1, T2	Lecture
15	Measurement of wavelength and refractive index, Antireflection coatings	2	T1, T2	Lecture
16	Diffraction of light	2	T1, T2	Lecture
17	Fresnel and Fraunhofer classes of diffraction, Diffraction Grating- Grating equation	2	T1, T2	Lecture
18	Rayleigh criterion for limit of resolution, Resolving and Dispersive power of a grating with expression (no derivation)	2	T1, T2	Lecture
19	Introduction for the need of Quantum mechanics, Wave nature of Particles, Uncertainty principle,	3	T1, T2	Lecture
20	Applications-Absence of electrons inside a nucleus and Natural line broadening mechanism.	3	T1, T2	Lecture
21	Formulation of time dependent and independent Schrodinger wave equations.	3	T1, T2	Lecture
22	Physical Meaning of wave function, Particle in a one-dimensional box.	3	T1, T2	Lecture
23	Derivation for normalized wave function and energy.	3	T1, T2	Lecture
24	Eigen values, Quantum Mechanical Tunneling (Qualitative).	3	T1, T2	Lecture
25	Introduction to nanoscience and technology, Increase in surface to volume ratio for nanomaterials,	3	T1, T2	Lecture
26	Quantum confinement in one dimension, two dimension and three dimension-Nano sheets, Nano wires and Quantum dots.	3	T1, T2	Lecture
28	Properties of nanomaterials-mechanical, electrical and optical. Applications of nanotechnology (qualitative ideas)	4	T1, T2	Lecture
29	Magnetic field and Magnetic flux density, Gauss's law for Magnetic flux density	4	T1, T2	Lecture
30	Ampere's Circuital law, Faraday's law in terms of EMF produced by changing magnetic flux	4	T1, T2	Lecture

31	Explanation for Magnetic permeability and susceptibility Classification of magnetic materials- para, dia and ferromagnetic materials	4	T1, T2	Lecture
32	Fundamentals of vector calculus, concept of divergence, gradient and curl along with physical significance, Line, Surface and Volume integrals,	4	T1, T2	Lecture
33	Gauss divergence theorem & Stokes' theorem	4	T1, T2	Lecture
34	Equation of continuity, Derivation of Maxwell's equations in vacuum,	4	T1, T2	Lecture
35	Comparison of displacement current with conduction current. Electromagnetic waves.	4	T1, T2	Lecture
36	Velocity of Electromagnetic waves in free space, Flow of energy and Poynting's vector (no derivation).	4	T1, T2	Lecture
37	Super conducting Phenomena, Meissner effect and perfect diamagnetism.	5	T1, T2	Lecture
38	Types of superconductors-Type I and Type II	5	T1, T2	Lecture
39	BCS Theory (Qualitative), High temperature superconductors,	5	T1, T2	Lecture
40	Applications of super conductivity	5	T1, T2	Lecture
41	Introduction to photonics-Photonic Devices-Light Emitting Diode,	5	T1, T2	Lecture
42	Photo detectors -Junction and PIN photodiodes, Solar cells-I-V Characteristics	5	T1, T2	Lecture
43	Optic fibre-Principle of propagation of light, Types of fibres-Step index and Graded index fibres, Numerical aperture –Derivation.	5	T1, T2	Lecture
44	Fibre optic communication system (block diagram), Industrial, Medical and Technological applications of optical fibre	5	T1, T2	Lecture
45	Fibre optic sensors-Intensity Modulated and Phase modulated sensors	5	T1, T2	Lecture

15. Question Bank

Module 1				
Sl. No	Question	Marks	CO	BL
1	Define resonance, give some examples	3	1	L1
2	Explain the relation between path difference and phase difference of wave function	3	1	L1
3	Define free oscillations	3	1	L1
4	Define q-factor	3	1	L1

5	Describe different types of waves	3	1	L2
6	Define the wavelength and frequency of a wave	3	1	L1
7	Distinguish between longitudinal and transverse waves	3	1	L2
8	Explain the concept of phase difference	3	1	L2
9	Discuss characteristics of wave motion	3	1	L2
10	Define wave front.	3	1	L1
11	Distinguish between free oscillation and damped oscillation.	3	1	L2
12	What will happen to fundamental frequency when the length of the string is reduced to one-third of the original length and kept under same tension?	3	1	L3
13	Write the differential equation of a forced harmonic oscillator and find its solution. Derive an expression for amplitude and phase difference.	14	1	L2
14	A simple harmonic wave is represented by $y=8\sin 2\pi(t/0.05 - 0.05x)$. Find wavelength, wavevector, amplitude and velocity of wave. Also find displacement of particle 40cm from the origin and 2s after the start of motion. (x,y in cm and t in second).	14	1	L3
15	Derive the differential equation of damped harmonic oscillation and deduce its solution. Calculate the time in which the amplitude of a damped harmonic oscillation with damping constant $.04 \text{ s}^{-1}$ reduces to $1/e$ of its undamped value	14	1	L2
16	Derive one dimensional wave equation. Calculate the phase difference between two particle separated by 4 m during the propagation of the wave described by $y(x,t)=2.5 \cos 2\pi(10t - 0.005x + 0.25)$, where x and y are in cm and t in sec. Also find the particle velocity at $x=1 \text{ cm}$ and $t=1 \text{ sec}$.	14	1	L3
17	Derive one dimensional wave equation and hence obtain the laws of vibration of stretched string. A wave is represented by $\psi=3 \times 10^{-3} \cos 8.4\pi \times 10^{13}t + 2.8\pi \times 10^5 z$. Compute 1) amplitude 2) frequency 3) wavelength 4) wave velocity {z in meters and t in seconds}	14	1	L3
18	Derive an expression for the velocity of transverse waves in a stretched string and state the laws of transverse vibrations.	10	1	L2
19	The amplitude of an undamped harmonic oscillator reduces to $1/10$ th of its initial value after 100 oscillations. Its time period is 1.15 s. Find the damping constant and relaxation time.	4	1	L3
20	Obtain the expression for sharpness of resonance for forced harmonic oscillator	10	1	L2
21	Derive and solve differential equation of forced harmonic oscillation and discuss resonance	10	1	L2
22	Amplitude of a damped harmonic oscillator falls to half the initial value in 150 second. Calculate the Q-factor if the period is 2 sec.	4	1	L3
23	The frequency of a tuning fork is 300 Hz and its Q-factor 5×10^4 . Find the time after which the energy becomes $(1/10)$ of its initial value	4	1	L3
24	The amplitude of an under damped harmonic oscillator reduces to $(1/10)$ of its initial value after 100 oscillation. Calculate the damping constant and relaxation time.	4	1	L3
25	Equation of transverse wave travelling along a string is $Y=4\sin \pi(0.01x - 2.0t)$ where x and y are in cm, and t is in seconds Find 1. Amplitude 2. Wavelength 3. Initial phase	4	1	L3

	4. Frequency of the wave			
26	Show that the plane wave equation satisfies the one-dimensional wave equation	10	1	L2
27	Show that $E=E_0 e^{-i(\omega t - kz)}$ satisfies the one-dimensional wave equation	10	1	L2
28	Obtain an expression of the or sharpness of resonance a for series LCR circuit	10	1	L2
29	What is amplitude resonance? How is the effect of damping related to the sharpness of resonance?	3	1	L2
Module 2				
1	Define non-reflecting film, give an application	3	2	L2
2	Mention the conditions for sustained interference pattern Define grating element, grating equation in terms of grating element	3	2	L1
3	Compare Fresnel and Fraunhofer diffraction	3	2	L2
4	Define resolving power of grating	3	2	L1
5	Compare prism spectrum and diffraction spectrum	3	2	L2
6	Define dispersive power of grating	3	2	L1
7	Define coherent sources	3	2	L1
8	Compare interference and diffraction	3	2	L2
9	Mention condition for sustained interference pattern	3	2	L2
10	Give four examples of interference	3	2	L1
11	Why thin transparent films appear to be beautifully colored under sunlight?	3	2	L3
12	Write any three difference between Fresnel and Fraunhofer diffraction?	3	2	L2
13	Explain air wedge arrangement with neat diagram, deduce the expression for bandwidth of air wedge arrangement and hence the diameter of thin wire using this setup.	10	2	L2
14	Newton's rings are observed by source emitting light of wavelength $\lambda_1=3000\text{\AA}$ and $\lambda_2=2500\text{\AA}$. It is found that nth dark ring due to λ_1 coincides with (n+1)th dark ring due to λ_2 . If the radius of curvature of lens is 90cm, calculate the diameter of nth dark ring of λ_1 .	4	2	L3
15	Explain the construction of a grating and derive grating equation.	10	2	L2
16	A plane transmission grating of length 6cm has 5000 lines/cm. Find the resolving power of grating and the smallest wavelength difference that can be resolved for light of wavelength $5000\text{\AA}$ in the second order.	4	2	L3
17	Describe with necessary theory experiment to determine the diameter of thin wire using air wedge. A thin soap film seen in sodium light by normal reflection appears totally dark. Deduce the possible values of film thickness ($\mu=1.3333, \lambda=589.3\text{ nm}$)	14	2	L2
18	Discuss the theory of plain transmission grating and also derive the expression $\sin \theta = n\lambda$ Determine the highest order spectrum which may be seen with light of wavelength $5 \times 10^{-5}\text{ cm}$ by means of grating 3000 lines/c	14	2	L2
19	How will you determine liquid forming newton's ring	10	2	L2
20	Describe a method for determination of wavelength of a monochromatic radiation using newton's ring	10	2	L2

21	A parallel beam of light consisting of two wavelength $5890\text{\AA}$ and $5896\text{\AA}$ is incident normally on a grating having 6000 lines/cm . calculate the angular separation between the two diffracted lines in the second order	4	2	L3
22	A grating has 6000 lines/cm. Find the angular separation of the two yellow lines of mercury of wavelength 577nm and 579nm in the second order.	4	2	L3
23	What is the highest order of spectrum which may be seen with light of wavelength 5×10^{-5} cm by means of grating with 3000 lines/cm	4	2	L3
24	In a newton's ring experiment diameter of the 4th and 12th dark rings are 0.400cm and 0.700cm respectively. Obtain the diameter of 20th dark ring	4	2	L3
25	Newton's rings are formed with reflected light of wavelength 5896×10^{-10} m with a liquid between the plane and curved surface. The diameter of the 5th ring is 0.3cm and the radius of curvature of the curved surface is 1 metre. Calculate the refractive index of the liquid.	4	2	L3
26	Newton's rings are observed in reflected light of wavelength 5.9×10^{-5} cm. The diameter of the 10th dark ring is .05cm. find the radius of curvature of the lens and thickness of the air film	4	2	L3
Module 3				
1	State and explain Heisenberg's uncertainty principle	3	3	L1
2	Define linear operator	3	3	L1
3	Explain the effect of increased surface to volume ratio	3	3	L2
4	Explain magnetic properties of Nano materials	3	3	L2
5	Explain electric properties of Nano materials	3	3	L1
6	Write a note on optical properties of Nano materials	3	3	L1
7	Define tunneling. Name two electronic devices based on this phenomenon	3	3	L1
8	Explain the probability interpretation of the wave function	3	3	L1
9	Define wave function. Write its normalization condition	3	3	L1
10	Explain NANO ring and its application	3	3	L2
11	Give the physical significance of the wave function.	3	3	L2
12	What are the reasons for the change of properties of materials at nano sizes?	3	3	L2
13	Apply Schrodinger equation to derive the energy values and normalized wave functions for a particle confined to an infinite potential box of width L.	10	3	L2
14	Explain the phenomenon of quantum mechanical tunneling with any two examples	4	3	L2
15	Write a note on quantum confinement and based on this explain nano sheets, nano wire and quantum dots.	10	3	L2
16	Write any four applications of nanotechnology in medical field.	4	3	L2
17	Deduce Schrödinger's time dependent equation from the operators for position and momentum. Which of the following functions are Eigen functions of the operator d^2/dx^2 ? Find the Eigen values in the case: a) $\cos x$ b) $\sin nx$ c) $\sin^2 x$	14	3	L3

18	Write short note on a) Nano sheets b) Nano wires c) quantum dots. Find the de-Broglie wavelength of an electron having energy 15 eV	14	3	L2
19	Explain nanostructures with its application	10	3	L2
20	Explain the properties of nanomaterial's	10	3	L2
21	Solve Schrödinger's equation for a particle in one dimensional box and obtain the following: (i)Energy values and (ii)Normalized wave function	10	3	L2
22	An electron is confined to one dimensional box of width "L" is known to be in its first excited state. Determine the probability density of electron in the central half	10	3	L2
23	If the kinetic energy of an electron known to be about 1eV, must be measured to within 0.0001eV, what accuracy can its position be measured simultaneously	10	3	L2
Module 4				
1	State Faraday's law of electromagnetic induction	3	4	L2
2	Define magnetic susceptibility	3	4	L1
3	Obtain the relation b/t relative permeability and susceptibility	3	4	L2
4	Give the properties of para, dia and Ferro magnetic materials	3	4	L1
5	Compare the displacement current and conduction current	3	4	L2
6	Compare the magnetic properties of steel and air.	3	4	L1
7	State a) Gauss law b) Ampere's circuital law	3	4	L1
8	Calculate μ for material with $\mu_r=1.4$ and $H=350$ A/m	3	4	L2
9	Distinguish b/t para, dia and Ferro magnetic materials write down Maxwell's equations in magnetism and explain the meaning of each one	3	4	L2
10	Derive free space electromagnetic wave equations from Maxwell's law and show that velocity of electromagnetic wave is $1/\sqrt{\mu_0 \epsilon_0}$	3	4	L1
11	Distinguish between musical sound and noise?	3	4	L2
12	Mention the properties of ultrasonic waves and list its significant industrial and medical applications?	3	4	L2
13	What is Piezo electric effect? Explain with a circuit diagram the generation of ultrasonics using a piezo electric oscillator.	10	4	L2
14	A quartz crystal of thickness 1mm is vibrating at resonance. Calculate the fundamental frequency, given Young's modulus $=7.9 \times 10^{10}$ N/m ² and density $=2650$ Kg/m ³ .	4	2	L3
15	Explain the terms i) Decibel ii) Sabine's formula iii) reverberation iv) reverberation time v) echo.	10	4	L2
16	A cinema hall has a volume of 20000m ³ . It is required to have a reverberation time of 4s. What should be the total absorption of the hall?	4	4	L3
17	Give some applications of ferromagnetic materials	3	4	L1
18	Define magnetizing field in terms of flux density and magnetization	4	4	L3
19	State Faraday's law of electromagnetic induction	4	4	L3
20	Define magnetic susceptibility	4	4	L3
21	Obtain the relation b/t relative permeability and susceptibility	4	4	L3
22	Give the properties of para, Dia and Ferro magnetic materials	4	4	L3

23	Compare the displacement current and conduction current	4	4	L3
Module 5				
1	What is Meissner effect	3	5	L1
2	Name two different types of optic sensors	3	5	L1
3	Define step index fiber	3	5	L2
4	Define graded index fiber	3	5	L2
5	Differentiate b/t a photo diode and photo transistor	3	5	L1
6	What is the principle of optic fiber cable	3	5	L2
7	Explain superconductivity.	3	5	L2
8	Write note on fiber optic sensors	3	5	L1
9	what is mean by the numerical aperture of optic fiber	3	5	L1
10	Write down important applications of superconductivity	3	5	L1
11	What do you mean by pumping in lasers? List any three pumping methods used.	3	5	L2
12	Draw a properly labelled block diagram of a fibre optic communication system.	3	5	L1
13	With properly labelled diagrams, explain the construction and working of He-Ne Laser.	10	5	L2
14	Calculate the acceptance angle and critical angle for a step index fibre whose refractive index are 1.5(core) and 1.45(cladding). The launching medium is air.	4	5	L3
15	What do you mean by acceptance angle and acceptance cone of an optical fibre? Obtain the expression for the acceptance angle of an optic fibre.	10	5	L2
16	Distinguish between spontaneous and stimulated emissions.	4	5	L2
17	Write a short note on high temperature superconductors	3	5	L2
18	Derive the expression for the numerical aperture(n) of a step index fiber.	10	5	L2
19	Calculate the acceptance angle for the following data $n_1=1.53$, $n_2=1.5$, $n_3=1$	4	5	L3
20	Show that super conductress is perfectly dia magnets	10	5	L2
21	Distinguish b/t type 1 and type 2 superconductors with suitable example	4	5	L3
22	Draw the block diagram of optic fibre communication system. Explain its various functional blocks	10	5	L2
24	Differentiate between a photo diode and a photo transistor	3	5	L2
25	Draw and explain VI characteristics of a photo transistor	3	5	L2

Prepared By: Ms.Sreeja C

Checked By: Ms. Dhanya George P

Course Code & Name: EST100 Engineering Mechanics

1. Prescribed Syllabus

Module	Topic	Hours
1	Introduction to Engineering Mechanics-statics-basic principles of statics-Parallelogram law, equilibrium law, principles of superposition and transmissibility, law of action and reaction(review) free body diagrams. Concurrent coplanar forces-composition and resolution of forces- resultant and equilibrium equations – methods of projections – methods of moments – Varignon’s Theorem of moments	7
2	Friction – sliding friction - Coulomb’s laws of friction – analysis of single bodies –wedges, ladder-analysis of connected bodies. Parallel coplanar forces – couple - resultant of parallel forces – centre of parallel forces – equilibrium of parallel forces – Simple beam subject to concentrated vertical loads. General coplanar force system - resultant and equilibrium equations.	7
3	Centroid of composite areas- – moment of inertia-parallel axis and perpendicular axis theorems. Polar moment of inertia, radius of gyration, mass moment of inertia-ring, cylinder and disc. Theorem of Pappus Guldinus (demonstration only) Forces in space - vectorial representation of forces, moments and couples –resultant and equilibrium equations – concurrent forces in space (simple problems only)	7
4	Dynamics – rectilinear translation - equations of kinematics (review) kinetics – equation of motion – D’Alembert’s principle. – motion on horizontal and inclined surfaces, motion of connected bodies. Impulse momentum equation and work energy equation (concepts only). Curvilinear translation - equations of kinematics –projectile motion (review), kinetics – equation of motion. Moment of momentum and work energy equation (concepts only).	7
5	Rotation – kinematics of rotation- equation of motion for a rigid body rotating about a fixed axis – rotation under a constant moment. Plane motion of rigid body – instantaneous centre of rotation (concept only). Simple harmonic motion – free vibration –degree of freedom- undamped free vibration of spring mass system-effect of damping(concept only)	7

2. Text Books (T)

- T1. Timoshenko and Young, Engineering Mechanics, McGraw Hill Publishers
- T2. Shames, I. H., Engineering Mechanics - Statics and Dynamics, Prentice Hall of India.
- T3. R. C. Hibbeler and Ashok Gupta, Engineering Mechanics, Vol. I statics, Vol II Dynamics, Pearson Education.
- T4. Benjamin J., Engineering Mechanics, Pentex Book Publishers and Distributors

3. Reference Books (R)

- R1. Merriam J. L and Kraige L. G., Engineering Mechanics - Vols. 1 and 2, John Wiley.
- R2. Tayal A K, Engineering Mechanics – Statics and Dynamics, Umesh Publications
- R3. Bhavikkatti, S.S., Engineering Mechanics, New Age International Publishers
- R4. F.P.Beer and E.R.Johnston (2011), Vector Mechanics for Engineers

4. Course Objectives

To expose the students to the fundamental concepts of mechanics and enhance their problem-solving skills. It introduces students to the influence of applied force system and the geometrical properties of the rigid bodies while stationary or in motion. After this course students will be able to recognize similar problems in real-world situations and respond accordingly.

5. Course Pre / Co-requisite

Nil

6. Course Outcomes

On successful completion of this course students shall be able to

CO1: Recall principles and theorems related to rigid body mechanics

CO2: Identify and describe the components of system of forces acting on the rigid body

CO3: Apply the conditions of equilibrium to various practical problems involving different force system.

CO4: Choose appropriate theorems, principles or formulae to solve problems of mechanics

CO5: Solve problems involving rigid bodies, applying the properties of distributed areas and masses.

7. Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	M	M													
CO2	H	H													
CO3	H	H													
CO4	H	H													
CO5	H	H													

8. Justification for CO-PO-PSO Correlation

CO	PO/PSO	Justification
CO1	PO1	The principles and theorems related to rigid body mechanics are applied to solve the engineering problems. Medium correlation is due to the fact that this involves the basic knowledge of mathematics and science to solve the complex engineering problems.
	PO2	The principles and theorems related to rigid body mechanics are used to identify, formulate and analyse the complex engineering problems. Medium correlation is due to the fact that this involves the basic knowledge using first principles of mathematics, science and engineering.
CO2	PO1	The components of system of forces acting on the rigid body are used to solve the engineering problems. High correlation is due to the fact that this involves the deep knowledge of mathematics and science to solve the complex engineering problems.

	PO2	The components of system of forces acting on the rigid body are used to identify, formulate and analyse the complex engineering problems. High correlation is due to the fact that this involves the deep knowledge using first principles of mathematics, science and engineering.
CO3	PO1	The conditions of equilibrium are used to solve the engineering problems. High correlation is due to the fact that this involves the deep knowledge of mathematics and science to solve the complex engineering problems.
	PO2	The conditions of equilibrium are used to identify, formulate and analyse the complex engineering problems. High correlation is due to the fact that this involves the deep knowledge using first principles of mathematics, science and engineering.
CO4	PO1	The theorems, principles or formulae should be appropriately used to solve the engineering problems. High correlation is due to the fact that this involves the deep knowledge of mathematics and science to solve the complex engineering problems.
	PO2	The theorems, principles or formulae should be appropriately used to identify, formulate and analyse the complex engineering problems. High correlation is due to the fact that this involves the deep knowledge using first principles of mathematics, science and engineering.
CO5	PO1	The knowledge in the properties of distributed areas and masses are necessary to solve the engineering problems. High correlation is due to the fact that this involves the deep knowledge of mathematics and science to solve the complex engineering problems.
	PO2	The properties of distributed areas and masses are used to identify, formulate and analyse the complex engineering problems. High correlation is due to the fact that this involves the deep knowledge using first principles of mathematics, science and engineering.

9. Curricular gaps (if any)

Derivation of centroid and moment of inertia of different laminae.

10. Course Enrichment Activities*

Sl No	Description	Proposed Activities **	Relevance to POs and PSOs
1	Centroid and moment of inertia of different laminae	NPTEL https://youtu.be/ZwuWzE1qAi4	PO1, PO4

11. Internal Assessment mark allocation (as per university curriculum)

(Provide details as mentioned in syllabus)

Attendance - 10 marks

Continuous Assessment Test - 25 marks

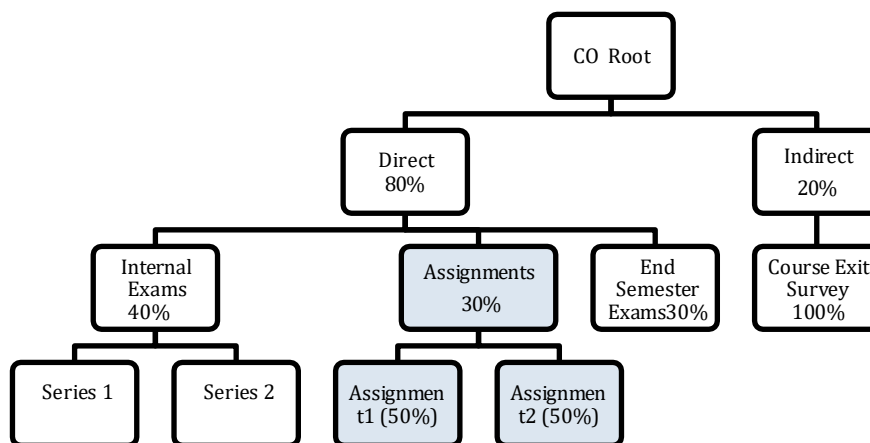
Assignment (s)/ Course Project - 15 marks

Total - 50 marks

12. Assessment – CO Mapping (Put ‘ x ’ if mapping is present)

	Tools		Weightage [#]	CO1	CO2	CO3	CO4	CO5
Direct Assessment Tools**	Internal Exam(s) 40%	Series 1	20%	x	x	x	x	
		Series 2	20%	x	x	x	x	x
	Assignment (s)/ Course Project /Quiz etc. 30%	Assignment 1	15%	x	x	x	x	
		Assignment 2	15%			x	x	x
	End Semester Exam		30%	x	x	x	x	x
Indirect Assessment Tool	Course Exit Survey		100%	x	x	x	x	x

13. Assessment Configuration



14. Course Plan

Hour	Topic	Module	Reference(s)	Teaching Pedagogy
1	Introduction to engineering mechanics – introduction on statics and dynamics - Basic principles of statics – Parellogram law, equilibrium law – Superposition and transmissibility, law of action and reaction (review the topics)	1	T1	Lecture
2	Free body diagrams. Degree of freedom-types of supports and nature of reactions - exercises for free body diagram preparation – composition and resolution of forces, resultant and equilibrium equations (review the topics) - numerical exercises for illustration.	1	T1	Lecture

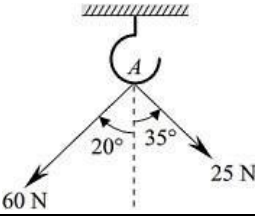
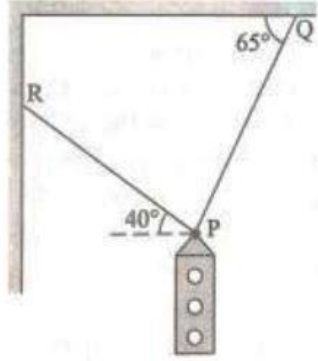
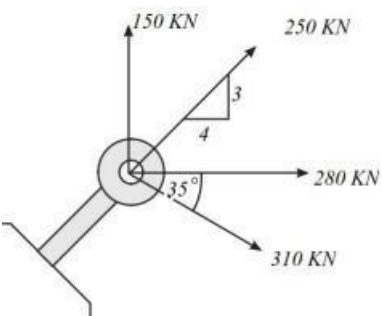
3	Concurrent coplanar forces - analysis of concurrent forces - methods of projections – illustrative numerical exercise – teacher assisted problem solving.	1	T1	Lecture
4	Analysis of concurrent forces - methods of moment-Varignon's Theorem of Moments - illustrative numerical exercise–	1t	T1	Lecture
5	Analysis of concurrent force systems – extended problem solving - Session I.	1	T1	Lecture
6	Analysis of concurrent force systems – extended problem solving - Session II	1	T1	Lecture
7	Analysis of concurrent force systems – extended problem solving - Session III.	1	T1	Tutorial
8	Friction – sliding friction - Coulomb's laws of friction – analysis of single bodies – illustrative examples on wedges and ladder2	2	T1	Tutorial
9	Problems on friction - analysis of connected bodies. Illustrative numerical exercise– teacher assisted problem solving.	2	T1	Lecture
10	Problems on friction-extended problem solving	2	T1	Lecture
11	Parallel coplanar forces – couple - resultant of parallel forces – centre of parallel forces – equilibrium of parallel forces – Simple beam subject to concentrated vertical loads.	2	T1	Lecture
12	General coplanar force system - resultant and equilibrium equations - illustrative examples- teacher assisted problem solving.	2	T1	Lecture
13	General coplanar force system- resultant and equilibrium equations - illustrative examples	2	T1	Lecture
14	General coplanar force system - Extended problem solving -	2	T1	Lecture
15	Centroid of simple and regular geometrical shapes – centroid of figures in combination - composite areas- examples for illustration – problems for practice to be done by self.	3	T2	Lecture
16	Moment of inertia- parallel axis theorem –examples for illustration - problems for practice to be done by self.	3	T2	Lecture
17	Moment of inertia - perpendicular axis theorem - example for illustration to be given as hand out and discussion on the solved example.	3	T2	Lecture
18	Solutions to practice problems – problems related to centroid and moment of inertia - problems for practice to be done by self.	3	T2	Tutorial

19	Polar moment of inertia, Radius of gyration. Mass moment of inertia of ring, cylinder and uniform disc. Theorem of Pappus Guldinus – Demonstration	3	T2	Lecture
20	Introduction to forces in space – vectorial representation of forces, moments and couples– simple problems to illustrate vector representations of forces, moments and couples to be done in class.	3	T2	Lecture
21	Solution to practice problems- resultant and equilibrium equations for concurrent forces in space	3	T2	Tutorial
	concurrent forces in space - 2 simple problems to illustrate the application of resultant and equilibrium equations for concurrent forces in space.	3	T2	Tutorial
22	Introduction to dynamics – review of rectilinear translation - equations of kinematics – problems to review the concepts – additional problems involving extended application as exercises .	4	T2	Lecture
23	Solutions to exercises with necessary explanation given as hand out – introduction to kinetics – equation of motion – D’Alembert’s principle – illustration of the concepts using one numerical exercise from motion on horizontal and inclined surfaces.	4	T2	Lecture
24	Motion of connected bodies - example for illustration to be given as hand out and discussion on the solved example – problems for practice to be done by self.	4	T2	Lecture
25	Motion of connected bodies-extended problem solving.	4	T2	Lecture
26	Curvilinear translation - Review of kinematics – projectile motion – simple problems to review the concepts – introduction to kinetics – equation of motion – illustration of the concepts using numerical exercises.	4	T2	Lecture
27	Extended problem solving – rectilinear and curvilinear translation.	4	T2	Lecture
28	Concepts on Impulse momentum equation and work energy equation (rectilinear translation – discussions to bring out difference between elastic and inelastic collisions). Concepts on Moment of momentum and work energy equation.	4	T2	Lecture
29	Rotation – kinematics of rotation- equation of motion for a rigid body rotating about a fixed axis – simple problems for illustration.	5	T1	Lecture
30	Rotation under a constant moment – teacher assisted problem solving.	5	T1	Lecture

31	Rotation under a constant moment - extended problem solving.	5	T1	Lecture
32	Plane motion of rigid body- instantaneous centre of rotation (concept only).	5	T1	Lecture
33	Introduction to harmonic oscillation –free vibrations - simple harmonic motion – differential equation and solution. Degree of freedom – examples of single degree of freedom (SDOF) systems – Idealisation of mechanical systems as spring-mass systems (concept only).	5	T1	Lecture
34	SDOF spring mass system – equation of motion – undamped free vibration response - concept of natural frequency. Free vibration response due to initial conditions. Simple problems on determination of natural frequency and free vibration response to test the understanding level.	5	T1	Lecture
35	Free vibration analysis of SDOF spring-mass systems – Problem solving Effect of damping on free vibration response (concept only).	5	T1	Lecture

15. Question bank

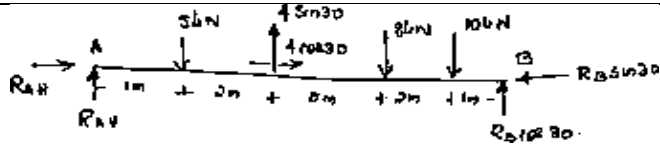
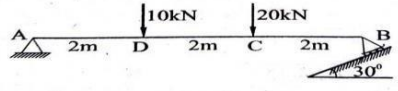
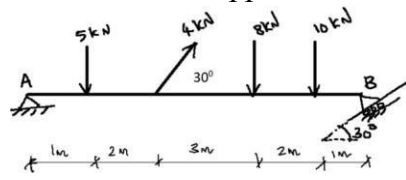
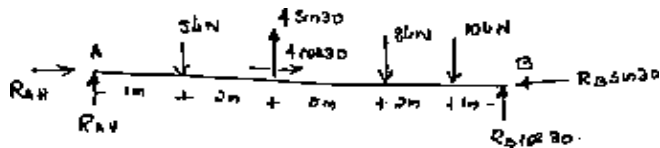
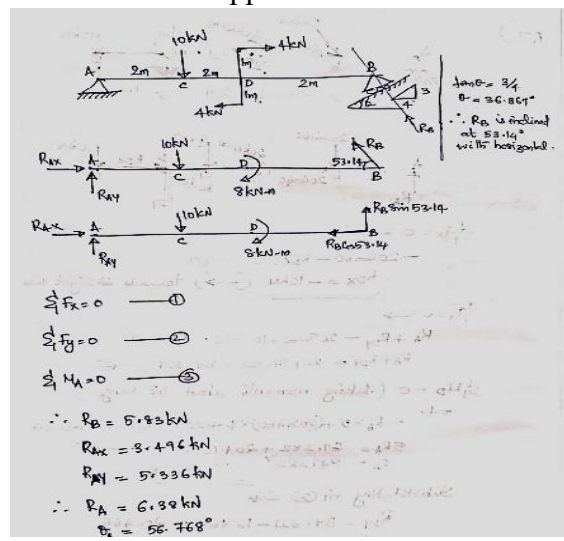
Sl. No.	Questions	Marks	CO	BL
1	List out and explain systems of forces.	3	CO1	L1
2	What is principle of superposition? State and explain it.	3	CO1	L1
3	Explain the conditions of equilibrium in concurrent force system?	3	CO1	L1
4	The resultant of 2 forces when they act at right angles is 12N. When the forces act at an angle of 60°, their resultant is 14N. Determine the magnitude of the forces.	6	CO3	L2
5	Explain the concept of free body diagram with examples?	3	CO1	L1
6	State and explain the principle of Transmissibility of force with sketches.	3	CO1	L2
7	State and illustrate Varignon's theorem of moments.	3	CO1	L2

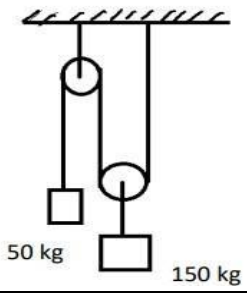
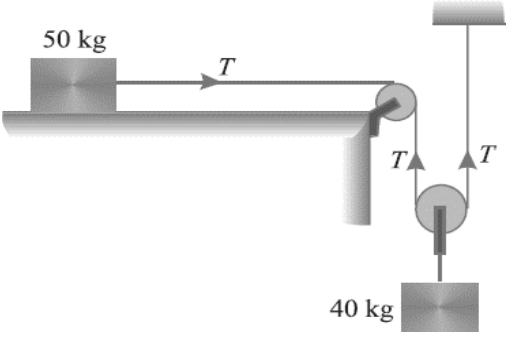
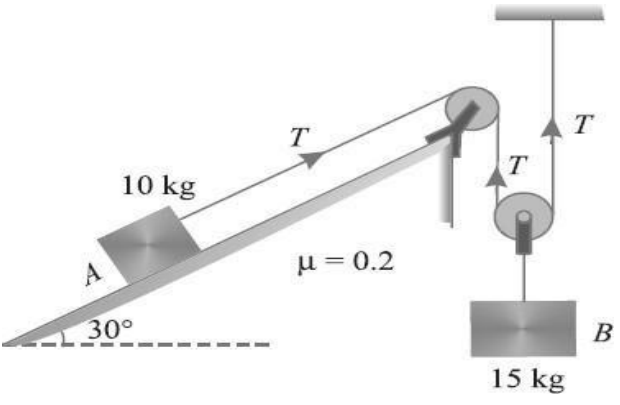
8	The greatest and least resultants of two forces F_1 and F_2 are 17 N and 3 N respectively. Determine the angle between them when their resultant is $\sqrt{149}$ N.	3	CO3	L2
9	Two forces are applied at the point A of a hook support as shown in Fig. Determine the magnitude and direction of the resultant force. 	7	CO3	L2
10	A traffic signal of mass 500 N is hung with the help of two strings, as shown in fig. below. Find the forces induced in the strings using Lami's theorem 	7	CO3	L3
11	Four forces are acting on a bolt as shown in Figure 3.10. Determine the magnitude and direction of the resultant force	10	CO4	L3
				
12	Four forces are acting at a point as shown in the Fig. Find the resultant in magnitude & direction	10	CO4	L3

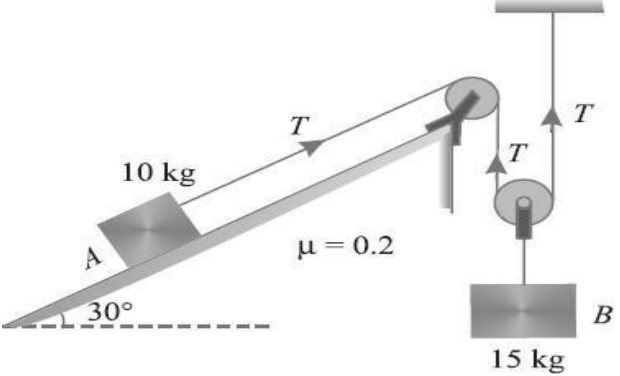
13	A rope 9m in length is connected at A & B, two points on the same level, 8m apart. A load of 300N is suspended from a point C on the rope, 3m from A. what load connected to a point D, on the rope, 2m from B is necessary to keep portions CD parallel to AB	10	CO3	L3
14	Two spheres, each of weight 1000N and radius 25 cm rest in a horizontal channel of width 90cm as shown in the Fig. Find the reactions on the point of contacts A, B and C.	14	CO3	L3
	$EF = 25 + 25 = 50 \text{ cm}$ $FG = 90 - 25 - 25 = 40 \text{ cm}$ $EG = \sqrt{EF^2 - FG^2} = 30 \text{ cm}$ $\cos \theta = \frac{EG}{EF} = \frac{3}{5}$ $\sin \theta = \frac{FG}{EF} = \frac{4}{5}$ Equilibrium of sphere 2 $\sum F_x = 0 \quad R_D \sin \theta = R_C$ $\sum F_y = 0 \quad R_D \cos \theta = 1000$ $R_D = \frac{1000}{\cos \theta} = 1250 \text{ N}$ $R_C = 1250 \cdot \frac{4}{5} = 1000 \text{ N}$ Equilibrium of sphere 1 $\sum F_x = 0 \quad R_A - R_D \sin \theta = 0$ $R_A = 1250 \cdot \frac{4}{5} = 1000 \text{ N}$ $\sum F_y = 0 \quad R_B - 1000 - R_D \cos \theta = 0$ $R_B = 1000 + 1250 \cdot \frac{3}{5} = 2000 \text{ N}$			
	Determine the reactions at contact points P, Q, R and S for the system shown in the figure. The radii of spheres 1 and 2 are respectively, 40 mm and 60 mm with the base width of channel being 190mm.			

15				
16	A uniform wheel 60 cm diameter weighing 1000 N rests against a rectangular obstacle 15 cm height as shown in fig. Find the	14	CO3	L3
	least force required which when acting through the centre of the wheel will just turn the wheel over the corner of the block.	14	CO3	L3
17	Six forces of magnitude 10 kN, 12 kN, 15 kN, 12 kN, 16 kN, and 10 kN are acting along the sides of the regular hexagon of side 2 m in order. Find the resultant force and its direction.	14	CO4	L3
	For the system of forces, determine the magnitude, direction and position of the resultant force about A.	14	CO4	L3

18				
19	State and explain D'Alembert's principle	3	CO1	L2
20	State Work Energy Principle.	3	CO1	L1
21	A stone is dropped from the top of a tower 70 m high. At the same time another stone is thrown up from the foot of the tower with a velocity of 30 m/s. At what distance from the top and after how much time the two stones cross each other	3	CO4	L2
22	On turning a corner, a motorist rushing at 20 m/s, finds a child on the road 50 m ahead. He instantly stops the engine and applies brakes, so as to stop the car within 10 m of the child. Determine the retardation, and time required to stop the car.	3	CO4	L2
23	An elevator of mass 600 kg is ascending with an acceleration of 2 m/s^2 . During this ascent, its operator who weighs 700N is standing on the scales placed on the floor of the elevator. Calculate the scale reading during this motion.	3	CO3	L2
24	An elevator weighing 2.5 kN is moving vertically downward with a constant acceleration. Starting from rest, it travels a distance of 35 m during an interval of 10 seconds. Find the cable tension during this time.	3	CO3	L2
25	State Coulomb's Laws of Friction.	3	CO1	L1
26	Define coefficient of friction. Show that the coefficient of friction is tangent of the angle of friction	3	CO2	L1
27	A system of parallel forces is acting on a rigid bar as shown. Reduce this system to a single force.	3	CO3	L2
	For the beam with loading shown in the figure, determine the reaction at the support.	10	CO3	L3

28	 $R_{AX}=4.683$ $R_{AY}=6.89\text{KN}$ $R_A=8.33\text{KN}$ $R_B=16.294\text{KN}$ (Refer class notes for the detailed solution)			
29	For the beam with loading shown in Fig., determine the reactions at the supports.  $R_{AX} = 9.625 \text{ kN}$ $R_{AY} = 13.33 \text{ kN}$ $R_A = 16.44 \text{ kN}$ Inclination of reaction with vertical = 35.830° $R_B = 19.25 \text{ kN}$	10	CO3	L3
30	For the beam with loading shown in the figure , determine the reaction at the support.   $R_{AX}=4.683$ $R_{AY}=6.89\text{KN}$ $R_A=8.33\text{KN}$ $R_B=16.294\text{KN}$ (Refer class notes for the detailed solution)	10	CO3	L3
31	For the beam with loading shown in the figure, determine the reaction at the support.  $\sum F_x = 0$ — (1) $\sum F_y = 0$ — (2) $\sum M_A = 0$ — (3) $\therefore R_B = 5.853 \text{ kN}$ $R_{AX} = 3.496 \text{ kN}$ $R_{AY} = 5.936 \text{ kN}$ $\therefore R_A = 6.88 \text{ kN}$ $\theta = 56.768^\circ$	10	CO3	L3
		14	CO4	L3

32	Determine the tension in the strings and accelerations of two blocks of mass 50 kg and 150 kg connected by a string and a frictionless and weightless pulley shown in figure. 			
33	Two blocks of mass 50 kg and 40 kg are connected by a light inextensible string as shown in Figure. Find, from first principles, the acceleration of the system and tensions in the cable. Take $\mu = 0.3$  Acceleration of A = 0.82 m/sec^2, Acceleration of B = 0.41 m/sec^2, Tension $T = 188 \text{ N}$	14	CO4	L3
	Determine the acceleration of body B and the tension in the string supporting body A.  $T = 71.52 \text{ N}$			

34		14	CO4	L3
35	A flywheel rotates with constant retardation due to braking. In the first 10 seconds, it made 300 revolutions. At $t = 7.5$ seconds, its angular velocity was 40π rad/s. Determine 1) Value of constant retardation 2) Total time taken to come to rest	14	CO4	L3
36	A shaft is uniformly accelerated from 10 rev/s to 18 rev/s in 4 seconds. The shaft continues to accelerate at this rate for the next 8 seconds. Thereafter the shaft rotates with a uniform angular speed. Find the total time to complete 400 revolutions.	14	CO4	L3
37	The equation of motion of a particle moving in a straight line is given by : $s = 18t + 3t^2 - 2t^3$ where (s) is in metres and (t) in seconds. Find (1) velocity and acceleration at start, (2) time, when the particle reaches its maximum velocity (3) maximum velocity of the particle.	10	CO4	L3
38	The equation of motion of an engine is given by $s = 12t + 3t^2 - 2t^3$, where (s) is in metres and (t) in seconds. Calculate (i) displacement and acceleration when velocity is zero (ii) Displacement and velocity when acceleration is zero.	10	CO4	L3

Prepared By : Dr. veena V

Checked By : Prof Rinku John

Course Code & Name: EST 130 Basics of Electrical and Electronics Engineering

1. Prescribed Syllabus

Module	Topic	Hours
1	Elementary Concepts of Electric Circuits- Elementary concepts of DC electric circuits: Basic Terminology including voltage, current, power, resistance, emf; Resistances in series and parallel; Current and Voltage Division Rules; Capacitors & Inductors: V-I relations and energy stored. Ohms Law and Kirchhoff's Laws-Problems; Star- delta conversion (resistive networks only-derivation not required)- problems. Analysis of DC electric circuits: Mesh current method - Matrix representation - Solution of network equations. Node voltage methods-matrix representation-solution of network equations by matrix methods. Numerical problems.	8
2	Elementary Concepts of Magnetic circuits, Electromagnetic Induction and AC Fundamentals- Magnetic Circuits: Basic Terminology: MMF, field strength, flux density, reluctance – comparison between electric and magnetic circuits- Series and parallel magnetic circuits with composite materials, numerical problems. Electromagnetic Induction: Faraday's laws, problems, Lenz's law- statically induced and dynamically induced emfs - Self-inductance and mutual inductance, coefficient of coupling Alternating Current fundamentals: Generation of alternating voltages-Representation of sinusoidal waveforms: frequency, period, Average, RMS values and form factor of waveforms-Numerical Problems.	8
3	AC Circuits: Phasor representation of sinusoidal quantities. Trigonometric, Rectangular, Polar and complex forms. Analysis of simple AC circuits: Purely resistive, inductive & capacitive circuits. Inductive and capacitive reactance, concept of impedance. Average Power factor. Analysis of RL, RC and RLC series circuits-active, reactive and apparent power. Simple numerical problems. Three phase AC systems: Generation of three phase voltages; advantages of three phase systems, star and delta connections (balanced only), relation between line and phase voltages, line and phase currents- Numerical problems	8
4	Introduction to Semiconductor devices: Evolution of electronics – Vacuum tubes to nano electronics. Resistors, Capacitors and Inductors: types, specifications. Standard values, color coding. PN Junction diode: Intrinsic and extrinsic semiconductors, Principle of operation, V-I characteristics, principle of avalanche breakdown and working of Zener diode. Bipolar Junction Transistors: PNP and NPN	8

	structures, Principle of operation, relation between current gains in CE, CB and CC, input and output characteristics of common emitter configuration.	
5	Basic electronic circuits and instrumentation: Rectifiers and power supplies: Block diagram description of a dc power supply, working of a full wave bridge rectifier, capacitor filter (no analysis), working of simple Zener voltage regulator. Amplifiers: Block diagram of Public Address system, Circuit diagram and working of common emitter (RC coupled) amplifier with its frequency response, Concept of voltage divider biasing. Electronic Instrumentation: Block diagram of an electronic instrumentation system, working of digital multimeter.	9
6	Introduction to Communication Systems: Evolution of communication systems – Telegraphy to 5G. Radio communication: principle of AM & FM, frequency bands used for various communication systems, block diagram of super heterodyne receiver, Principle of antenna – radiation from accelerated charge, working of parabolic reflector. Mobile communication: basic principles of cellular communications, principle and block diagram of GSM.	7

2. Textbooks (T)

- T1. D P Kothari and I J Nagrath, “Basic Electrical Engineering”, Tata McGraw Hill, 2010.
T2. D C Kulshreshtha, “Basic Electrical Engineering”, Tata McGraw Hill, 2010.
T3. Chinmoy Saha, Arindham Halder and Debarati Ganguly, Basic Electronics - Principles and Applications, Cambridge University Press, 2018.
T4. M.S. Sukhija and T.K. Nagsarkar, Basic Electrical and Electronics Engineering, Oxford University Press, 2012.
T5. Wayne Tomasi and Neil Storey, A Textbook on Basic Communication and Information Engineering, Pearson, 2010.
T6. Imthias Ahamed T.P., “Basics of electrical engineering” T7. Babujan,

3. Reference Books (R)

- R1. Del Toro V, “Electrical Engineering Fundamentals”, Pearson Education.
R2. T. K. Nagsarkar, M. S. Sukhija, “Basic Electrical Engineering”, Oxford Higher Education.
R3. Hayt W H, Kemmerly J E, and Durbin S M, “Engineering Circuit Analysis”, Tata McGraw-Hill
R4. Hughes, “Electrical and Electronic Technology”, Pearson Education.
R5. V. N. Mittle and Arvind Mittal, “Basic Electrical Engineering,” Second Edition, McGraw Hill.
R6. Parker and Smith, “Problems in Electrical Engineering”, CBS Publishers and Distributors.
R7. S. B. Lal Seksena and Kaustuv Dasgupta, “Fundamentals of Electrical Engineering”, Cambridge University Press.
R8. Anant Agarwal, Jeffrey Lang, Foundations of Analog and Digital Electronic Circuits, Morgan Kaufmann Publishers, 2005.
R9. Bernard Grob, Basic Electronics, McGraw Hill.
R10. A. Bruce Carlson, Paul B. Crilly, Communication Systems: An Introduction to Signals and Noise in Electrical Communication, Tata McGraw Hill, 5th Edition

4. Course Objectives

- ✓ Equip the students with an understanding of the fundamental principles of Electrical engineering
- ✓ Provide an overview of evolution of electronics, and introduce the working principle and examples of fundamental electronic devices and circuits
- ✓ Provide an overview of evolution of communication systems and introduce the basic concepts in radio communication.

5. Course Pre / Co-requisite

Physics and Mathematics (Pre-university level)

6. Course Outcomes

After completion of the course, student will be able to

CO1. Apply fundamental concepts and circuit laws to solve simple DC electric circuits CO2: Develop and solve models of magnetic circuits

CO2. Apply the fundamental laws of electrical engineering to solve simple ac circuits in steady State

CO3. Describe working of a voltage amplifier.

CO4. Outline the principle of an electronic instrumentation system CO6: Explain the principle of radio and cellular communication.

7. Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes

PO/ CO	PO 1	PO 2	PO 3	PO 4	PO5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO 3
CO1	H	L										M			
CO2	H	L										M			
CO3	H	L										M			
CO4	H														
CO5	H											M			
CO6	H											M			

8. Justification for CO-PO-PSO Correlation

CO	PO/PSO	Justification
CO1	PO1	Enables the students to apply the fundamental knowledge of electrical engineering and engineering mathematics for solving simple DC electric circuits
	PO2	Attributes towards the analysis of voltage and current of simple dc electrical circuits
	PO12	Enables the students to recognize the need for independent and lifelong learning in electrical field
	PO1	Enhances the students to apply the knowledge of electrical engineering to solve series and parallel magnetic circuits
	PO2	Analyze the flux distributions in given magnetic circuit
	PO12	Enables the students to recognize the need and preparation for independent and lifelong learning in electrical discipline
	PO1	Enables the students to apply the knowledge of electrical engineering to solve simple ac circuits in steady state

PO2	Analyze the 1ph and 3ph ac circuits and its properties.
PO12	Enables the students to recognize the need for independent and lifelong learning in electrical field
PO1	Knowledge in basic concepts of active and passive components will help the students to understand the working of a voltage amplifier. Hence a medium correlation is given.
PO1	Understanding the principle of an electronic instrumentation system will help the students to attain knowledge in the working of a transistor as a public address system. Hence a medium correlation is given.
PO12	Knowledge about the fundamentals of public address systems & amplifiers will encourage students to learn advanced electronics instrumentation system in future. Hence a medium correlation is given.
PO1	Understanding the basics of radio & mobile communication will help the students to gain knowledge in fundamentals of communication techniques. Hence a medium correlation is given.
PO12	Knowledge in principle of antenna and the modulation techniques will help the students to learn more advanced communication systems in future. Hence a medium correlation is given.

9. Curricular gaps (if any)

Energy stored in electric and magnetic field (Module 2)

10.Course Enrichment Activities

Sl No	Description	Proposed Activities	Relevance to POs and PSOs
1	Evolution of mobile technology	Invited Talk	PO1, PO12
2	Industrial Visit	Visit to Akashvani	PO1, PO12

11. Internal Assessment mark allocation (as per university curriculum)

(Provide details as mentioned in syllabus)

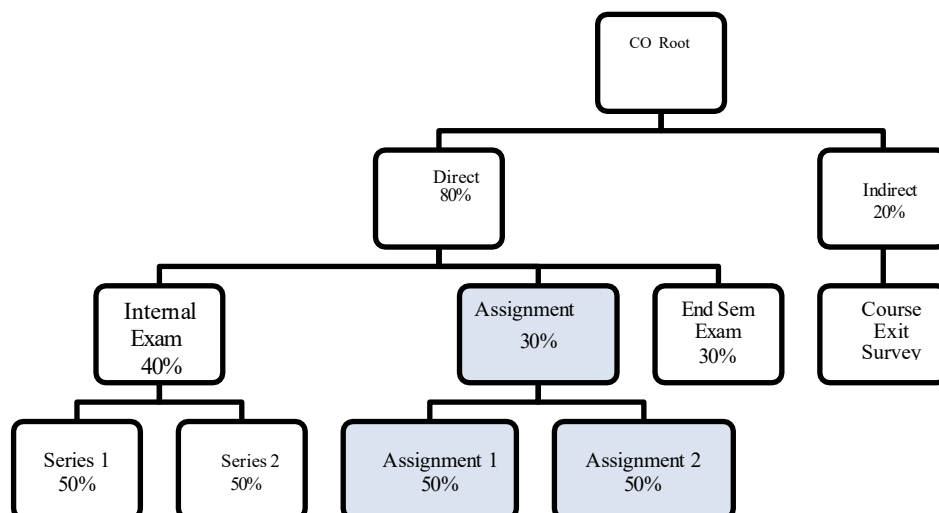
Attendance	- 10 marks
Continuous Assessment Test	-25 marks
Assignment (s)/ Course Project	- 15 marks
<u>Total</u>	<u>- 50 marks</u>

12. Assessment – CO Mapping (Put ‘x’ if mapping is present)

	Tools		Weightage	CO 1	CO 2	CO 3	CO 4	CO 5	CO 6
Direct Assessment Tools**	Internal Exam(s) 40%	Series 1	20%	x			x		
		Series 2	20%	x	x	x	x	x	
	Assignment (s)/ Course Project /Quiz etc. 30%	Assignment 1	15%	x			x	x	
		Assignment 2	15%		x	x			x
	End Semester Exam		30%	x	x	x	x	x	x

Indirect Assessment Tool	Course Exit Survey	100%	x	x	x	x	x	x

13. Assessment Configuration



14. Course Plan

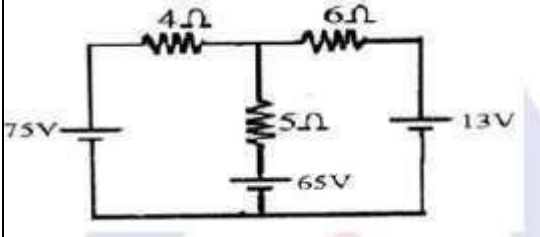
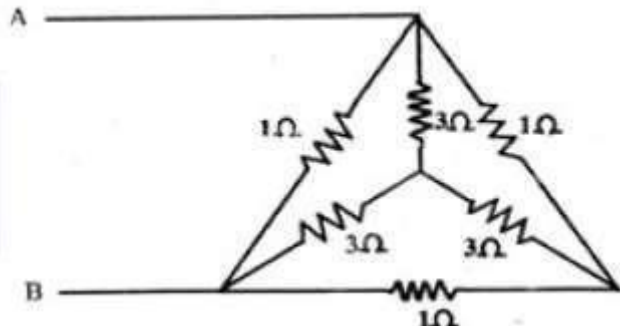
Hour	Topic	Module	Reference(s)	Teaching Pedagogy
Module 1				
1	Introduction	1	T1	Lecture
2	Elementary Concepts: Current, Voltage, Resistance, Power, Energy. Series & Parallel circuits	1	T1	Lecture
3	Current and Voltage Division Rule	1	T1	Lecture
4	Current and Voltage Division Rule – Simple Numerical	1	T1	Lecture
5	Capacitor and Inductor: V-I Relations and Energy Stored	1	T1	Lecture
6	Ohm's Law and Kirchhoff's laws	1	T1	Lecture
7	Mesh Analysis	1	T1	Lecture
8	Mesh Analysis-Matrix Method	1	T1	Lecture
9	Nodal Analysis	1	T1	Lecture
10	Nodal Analysis	1	T1	Lecture
11	Nodal Analysis-Matrix method	1	T1	Lecture
12	Star Delta Conversion	1	T1	Lecture
13	Star Delta Conversion	1	T1	Lecture

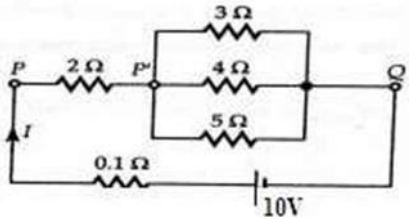
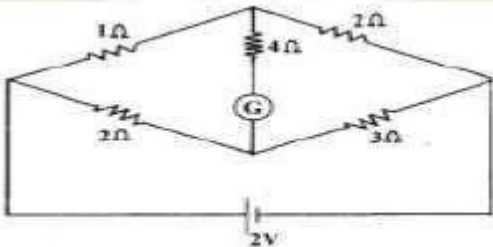
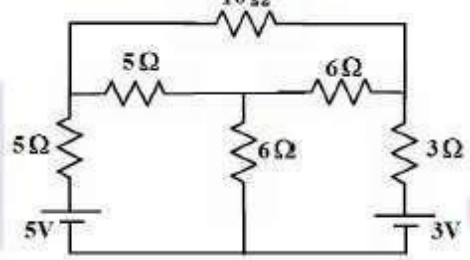
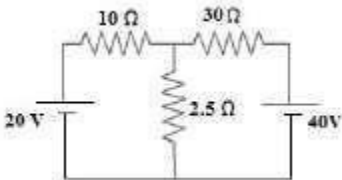
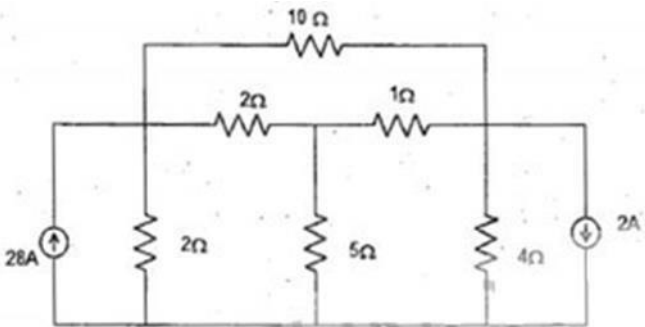
Module 2				
14	Magnetic circuit: Basic terminology	2	T1	Lecture
15	Comparison of electric and magnetic circuits, series magnetic circuit	2	T1	Lecture
16	Parallel magnetic circuit	2	T1	Lecture
17	Class Test	2	T1	Lecture
18	Electromagnetic Induction, Faraday's laws, Lenz's law; statically induced and dynamically induced emfs	2	T1	Lecture
19	Self-inductance and mutual inductance,	2	T1	Lecture
20	coefficient of coupling	2	T1	Lecture
21	Generation of alternating voltages	2	T1	Lecture
22	Representation of sinusoidal waveforms: frequency, period, average value, RMS value and form factor	2	T1	Lecture
23	Average value, RMS value and form factor Value - numerical problems	2	T1	Lecture
24	Average value, RMS value and form factor Value - numerical problems	2	T1	Lecture
Module 3				
25	AC Circuits: Phasor representation of sinusoidal quantities, Trigonometric, Rectangular, Polar and complex forms	3	T1	Lecture
26	Analysis of AC Circuits: Purely resistive, inductive & capacitive circuits;	3	T1	Lecture
27	Inductive and capacitive reactance, concept of impedance	3	T1	Lecture
28	Analysis of RL and RC series circuit - power factor, active, reactive and apparent power.	3	T1	Lecture
29	Analysis of RLC series circuit - power factor, active, reactive and apparent power.	3	T1	Lecture
30	RL, RC and RLC series circuits - numerical problems	3	T1	Lecture
31	RL, RC and RLC series circuits - numerical problems	3	T1	Lecture
32	Three phase AC systems: Generation of three phase voltages, advantages of Three-phase systems	3	T1	Lecture
33	Star and delta connections (balanced only), relation between line and phase voltages, line and phase currents	3	T1	Lecture
34	Star and delta connections (balanced only) - numerical problems	3	T1	Lecture
Module 4				

35	Evolution of electronics – Vacuum tubes to nano electronics (In evolutionary perspective only)	4	T3, T4	Lecture
36	Resistors, Capacitors and Inductors: types, specifications.	4	T3, T4	Lecture
37	Standard values, color coding (No constructional features)	4	T3, T4	Lecture
38	PN Junction diode: Principle of operation, V-I characteristics	4	T3, T4	Lecture
39	principle of avalanche breakdown	4	T3, T4	Lecture
40	Bipolar Junction Transistors: PNP and NPN structures	4	T3, T4	Lecture
41	Principle of operation, relation between current gains in CE, CB and CC	4	T3, T4	Lecture
42	input and output characteristics of common emitter configuration	4	T3, T4	Lecture
Module 5				
43	Rectifiers and power supplies: Block diagram description of a dc power supply	5	T3, T4	Lecture
44	Working of a full wave bridge rectifier, capacitor filter (no analysis)	5	T3, T4	Lecture
45	working of simple zener voltage regulator	5	T3, T4	Lecture
46	Amplifiers: Block diagram of Public Address system	5	T3, T4	Lecture
47	Circuit diagram and working of common emitter (RC coupled) amplifier with its frequency response	5	T3, T4	Lecture
48	Circuit diagram and working of common emitter (RC coupled) amplifier with its frequency response	5	T3, T4	Lecture
49	Concept of voltage divider biasing	5	T3, T4	Lecture
50	Electronic Instrumentation: Block diagram of an electronic instrumentation system	5	T3, T4	Lecture
Module 6				
60	Evolution of communication systems – Telegraphy to 5G	6	T3, T4	Lecture
61	Radio communication: principle of AM & FM	6	T3, T4	Lecture
62	frequency bands used for various communication systems	6	T3, T4	Lecture
63	block diagram of super heterodyne receiver	6	T3, T4	Lecture

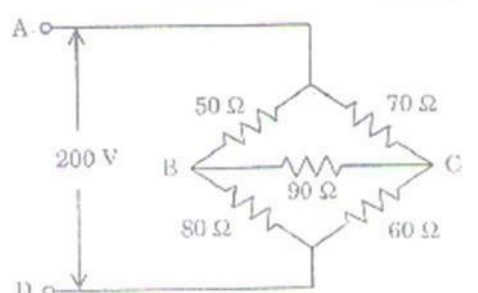
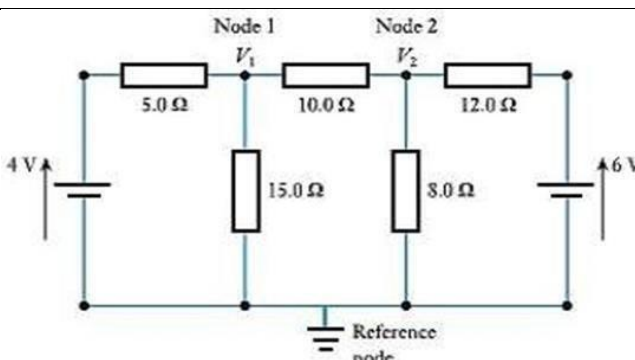
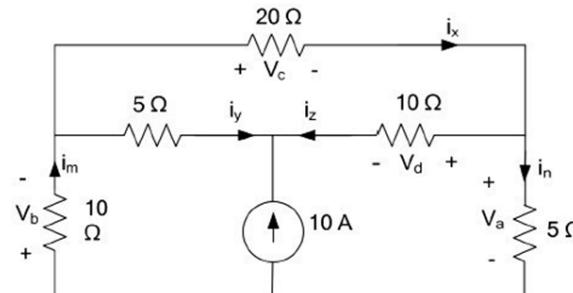
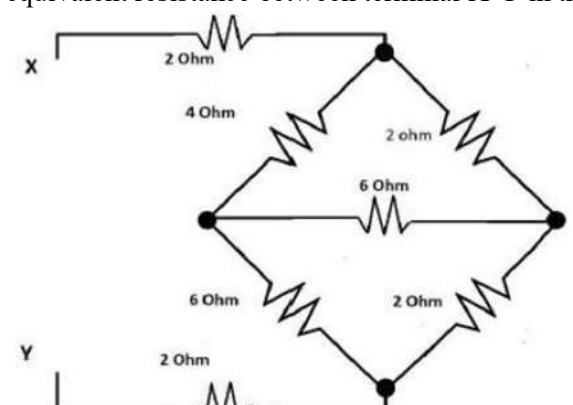
64	Principle of antenna – radiation from accelerated charge	6	T3, T4	Lecture
65	Mobile communication: basic principles of cellular communications	6	T3, T4	Lecture
66	principle and block diagram of GSM.	6	T3, T4	Lecture

15. Question bank

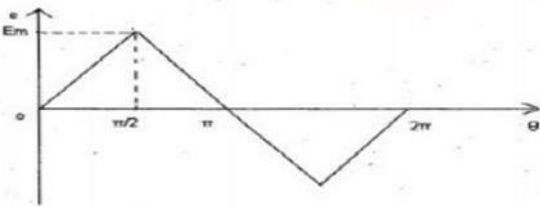
Module 1				
Sl. No	Question	Marks	CO	BL
1	State and explain Kirchhoff's laws.	4	CO1	L2
2	What are constant voltage and constant current sources? Voltage and current sources are mutually transferable. Explain. Derive the relationship between line and phase voltage in a star connected system.	4	CO1	L2
3	Find the current through 5ohm resistor using nodal analysis. 	4	CO1	L3
4	Determine the equivalent resistance R_{AB} using star delta transformation. 	4	CO1	L3
5	A 50-ohm resistor is in parallel with a 100-ohm resistor. Current in 50 ohm is 7.2A. What is the value of third resistance to be added in parallel to this circuit to make the total current 12.1 A.	4	CO1	L3
6	Three resistors $R_1=20$ ohm, $R_2=90$ ohm and $R_3=10$ ohm is connected in star. Obtain the equivalent delta circuit.	4	CO1	L2
7	Calculate the current through the $4\ \Omega$ resistor in the circuit shown, applying current division rule	4	CO1	L3

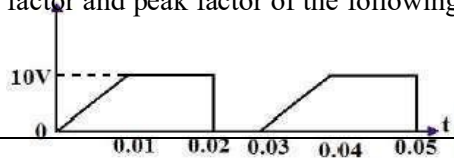
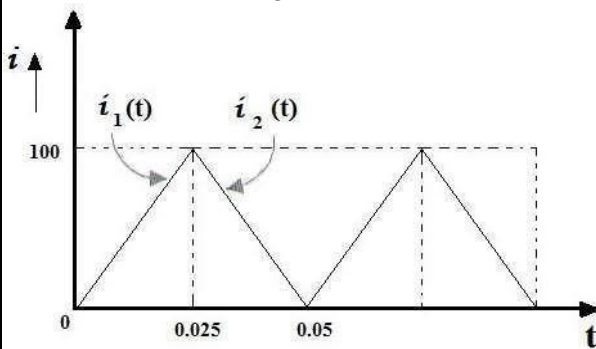
				
8	Calculate the current through the galvanometer (G) in the circuit shown 	4	CO1	L3
9	Find the current t  Mesh	4	CO1	L3
10	Calculate the current through the 2.5Ω resistor in the network of the following figure by mesh method. 	4	CO1	L3
11	Using nodal analysis to form network equations and solve the nodal voltages using matrix method. Also calculate the current in different branches. 	10	CO1	L3
	Calculate the current in each branch of the circuit using mesh analysis.			

12		10	CO1	L3
13	Find current in 100-ohm resistor using node analysis.			
		10	CO1	L3
14	Calculate the node voltages in the circuit shown, applying node analysis			
		10	CO1	L3
15	Find the resistance between A and B in the circuit shown below.			
		10	CO1	L3
16	In the circuit shown below find the total current from the supply and current in 90Ω resistor.			
		10	CO1	L3

				
17	Using the Node Voltage method, calculate the voltages V_1 and V_2 in the figure and hence calculate the current in the $8\ \Omega$ resistor.	10	CO1	L3
				
18	Use nodal analysis to find voltages V_a, V_b, V_c, V_d 	10	CO1	L3
19	Find the equivalent resistance between terminal X-Y in the network 	10	CO1	L3

Module 2				
1	Define the terms: i) MMF ii) magnetic field strength iii) magnet flux and iv) magnetic field density.	4	CO2	L2
2	An iron ring having cross-sectional area of 400mm^2 and mean circumference of 500mm carries a coil of 250 turns wound uniformly around it. Calculate (a) Reluctance of the ring. (b) Current required to produce a flux of $1000\mu\text{Wb}$ in the ring. Relative permeability of iron is 400	4	CO2	L3
3	State and explain Faraday's laws and Lenz's laws.	4	CO2	L2
4	Distinguish between self-inductance and mutual inductance.	4	CO2	L2
5	Define MMF, magnetizing force, flux density, reluctance, Permeability	4	CO2	L2
6	Compare electric and magnetic circuit	4	CO2	L2
7	Define rms and average value of an alternating quantity	4	CO2	L2
8	Calculate the RMS and average values of a purely sinusoidal current having peak value 15A	4	CO2	L3
9	Derive the amplitude factor and form factor of a purely sinusoidal waveform.	4	CO2	L3
10	Derive an expression for the energy stored in an inductor.	4	CO2	L3
11	A current wave is made up of two components-a 5A dc component and a 50Hz ac component, which is a sinusoidal wave with a peak value of 5A. Sketch the resultant waveform and determine its RMS and average values.	4	CO2	L3
12	An alternating current is represented by $i(t)=14.14 \sin (377t)$. Find (i)rms value (ii) frequency (iii)time period and (iv)instantaneous value of the current at $t=3\text{ms}$.	4	CO2	L3
13	A coil of 180 turns is linked with a flux of 0.03 Wb when carrying a current of 10A. Calculate the inductance of the coil. If the current is uniformly reversed in 0.04 sec, calculate the emf induced in the coil.	4	CO2	L3
14	Differentiate between statically and dynamically induced emf. A conductor of length 0.5m moves in a uniform magnetic field of flux density 1.1T at a velocity of 30m/s. Calculate the emf induced in the conductor if the direction of motion of the conductor is inclined at 60° to the direction of field.	4	CO2	L2
15	A coil of insulated wire 500 turns and of resistance 49ohm is closely wound on iron ring. The ring has a mean diameter of 0.25m and a uniform cross-sectional area of 700mm^2 . Calculate the total flux in the ring when a dc supply of 6V is applied to the end of the winding. Assume a relative permeability of 550.	4	CO2	L3
16	An iron ring of mean length 50cm has an air gap of 1mm and a winding of 200 turns. If the relative permeability of iron is 300 when a current of 1A flows through the coil, find flux density. Take permeability of air as $4\pi \times 10^{-7}\text{H/m}$.	4	CO2	L3

17	Determine average value & rms value of symmetrical square wave also find the form factor.	4	CO2	L3
18	Find rms and average value of the given waveform 	4	CO2	L3
19	A ring-shaped electromagnet has an air gap of 6mm and cross sectional area of 12 cm ² . The mean length of the core (excluding air gap) is 60cm. Calculate the mmf required to produce a flux density of 0.4 Wb/m ² in the gap. Take the relative permeability of the material as 400	4	CO2	L3
20	Define the term coefficient of coupling and write an expression for it.	4	CO2	L2
21	Two magnetically coupled coils have a mutual inductance of 32mH. What is the average emf induced in one, if the current through the other changes from 3 to 15mA in 0.004 second? Given that one coil has twice the no: of turns in the other, Calculate the inductance of each coil. Neglect the leakage.	4	CO2	L3
22	A coil of 1200 turns and coil B of 800 turns lie near each other so that 60 percent of the flux produced in one links with the other. It is found that a current of 5A in coil A produces a flux of 0.25mWb while the same current in coil B produces a flux of 0.15mWb. Determine the mutual inductance and coefficient of coupling between the coils.	4	CO2	L3
23	The no: of turns in a coil is 250. When a current of 2A flows in this coil the flux in the coil is 0. 3mWb. When this current is reduced to zero in 2ms, the voltage induced in the nearby coil is 63.75V. The coefficient of coupling between the two coils is 0.75. Find the self- inductance of the two coils, mutual inductance and no: of turns in the second coil.	4	CO2	L3
24	A coil of 300 turns and resistance of 10Ω is wound uniformly over a steel ring of mean circumference 30cm and cross-sectional area 9 cm ² . It is connected to a 20 V dc supply if $\mu_r = 1500$, find (i) mmf (ii) reluctance and (iii) magnetizing force.	4	CO2	L3
25	Define frequency, period and cycle.	4	CO2	L2
26	How is an alternating voltage generated? Derive the general expression for a sinusoidal ac voltage.	4	CO2	L2
27	A sinusoidal alternating current of frequency 50Hz has a rms value of 20A. Find the instantaneous value (i) 0.0025 sec, (ii) 0.0125 sec after passing through a positive maximum. At what time measured from the positive maximum; will the instantaneous current be 14.14A?	4	CO2	L3

28	Find the form factor and peak factor of the following waveform. 	10	CO2	L3
29	An iron ring has a cross-section area of 3 cm ² and a mean diameter of 25 cm. An air gap of 0.5mm is cut across the section of the ring. The ring is wound with a coil of 200 turns through which a current of 3A is passed. If the total magnetic flux is 0.28 mWb, find the relative permeability of iron, assuming no magnetic leakage.	10	CO2	L3
30	The instantaneous value of an alternating voltage is given by $v=110 \sin 314t$. Find the angular velocity, frequency, and time period of the voltage. Differentiate between statically and dynamically induced emfs.	10	CO2	L3
31	Find the rms and average values of the current wave shown in figure below. 	10	CO2	L3
32	An iron ring of mean diameter 100cm and a cross-sectional area of 6cm ² is wound with 200 turns of wire. Calculate the current required to produce a flux of 0.6mWb in the ring, if $\mu_r = 2000$. If now a radial cut of 2mm is made in the iron ring, find the new value of current required to produce the same flux in the air gap. Neglect fringing and leakage flux.	10	CO2	L3
33	A steel ring of circular cross section of 1 cm in radius and having a mean circumference of 94.3 cm has an air gap of 1 mm long. It is uniformly wound with an exciting coil consisting of 600 turns and excited with a current of 2.5 A. Neglecting magnetic leakage Calculate: m.m.f Magnetic flux Reluctance Flux density Relative permeability of steel Assume that steel part takes about 40% of total ATs	10	CO2	L3
Module 3				
1	Two impedances $25.23 \angle 37^\circ$ and $18.65 \angle -68^\circ$ are connected in series across 230V, 50Hz supply. Find the current, power factor,	4	CO3	L3

	active power and apparent power.			
2	Define active, reactive & apparent power in an ac circuit with the help of power triangle.	4	CO3	L2
3	A Series R-C circuit takes a power of 7000W when connected to 200V, 50Hz supply. The voltage across the resistor is 130 V. Calculate Resistance Current Power factor Capacitance Impedance Equations for instantaneous values of voltage and current.	4	CO3	L3
4	Derive the relation between line and phase current in three phase delta connected system	4	CO3	L2
5	A 10ohm resistor & 400uF capacitor are connected in series to a 240V sinusoidal ac supply. The circuit current is 5A. Calculate the supply frequency & phase angle between current & voltage.	4	CO3	L3
6	Explain the advantage of three phase system compared to single phase system.	4	CO3	L2
7	Draw the power triangle and define active, reactive and apparent powers in ac circuits. Draw the phasor diagram and waveform of RLC circuit.	4	CO3	L2
8	A resistance of 100Ω in series with $50\mu\text{F}$ capacitor is connected to supply of 200V, 50 Hz. Find impedance, current, power factor and phase angle Voltage across the resistance and capacitor. Draw phasor diagram.	4	CO3	L3
9	An alternating voltage of $(80+j60)$ V is applied to an RX circuit and the current flowing through the circuit is $(-4+j10)$ A. Calculate the impedance of the circuit in rectangular and polar forms. Also determine if X is inductive or capacitive.	4	CO3	L3
10	Derive the relation between line and phase values of voltage in a three-phase star connected system.	4	CO3	L2
11	Prove that the average power for a purely capacitive circuit is zero	4	CO3	L2
12	Prove that in a purely inductive circuit the current lags behind the applied voltage by 90 degree and the power consumed is zero.	4	CO3	L2
13	Explain the term power factor. What will be the power factor in a resistor, inductor and capacitor?	4	CO3	L2

14	Explain balanced 3 phase star connected system with phasor diagram.	4	CO3	L2
15	Derive the expression for the current in an ac series RLC circuit.	4	CO3	L2
16	Explain the generation of a three-phase voltage with necessary figures.	4	CO3	L2
17	A resistance of 10Ω , an inductance of 0.3 H , and a capacitance of $100\mu\text{F}$ are connected in series across 230V , 50 Hz single phase power supply. Calculate the impedance, current through and power factor of the circuit.	4	CO3	L2
18	A star connected, 3 phase load consists of three identical impedances. When the load is connected to a 3 phase, 400-volt supply, and the line current is 23.09A and p.f is 0.8 lagging. Calculate the total power taken by the load? If the load were reconnected in delta and supplied from the same three phase supply, calculate the current flowing in each line.	10	CO3	L3
19	A two-branch parallel circuit consists of $R = 30\Omega$, $L = 0.06\text{H}$ in series branch 1 and $R = 50\Omega$, $C = 30\mu\text{F}$ in series branch 2. The circuit connected to 230V , 50Hz supply. Find (i) current in each branch, (ii) total current and (iii) power and power factor.	10	CO3	L3
20	Each phase of a 3- phase alternator produces a voltage of 6351 volts carry a current of 315 A . Find the line voltage, line current and the kVA capacity of the 3- p h a s e alternator when it is (i) star connected delta connected.	10	CO3	L3
21	A balanced delta connected 3 phase load is fed from a 3 phase, 400 V , 50 Hz power supply. The line current is 20A and the total power absorbed by the load is 10kW . Calculate (i) the impedance in each branch (ii) the power factor and (iii) the total power consumed if the same impedances are star connected.	10	CO3	L3
22	Three identical resistors of 20 ohm each are connected in star to 415V , 50Hz three phase supply. Calculate (i) the total power consumed, (ii) total power consumed if they are connected in delta (iii) total power consumed, if one of the resistors is opened in both star connection and delta connections.	10	CO3	L3
23	Draw the power triangle and define active, reactive and apparent powers in ac circuits. Two coils A and B are connected in series across a 240V , 50Hz supply. The resistance of A is 5Ω and the inductance of B is 0.015H . If the input from the supply is 3kW and 2kVAR , find the inductance of A and the resistance of B. Also calculate the voltage across each coil.	10	CO3	L3
24	A balanced three phase load consists of three coils each having resistance of 4Ω and inductance 0.02H . It is connected to a 415V , 50Hz , 3-phase ac supply. Determine the phase voltage, phase current, power factor and active power when the loads are connected in (i) star (ii) delta.	10	CO3	L3
Module 4				

1	Describe the evolution of electronics from vacuum tube to Nano electronics.	5	CO4	L2
2	Distinguish between Zener and Avalanche breakdown.	5	CO4	L2
3	Explain with diagram the principle of operation of an NPN transistor	5	CO4	L2
4	Describe with suitable sketches the input-output characteristics of a BJT when connected in common emitter configuration. [Sketch the output characteristic of a transistor and explain different regions of operation.]	5	CO4	L2
5	Derive an expression for current gain of CE, CB and CC configuration Or Derive the relation between α & β , α & γ , β & γ	6	CO4	L2
6	What is tolerance of a resistor? What are the specifications of a resistor? Define any three. Find the resistance range for carbon resistor having colour bands: yellow, violet, red and gold red black brown Blue red gold gold	6	CO4	L1
7	What is a diode? Explain the VI characteristics of PN junction diode in forward biased and reverse biased condition or Describe the forward and reverse characteristics of a diode.	8	CO4	L2
8	Compare and contrast various types of resistors, capacitors & inductors. Mention its applications.	10	CO4	L2
9	In a 4-band resistor the last colour in the colour band is gold. If the upper range of resistance is 3.465Ω find its colour code.	5	CO4	L1
10	Explain the working of a Zener diode.	5	CO4	L2
11	Explain intrinsic and extrinsic semiconductors with crystalline diagrams.	5	CO4	L2
12	Draw the energy band diagram of metals, semiconductors and insulators. Write examples.	3	CO4	L1
13	Explain the formation of potential barrier in a PN junction diode.	4	CO4	L2
14	Find the value of capacitor i) 2M2 ii) 4k7 iii) 104 iv) 47K	4	CO4	L1
Module 5				
1	With neat block diagram, explain the working of a DC regulated power supply.	5	CO4	L1
2	With sufficient waveforms, explain the working of capacitor filter. [Narrate how capacitor filter eliminates ripples from the output of a rectifier.]	5	CO4	L1
3	Explain the working of Zener voltage regulator and draw its V-I characteristics. Define line regulation and load regulation.	8	CO4	L2

4	Explain the characteristics of an amplifier.	5	CO5	L2
5	Explain Public Address (PA) system with a neat block diagram.	6	CO5	L2
6	Draw the basic block diagram of an electronic measuring instrument and explain the functions of each block. [With a neat sketch explain the block diagram of an instrumentation system]	6	CO3	L2
7	Explain working of multimeter with necessary diagrams.	8	CO5	L2
8	Explain with neat diagrams working of half wave and full wave (Centre tapped, Bridge) rectifier.	10	CO4	L2
9	Define Peak inverse voltage and obtain the same for half wave and full wave rectifier.	5	CO4	L1
10	Derive expression for I_{max} , I_{DC} , I_{RMS} , V_{DC} , V_{RMS} , Form Factor, Peak Factor, Efficiency of Half wave and Full wave (Centre tapped, Bridge) rectifier.	10	CO4	L2
11	Compare half wave and full wave rectifiers.	6	CO4	L2
12	What do you mean by ripple factor? Find the ripple factor for half wave & full wave rectifier.	5	CO4	L1
13	Draw the circuit diagram and explain the working of R-C coupled amplifier, plot its frequency response. Describe gain and bandwidth of an RC coupled amplifier. [State the reason for reduction in gain at low and high frequencies. Explain the role of capacitors used in RC coupled Amplifier. Draw the circuit diagram of a CE amplifier and discuss the role of each component used in it.]	10	CO5	L2
14	What is the need for biasing? Analyze voltage divider arrangement for common emitter configuration.	10	CO5	L2
Module 6				
1	With the help of a block diagram, explain the working of Super heterodyne receiver for AM & FM. Explain the relevance of Intermediate Frequency in a superheterodyne receiver.	7	CO3	L2
2	Define Modulation and describe the need for modulation.	4	CO3	L1
3	Define Amplitude Modulation & Frequency Modulation. Derive an expression for modulated signal of AM & FM. Comment on the bandwidth requirement and modulation index.	10	CO3	L2
4	Define Modulation index? Find modulation index for AM & FM. Draw the frequency spectrum of an amplitude modulated (AM) wave. Given that modulating signal is of frequency f_m and amplitude V_m and carrier is of frequency f_c and amplitude V_c . Take modulation index as m . What is the bandwidth requirement of this AM wave?	5	CO3	L1
5	Define frequency deviation. Find the frequency deviation of FM wave.	5	CO3	L1

6	What are the merits AM compared to FM? The carrier amplitude of a given AM wave is 5V and the message signal amplitude is 3V. Find the modulation index.	5	CO3	L3
7	Describe the evolution of communication system from telegraphy to 5G.	6	CO3	L2
8	List five advantages and applications of communication systems.	5	CO3	L1
9	With neat sketches, explain a cellular communication system. [Explain the concept of cells in cellular communication.]	10	CO3	L2
10	Explain GSM communication with the help of its architecture. [Explain the call setup procedure in GSM.]	8	CO3	L2
11	Explain in detail parabolic reflector antenna	6	CO3	L2
12	Explain the concept of frequency reuse and handoff in cellular communication.	8	CO3	L2
13	Describe the principle of Antenna.	5	CO3	L2
14	List out the frequency bands and its uses.	5	CO3	L1

Prepared By: Thomas Felix, Neethu Varghese

Checked By: Kanaka Xavier

Course Code & Name: HUN101 Life Skill

1. Prescribed Syllabus

Module	Topic	Hours
1	Overview of Life Skills: Meaning and significance of life skills, Life skills identified by WHO: Self-awareness, Empathy, Critical thinking, Creative thinking, Decision making, problem solving, Effective communication, interpersonal relationship, coping with stress, coping with emotion. Life skills for professionals: positive thinking, right attitude, attention to detail, 8having the big picture, learning skills, research skills, perseverance, setting goals and achieving them, helping others, leadership, motivation, self-motivation, and motivating others, personality development, IQ,EQ, and SQ	9
2	Self-awareness: definition, need for self-awareness; Coping with Stress and Emotions, Human Values, tools and techniques of SA: questionnaires, journaling, reflective questions, meditation, mindfulness, psychometric tests, feedback. Stress Management: Stress, reasons and effects, identifying stress, stress diaries, the four A's of stress management, techniques, Approaches: action-oriented, emotion-oriented, acceptance oriented, resilience, Gratitude Training, Coping with emotions: Identifying and managing emotions, harmful ways of dealing with emotions, PATH method and relaxation techniques. Morals, Values and Ethics: Integrity, Civic Virtue, Respect for Others, Living Peacefully. Caring,Sharing, Honesty, Courage, Valuing Time, Time management, Co operation, Commitment, Empathy,Self-Confidence, Character, Spirituality, Avoiding Procrastination, Sense of Engineering Ethics.	10
3	21st century skills: Creativity, Critical Thinking, Collaboration, Problem Solving, Decision Making, Need for Creativity in the 21st century, Imagination, Intuition, Experience, Sources of Creativity, Lateral Thinking, Myths of creativity, Critical thinking Vs Creative thinking, Functions of Left Brain &Right brain, Convergent & Divergent Thinking, Critical reading & Multiple Intelligence. Steps in problem solving: Problem Solving Techniques, Six Thinking Hats, Mind Mapping, Forced Connections. Analytical Thinking, Numeric, symbolic, and graphic reasoning. Scientific temperament and Logical thinking.	9
4	Group and Team Dynamics: Introduction to Groups: Composition, formation, Cycle, thinking, Clarifying expectations, Problem Solving, Consensus, Dynamics techniques, Group vs Team, Team Dynamics, Virtual Teams. Managing team performance and managing conflicts, Intrapreneurship.	9
5	Leadership: Leadership framework, entrepreneurial and moral leadership, vision, cultural dimensions. Growing as a leader, turnaround leadership, managing diverse stakeholders, crisis management. Types of Leadership, Traits, Styles, VUCA Leadership, Levels of Leadership, Transactional vs	8

2. Text Books (T)

Nil

3. Reference Books (R)

- R1. English for Engineers and Technologists (Combined edition, Vol. 1 and 2), Orient Blackswan 2010.
- R2. Meenakshi Raman and Sangeetha Sharma, "Technical Communication: Principles and Practice", 2nd Edition, Oxford University Press, 2011
- R3. Stephen E. Lucas, "The Art of Public Speaking", 10th Edition; McGraw Hill Education, 2012.
- R4. Ashraf Rizvi, "Effective Technical Communication", 2nd Edition, McGraw Hill Education, 2017.
- R5. William Strunk Jr. & E.B. White, "The Elements of Style", 4th Edition, Pearson, 1999.
- R6. David F. Beer and David McMurrey, Guide to writing as an Engineer, John Wiley. New York, 2004.
- R7. Goodheart-Willcox, "Professional Communication", First Edition, 2017.
- R8. Training in Interpersonal Skills: Tips for Managing People at Work, Pearson Education, India, 6 edition, 2015.
- R9. The Ace of Soft Skills: Attitude, Communication and Etiquette for Success, Pearson Education; 1 edition, 2013.
- R10. Anand Ganguly, "Success in Interview", RPH, 5th Edition, 2016.
- R11. Raman Sharma, "Technical Communications", Oxford Publication, London, 2004.

4. Course Objectives

Clear, precise, and effective communication has become a sine qua non in today's information-driven world given its interdependencies and seamless connectivity. Any aspiring professional cannot but master the key elements of such communication. The objective of this course is to equip students with the necessary skills to listen, read, write, and speak so as to comprehend and successfully convey any idea, technical or otherwise, as well as give them the necessary polish to become persuasive communicators.

5. Course Pre / Co-requisite

None

6. Course Outcomes

- CO1. Define and Identify different life skills required in personal and professional life.
- CO2. Develop an awareness of the self and apply well-defined techniques to cope with emotions and stress.
- CO3. Explain the basic mechanics of effective communication and demonstrate these through presentations.
- CO4. Take part in group discussions
- CO5. Use appropriate thinking and problem solving techniques to solve new problems.
- CO6. Understand the basics of teamwork and leadership.

7. Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes

PO/ CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 2
CO1						M		L	M	M	L	H			
CO2									H			M			
CO3						L			L	H					
CO4										H		L			
CO5		H	M	L											
CO6						L			H						

8. Justification for CO-PO-PSO Correlation

CO1	PO6- Identification of different life skills like Morals, values, empathy, professionalism etc; will enable to identify social issues and handle the responsibilities relevant for the engineering profession
	PO8- Learning the fundamental ethical principles like trustworthiness and honesty will help to commit themselves to professional ethics and responsibilities of engineering practice
	PO9-. By understanding the importance of caring, sharing, cooperation and team work will help to perform better as an individual and also as a member in a team or groups.
	PO10- Knowledge of technical communication helps to communicate effectively with the engineering community through effective reports and presentations
	PO11- By understanding the concepts like team performance management, it will be easy to analyse and manage the team as a leader or the member and improve the performance of the team.
	PO12- Learning, understanding and application of life skills helps to engage in lifelong learning which gives a broadest perspective of life.
	PO9- Learning different techniques of stress management helps to work effectively in a group or team by handling various levels of stressful situations.
	PO12- Understanding the relevance of self-awareness helps the students recognize the need for life-long learning in the broadest context of technological knowledge.
	PO6- By leaning basic mechanics of communication helps to analyse various societal issues and discuss them through presentations.
	PO9- effective communication will give immense opportunities to perform better in multidisciplinary teams as a member or a leader
	PO10- Effective communication skills helps to have elaborate discussions and presentations with the professional bodies regarding engineering concepts and various other related societal issues.
	PO10- By taking part in different group discussions, students will be able to communicate effectively with the engineering community and society at large and discuss about the problems and find out the solutions needed.

	PO12—By developing the capacity to effective participation in group discussions, enables to recognize the need for life-long learning in the broadest context of technological knowledge.
	PO2- Concepts of mind mapping and six thinking Hats in problem solving will help the students to analyse and formulate different engineering problems from different dimensions
	PO3- By critical and creative thinking it is easy to design and develop solutions for complex engineering problems highlighting public health, safety and other societal issues
	PO4- Problem solving techniques helps to identify and choose various modern tools to apply in various engineering problems.
	PO6- Being the part or being a leader of a team, helps to analyse and apply reasoning in various issues related to society.
	PO9- Understanding the importance of team dynamics will provide a better platform to perform effectively as a team member and leader as well.

9. Curricular gaps (if any)

Nil

10. Course Enrichment Activities

Sl No	Description	Proposed Activities	Relevance to POs and PSOs

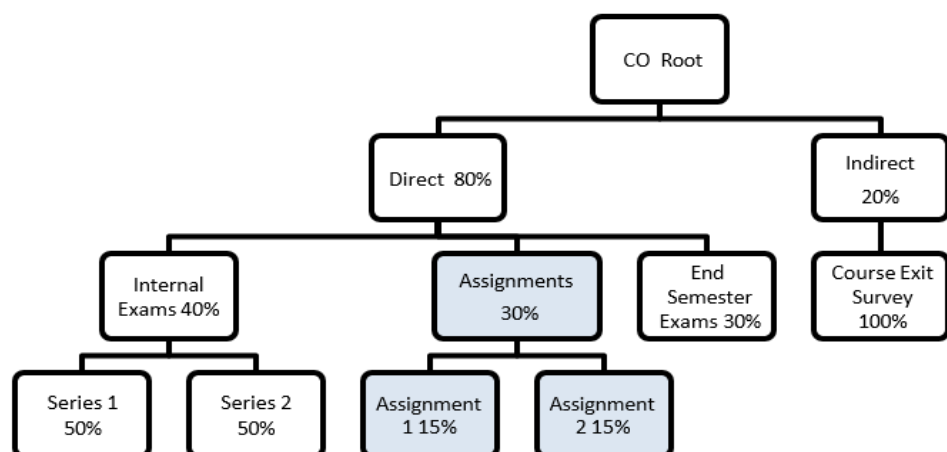
11. Internal Assessment mark allocation (as per university curriculum) (Provide details as mentioned in syllabus)

Attendance	- 10 marks
Continuous Assessment Test	- 25 marks
Assignment (s)/ Course Project	- 15 marks
Total	- 50 marks

12. Assessment – CO Mapping (Put „x“ if mapping is present)

	Tools		Weightage [#]	CO1	CO2	CO3	CO4	CO5	CO6
Direct Assessment Tools	Internal Exam(s) 40%	Series 1	20%	x	x				
		Series 2	20%					x	x
	Assignment (s) 30%	Assignment 1	15%		x	x	x		
		Assignment 2	15%			x	x		
	End Semester Exam		30%	x	x	x	x	x	x
Indirect Assessment Tool	Course Exit Survey		100%	x	x	x	x	x	x

13. Assessment Configuration



14. Course Plan

Sl.no	Topic Name	Reference	Module	Teaching Pedagogy
1	Meaning and significance of life skills	R1, R2	1	Lecture
2	Life skills identified by WHO	R1, R2	1	Lecture
3	Life skills for professionals	R1, R2	1	Lecture
4	leadership, motivation, personality development,	R1, R2	1	Lecture
5	IQ,EQ, and SQ	R1, R2	1	Lecture
6	Self-awareness: definition, need for self-awareness	R1, R2	2	Lecture
7	Coping With Stress and Emotions, HumanValues, tools and techniques of SA	R1, R2	2	Lecture
8	Effective communication	R1, R2	2	Lecture
9	Stress Management: Stress, reasons and effects, identifying stress, stress diaries	R1, R2	2	Lecture
10	the four A's of stress management, techniques, Approaches	R1, R2	2	Lecture
11	Coping with emotions: Identifying and managing emotions, harmful ways of dealing with emotions, PATH method and relaxation techniques.	R1, R2	2	Lecture
12	Presentation skills	R1, R2	2	Lecture
13	Morals, Values and Ethics	R1, R2	2	Lecture
14	Integrity, Civic Virtue, Respect for Others, Living Peacefully	R1, R2	2	Lecture
15	Caring, Sharing, Honesty, Courage, Valuing Time, Time management, Co operation, Commitment	R1, R2	2	Lecture
16	Empathy, Self-Confidence, Character, Spirituality, Avoiding Procrastination, Sense of Engineering Ethics., Revision	R3,R4	2	Lecture
17	21st century skills: Creativity, Critical Thinking, Collaboration, Problem Solving, Decision Making,	R3,R4	3	Lecture
18	Need for Creativity in the 21st century, Imagination, Intuition, Experience	R3,R4	3	Lecture
19	Introduction to presentations and group discussions	R3,R4	4	Lecture
20	Sources of Creativity, Lateral Thinking, Myths of creativity	R3,R4	3	Lecture
21	Critical thinking Vs Creative thinking, Functions of Left Brain & Right brain, Convergent & Divergent Thinking	R3,R4	3	Lecture
22	Critical reading & Multiple Intelligence.	R3,R4	3	Lecture
23	Steps in problem solving: Problem Solving Techniques	R3,R4	3	Lecture
24	Six Thinking Hats, Mind Mapping, Forced Connections	R4, R5	3	Group Discussion

25	Analytical Thinking, Numeric, symbolic, and graphic reasoning	R4, R5	3	Lecture
26	Scientific temperament and Logical thinking	R4, R5	3	Lecture
27	Scientific temperament and Logical thinking	R4, R5	3	Lecture
28	revision-module 3	R4, R5	3	Lecture
29	Group and Team Dynamics	R4, R5	4	Lecture
30	Introduction to Groups	R4, R5	4	Lecture
31	Composition, formation, Cycle, thinking	R4, R5	4	Lecture
32	Clarifying expectations, Problem Solving, Consensus	R4, R5	4	Lecture
33	Dynamics techniques, Group vs Team	R4, R5	4	Group Discussion
34	Team Dynamics	R4, R5	4	Lecture
35	Virtual Teams	R4, R5	4	Lecture
36	Managing team performance and managing conflicts	R4, R5	4	Lecture
37	Intrapreneurship.	R4, R5	4	Lecture
38	revision-module 4	R4, R5	4	Lecture
39	Leadership	R4, R5	5	Lecture
40	Leadership framework, entrepreneurial and moral leadership	R4, R5	5	Lecture
41	vision, cultural dimensions	R4, R5	5	Lecture
42	Growing as a leader	R4, R5	5	Lecture
43	turnaround leadership, managing diverse stakeholders, crisis management	R4, R5	5	Lecture
44	Growing as a leader, turnaround leadership	R4, R5	5	Lecture
45	Types of Leadership, Traits, Styles	R4, R5	5	Lecture
46	managing diverse stakeholders, crisis management	R4, R5	5	Lecture
47	Non-verbal Communication and Body Language	R4, R5	5	Group Discussion
48	VUCA Leadership, Levels of Leadership	R4, R5	5	Lecture
49	Transactional vs Transformational Leaders, Leadership Grid, Effective Leaders	R4, R5	5	Lecture
50	revision-module 5	R4, R5	5	Lecture

15. Question Bank

SL.N O	QUESTIONS	Marks	C O	BL
MODULE 1				
1.	Define Life skills and list the Life skills defined by WHO	5	CO1	L1
2.	List out the 10 core life skills identified by World Health Organization	5	CO1	L1
3.	List out the major life skills identified by WHO and explain any four of them	5	CO1	L1
4.	Recall the core life skills as social, thinking and emotional skills	5	CO1	L1
5.	Identify the negative consequences of lacking major life skills	5	CO1	L1
6.	Define in your own words the 5 C's of effective communication	5	CO1	L1
7.	List out the major life skills required by a professional	5	CO1	L1
8.	List out the 10 skills important for a research scholar	5	CO1	L1
9.	State the importance of learning skills and research skills	5	CO1	L1
10.	Define goal setting and explain the concept of S.M.A.R.T goal	5	CO1	L1
11.	List out any five measures for pursuing goals	5	CO1	L1
12.	Define creative thinking and compare between Critical thinking and creative thinking.	5	CO1	L1
13.	Define the three types of human intelligence with examples	5	CO1	L1
14.	Briefly explain the importance of life skills in one's life	5	CO1	L2

15.	Explain the importance of communication skill and empathy in the social life of an individual.	5	CO1	L2
17.	Explain any 5 life skills that are necessary for a professional life	5	CO1	L2
18.	Briefly explain the idea of 'having bigger vision' and 'attention to detail'.	5	CO1	L2
19.	Explain the importance of Positive Attitude and ways to develop the same.	5	CO1	L2
20.	Explain the terms EQ , SQ and IQ	5	CO1	L2
21.	Explain the role life skills play in helping people achieve better results in both their personal and professional lives? Describe the Main Components of Life Skills?	5	CO1	L2
22.	Explain how life skills aid for the personality development of an individual	5	CO1	L2
23.	Identify the different types of communication.	5	CO3	L1
24	Identify the communication network structure that can be observed in the given situations. (a) A group discussion on development. (b) An address from the Principal regarding punctuality. (c) A reporter interviewing a movie star. (d) Discussing the answers of a test with a group of friends.	5	CO3	L1
25	Recall the differences between kinesics, proxemics, and chronemics with examples	5	CO3	L1
26	Define Effective Communication. Identify different types of communication networks.	5	CO3	L1
27	Explain the importance of non-verbal communication in making a presentation	5	CO3	L2
28	Explain the term 'Miscommunication'. Explain different barriers to communication.	5	CO3	L2
29	Briefly explain non-verbal communication and its importance.	5	CO3	L2
30	Explain the importance of communication in a multicultural environment.	5	CO3	L2
MODULE 2				
1	Define the term self-awareness and state its importance	5	CO2	L1
2	Identify various self-awareness tools.	5	CO2	L1
3	Identify how knowing about yourself helps in the overall development of a person	5	CO2	L1
4	Define stress and stressors list out the factors that causes stress	5	CO2	L1
5	Define stress diary and illustrate the basic format of a stress diary	5	CO2	L1
6	List few stress management techniques and explain them	5	CO2	L1
7	Define stress management and name few techniques of stress management	5	CO2	L1
8	Define stress management and three healthy ways to manage stress	5	CO2	L1
9	Define the term commitment and explain the three components of commitment proposed by Allen and Meyer	5	CO2	L1
10	Define the following skills with examples: a) coping with stress b) coping with emotions	5	CO2	L1
11	Identify the different types of harmful ways and healthy ways of dealing with emotions with examples	5	CO2	L1
12	List out and explain the harmful ways of dealing with negative emotions	5	CO2	L1
13	List the arguments raised against moral absolutism and moral relativism.	5	CO2	L1
14	Identify the common forms of unethical behaviour	5	CO2	L1

15	List out the measures to promote good work ethics	5	CO2	L1
16	Define the term 'integrity' and illustrate the different types of integrity	5	CO2	L1
17	Identify the categories of civic virtues	5	CO2	L1
18	Identify the different types of courage	5	CO2	L1
19	List the ways to improve self-confidence	5	CO2	L1
20	Explain the term 'self-awareness' and list out the ways of improving self-awareness	5	CO2	L2
21	Describe how journaling helps in developing self-awareness	5	CO2	L2
22	Explain 5 healthy ways to deal with stress.	5	CO2	L2
23	Explain the concepts of questionnaire, reflective questions and feedback with suitable examples	5	CO2	L2
24	Describe how mind relaxation techniques help in developing self awareness	5	CO2	L2
25	Explain the differences between internal stressors and external stressors with examples	5	CO2	L2
26	Describe the ways to identify stress	5	CO2	L2
27	Explain the four categories of symptoms of stress with at least two examples	5	CO2	L2
28	Briefly explain the 4 A's of stress management	5	CO2	L2
29	Explain the concept and importance of stress diary	5	CO2	L2
30	Explain stress management and three approaches to managing stress	5	CO2	L2
31	Explain the term resilience and its three essential components	5	CO2	L2
32	Explain the term 'gratitude' Identify the importance of gratitude journaling	5	CO2	L2
33	Explain the term 'emotion' and the ways to identify emotions	5	CO2	L2
34	Describe the importance of coping with emotion and explain the PATH method of emotion management.	5	CO2	L2
35	Explain the steps involved in managing emotions	5	CO2	L2
36	Describe the importance of morality with examples	5	CO2	L2
37	Explain the term 'values' and give examples of ethical values	5	CO2	L2
38	Briefly explain the term 'Ethics' and its importance	5	CO2	L2
39	Explain the importance of work ethics	5	CO2	L2
40	Describe the factors that influence work ethics	5	CO2	L2
41	Explain the importance and examples of service learning	5	CO2	L2
42	Describe the concept and categories of civic virtues	5	CO2	L2
43	Describe how having respect for others and honesty enhance our life	5	CO2	L2
44	Briefly explain the concepts of sharing and caring	5	CO2	L2
45	Explain the importance of cooperation and time management	5	CO2	L2
46	Explain with examples the different ways of effective time management	5	CO2	L2
47	Describe the importance of self-confidence	5	CO2	L2
48	Explain the concept of spirituality and give examples of spiritual practices	5	CO2	L2
49	Describe in your own words the different senses of engineering ethics	5	CO2	L2
50	Discuss the potential moral issues faced by an engineer.	5	CO2	L2
51	"Manage Stress by Knowing What You Value" - Interpret the given statement by explaining stress and the relationship between Self-awareness, coping of emotion, values and ethics	5	CO2	L2

MODULE 3

1	State the importance of creativity in thinking.	5	CO5	L1
2	Identify the skills that are relevant in 21 st century.	5	CO5	L1
3	Define creativity and illustrate the three levels of creativity.	5	CO5	L1
4	Recall the differences between imagination and intuition.	5	CO5	L1
5	Recall the differences between Intrinsic and extrinsic motivation with examples	5	CO5	L1
6	Define Lateral thinking	5	CO5	L1
7	Recall the differences between Vertical thinking and lateral thinking	5	CO5	L1
8	Identify and define different myths of creativity.	5	CO5	L1
9	List out the myths of creativity and explain any four of them	5	CO5	L1
10	Define critical thinking and explain its three components	5	CO5	L1
11	Identify the essential skills required for effective critical thinking	5	CO5	L1
12	Identify the differences in the cognitive functions of left and right brain	5	CO5	L1
13	Recall the differences between creative thinking and critical thinking	5	CO5	L1
14	Define the importance of problem solving	5	CO5	L1
15	Define the term brainstorming and explain four rules of brainstorming	5	CO5	L1
16	Recall the advantages and disadvantages of six thinking hats	5	CO5	L1
17	List out the useful strategies for mathematical problem solving	5	CO5	L1
18	Explain any FIVE types of creativity	5	CO5	L2
19	Describe in detail the functions of the left and right brain.	5	CO5	L2
20	Explain a) imagination, intuition and experience b) relation of above mentioned factors with creativity	5	CO5	L2
21	Describe the sources of creativity	5	CO5	L2
22	Explain the main aspects important for creative thinking	5	CO5	L2
23	Briefly explain a)convergent thinking b)divergent thinking	5	CO5	L2
24	Explain the concept of critical reading and its importance	5	CO5	L2
25	Describe the concept of multiple intelligence defined by Gardner	5	CO5	L2
26	'Critical reading is an active process'. Discuss.	5	CO5	L2
27	Describe the various strategies of problem solving	5	CO5	L2
28	Explain the categories of problem solving activities	5	CO5	L2
29	Describe the steps involved in problem solving	5	CO5	L2
30	Explain six thinking hats.	5	CO5	L2
31	Briefly explain the concept of mind mapping and its benefits	5	CO5	L2
32	Explain in your own words the idea of forced connections	5	CO5	L2
33	Explain the three components of quantitative reasoning	5	CO5	L2
34	Describe the steps involved in mathematical reasoning	5	CO5	L2
35	Explain the relation between creativity level and problem solving skill.	5	CO5	L2

MODULE 4

1	List the ways in which a person can participate in a group discussion effectively?	5	CO4	L1
2	Identify the important characteristics of group discussion.	5	CO4	L1
3	'Listening skills are essential for effectively participating in a group discussion.' Explain.	5	CO4	L2

4	Discuss the importance of group dynamics in a Group Discussion.	5	CO4	L2
5	Define the term 'group' and list the characteristics of a group.	5	CO6	L1
6	List out the 5 stages of a group formation.	5	CO6	L1
7	Recall the different types of groups	5	CO6	L1
8	List the different steps in group problem solving	5	CO6	L1
9	Recall The differences between a group and a team	5	CO6	L1
10	Define virtual team	5	CO6	L1
11	Recall The differences between homogeneous and heterogeneous teams	5	CO6	L1
12	Outline the steps in a TPM cycle	5	CO6	L1
13	Outline the characteristics of an effective group work	5	CO6	L1
14	Explain what team dynamics is and how it affects the team's performance.	5	CO6	L2
15	Explain the importance of group formation	5	CO6	L2
16	Explain the phenomenon of 'groupthink'	5	CO6	L2
17	Describe elaborately the process involved in problem solving as group	5	CO6	L2
18	Explain the group dynamics techniques	5	CO6	L2
19	Describe the types and benefits of teamwork	5	CO6	L2
20	Describe the ways to overcome the barrier of expectation and conflicts within a group	5	CO6	L2
21	Explain about managing team performances	5	CO6	L2
22	A group focuses on individual contribution, while a team focuses on synergy. Discuss	5	CO6	L2
23	Explain intrapreneurship and its characteristics	5	CO6	L2
MODULE 5				
1	Identify the differences between a leader and a boss	5	CO6	L1
2	List out the key elements of the leadership framework	5	CO6	L1
3	Identify and explain the major personality traits of leaders	5	CO6	L1
4	Recall the differences between transactional and transformational leadership	5	CO6	L1
5	Identify the 4 basic steps to grow as a leader	5	CO6	L1
6	Define the 5 levels of leadership	5	CO6	L1
7	Define leadership Grid with examples	5	CO6	L1
8	List the personality traits of effective leader	5	CO6	L1
9	Identify the role of leaders in managing diverse stakeholders successfully.	5	CO6	L1
10	Explain leadership skill and its characteristics	5	CO6	L2
11	'Management is doing things right; leadership is doing the right things'. Discuss	5	CO6	L2
12	Briefly explain different leadership styles	5	CO6	L2
13	Explain Entrepreneurial leadership	5	CO6	L2
14	Describe turnaround leadership.	5	CO6	L2
15	Describe the strategies and qualities of turnaround leadership.	5	CO6	L2
16	Explain and elaborate the term VUCA LEADERSHIP	5	CO6	L2
17	Discuss leadership styles that are effective for successful management of multicultural groups and teams.	5	CO6	L2
18	Explain the 5 principles of moral leadership?	5	CO6	L2
CASE STUDY-SAMPLE				
	Read carefully the following case and answer the questions given below Rita and her family moved to the city from a remote community in the middle	25		

	off the school year. Within a week, Rita was registered at the local high school and began attending classes. She travelled to and from school by school bus. After two weeks at the new school, Rita was just beginning to settle into her classes. However, she was somewhat nervous about her history course. After her first class, the teacher made it clear that Rita had a lot of “catching up” to do, if she were to pass the course. The following week, some students gave a presentation on Columbus' voyage in 1492 to the “New World.” There was lively discussion, and readings and prints were circulated depicting Columbus' arrival in various territories. There were several references made to “Indians and savages” that the colonists “had to defeat” to settle the New World. As a member of the Cree Band, Rita was dismayed by the way the teacher did not question the portrayal of Aboriginal persons in the presentation. She approached her teacher before class the next day to discuss the issue. As the class began, the teacher announced that Rita had concerns with the Columbus presentation. She then turned to Rita and asked her to give her version of the “Columbus discovery” from an Aboriginal point of view. Caught off guard, Rita haltingly made several points, and then sat down quickly when several of the students began to snicker. Later that day on the bus ride home, some of the other students jeered at her, saying if she didn't like history the way it was taught, then she should drop out. She turned away and ignored them. The next day, the jeering continued in the hallway. When she went to her locker at lunch, someone had scrawled the words “gone hunting” on her locker door. Again, she ignored the curious students around her. Rita told her parents about the incidents. They called the principal, who said she would give “hell” to the offenders. She also suggested that Rita should make more of an effort to fit in and get along with others a) Who are the characters in this story? Describe each one's characteristics. b) Determine the issues Rita is dealing with. Do you agree with how she handled the situation? Offer a suggestion about how to manage it. c) Describe the attitude of Rita's classmates. d) How should the teacher have handled Rita's concern over the Columbus presentation? Evaluate the approach in term of professionalism. e) Consider yourself in Rita's role, suggest some life skills to overcome such situations in life.			

Prepared By : Merrina Margaret

Checked By : Rose Paul

Course Code & Name: PHL120 Engineering Physics Lab**1. Prescribed Syllabus**

Experiment	Topic	Hours
1	CRO-Measurement of frequency and amplitude of wave forms	3
2	Measurement of strain using strain gauge and wheatstone bridge	3
3	LCR Circuit – Forced and damped harmonic oscillations	3
4	Meld's string apparatus- Measurement of frequency in the transverse and longitudinal mode	3
5	Wave length measurement of a monochromatic source of light using Newton's Rings method.	3
6	Determination of diameter of a thin wire or thickness of a thin strip of paper using air wedge method.	3
7	To measure the wavelength using a millimetre scale as a grating.	3
8	Measurement of wavelength of a source of light using grating.	3
9	Determination of dispersive power and resolving power of a plane transmission grating	3
10	Determination of the particle size of lycopodium powder	3
11	Determination of the wavelength of He-Ne laser or any standard laser using diffraction grating	3
12	Calculate the numerical aperture and study the losses that occur in optical fibre cable.	3
13	I-V characteristics of solar cell.	3
14	LED Characteristics.	3
15	Ultrasonic Diffractometer- Wavelength and velocity measurement of ultrasonic waves in a liquid	3
16	Deflection magnetometer-Moment of a magnet- Tan A position.	3

2. Text Books (T)

Lab Manual

3. Reference Books (R)

- R1. S.L.Gupta and Dr.V.Kumar, "Practical physics with viva voice", Pragati Prakashan Publishers, Revised Edition, 2009
R2. M.N.Avadhanulu, A.A.Dani and Pokely P.M, "Experiments in Engineering Physics", S.Chand&Co,2008
R3. S. K. Gupta, "Engineering physics practical's", Krishna Prakashan Pvt. Ltd., 2014 R4. P. R. Sasikumar "Practical Physics", PHI Ltd., 2011.

4. Course Objectives

This course is designed (i) to impart practical knowledge about some of the phenomena they have studied in the Engineering Physics course and (ii) to develop the experimental skills of the students.

5. Course Pre / Co-requisite

Higher secondary level Physics

6. Course Outcomes

After completion of the course, student will be able to

- CO1. Develop analytical/experimental skills and impart prerequisite hands-on experience for engineering laboratories.
- CO2. Understand the need for precise measurement practices for data recording.
- CO3. Understand the principle, concept, working and applications of relevant technologies and comparison of results with theoretical calculations
- CO4. Analyze the techniques and skills associated with modern scientific tools such as lasers and fibre optics
- CO5. Develop basic communication skills through working in groups in performing the laboratory experiments and by interpreting the results

7. Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes

PO/ CO	PO 1	PO 2	PO 3	PO 4	PO5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO 3
CO1	H				H			L	M			L		H	
CO2	H				H			L	M			L		H	
CO3	H				H			L	M			L		H	
CO4	H				H			L				L		H	
CO5	H				H			L	M			L		H	

8. Justification for CO-PO-PSO Correlation

CO	PO/PSO	Justification
CO1	PO1	Develop analytical/experimental skills and impart prerequisite hands on experience for engineering laboratories based on the knowledge of mathematics and engineering fundamentals helps to solve complex engineering problems
	PO5	Analytical/experimental skills in engineering laboratories can be used for the creation of engineering and IT tools helps to create select and apply appropriate techniques
	PO8	Develop analytical/experimental skills and impart prerequisite hands-on experience for engineering laboratories helps to apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practices
	PO9	Develop analytical/experimental skills and impart prerequisite hands on experience for engineering laboratories helps to function effectively as an individual and a member in diverse teams and in multidisciplinary settings
	PO12	Develop analytical/experimental skills and impart prerequisite hands on experience for engineering laboratories help to recognize the need for engaging independent and lifelong

	learning the broadest context of technological knowledge
PO1	Understand the need for precise measurement practices for data recording based on the knowledge of mathematics and engineering fundamentals helps to solve complex engineering problems;
PO5	Understand the need for precise measurement practices for data recording helps to create ,select and apply appropriate techniques
PO8	Understand the need for precise measurement practices for data recording helps to apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practices
PO9	Understand the need for precise measurement practices for data recording helps to function effectively as an individual and a member in diverse teams and in multidisciplinary settings
PO12	Understand the need for precise measurement practices for data recording help to recognize the need for engaging independent and lifelong learning the broadest context of technological knowledge
PO1	Understand the principle, concept, working and applications of relevant technologies and comparison of results with theoretical calculations to solve complex engineering problems
PO5	Understand the principle, concept, working and applications of relevant technologies and comparison of results with theoretical calculations helps to formulate and analyse complex engineering problems helps to create ,select and apply appropriate techniques
PO8	Understand the principle, concept, working and applications of relevant technologies and comparison of results with theoretical calculations helps to apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practices
PO9	Understand the principle, concept, working and applications of relevant technologies and comparison of results with theoretical helps to function effectively as an individual and a member in diverse teams and in multidisciplinary settings
PO12	Understand the principle, concept, working and applications of relevant technologies and comparison of results with theoretical calculations help to recognize the need for engaging independent and lifelong learning the broadest context of technological knowledge
PO1	Analyze the techniques and skills associated with modern scientific tools such as lasers and Fibre optics will help to solve complex engineering problems.
PO5	Analyze the techniques and skills associated with modern scientific tools such as lasers and fibre optics helps to create ,select and apply appropriate techniques

PO8	Analyze the techniques and skills associated with modern scientific tools such as lasers and fibre optics helps to apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practices
PO9	Analyze the techniques and skills associated with modern scientific tools such as lasers and fibre optics helps to function effectively as an individual and a member in diverse teams and in multidisciplinary settings
PO12	Analyze the techniques and skills associated with modern scientific tools such as lasers and fibre optics help to recognize the need for engaging independent and lifelong learning the broadest contest of technological knowledge
PO1	Develop basic communication skills through working in groups in performing the laboratory experiments and by interpreting the results helps to solve complex engineering problems
PO5	Develop basic communication skills through working in groups in performing the laboratory experiments and by interpreting the results helps to analyse and formulate engineering problems helps to create, select and apply appropriate techniques
PO8	Develop basic communication skills through working in groups in performing the laboratory experiments and by interpreting the results helps to apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practices
PO9	Develop basic communication skills through working in groups in performing the laboratory experiments and by interpreting the results helps to function effectively as an individual and a member in diverse teams and in multidisciplinary settings
PO12	Develop basic communication skills through working in groups in performing the laboratory experiments and by interpreting the results help to recognize the need for engaging independent and lifelong learning the broadest contest of technological knowledge

9. Curricular gaps (if any)

Nil

10. Course Enrichment Activities*

Sl No	Description	Proposed Activities **	Relevance to POs and PSOs
1.	NIL		

11. Internal Assessment mark allocation (as per university curriculum)

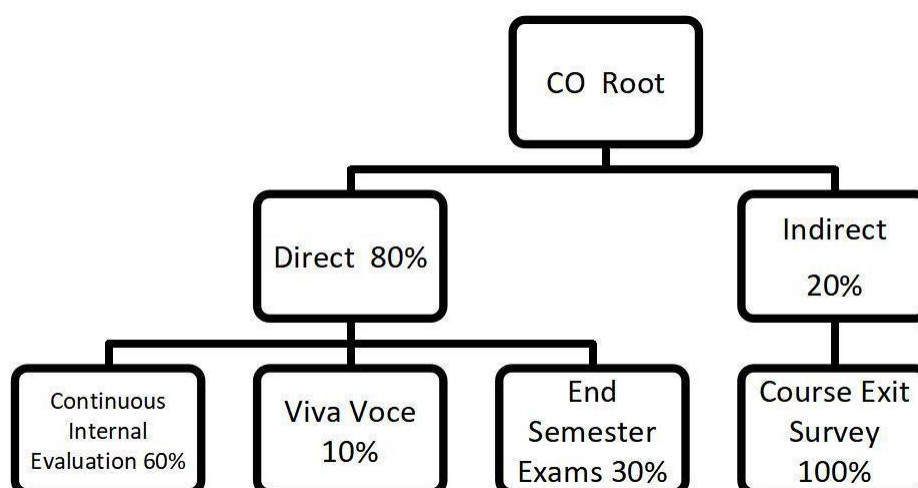
(Provide details as mentioned in syllabus)

Attendance	- 10 marks
Continuous Assessment Test	-25 marks
Assignment (s)/ Course Project	- 15 marks
Total	- 50 marks

12. Assessment – CO Mapping (Put 'x' if mapping is present)

	Tools	Weightage [#]	CO 1	CO 2	CO 3	CO 4	CO 5
Direct Assessment Tools**	Continuous Evaluation - Experiment wise CO mapping	60%	x	x	x	x	x
	Viva – Voce - Experiment wise CO mapping	10%	x	x	x	x	x
	End Semester Exam	30%	x	x	x	x	x
Indirect Assessment Tool	Course Exit Survey	100%	x	x	x	x	x

13. Assessment Configuration



14. Course Plan

Weeks(W)	Experiments	Relevance to COs
1	CRO-Measurement of frequency and amplitude of wave forms.	CO 1
2	Melde's string apparatus- Measurement of frequency in the transverse and longitudinal mode	CO2
3	Wave length measurement of a monochromatic source of light using Newton's Rings method.	CO2
4	Determination of diameter of a thin wire or thickness of a thin strip of paper using air wedge method.	CO2
5	Measurement of wavelength of a source of light using grating.	CO2

6	Determination of the wavelength of He-Ne laser or any standard laser using diffraction grating	CO5
7	I-V characteristics of solar cell.	CO4
8	Determination of dispersive power and resolving power of a plane transmission grating	CO2

Prepared By: Ms. Sreeja C

Checked By: Ms. Dhanya George P

Course Code & Name: ESL130 Electrical and Electronics Workshop

1. Prescribed Syllabus

Experiments	Topic	Hours
Electrical Workshop (Minimum 7 Experiments to be done)		
1	Demonstrate the precautionary steps adopted in case of Electrical shocks. Identify different types of cables, wires, switches, fuses, fuse carriers, MCB, ELCB and MCCB, familiarize the ratings.	3
2	Wiring of a simple light circuit for light/ fan point (PVC conduit wiring) and a 6A plug socket with individual control.	3
3	Wiring of light/fan circuit using two-way switches. (Staircase wiring)	3
4	Wiring of fluorescent lamp and a power plug (16 A) socket with a control switch.	3
5	Wiring of power distribution arrangement using single phase MCB distribution board with ELCB, main switch and Energy meter.	3
6	Familiarization of step up and step-down transformers, (use low voltage transformers) Measurement and representation of voltage and waveform to scale in graph sheet with the help of CRO	3
7	Familiarization of rheostats, measurement of potential across resistance elements and introducing the concept of relative potential using a DC circuit.	3
List of Electronics Experiments ((Minimum of 7 mandatory)		
1	Familiarization/Identification of electronic components with specification (Functionality, type, size, colour coding, package, symbol, cost etc. [Active, Passive, Electrical, Electronic, Electro-mechanical, Wires, Cables, Connectors, Fuses, Switches, Relays, Crystals, Displays, Fasteners, Heat sink etc.)	3
2	Drawing of electronic circuit diagrams using BIS/IEEE symbols and introduction to EDA tools (such as Dia or Xcircuit), Interpret data sheets of discrete components and IC's, Estimation and costing.	3
3	Familiarization/Application of testing instruments and commonly used tools. [Multimeter, Function generator, Power supply, CRO etc.] [Soldering iron, De-soldering pump, Pliers, Cutters, Wire strippers, Screw drivers, Tweezers, Crimping tool, Hot air soldering and de-soldering station etc.]	3
4	Testing of electronic components [Resistor, Capacitor, Diode, Transistor and JFET using Multimeter]	3

5	Inter-connection methods and soldering practice. [Bread board, Wrapping, Crimping, Soldering - types - selection of materials and safety precautions, soldering practice in connectors and general-purpose PCB, Crimping.]	3
6	Printed circuit boards (PCB) [Types, Single sided, Double sided, PTH, Processing methods, Design and fabrication of a single sided PCB for a simple circuit with manual etching (Ferric chloride) and drilling.]	3
7	Assembling of electronic circuits using SMT (Surface Mount Technology) stations. Assembling of electronic circuit/system on general purpose PCB, test and show the functioning (Any Two circuits). 1. Fixed voltage power supply with transformer, rectifier diode, capacitor filter, Zener/IC regulator. 2. Square wave generation using IC 555 timer in IC base. 3. Sine wave generation using IC 741 OP-AMP in IC base. 4. RC coupled amplifier with transistor BC 107.	3

2. Textbooks (T)

- T1. Electrical Design Estimating and Costing, K B Raina and S K Bhattacharya, New Age International Publishers, 2/e 2024.
T2. Electrical Systems Design, M K Giridharan, I K International Publishing House Pvt. Ltd, 3/e 2022.
T3. Basic Electrical Engineering, D P Kothari and I J Nagrath, Tata McGraw Hill, 4/e 2019.
T4. Bell, D. A., Electronic Devices and Circuits, Oxford University Press
T5. Basics of Soldering, Armin Rahn.

3. Reference Books (R)

- R1. R. P. Singh, Electrical Workshop: Safety, Commissioning, Maintenance & Testing of Electrical Equipment, I K International Publishing House
R2. Sunil S. Rao, R. K. Jain, H. L. Saluja, Electrical Safety, Fire Safety Engineering and Safety Management
R3. Hari Mohan Johri, Electrical Installations in Building, KW Publishers
R4. Boylested, R. L. and Nashelsky, L., Electronic Devices and Circuit Theory, Pearson education
R5. N. N. Bhargava, Basic Electronics and Linear Circuits R6. J B Gupta, Electronics Devices and Circuits
R7. Ramakanth A Gayakwad, Op-amps and Linear Integrated Circuits.

4. Course Objectives

- To create awareness and familiarity with electrical wiring and safety measures to be taken.
- This course gives the basic introduction of electronic hardware systems.
- Provides hands-on training with familiarization, identification, testing, assembling, dismantling, fabrication and repairing such systems by making use of the various tools and instruments available in the Electronics Workshop.

5. Course Pre / Co-requisite

Nil

6. Course Outcomes

After completion of the course, student will be able to

- CO1. Demonstrate safety measures against electric shocks.
- CO2. Identify the tools used for electrical wiring, electrical accessories, wires, cables, batteries and standard symbols
- CO3. Develop the connection diagram, identify the suitable accessories and materials necessary for wiring simple lighting circuits for domestic buildings
- CO4. Identify and test various electronic components.
- CO5. Draw circuit schematics with EDA tools.
- CO6. Assemble and test electronic circuits on boards.
- CO7. Work in a team with good interpersonal skills.

7. Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes

PO/ CO	PO 1	PO 2	PO 3	PO 4	PO5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO 3
CO1						H						L			
CO2	M									L			L		
CO3	M			L		L		L	M	M		M	L	L	
CO4	H											M	H		
CO5	H				M							M	H		
CO6	H				M							L	H		

8. Justification for CO-PO-PSO Correlation

CO	PO/PSO	Justification
CO1	PO6	Apply the knowledge obtained from the practical course for the societal safety against electric shocks.
	PO12	Able to explore different protective measures and techniques against electric shock and thus to get engaged in life-long learning.
CO2	PO1	Apply the knowledge about the types of wires, accessories, batteries and standard symbols to put forward innovative solutions in electrical wiring.
	PO10	Suggest suitable electrical wires, battery, cables etc. for specific needs of the society.
	PSO1	Demonstrate safety measures against electric shocks by applying fundamental knowledge in Electrical and Electronics Engineering.
	PO1	Design wiring system for domestic buildings and by that to apply the knowledge of engineering fundamentals.

CO3	PO4	Analyze and provide solutions related to domestic wiring and thereby enhancing the capability to conduct investigations of complex problems.
	PO6	Able to identify the cost effective and safe measures of wiring practices for the society.
	PO8	Able to understand the responsibilities and ethical principles behind the wiring practices involved in domestic buildings.
	PO9	Able to work in team to design, estimate and wire the simple lighting circuits enables a student to be an effective team player.
	PO10	Able to write effective reports about the wiring practices of domestic buildings and there by permitting student to effectively communicate, comprehend and write effective reports about the wiring practices of domestic buildings.
	PO12	Able to recognize the need of cost and material estimation and apply it in surrounding buildings and thus to engage in lifelong learning.
	PSO1	Develop the connection diagram, identify the accessories and materials necessary for wiring using fundamental knowledge in Electrical and Electronics engineering.
	PSO2	Identify the accessories and materials necessary for wiring by analyzing components and processes.
CO4	PO1	Understanding the fundamentals of various active and passive components will help the students to identify and test various electronic components. Hence a high correlation is given.
	PO12	Knowledge in basic concepts of active and passive components will encourage students to design advanced electronics hardware circuits. Hence a medium correlation is given.
	PSO1	Understanding the fundamentals of various active and passive components will help students to apply contextual knowledge of Electronics and Communication Engineering in development of various electronic systems. Hence a high correlation is given
CO5	PO1	Understanding the fundamentals of various electronic components will help students to draw schematics with EDA tools. Hence a high correlation is given.
	PO5	By selecting appropriate modern engineering tools students will be able to draw schematics and understand its limitations. Hence a medium correlation is given.
	PO12	Knowledge of use of schematics with EDA tools will encourage students to engage in independent and lifelong learning in context of technological change. Hence a medium correlation is given.
	PSO1	Understanding the circuit schematics with EDA tools will help students to apply contextual knowledge of Electronics and Communication Engineering in the design of various electronic systems. Hence a high correlation is given.
	PO1	Understanding the fundamentals of various components will help the students to assemble and test electronic circuits on boards. Hence a high

	correlation is given.
PO5	By selecting appropriate resources and modern engineering tools, students will be able to assemble and test electronic circuits. Hence a medium correlation is given.
PO12	Knowledge of assembly and testing of electronic circuit components will encourage students to engage in independent and lifelong learning. Hence a low correlation is given.
PSO1	By assembling and testing electronic circuits on boards will help students to apply contextual knowledge of Electronics and Communication Engineering in development of various electronic systems. Hence a high correlation is given.
PO9	Conduct of experiments individually and in groups will enable students to function effectively as a member of a team or as a team leader. Hence a high correlation is given.
PO10	Preparation of lab reports with reference to standard specifications and developing effective interpersonal communication skills will help students to prepare effective reports in real time projects and in making effective presentations. Hence a medium correlation is given.
PO12	Working in a team and developing good interpersonal skills will encourage students to engage in life-long learning of changes and advancements in technology. Hence a medium correlation is given.

9. Curricular gaps (if any)

Nil

10. Course Enrichment Activities*

Sl No	Description	Proposed Activities	Relevance to POs and PSOs
1	Nil		

11. Internal Assessment mark allocation (as per university curriculum)

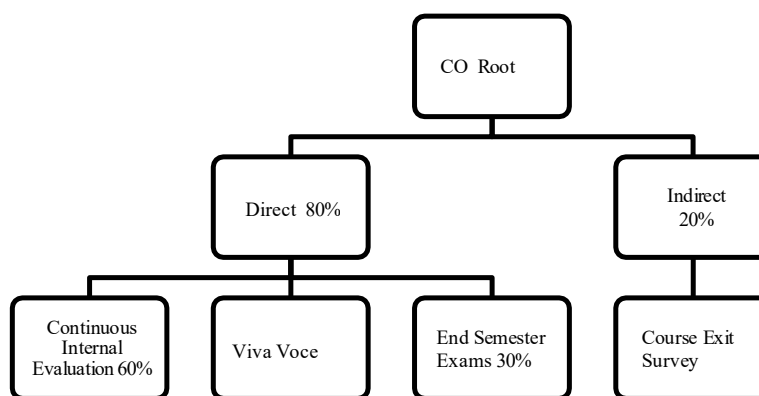
(Provide details as mentioned in syllabus)

Classwork/Assessment/Viva voce	- 50 marks
Attendance	- 20 marks
<u>End Semester Examination</u>	<u>- 30 marks</u>
Total	-100 marks

12. Assessment – CO Mapping (Put ‘x’ if mapping is present)

	Weightage [#]	Weightage	CO1	CO2	CO3	CO4	CO5	CO6	CO7
Direct Assessment Tools**	Viva	10%	x	x	x	x	x	x	x
	Classwork/ Assessment	60%	x	X	x	x	x	x	x
	End Semester Exam	30%	x	x	x	x	x	x	x
Indirect Assessment Tool	Course Exit Survey	100%	x	x	x	x	x	x	x

13. Assessment Configuration



14. Course Plan

Weeks (W)	Experiments	Relevance to COs
Electrical Workshop		
1	a) Demonstrate the precautionary steps adopted in case of Electrical shocks. b) Identify different types of cables, wires, switches, fuses, fuse carriers, MCB, ELCB and MCCB, familiarize the ratings.	CO1
2	Wiring of a simple light circuit for light/ fan point (PVC conduit wiring) and a 6A plug socket with individual control.	CO3, CO7
3	Wiring of light/fan circuit using two-way switches. (Staircase wiring)	CO3, CO7
4	Wiring of fluorescent lamp and a power plug (16 A) socket with a control switch.	CO3, CO7

5	Wiring of power distribution arrangement using single phase MCB distribution board with ELCB, main switch and Energy meter.	CO3, CO7
6	Familiarization of rheostats, measurement of potential across resistance elements and introducing the concept of relative potential using a DC circuit.	CO2, CO7
7	a) Identify battery specifications using different types of batteries. (Lead acid, Li Ion, NiCd etc.) b) Familiarize different types of earthing (Pipe, Plate Earthing, Mat Schemes) and ground enhancing materials (GEM).	CO2
Electronics Experiments		
1	Familiarization/Identification of electronic components with specification (Functionality, type, size, color coding, package, symbol, cost etc.)	CO4, CO7
2	Drawing of electronic circuit diagrams using BIS/IEEE symbols and introduction to EDA tools (such as Dia or Xcircuit), Interpret data sheets of discrete components and IC's, Estimation and costing.	CO5, CO7
3	Familiarization/Application of testing instruments and commonly used tools. [Multimeter, Function generator, Power supply, CRO etc.] [Soldering iron, De-soldering pump, Pliers, Cutters, Wire strippers, Screw drivers, Tweezers, Crimping tool, Hot air soldering and de-soldering station etc.]	CO4, CO7
4	Testing of electronic components [Resistor, Capacitor, Diode, Transistor and JFET using Multimeter]	CO4, CO7
5	Inter-connection methods and soldering practice. [Bread board, Wrapping, Crimping, Soldering - types - selection of materials and safety precautions, soldering practice in connectors and general-purpose PCB, Crimping.]	CO6, CO7
6	Printed circuit boards (PCB) [Types, Single sided, Double sided, PTH, Processing methods, Design and fabrication of a single sided PCB for a simple circuit with manual etching (Ferric chloride) and drilling.]	CO6, CO7
7	Assembling of electronic circuits using SMT (Surface Mount Technology) stations.	CO6, CO7
8	Assembling of electronic circuit/system on general purpose PCB, test and show the functioning of fixed voltage power supply with transformer, rectifier diode, capacitor filter, Zener/IC regulator.	CO6, CO7
9	Assembling of electronic circuit/system on general purpose PCB, test and show the functioning of square wave generation using IC 555 timer in IC base.	CO6, CO7
10	Assembling of electronic circuit/system on general purpose PCB, test and show the functioning of Sine wave generation using IC 741 OP-AMP in IC base.	CO6, CO7

11	Assembling of electronic circuit/system on general purpose PCB, test and show the functioning of RC coupled amplifier with transistor BC 107.	CO6, CO7

Prepared By: Neethu Varghese, Lakshmi Babu

Checked By: Ambily Joseph

Semester: 2

CONTENTS

SLOT	COURSE CODE	COURSES	L-T-P	HOURS	CREDIT
A	MAT 102	VECTOR CALCULUS, DIFFERENTIAL EQUATIONS AND TRANSFORMS	3-1-0	4	4
B	CYT 100	ENGINEERING CHEMISTRY	3-1-0	4	4
C	EST 110	ENGINEERING GRAPHICS	2-0-2	4	3
D	EST 120	BASICS OF CIVIL & MECHANICAL ENGINEERING	4-0-0	4	4
E	HUT 102	PROFESSIONAL COMMUNICATION	2-0-2	4	--
F	EST 102	PROGRAMMING IN C	2-1-2	5	4
S	CYL 120	ENGINEERING CHEMISTRY LAB	0-0-2	2	1
T	ESL 120	CIVIL & MECHANICAL WORKSHOP	0-0-2	2	1

Course Code & Name: MAT102 Vector Calculus, Differential Equations and Transforms

1. Prescribed Syllabus

Module	Topic	Hours
1	Vector valued function of single variable, derivative of vector function and geometrical interpretation, motion along a curve-velocity, speed and acceleration. Concept of scalar and vector fields, Gradient and its properties, directional derivative, divergence and curl, Line integrals of vector fields, work as line integral, Conservative vector fields, independence of path and potential function (results without proof).	9
2	Green's theorem (for simply connected domains, without proof) and applications to evaluating line integrals and finding areas. Surface integrals over surfaces of the form $z = g(x, y)$, $y = g(x, z)$ or $x = g(y, z)$, Flux integrals over surfaces of the form $z = g(x, y)$, $y = g(x, z)$ or $x = g(y, z)$, divergence theorem (without proof) and its applications to finding flux integrals, Stokes' theorem (without proof) and its applications to finding line integrals of vector fields and work done.	9
3	Homogenous linear differential equation of second order, superposition principle, general solution, homogenous linear ODEs with constant coefficients-general solution. Solution of Euler-Cauchy equations (second order only). Existence and uniqueness (without proof). Non homogenous linear ODEs-general solution, solution by the method of undetermined coefficients (for the right-hand side of the form $x^n, e^{kx}, \sin ax, \cos ax, e^{kx} \sin ax, e^{kx} \cos ax$ and their linear combinations), methods of variation of parameters. Solution of higher order equations-homogeneous and non-homogeneous with constant coefficient using method of undetermined coefficient.	9
4	Laplace Transform and its inverse, Existence theorem (without proof), linearity, Laplace transform of basic functions, first shifting theorem, Laplace transform of derivatives and integrals, solution of differential equations using Laplace transform, Unit step function, Second shifting theorems. Dirac delta function and its Laplace transform, Solution of ordinary differential equation involving unit step function and Dirac delta functions. Convolution theorem (without proof) and its application to finding inverse Laplace transform of products of functions	10
5	Fourier integral representation, Fourier sine and cosine integrals. Fourier sine and cosine transforms, inverse sine and cosine transform. Fourier transform and inverse Fourier transform, basic properties. The Fourier transforms of derivatives. Convolution theorem (without proof)	8

2. Text Books (T)

T1. H. Anton, I. Biven S.Davis, "Calculus", Wiley, 10th edition, 2015.

T2. Erwin Kreyszig, "Advanced Engineering Mathematics", Wiley, 10th edition, 2015.

3. Reference Books (R)

- R1. J. Stewart, Essential Calculus, Cengage, 2nd edition, 2017
R2. G.B. Thomas and R.L. Finney, Calculus and Analytic geometry, 9th Edition, Pearson, Reprint, 2002.
R3. Peter O Neil, Advanced Engineering Mathematics, 7th Edition, Thomson, 2007.
R4. Louis C Barret, C Ray Wylie, “Advanced Engineering Mathematics”, Tata McGraw Hill, 6th edition, 2003.
R5. Veerarajan T.” Engineering Mathematics for first year”, Tata McGraw - Hill, 2008
R6. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 36th edition, 2010.
R7. Srimanta Pal, Subodh C. Bhunia, “Engineering Mathematics”, Oxford University Press, 2015
R8. Ronald N. Bracewell, “The Fourier Transform and its Applications”, McGraw – Hill International Editions, 2000.

4. Course Objectives

This course introduces the concepts and applications of differentiation and integration of vector valued functions, differential equations, Laplace and Fourier Transforms. The objective of this course is to familiarize the prospective engineers with some advanced concepts and methods in Mathematics which include the Calculus of vector valued functions, ordinary differential equations and basic transforms such as Laplace and Fourier Transforms which are invaluable for any engineer’s mathematical tool box. The topics treated in this course have applications in all branches of engineering.

5. Course Pre / Co-requisite

Calculus of single and multi variable functions.

6. Course Outcomes

After the completion of the course the student will be able to

CO1: Compute the derivatives and line integrals of vector functions and learn their applications

CO2: Evaluate surface and volume integrals and learn their inter-relations and applications.

CO3: Solve homogeneous and non-homogeneous linear differential equation with constant coefficients

CO4: Compute Laplace transform and apply them to solve ODEs arising in engineering

CO5: Determine the Fourier transforms of functions and apply them to solve problems arising in engineering

7. Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes

PO/ CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	H	H	M	L			L	M		M
CO2	H	H	H	H	M	L			L	M		M
CO3	H	H	H	H	M	L			L	M		M
CO4	H	H	H	H	M	L			L	M		M
CO5	H	H	H	H	M	L			L	M		M

8. Justification for CO-PO-PSO Correlation

	PO1	Concept of calculus of vector valued functions will help to solve problems in Engineering
	PO2	The concept of derivatives and line integrals of vector functions can be used to identify, formulate and analyse complex engineering problems

CO1	PO3	The concept of derivatives and line integrals of vector functions and their applications can be used to design solutions for complex engineering problems
	PO4	The concept of derivatives and line integrals of vector functions and their applications can be used to conduct investigation of complex problems including design of experiments, analysis and interpretation of data to provide valid conclusions
	PO5	The concept of derivatives and line integrals of vector functions and their applications can be used to create, select and apply appropriate techniques, modern engineering and IT tools including prediction and modelling to complex engineering activities
	PO6	The concept of derivatives and line integrals of vector functions and their applications can be used to assess the issues related to society
	PO9	The knowledge of derivatives and line integrals of vector functions and their applications will help the individual to function effectively in diverse teams
	PO10	The concept of derivatives and line integrals of vector functions and their applications will help to communicate effectively on complex engineering activities
	PO12	The concept of derivatives and line integrals of vector functions and their applications will help to recognise the need for independent and lifelong learning in the broadest context of technological knowledge
CO2	PO1	Basic knowledge in finding area and volume using multiple integrals can be used to solve Engineering problems
	PO2	Theory of multiple integrals can be used to analyse complex Engineering problems
	PO3	The concept of finding area and volume using multiple integrals can be used to design solutions of complex engineering problems
	PO4	The concept of finding area and volume using multiple integrals can be used to conduct investigations of complex problems involving the synthesis of data to provide valid conclusions
	PO5	The concept of finding area and volume using multiple integrals can be used to create and select appropriate techniques and model complex engineering activities with an understanding of the limitations

	PO6	The concept of finding area and volume using multiple integrals will help to apply reasoning to assess issues and responsibilities relevant to the professional engineering practice
	PO9	The knowledge of multiple integrals enhances the leadership quality of students before entering into team works
	PO10	The concept of finding area and volume using multiple integrals will help to communicate effectively on complex engineering activities with the engineering community
	PO12	Theory of multiple integrals can be used and applied in the future course of action
CO3	PO1	Fundamental knowledge of methods of solving differential equations will help to simplify several problems in Engineering
	PO2	Methods of solving differential equations will help to formulate problems with high complexity in Engineering.
	PO3	Solution of homogeneous and non-homogeneous differential equations are used to design solutions for complex engineering problems
	PO4	Solution of homogeneous and non-homogeneous differential equations are used to conduct investigation of complex problems
	PO5	Various methods of solving differential equations will help to select appropriate techniques in complex engineering activities.
	PO6	The concept of differential equations will help to assess the issues related to society
	PO9	Various methods of solving differential equations will help to function effectively as an individual and a member in diverse teams
	PO10	Methods of solving differential equations will help to communicate effectively on complex engineering activities.
	PO12	Theory of differential equations will help to engage in independent and lifelong learning.
CO4	PO1	Knowledge of Laplace transforms is used to solve ODEs arising in engineering.
	PO2	The concept of Laplace transforms and its application to solve ODEs are used to find solutions of complex problems in the field of engineering.
	PO3	The concept of Laplace transforms and its application to solve ODEs are used to develop solutions for complex engineering problems.

	PO4	The concept of Laplace transforms and its application to solve ODEs are used to conduct investigation of complex problems involving analysis and interpretation of data to obtain valid conclusions.
	PO5	The concept of Laplace transforms and its application to solve ODEs are used to create, select and apply appropriate techniques, modern engineering and IT tools including prediction and modelling to complex engineering activities
	PO6	The concept of Laplace transforms and its application to solve ODEs are used to assess the issues related to the professional engineering society.
	PO9	The concept of Laplace transforms and its application to solve ODEs are used to function effectively as an individual and a member in diverse teams.
	PO10	The concept of Laplace transforms and its application to solve ODEs are used to communicate effectively, give, and receive instructions on complex engineering activities with the engineering community.
	PO12	The concept of Laplace transforms and its application to solve ODEs are used to recognise the need for independent and lifelong learning in the broadest context of technological knowledge.
CO5	PO1	Basic knowledge of Fourier transforms of functions will help to solve problems arising in engineering
	PO2	Fundamental knowledge Fourier transforms of functions will help to formulate and analyze problems with high complexity in Engineering.
	PO3	Theory of Fourier transforms of functions are used to design solutions for complex engineering problems
	PO4	The concept of Fourier transforms of functions are used to conduct investigation of complex problems
	PO5	Evaluation of Fourier transforms of functions will help to select appropriate techniques in complex engineering activities.
	PO6	The concept of Fourier transforms will help to assess the issues related to society
	PO9	Knowledge of Fourier transforms of functions will help to function effectively as an individual and a member in diverse teams
	PO10	Evaluation of Fourier transforms of functions will help to communicate effectively on complex engineering activities.
	PO12	Theory of Fourier transforms of functions will help to engage in independent and lifelong learning.

9. Curricular gaps (if any)

Nil

10. Course Enrichment Activities*

Nil

11. Internal Assessment mark allocation (as per university curriculum)

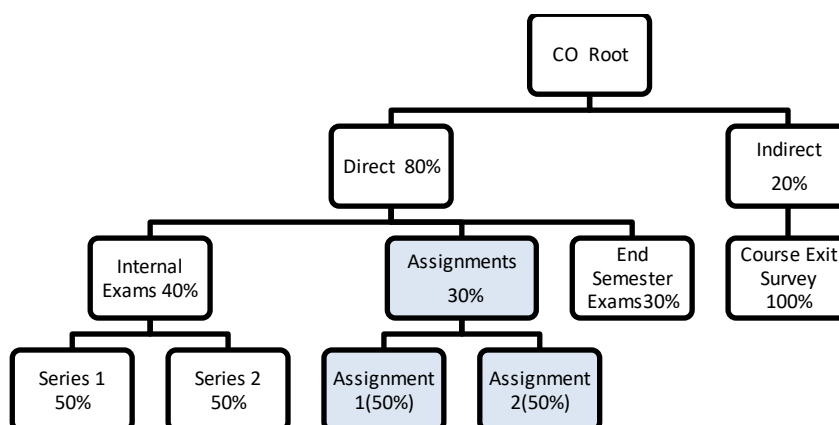
(Provide details as mentioned in syllabus)

Attendance	- 10 marks
Continuous Assessment Test	- 25 marks
<u>Assignment (s)/ Course Project</u>	<u>- 15 marks</u>
<u>Total</u>	<u>- 50 marks</u>

12. Assessment – CO Mapping (Put ‘ x’ if mapping is present)

	Tools		Weightage [#]	CO1	CO2	CO3	CO4	CO5
Direct Assessment Tools**	Internal Exam(s) 40%	Series 1	20%	x	x	x		
		Series 2	20%			x	x	x
	Assignment (s)/ Course Project /Quiz etc. 30%	Assignment 1	15%	x	x			
		Assignment 2	15%			x	x	x
	End Semester Exam		30%	x	x	x	x	x
Indirect Assessment Tool	Course Exit Survey		100%	x	x	x	x	x

13. Assessment Configuration



15. Question Bank

Module 1				
Sl. No	Question	Marks	CO	BL
1.	Prove that $\vec{F} = (x^2 - yz)i + (y^2 - xz)j + (z^2 - xy)k$ is irrotational	3	CO1	L1
2.	Show that $F(x, y) = 2xy^3i + 3x^2y^2j$ is conservative	3	CO1	L1
3	Confirm that $\phi(x, y, z) = x^2 - 3y^2 + 4z^3$ is a potential function for $F(x, y, z) = 2xi - 6yj + 12z^2k$	3	CO1	L2
4.	Find the divergence of the vector field $f(x, y, z) = x^2yi + 2y^3zj + 3zk$	3	CO1	L2
5.	Find the velocity, acceleration and speed of a particle moving along the curve $\vec{r} = (1 + 3t)\hat{i} + (3 - 4t)\hat{j} + (1 + 3t)\hat{k}$.	3	CO1	L2
6.	Find the workdone by the force field on a particle that moves along the curve $y^2 = x$ from (0,0) to (0,1)	3	CO1	L2
7.	Find the unit tangent vector at a point $t_0 = \frac{\pi}{6}$ to the curve $\vec{r}(t) = \cos 3t \hat{i} + \sin 3t \hat{j} + 3t \hat{k}$	3	CO1	L2
8.	Show that $\int_A^B (2xy + z^3)dx + x^2 dy + 3xz^2 dz$ is independent of the path joining the points A & B	3	CO1	L2
9.	Find the directional derivative of $f(x, y) = xe^y$ at (1,1) in the direction of $\hat{i} - \hat{j}$.	3	CO1	L2
10.	Find the directional derivative of the function $\phi = 3x^2y - y^3z^2$ at $(-1, -2, -1)$ in the direction of negative z axis.	3	CO1	L2
11.	Find the directional derivatives of $f(x, y) = x^2 - 3xy + y^2$ at the point P(2,1) in the direction of $\vec{a} = \frac{1}{3}\vec{i} + \frac{2}{3}\vec{j}$.	3	CO1	L2
12.	Evaluate $\int_C 3xy dy$ where C is the line segment joining (0,0) and (1,2).	3	CO1	L2
13.	If $F(x, y, z) = x^2i - 3j + yz^2k$, find $\text{div } \vec{F}$	3	CO1	L2
14.	Find the velocity and acceleration of a particle whose position vector is given by $\vec{r}(t) = e^t \vec{i} + e^{-t} \vec{j}$ at $t = 0$.	3	CO1	L2
15.	If C is the unit circle $x^2 + y^2 = 1$ oriented counter clockwise, find $\int_C x dx + y dy$.	3	CO1	L2
16.	Find the values of constants a, b, c so that $\vec{F} = (axy + bz^3)i + (3x^2 - cz)j + (3xz^2 - y)k$ may be irrotational. For these values of a, b, c find the scalar potential of $\vec{F}$	7	CO1	L2

17.	Find the divergence and curl of $\vec{F}(x, y, z) = x^2\vec{i} + y^3z\vec{j} + 3zk$	7	CO1	L2
18.	Prove that $\nabla^2(r^n) = n(n+1)r^{n-2}$, where $\vec{r} = x\vec{i} + y\vec{j} + z\vec{k}$	7	CO1	L3
19.	Find the work done by the force field $\vec{F}(x, y, z) = (x^2 + xy)\vec{i} + (y - x^2y)\vec{j}$ on a particle that moves along the curve $C: x = t, y = \frac{1}{t}, 1 \leq t \leq 3$	7	CO1	L3
20.	Determine whether $F(x, y) = 4y\vec{i} + 4x\vec{j}$ is a conservative vector field. If so, find the potential function and the potential energy.	7	CO1	L3
21.	Let $\vec{r} = x\vec{i} + y\vec{j} + z\vec{k}$ and let $r = \ \vec{r}\ $ and f be a differentiable function of one variable show that $\nabla f(r) = \frac{f'(r)}{r} \vec{r}$.	7	CO1	L3
22.	Evaluate the line integral $\int_C [-y dx + x dy]$ along $y^2 = 3x$ from (3,3) to (0,0)	7	CO1	L3
23.	Evaluate the line integral $\int_C (xy + z^3) ds$ from (1,0,0) to $(-1,0,\pi)$ along the helix C that is represented by the parametric equations $x = \cos t, y = \sin t, z = t$	7	CO1	L3
24.	Evaluate the line integral $\int_C (y - x) dx + x^2y dy$ along the curve $C, y^2 = x^3$ from (1, -1) to (1,1)	7	CO1	L3
25.	Find the work done by the force field $\vec{F} = (x + y)\vec{i} + xy\vec{j} - z^2\vec{k}$ along the line segment from (0,0,0) to (1,3,1) and then to (2, -1,5).	7	CO1	L3
26.	Show that $\vec{F} = (2xy + z^3)\vec{i} + x^2\vec{j} + 3xz^2\vec{k}$ is a conservative vector field. Also find its scalar potential.	7	CO1	L3
27.	Show that $\int_{(1,2)}^{(4,0)} 4y dx + 4x dy$ is independent of path and find its value.	7	CO1	L3
28.	Find the work done by $\vec{F}(x, y) = (x^2 + y^2)\vec{i} - x\vec{j}$ along the curve $C: x^2 + y^2 = 1$ counter clockwise from (1,0) to (0,1).	7	CO1	L3
29.	Find the divergence of the vector field $\vec{F} = \frac{c}{(x^2 + y^2 + z^2)^{3/2}} (x\vec{i} + y\vec{j} + z\vec{k})$	7	CO1	L3
30.	Evaluate $\int y dx + z dy + x dz$ along the path $x = \cos \pi t, y = \sin \pi t, z = t$ from (1,0,0) to (-1,0,1)	7	CO1	L3
31.	Use a line integral to evaluate the work done by the force field $\vec{F} = xy^2\vec{i} + xy\vec{j}$ along the triangle with vertices (0,0), (2,1) and (0,1) in the positive direction.	7	CO1	L3

32.	Use the given information to find the position and velocity vectors of the particle with acceleration $\vec{a}(t) = -\cos t \hat{i} - \sin t \hat{j}$, $\vec{v}(0) = \hat{i}$, $\vec{r}(0) = \hat{j}$	7	CO1	L3
33.	Evaluate $\int_C (xyz)dx - \cos(yz) dy$ where C is the straight line segment from $(1, 1, 1)$ to $(-2, 1, 3)$.	7	CO1	L3
34.	Show that the vector field $\vec{F}(x, y) = \cos y \hat{i} - x \sin y \hat{j}$ is conservative and find ϕ such that $\vec{F} = \nabla\phi$. Hence evaluate $\int_{(0,1)}^{(\pi,0)} \cos y dx - x \sin y dy$	7	CO1	L3
35.	Find the directional derivative of $\phi(x, y, z) = x^3 z - y x^2 + z^2$ at $(1, 1, 1)$ in the direction of $\vec{a} = 2\vec{i} - \vec{j} + 2\vec{k}$. Also find the maximum directional derivative.	7	CO1	L3
36.	Find the parametric equation of the tangent line to the graph $\vec{r}(t) = t^2 \vec{i} - \frac{1}{t+3} \vec{j} + (4-t^2) \vec{k}$ at $(4, -1, 0)$.	7	CO1	L3
37.	Using line integral evaluate $\int_C x^2 y dx + x dy$ where C is the triangular path connecting $(0, 0)$, $(1, 0)$ and $(1, 2)$ in the positive direction.	7	CO1	L3
38.	Find the parametric equation of the tangent line to the curve $\vec{r}(t) = 2 \cos \pi t \vec{i} + 2 \sin \pi t \vec{j} + 6t \vec{k}$ at the point $t = \frac{1}{3}$	7	CO1	L3
39.	Find the position and velocity vectors of the particle given $\vec{a}(t) = (t+1)^{-2} \vec{j} - e^{-2t} \vec{k}$, $\vec{v}(0) = 3\vec{i} - \vec{j}$, $\vec{r}(0) = \vec{k}$	7	CO1	L3
40.	If $\vec{r} = x\vec{i} + y\vec{j} + z\vec{k}$ and let $\vec{F}(r) = f(r) \vec{r}$ prove that $\text{div} \vec{F} = 3f(r) + \vec{r} \cdot \vec{f}'(r)$	7	CO1	L3

Module 2

Sl. No	Question	Marks	CO	BL
1.	State Green's theorem.	3	CO2	L1
2.	State Divergence theorem.	3	CO2	L1
3.	State Stoke's theorem.	3	CO2	L1
4.	Evaluate $\int_C \vec{F} \cdot d\vec{r}$ where $F(x, y) = \sin x \hat{i} + \cos x \hat{j}$ where C is the curve $r(t) = \pi t + t \hat{j}$, $0 \leq t \leq 2$	3	CO2	L2
5	Evaluate $\int_C (e^x dx + 2y dy - dz)$ where C is the curve $x^2 + y^2 = 4, z = 2$.	3	CO2	L2
6	Evaluate $\iint_S \vec{F} \cdot \vec{n} dS$ where S is the surface of the cylinder $x^2 + y^2 = 4, z = 0, z = 3$ where $\vec{F} = (2x - y)\vec{i} + (2y - z)\vec{j} + z^2 \vec{k}$	3	CO2	L2
7	Using Green's theorem evaluate $\int_C x dy - y dx$ where C is the circle $x^2 + y^2 = 4$	3	CO2	L2

8	Use line integral to find the area enclosed by the ellipse $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$	3	CO2	L2
9	If S is the surface of the sphere $x^2 + y^2 + z^2 = 1$ evaluate $\iint_S (xi + 2yj + 3zk) \cdot \hat{n} \, dS$	3	CO2	L2
10	Determine the source and sink of the vector field $\vec{F} = 2(x^3 - 2x)i + 2(y^3 - 2y)j + 2(z^3 - 2z)k$	3	CO2	L2
11	Use the Divergence theorem to find the outward flux of the vector field $F(x, y, z) = 2x i + 3y j + z^2 k$ across the unit cube.	3	CO2	L2
12	If σ is any closed surface enclosing a volume V and $F = 2xi + 2yj + 3zk$, Using Divergence theorem show that $\iint_{\sigma} F \cdot n \, dS = 7V$	3	CO2	L2
13	Determine the sources and sinks of the vector field $\vec{f}(x, y) = x^2 \vec{i} + y^2 \vec{j} + z^2 \vec{k}$.	3	CO2	L2
14	Using Divergence theorem evaluate $\iint_S \vec{f} \cdot \vec{n} \, dS$ where $\vec{f} = 2x\vec{i} + 4y\vec{j} - 3z\vec{k}$ and S is the surface of the sphere $x^2 + y^2 + z^2 = 1$	3	CO2	L2
15	Apply Stoke's theorem to evaluate $\int_C (x + y)dx + (2x - y)dy + (y + z)dz$ where C is the boundary of the triangle with vertices (0,0,0), (2,0,0), (0,3,0).	3	CO2	L2
16	Use Green's Theorem to evaluate $\int_C y^2 dx + x^2 dy$ where C is the square with vertices (0,0), (1,0), (1,1) and (0,1) oriented counter clockwise.	7	CO2	L2
17	Using Green's theorem to evaluate $\int_C (3x^2 - 8y^2)dx + (4y - 6xy)dy$ where C is the boundary of the region defined by $x=0, y=0, x+y=1$.	7	CO2	L2
18	Use Green's Theorem to evaluate $\int_C x^2 y dx + x dy$ along the triangular path joining (0,0), (1,0), (1,2).	7	CO2	L2
19	Verify Green's theorem for $\int_C (xy + y^2)dx + x^2 dy$ where C is bounded by $y=x$ and $y=x^2$	7	CO2	L2
20	Use Green's theorem to evaluate $\int_C (xy + y^2)dx + x^2 dy$ where C is the boundary of the region defined by $y=x^2$ and $x=y^2$.	7	CO2	L2
21	Use Green's theorem to evaluate $\int_C \log(1+y)dx - \frac{xy}{1+y} dy$ where C is the triangle with vertices (0,0), (2,0) and (0,4).	7	CO2	L2
22	Apply Green's theorem to evaluate the work done by the force field $\vec{F} = (e^x - y^3)i + (\cos y + x^3)j$ on a particle that travels once around the unit circle $x^2 + y^2 = 1$ in the counter clockwise direction.	7	CO2	L3
23	Using Divergence theorem evaluate $\iint_S F \cdot \hat{n} \, dS$ where $\vec{F} = x^3 i + y^3 j + z^3 k$ and S is the surface of the cylindrical solid bounded by $x^2 + y^2 = 4$, $z = 0, z = 4$.	7	CO2	L3
24	Verify Divergence theorem for $\vec{F} = x^2 i + zj + yzk$ taken over the cube bounded by $x = 0, x = 1, y = 0, y = 1, z = 0, z = 1$	7	CO2	L3
25	Use Stoke's theorem to evaluate $\int_C F \cdot dr$ where $\vec{F} = xyi + yzj + xzk$, C is the triangle in the plane $x + y + z = 1$ with vertices (1,0,0), (0,1,0) and (0,0,1) with counter clockwise orientation looking from the first octant towards the origin.	7	CO2	L3
26	Use Stoke's theorem to evaluate $\oint_C F \cdot dr$ where $\vec{F} = y^2 \vec{i} + x^2 \vec{j} - (x + z)\vec{k}$ and C is the boundary of the triangle with vertices (0,0,0), (1,0,0) and (1,1,0).	7	CO2	L3
27	Use Stoke's theorem to evaluate $\int_C F \cdot dr$ where $\vec{F} = xzi + 4x^2 y^2 j + yxk$, C is the rectangle $0 \leq x \leq 1, 0 \leq y \leq 3$ in the plane $z=y$.	7	CO2	L3
28	Use Stoke's theorem to find the work performed by the force field $\vec{F} = x^2 i + 4xy^3 j + y^2 xk$ on a particle that traverses the rectangle $0 \leq x \leq 1,$	7	CO2	L3

	$0 \leq y \leq 3$ in the plane $z=y$.			
29	Use Stoke's theorem to calculate the circulation around the bounding circle $x^2 + y^2 = 9$ and the force field $\vec{F} = yi - xj$, where S is the disk of radius 3 centred at origin in the XY plane.	7	CO2	L3
30	Use Stoke's Theorem to evaluate the work done by the force field $\vec{F}(x, y, z) = 3z\hat{i} + 4x\hat{j} + 2y\hat{k}$ over the boundary of the paraboloid $z = 4 - x^2 - y^2, z \geq 0$ with upward orientation.	7	CO2	L3
31	Let σ be the portion of the surface $z = 1 - x^2 - y^2$ that lies above the xy -plane and σ is the oriented upwards. Find the flux of the vector field	7	CO2	L3
32	Find the mass of the lamina that is the portion of the plane $x + y + z = 2$ lying in the first octant where the density function of the surface is $\sigma = xz$.	7	CO2	L3
33	Use Divergence theorem to find the outward flux of the vector field $\vec{F} = (2x + y^2)\vec{i} + xy\vec{j} + (xy - 2z)\vec{k}$ across the surface of the tetrahedron bounded by $x + y + z = 2$ and the coordinate planes.	7	CO2	L3
34	Find the flux of the vector field $\vec{F}(x, y, z) = x\vec{k}$ across the surface, the portion of the paraboloid $z = x^2 + y^2$ below the plane $z = 2y$ oriented by downward unit normal.	7	CO2	L3
35	Use Stokes theorem evaluate $\oint_C \vec{f} \cdot d\vec{r}$ where $\vec{f}(x, y, z) = (z - y)\vec{i} + (z + x)\vec{j} - (x + y)\vec{k}$ and C is the boundary of the paraboloid $z = 9 - x^2 - y^2$ above the XY -plane with upward orientation.	7	CO2	L3
36	Use Green's theorem to find the work done by the force field $\vec{f}(x, y) = xy\vec{i} + \left(\frac{x^2}{2} + xy\right)\vec{j}$ on a particle that starts at $(4,0)$ traverse the upper semicircle $x^2 + y^2 = 16$ and returns to its starting point along the x -axis.	7	CO2	L3
37	Find mass of the lamina that is a portion of cone $z = \sqrt{x^2 + y^2}$ that lies between the planes $z = 1$ and $z = 3$, if the density is $\phi(x, y, z) = x^2 z$	7	CO2	L3
38	Let σ be the portion of the surface $z = 1 - x^2 - y^2$ that lies above the xy -plane and σ is the oriented upwards. Find the flux of the vector field	7	CO2	L3
39	Use stokes theorem to evaluate $\oint_C \vec{F} \cdot d\vec{r}$ where $\vec{F}(x, y, z) = z^2\vec{i} + 3x\vec{j} - y^3\vec{k}$ and C is the circle $x^2 + y^2 = 1$ in the XY plane with counter clockwise orientation looking down the positive Z axis	7	CO2	L3
	Module 3			
Sl. No	Question	Marks	CO	BL

1.	Find the Wronskian of $e^{-x}\cos 5x, e^{-x}\sin 5x$	3	CO3	L2
2.	Show that e^{2x}, e^{3x} are linearly independent solutions of the differential equation $\frac{d^2y}{dx^2} - 5\frac{dy}{dx} + 6y = 0$. What is its general solution	3	CO3	L2
3.	Find a second order homogenous linear ODE for which e^{-x} , and e^{-2x} are the solutions	3	CO3	L2
4.	Solve the ODE $\frac{d^3y}{dx^3} - 4\frac{d^2y}{dx^2} + 5\frac{dy}{dx} - 2y = 0$	3	CO3	L2
5.	Find the general solution of $y'' - y = 0$	3	CO3	L2
6.	Does the function $y = c_1\cos x + c_2\sin x$ form a solution of $y'' + y = 0$. Is it the general solution? Justify your answer.	3	CO3	L2
7.	Find the general solution of $y''' - y'' + 4y' = 0$	3	CO3	L2
8.	Solve $(x^2D^2 + xD - 9)y = 0$	3	CO3	L2
9.	Solve the initial value problem $y'' + y = 0; y(0) = 3, y'(0) = 1$.	3	CO3	L2
10.	Find the Wronskian corresponding to the solution of $y'' - 3y' + 2y = 0$.	3	CO3	L2
11.	Solve the initial value problem $y'' + y' - 2y = 0, y(0) = 4, y'(0) = -5$.	3	CO3	L2
12.	Solve $y'''' + 10y'' + 9y = 0$.	3	CO3	L2
13.	Solve the initial value problem $y'' + 5y' + 6y = 0, y(0) = 1, y'(0) = 2$	3	CO3	L2
14.	Solve $y''' - y' = 0$	3	CO3	L2
15.	Solve the ODE $y''' - 3y'' - 4y' + 6y = 0$	7	CO3	L2
16.	Solve the IVP $y'' - 2y' + 5y = 0, y(0) = -3, y'(0) = 1$	7	CO3	L2
17.	Verify linear independence of $e^{-x}\cos x$ and $e^{-x}\sin x$ using Wronskian and hence solve the initial value problem $y'' + 2y' + y = 0, y(0) = 0, y'(0) = 15$	7	CO3	L2
18.	Show that the functions x and $\ln x$ are linearly independent. Hence form an ODE for the given basis $\{x, \ln x\}$	7	CO3	L2
19.	Solve $(D^2 + 3D + 2)y = 5$	7	CO3	L2
20.	Solve $y'' - 6y' + 9y = e^{3x}$	7	CO3	L2
21.	Solve using the method of undetermined coefficients $y'' - 7y' + 12y = e^{2x}, y(0) = 1, y'(0) = 2$.	7	CO3	L2
22.	Solve $y'' + y = \sin x$	7	CO3	L3
23.	Solve $y'' + 4y = 4\sec^2 2x$ by the method of variation of parameters.	7	CO3	L3
24.	Solve $y'' + 4y = \tan 2x$ by the method of variation of parameters.	7	CO3	L3
25.	Solve the IVP $y''' + 3y'' + 3y' + y = 30e^{-x}, y(0) = 3, y'(0) = -3, y''(0) = -47$	7	CO3	L3
26.	Solve $y'' + 4y' + 4y = x^2 + e^{-x}\cos x$	7	CO3	L3
27.	Solve $(D^2 - 4D + 4)y = \sin^2 x$	7	CO3	L3
28.	Find the particular integral of $(D^2 + 4D + 1)y = e^x \sin 3x$	7	CO3	L3
29.	Solve $(D^4 + 2D^2 + 1)y = x^4$	7	CO3	L3
30.	Using the method of variation of parameters solve $y'' + y = \sec x$	7	CO3	L3
31.	Solve using the method of undetermined coefficients: $y'' - 4y' + 4y = 4\sin^2 x$	7	CO3	L3
32.	Solve using the method of variation of parameters: $y'' + 4y = \sec 2x$.	7	CO3	L3
33.	Solve using the method of undetermined coefficients: $y''' + 2y'' - y' - 2y = e^x$.	7	CO3	L3
34.	Solve the initial value problem $x^2y'' - 3xy' + 3y = 0, y(1) = 0, y'(1) = 1$.	7	CO3	L3
35.	Solve using the method of undetermined coefficients $y'' - 4y' - 5y = 4\cos 2x$.	7	CO3	L3

36	Solve using the Method of variation of parameters $y'' + y = \operatorname{cosec} x$	7	CO3	L3
37	Solve the boundary value problem $x^2 y'' - 3xy' + 4y = 0$, $y(1) = 0$, $y'(1) = 1$	7	CO3	L3
38	Using the method of undetermined coefficients solve, $y'' - 4y = xe^x$	7	CO3	L3
39	Using the Method of variation of parameters solve, $y'' - 4y' + 5y = \frac{e^{2x}}{\sin x}$	7	CO3	L3
40	Solve the initial value problem, by method of undetermined coefficients $y'' + 4y = 8x^2$, $y(0) = -3$, $y'(0) = 0$	7	CO3	L3
41	Solve the initial value problem $x^2 y'' + 3xy' + y = 0$, $y(1) = -3$, $y'(1) = 1$	7	CO3	L3
Module 4				
Sl. No	Question	Marks	CO	BL
1	Find the Laplace transform of (i) $\sinh t / \cosh t$ (ii) $(t-1)^3$	3+3	CO4	L2
2	Find the inverse Laplace transform of (i) $\frac{2}{s^2 + \frac{s}{3}}$ (ii) $\frac{1}{s(s^2 - a^2)}$	3+3	CO4	L2
3	Find the inverse Laplace transform of (i) $\frac{2\pi}{(s+\pi)^3}$ (ii) $\frac{2}{s^4} - \frac{48}{s^6}$	3+3	CO4	L2
4	Define Unit step function. Find its Laplace Transform	3	CO4	L1
5	State First shifting theorem	3	CO4	L1
6	Find the Laplace transforms of the following i) $\cos t - t \sin t$ ii) $4t e^{-2t}$	3+3	CO4	L2
7	Find the Laplace Transform of : (i) $\sin 3t \cos 2t$ (ii) $e^{-2t} \cos^2 t$	3+3	CO4	L2
8	Find the Laplace transforms of (i) $t e^{kt}$ (ii) $\cos(wt + \theta)$	3+3	CO4	L2
9	Find the inverse Laplace transform of $\frac{1}{(s + \sqrt{2})(s - \sqrt{2})}$	7	CO4	L3
10	Find (i) $L^{-1}\left(\frac{3s-137}{s^2+2s+101}\right)$ (ii) $L^{-1}\left(\frac{5s+1}{s^2-25}\right)$	7	CO4	L2
11	Solve the initial value problem, using Laplace transforms. $y'' + y' + 9y = 0$, $y(0) = 0.16$, $y'(0) = 0$	7	CO4	L3
12	Solve $\frac{d^2 y}{dt^2} - 4\frac{dy}{dt} + 5y = 4e^{2t}$ given that $y = 2$, $\frac{dy}{dt} = 7$ when $t = 0$	7	CO4	L3
13	Using convolution theorem find $L^{-1} \frac{s}{(s^2 + a^2)^2}$	7	CO4	L2
14	Find (i) $L^{-1} \left[\frac{e^{-2s}}{s^2} \right]$ (ii) $L^{-1} \left[\frac{se^{-3s}}{s^2 - \pi^2} \right]$	7	CO4	L2
15	Find the inverse Laplace transform of the following i) $\frac{2s+1}{s^2+2s+5}$ ii) $\frac{(2s-10)}{s^3} e^{-5s}$	7	CO4	L3
16	Solve $y'' + 2y' + 5y = 25t$, $y(0) = -2$, $y'(0) = -2$ using Laplace transforms	7	CO4	L3
17	Find the Inverse Laplace Transform of: (i) $\frac{s-4}{s^2-4}$ (ii) $\frac{4}{s^2-2s-3}$	7	CO4	L2

18	Solve, by using Laplace Transform: $y'' + y = 3 \cos 2t$; $y(0) = 0, y'(0) = 0$.	7	CO4	L3
19	Find the inverse Laplace transform of $\frac{5}{(s^2+1)(s^2+25)}$ using Convolution Theorem.	7	CO4	L2
20	Find the Laplace inverse transform of $\left[\frac{240}{(s^2+1)(s^2+25)}\right]$ using convolution theorem.	7	CO4	L2
21	Find the inverse Laplace transform of $\left[\frac{18}{s(s^2-9)}\right]$ using convolution theorem.	7	CO4	L2
22	Solve the initial value problem $y'' - y' - 6y = 0, y(0) = 6, y'(0) = 13$ by using Laplace transforms.	7	CO4	L3
23	Determine the response of the damped mass spring system under a square wave modelled by $y'' + 3y' + 2y = u(t-1) - u(t-2), y(0) = 0, y'(0) = 0$	7	CO4	L3
24	Determine the response of the damped mass spring system under a unit impulse at time $t=1$ modelled by $y'' + 3y' + 2y = \delta(t-1), y(0) = 0, y'(0) = 0$	7	CO4	L3
Module 5				
Sl. No	Question	Marks	CO	BL
1.	State the convolution theorem for Fourier transform	3	CO5	L1
2.	Recall the formula for the Fourier Transform of $f(x)$ and its inverse.	3	CO5	L1
3.	Find the Fourier cosine transform of $e^{-x} (x > 1)$	3	CO5	L2
4.	Find the Fourier sine transform of $e^{-x} (x > 1)$	3	CO5	L2
5.	Find the Fourier cosine transform of $f(x) = \begin{cases} k, & 0 < x < a \\ 0, & x > a \end{cases}$	3	CO5	L2
6.	Find the Fourier cosine integral representation of the function $f(x) = \begin{cases} 1, & 0 < x < 1 \\ 0, & x > 1 \end{cases}$	3	CO5	L2
7.	Given the Fourier transform $\frac{1}{\sqrt{2}} e^{-\frac{\omega^2}{4}}$ of $f(x) = e^{-x^2}$. Find the Fourier transform of xe^{-x^2} .	3	CO5	L2
8.	Express $f(x) = \begin{cases} \frac{1}{2}, & 0 < x < \pi \\ 0, & x > \pi \end{cases}$ as a Fourier sine integral.	3	CO5	L2
9.	Find the Fourier cosine transform of the function $f(x) = \begin{cases} x & \text{if } 0 < x < a \\ 0 & \text{if } x > a \end{cases}$	3	CO5	L2
10.	Find the Fourier Sine Integral of $f(x) = \begin{cases} \sin x & \text{if } 0 < x < \pi \\ 0 & \text{if } x > \pi \end{cases}$	3	CO5	L2
11.	Find the Fourier cosine transform of $f(x) = \begin{cases} x^2, & \text{if } 0 < x < 1 \\ 0, & \text{if } x > 1 \end{cases}$	7	CO5	L2
12.	Represent $f(x) = \begin{cases} x^2 & 0 < x < 1 \\ 0 & x > 1 \end{cases}$ as a Fourier cosine integral.	7	CO5	L2
13.	Find the Fourier transform of $f(x) = \begin{cases} 1 & \text{if } x < 1 \\ 0 & \text{otherwise} \end{cases}$	7	CO5	L2
14.	Find the Fourier Integral representation of $f(x) = \begin{cases} 1 & \text{if } x < 1 \\ 0 & \text{if } x > 1 \end{cases}$	7	CO5	L2
15.	Find the Fourier Cosine Transform of $f(x) = \sin x; 0 < x < \pi$.	7	CO5	L2
16.	Find the Fourier sine transform of $f(x) = \begin{cases} \sin x & \text{if } 0 < x < \pi \\ 0 & \text{if } x > \pi \end{cases}$.	7	CO5	L2

17.	Find the Fourier transform of $f(x) = \begin{cases} e^{kx} & \text{if } x < 0 \\ 0 & \text{if } x > 0 \end{cases}, k > 0.$	7	CO5	L2
18.	Find the Fourier sine transform of the function $f(x) = \begin{cases} 1, & 0 < x < 1 \\ -1, & 1 < x < 2 \\ 0, & x > 2 \end{cases}$	7	CO5	L2
19.	Find the Fourier integral of $f(x) = \begin{cases} \pi - x & \text{if } 0 < x < \pi \\ 0 & \text{otherwise} \end{cases}$	7	CO5	L2
20.	Find the Fourier Transform of $f(x) = \begin{cases} e^x & \text{if } -a < x < a \\ 0 & \text{otherwise} \end{cases}$	7	CO5	L2
21.	Find the Fourier Cosine integral of $f(x) = \begin{cases} \cos x & \text{if } 0 < x < \frac{\pi}{2} \\ 0 & \text{otherwise} \end{cases}$	7	CO5	L2
22.	Find the Fourier Cosine Transform of $f(x) = \begin{cases} x^2 & \text{if } 0 < x < 1 \\ 0 & \text{if } x > 1 \end{cases}$	7	CO5	L2
23.	Find the Fourier Transform of $f(x) = \begin{cases} a - x & \text{if } x < a \\ 0 & \text{otherwise} \end{cases}$	7	CO5	L2
24.	Using Fourier sine integral, show that $\int_0^\infty \frac{\omega \sin \omega x}{1 + \omega^2} d\omega = \frac{\pi}{2} e^{-x}$	7	CO5	L2
25.	Using Fourier sine integral for $f(x) = e^{-ax}$ show that $\int_0^\infty \frac{\lambda \sin \lambda x}{\lambda^2 + a^2} d\lambda = \pi e^{-ax}$	7	CO5	L2
26.	Express $f(x) = 1, 0 < x < \pi$ $0, x > \pi$, a Fourier sine integral and evaluate $\int_0^\infty \frac{1 - \cos \pi \omega}{\omega} \sin x \omega d\omega$	7	CO5	L3
27.	Using Fourier integral representation show that $\int_0^\infty \frac{\sin \omega - \omega \cos \omega}{\omega^2} \sin x \omega d\omega = \frac{\pi}{2} x, \text{ if } 0 < x < 1$ $\frac{\pi}{4}, \text{ if } x = 1$ $0, \text{ if } x > 1$	7	CO5	L3
28.	Find the Fourier transform of $f(x) = \begin{cases} 1 - x & \text{if } x \leq 1 \\ 0 & \text{if } x > 1 \end{cases}$ and also find Fourier inverse transform	7	CO5	L3
29.	Find the Fourier sine transform of $e^{-x}, x \geq 0$. Hence evaluate $\int_0^\infty \frac{x \sin x}{1 + x^2} dx$	7	CO5	L3
30.	Use Fourier integral to show that $\int_0^\infty \frac{\cos x \omega + \omega \sin x \omega}{1 + \omega^2} d\omega = \begin{cases} 0 & \text{if } x < 0 \\ \pi/2 & \text{if } x = 0 \\ \pi e^{-x} & \text{if } x > 0 \end{cases}$	7	CO5	L3
31.	Find the Fourier Sine Transform of $f(x) = e^{- x }$. Hence evaluate $\int_0^\infty \frac{\omega \sin \omega x}{1 + \omega^2} d\omega$.	7	CO5	L3

Course Code & Name: CYT100 Engineering Chemistry

1. Prescribed Syllabus

Module	Topic	Hours
1	Electrochemistry and Corrosion Introduction – Differences between electrolytic and electrochemical cells – Daniel cell – redox reactions – cell representation. Different types of electrodes (brief) – Reference electrodes – SHE – Calomel electrode – Glass Electrode - Construction and Working. Single electrode potential - definition - Helmholtz electrical double layer -Determination of E^0 using calomel electrode. Determination of pH using glass electrode. Electrochemical series and its applications. Free energy and EMF - Nernst Equation - Derivation - single electrode and cell (Numericals) -Application - Variation of emf with temperature. Potentiometric titration - Introduction -Redox titration only. Lithium-ion cell – construction and working. Conductivity – Measurement of conductivity of a solution (Numericals). Corrosion – Electrochemical corrosion – mechanism. Galvanic series – cathodic protection – electroless plating – Copper and Nickel plating.	9
2	Spectroscopic Techniques and Applications Introduction- Types of spectrum - electromagnetic spectrum - molecular energy levels - Beer Lambert's law (Numericals). UV-Visible Spectroscopy – Principle – Types of electronic transitions - Energy level diagram of ethane, butadiene, benzene and hexatriene. Instrumentation of UV-Visible spectrometer and applications. IR-Spectroscopy – Principle - Number of vibrational modes - Vibrational energy states of a diatomic molecule and - Determination of force constant of diatomic molecule (Numericals) – Applications. ^1H NMR spectroscopy – Principle – Relation between field strength and frequency – chemical shift – spin-spin splitting (spectral problems) – coupling constant (definition) – applications of NMR – including MRI (brief).	9
3	Instrumental Methods and Nanomaterials Thermal analysis – TGA – Principle, instrumentation (block diagram) and applications – TGA of $\text{CaC}_2\text{O}_4 \cdot \text{H}_2\text{O}$ and polymers. DTA-Principle, instrumentation (block diagram) and applications - DTA of $\text{CaC}_2\text{O}_4 \cdot \text{H}_2\text{O}$. Chromatographic methods - Basic principles and applications of column and TLC – Retention factor. GC and HPLC – Principle, instrumentation (block diagram) - retention time and applications. Nanomaterials - Definition - Classification - Chemical methods of preparation - Hydrolysis and Reduction - Applications of nanomaterials - Surface characterisation – SEM – Principle and instrumentation (block diagram).	9
4	Stereochemistry and Polymer Chemistry Isomerism-Structural, chain, position, functional, tautomerism and matamerism - Definition with examples - Representation of 3D structures- Newman, Sawhorse, Wedge and Fischer projection of substituted methane and ethane. Stereoisomerism - Geometrical isomerism in double bonds and	9

	cycloalkanes (cis-trans and E-Z notations). R-S Notation – Rules and examples - Optical isomerism, Chirality, Enantiomers and Diastereoisomers-Definition with examples. Conformational analysis of ethane, butane, cyclohexane, mono and di methyl substituted cyclohexane. Copolymers - Definition - Types - Random, Alternating, Block and Graft copolymers - ABS - preparation, properties and applications. Kevlar-preparation, properties and applications. Conducting polymers - Doping - Polyaniline and Polypyrrole - preparation properties and applications. OLED - Principle, construction and advantages.	
5	Water Chemistry and Sewage Water Treatment Water characteristics - Hardness - Types of hardness- Temporary and Permanent - Disadvantages of hard water -Units of hardness- ppm and mg/L -Degree of hardness (Numericals) - Estimation of hardness-EDTA method (Numericals). Water softening methods-Ion exchange process-Principle, procedure and advantages. Reverse osmosis – principle, process and advantages. Municipal water treatment (brief) - Disinfection methods - chlorination, ozone and UV irradiation. Dissolved oxygen (DO) -Estimation (only brief procedure-Winkler's method), BOD and COD – definition, estimation (only brief procedure) and significance (Numericals). Sewage water treatment - Primary, Secondary and Tertiary - Flow diagram -Trickling filter and UASB process.	9

2. Text Books (T)

- T1. B. L. Tembe, Kamaluddin, M. S. Krishnan, “Engineering Chemistry (NPTEL Web-book)”, 2018.
T2. P. W. Atkins, “Physical Chemistry”, Oxford University Press, 10th edn., 2014.

3. Reference Books (R)

- R1. C. N. Banwell, “Fundamentals of Molecular Spectroscopy”, McGraw-Hill, 4th edn., 1995.
R2. Donald L. Pavia, “Introduction to Spectroscopy”, Cengage Learning India Pvt. Ltd., 2015.
R3. B. R. Puri, L. R. Sharma, M. S. Pathania, “Principles of Physical Chemistry”, Vishal Publishing Co., 47th Edition, 2017.
R4. H. H. Willard, L. L. Merritt, “Instrumental Methods of Analysis”, CBS Publishers, 7th Edition, 2005.
R5. Ernest L. Eliel, Samuel H. Wilen, “Stereo-chemistry of Organic Compounds”, WILEY, 2008.
R6. Raymond B. Seymour, Charles E. Carraher, “Polymer Chemistry: An Introduction”, Marcel Dekker Inc; 4th Revised Edition, 1996.
R7. MuhammedArif, Annette Fernandez, Kavitha P. Nair “Engineering Chemistry”, Owl Books, 2019.
R8. Ahad J., “Engineering Chemistry”, Jai Publication, 2019.
R9. Roy K. Varghese, “Engineering Chemistry”, Crownplus Publishers, 2019. R10. Soney C. George, Rino Laly Jose, “Text Book of Engineering Chemistry”, S. Chand & Company Pvt Ltd, 2019.

4. Course Objectives

To enable the students to acquire knowledge in the concepts of chemistry for engineering applications and to familiarize the students with different application-oriented topics like spectroscopy, electrochemistry, instrumental methods etc. Also familiarize the students with topics like mechanism of corrosion, corrosion prevention methods, SEM, stereochemistry, polymers, desalination etc., which enable them to develop abilities and skills that are relevant to the study and practice of chemistry.

5. Course Pre / Co-requisite

Concepts of chemistry introduced at the plus two levels in schools.

6. Course Outcomes

- CO1. Apply the basic concepts of electrochemistry and corrosion to explore its possible applications in various engineering fields.
- CO2. Understand various spectroscopic techniques like UV-Visible, IR, NMR and its applications.
- CO3. Apply the knowledge of analytical method for characterizing a chemical mixture or a compound. Understand the basic concept of SEM for surface characterisation of nanomaterials.
- CO4. Learn about the basics of stereochemistry and its application. Apply the knowledge of conducting polymers and advanced polymers in engineering.
- CO5. Study various types of water treatment methods to develop skills for treating wastewater.

7. Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes

PO/ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	L	M	L												
CO2	L	L		L	M										
CO3	L	L		L	M										
CO4	M	L													
CO5	L			L			H								

8. Justification for CO-PO-PSO Correlation

CO1	PO 1 The student will gain awareness about the fundamental concepts of electrochemical techniques that helps to solve engineering problems and an ability to design and construct engineering products like cells and batteries. PO 2 The study of Galvanic Series and Corrosion will be helpful for the student to choose appropriate materials for various engineering purposes. PO 3 Knowledge on Electrochemistry and Corrosion helps to design and construct various engineering products, system components etc by proper material selection.
CO2	PO 1 The student can acquire an ability to apply modern techniques of analysis like spectroscopy to solve complex engineering problems. PO 2 Knowledge on spectroscopic techniques will help the student to analyse engineering problems like structure analysis and material applications. PO 4 Knowledge on modern tools like spectroscopy will help the student in the prediction of structure, synthesis and characterization of new engineering materials. PO 5 An awareness about the fundamental concepts of spectroscopic techniques helps to gain ability to use modern instrumental techniques for engineering practice.
CO3	PO 1 The student will acquire the knowledge of Thermal Analysis & SEM to solve engineering problems. PO 2 Knowledge on Thermal Analysis & SEM will help the student to identify and find solution to engineering problems like stability of materials and structure analysis.

	PO 4 The study of the structural features of materials using SEM will help the student in synthesis and characterization of new engineering materials. PO 5 An awareness about the fundamental concepts of Thermal Analysis and SEM will help the student to gain the ability to use modern instrumental techniques.
CO4	PO 1 Study of Engineering Polymers and Conducting Polymers will help the student to solve many industrial problems. PO 2 Knowledge on Engineering Polymers and Conducting Polymers will help the student to analyse various system components by using appropriate techniques.
CO5	PO 1 The student with the knowledge of Water Chemistry and treatment methods will be able to solve environmental problems. PO 4 Knowledge of water treatment methods will help the student to design various system components by using appropriate materials for setting up water treatment plants and recycling plants, Sewage removal from waste water etc. PO 7 Knowledge about water treatment methods will help the student to meet the specifications of public health and safety measurements and Societal considerations.

9. Curricular gaps (if any)

Modules 2 and 3 requires some foundation work - Electromagnetic spectrum, Interaction between matter and radiation, Thermal analysis.

10. Course Enrichment Activities*

Sl No	Description	Proposed Activities **	Relevance to POs and PSOs
1	To better attainment of PO's	Expert talks	Better understanding of the relevance of the topic.

** Proposed Actions: Webinar/Industry Visit/Expert talks /NPTEL/project/training Etc

* To better attain POs and PSOs and to bridge the gap between industry academia

11. Internal Assessment mark allocation (as per university curriculum)

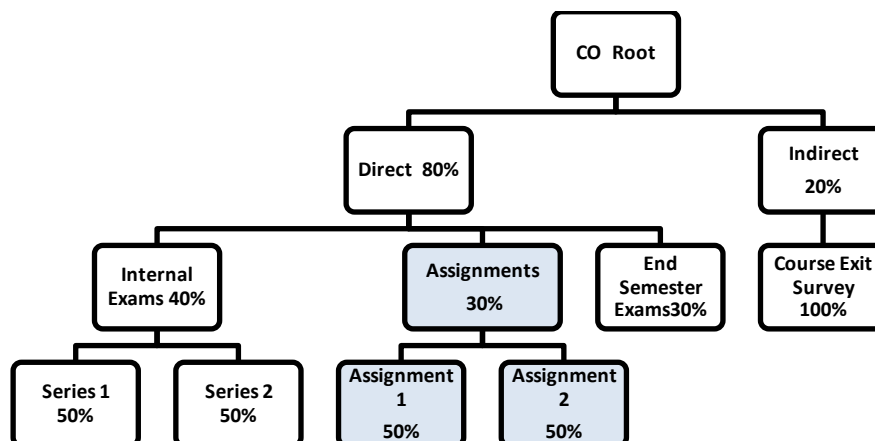
(Provide details as mentioned in syllabus)

Attendance	- 10 marks
Continuous Assessment Test	- 25 marks
Assignment (s)/ Course Project	- 15 marks
Total	- 50 marks

12. Assessment – CO Mapping (Put 'x' if mapping is present)

	Tools		Weightage [#]	CO1	CO2	CO3	CO4	CO5
Direct Assessment Tools**	Internal Exam(s) 40%	Series 1	20%	x		x		x
		Series 2	20%		x		x	x
	Assignment (s)/ Course Project /Quiz etc. 30%	Assignment 1	15%	x		x		
		Assignment 2	15%		x		x	x
	End Semester Exam		30%	x	x	x	x	x
Indirect Assessment Tool	Course Exit Survey		100%	x	x	x	x	x

13. Assessment Configuration

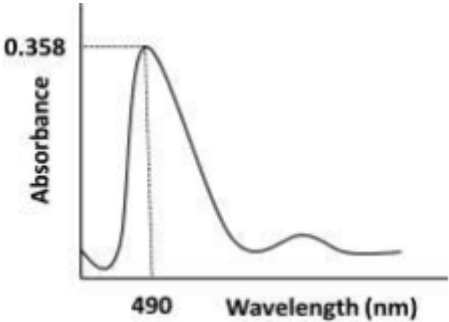
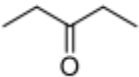
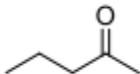


14. Question Bank

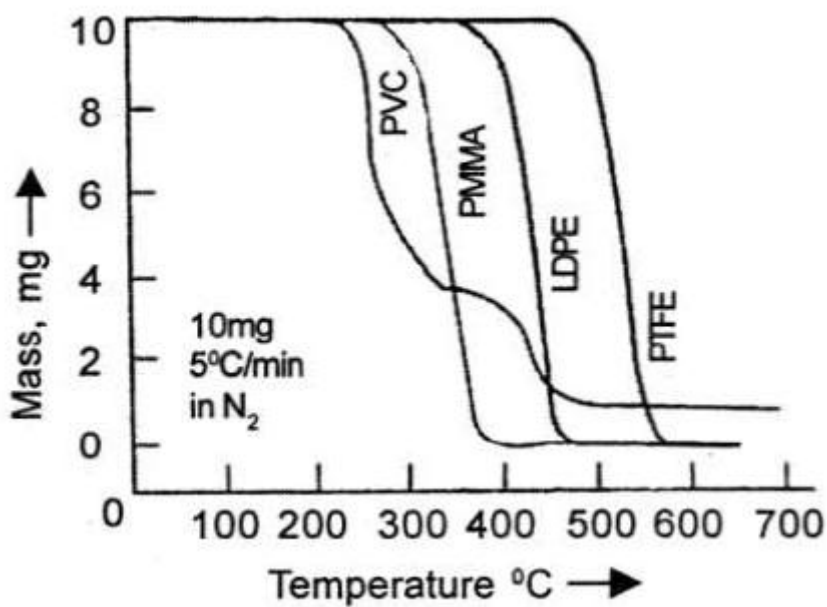
Module 1 ELECTROCHEMISTRY AND CORROSION				
Sl. No.	Question	Marks	CO	BL
1.	Outline the differences between the Electrolytic cell and Electrochemical cell.	3	CO1	L1
2.	Define single electrode potential? Recall how it is determined.	3	CO1	L1
3.	Explain the construction of a Galvanic cell? Represent the cell using notations.	3	CO1	L2
4.	Potentiometric titrations can be employed to find the end point of a redox titration. Explain with a suitable example.	3	CO1	L2
5.	Explain the construction and working of a glass electrode.	3	CO1	L2
6.	Explain the process of Cathodic Protection?	3	CO1	L2
7	Discuss the electrochemical reactions taking place during corrosion of iron?	3	CO1	L2
8	Describe the electroless plating using Copper?	3	CO1	L2
9	Explain the process - electroless plating using Nickel?	3	CO1	L2
10	Discuss Helmholtz Electric Double Layer.	3	CO1	L2
11	Demonstrate how a glass electrode can be used to determine the pH of a solution?	3	CO1	L3
12	Illustrate that the Calomel electrode can act as a reversible electrode. How can you construct a saturated Calomel Electrode.	3	CO1	L3
13	Illustrate Impressed Current Anodic protection.	3	CO1	L4
14.	a) Explain the construction, working and cell reaction for a Lithium ion cell.	10	CO1	L2
	b) What is Nernst Equation? What are the terms involved?	4		
15.	Define is a reference electrode? How is SHE constructed?	4	CO1	L2
	Describe the electrode reactions, cell reaction and calculate the emf of the given cell – $\text{Ag}_{(s)} / \text{Ag}^+ (1\text{M}) \parallel \text{Zn}^{2+} (1\text{M}) / \text{Zn}_{(s)}$, given $E^\circ \text{Ag}/\text{Ag}^+ = 0.799 \text{ V}$ and $E^\circ \text{Zn}^{2+}/\text{Zn} = - 0.763 \text{ V}$. Is the reaction spontaneous?	10		
16	What is an electrochemical series?	4	CO1	L4
	Explain its applications?	6		
	Explain the charge on anode and cathode in an electrochemical cell?	4		
PREVIOUS UNIVERSITY QUESTIONS				
1	How is Helmholtz electrical double layer formed?	3	DEC21	

2	Calculate the single electrode potential of dichromate electrode at 25°C when $[\text{Cr}_2\text{O}_7^{2-}]$ is 0.3M, $[\text{Cr}^{3+}]$ is 0.02M and $[\text{H}^+]$ is 1M. Given: $\text{Cr}_2\text{O}_7^{2-} + 14\text{H}^+ + 6\text{e}^- \rightarrow 2\text{Cr}^{3+} + 7\text{H}_2\text{O}$; $E_0 = 1.33\text{ V}$	3		
3	a) How is glass electrode used in determining the pH of a solution? What are the advantages and limitations of a glass electrode? b) Describe the principle and applications of Electroless copper plating.	8 6		
4	a) Write the principle and procedure for the estimation of ferrous ion using dichromate solution potentiometrically. $E_0 \text{Fe}^{3+}/\text{Fe}^{2+} = 0.77\text{ V}$ b) Emf of an electrochemical cell is 1.5175 V at 20°C and 1.5213 V at 35°C. If the cell reaction involve 2 electrons, find the standard emf of the cell and the reaction quotient.	8 6		
5	What is galvanic series? How is galvanic series advantageous over electrochemical series in corrosion chemistry?	3	JAN21	
6	Why full charging is not allowed in Li-ion cell?	3		
7	a) Derive Nernst equation and apply it for the emf of Daniel cell. b) How is electroless nickel plating done? Write the reactions involved. Give any two applications of it.	(8) (6)		
8	a) With the help of electrochemical equations, show that rusting of iron is more severe in oxygen rich acidic medium than alkaline medium. b) A glass electrode – calomel electrode assembly shows an emf of 212 mV with pH = 4 buffer solution and -30 mV with pH = 9.2 buffer solution. Find the pH of the test solution if it shows an emf of 120 mV. Also find $E_0 \text{G}$ if $E_{\text{SCE}} = 0.2422\text{ V}$	(8) (6)		
9	What will be the standard electrode potential of Ni^{2+}/Ni electrode if the cell potential of the cell $\text{Ni}/\text{Ni}^{2+}_{(1\text{M})} // \text{Cu}^{2+}_{(0.1\text{M})}/\text{Cu}$ is 0.59V at 25°C? $E_0 \text{Cu}^{2+}/\text{Cu} = 0.34\text{ V}$	3	DEC20	S1
10	Briefly explain the principle of electroless plating.	3		
11	a) Explain the mechanism of electrochemical corrosion in different environmental conditions. b) How is the cell constant of a conductivity cell measured?	(10) (4)		
12	a) Describe the construction and working of Li-ion battery. What are the major advantages of it? b) Calculate the EMF of the cell at 25°C: $\text{Al}/\text{Al}^{3+}_{(0.1\text{M})} // \text{Sn}^{4+}_{(0.1\text{M})}/\text{Sn}^{2+}_{(0.01\text{M})}$ $E_0 \text{Al}^{3+}/\text{Al} = -1.66\text{ V}$, $E_0 \text{Sn}^{4+}/\text{Sn}^{2+} = 0.15\text{ V}$	(10) (4)		
Module 2. Spectroscopic Techniques and applications				
Sl. No.	Question	Marks	CO	BL
1.	Give the applications of U.V Spectroscopy	3	CO 2	L1
2.	Illustrate HOMO – LUMO concept with a suitable example?	3	CO 2	L1
3.	Recall what you mean by electromagnetic radiation and electromagnetic spectrum.	3	CO 2	L1
4.	List out the requirements of a molecule to be IR active	3	CO 2	L1
5.	Recall on the advantages of Spectroscopic analysis.	3	CO 2	L1
6	What are the three regions of IR spectrum? Describe why the region $1300 - 900\text{ cm}^{-1}$ is called the finger print region of the compound?	3	CO 2	L2
7	Tetramethylsilane is the customary standard used in NMR spectroscopy. Explain?	3	CO 2	L2

8	Discuss the difference between NMR spectroscopy and UV or IR spectroscopy?	3	CO 2	L2
9	Explain what are stretching and bending vibrations?	3	CO 2	L2
10	Explain various modes of vibration possible for CO ₂ molecule?	3	CO 2	L2
11	Explain various modes of vibration possible for H ₂ O molecule?	3	CO 2	L2
12	IR Spectroscopy can be used to identify functional groups. Explain?	3	CO 2	L2
13	Calculate the number of modes of vibrations available for a linear and a non-linear molecule.	3	CO 2	L3
14	Represent the normal NMR spectrum and splitting pattern of ethyl alcohol (CH ₃ – CH ₂ – OH)	3	CO 2	L1
15	Explain the principle of UV and IR Spectroscopy. A dye solution of concentration 0.08M shows absorbance of .012 at 600mm. While a test solution of same dye shows absorbance of 0.084 under same conditions. Find the concentration of test solution	10 4	CO 2	L3
16	Why is TMS taken as a standard in NMR Spectroscopy? Illustrate the normal spectrum and splitting pattern of ethyl alcohol (CH ₃ – CH ₂ – OH) Compare U.V and IR spectrum	6 4 4	CO 2	L3
17	What is chemical shift in NMR spectroscopy? What are the factors that affect chemical shift? Sketch the vibrational modes of CO ₂ and H ₂ O	10 4	CO 2	L4
18	Define Beer Lamberts law and the mathematical form of the law. Explain the instrumentation and working of U.V Spectrometer. What are the applications of U.V Spectroscopy?	4 6 4	CO 2	L3 L4
19	An organic compound C ₇ H ₇ Cl shows a strong IR band around 800 cm ⁻¹ , two bands at 1800 cm ⁻¹ and 1900 cm ⁻¹ (the band at 1900 cm ⁻¹ being stronger) and three IR bands at 3100, 2930 and 2860 cm ⁻¹ . Suggest a suitable structure for the compound. What are the factors affecting chemical shift? Explain?	10 4	CO 2	L4
20.	a) A compound having molecular formula C ₉ H ₁₂ gives two signals at δ = 2.27 (9H) and 6.7 (3H) respectively in NMR spectra. The area under the two peaks is 3:1. Assign structure to the compound. b) Draw the MO representation of 1, 3, 5 – Hexatriene and indicate HOMO and LUMO.	10 4	CO 2	L4
PREVIOUS UNIVERSITY QUESTIONS				
1.	Recognize the atoms showing NMR phenomenon among the following. Give reason.	3	DEC 21	

	a) ${}^1_1\text{H}$ b) ${}^2_1\text{H}$ c) ${}^3_1\text{H}$ d) ${}^{16}_8\text{O}$ e) ${}^{18}_8\text{O}$ f) ${}^{14}_7\text{N}$			
2.	IR spectroscopy can be used to differentiate intra molecular and inter molecular hydrogen bonds. Explain with an example.	3		
3.	a) What are the various types of electronic transitions possible in organic molecules? Give examples of each. Also give the instrumentation of UV Visible spectrophotometer. b) Suggest structural formula for the following compounds such that they give a single signal in proton NMR spectroscopy. a) $\text{C}_9\text{H}_{18}\text{O}$ and b) $\text{C}_{12}\text{H}_{18}$	8 6		
4.	a) Write the various modes of vibration possible for HCl , CO_2 and H_2O and state which of these modes are IR active. Write reason for their IR activity. b) State Beer- Lambert's law and explain the term molar extinction coefficient. Given is the absorption spectrum of a compound A of 2.5×10^{-6} M concentration, when measured using 1 cm cuvette in a UV-Vis spectrometer. Calculate the unknown concentration of a test sample of compound A if the absorbance is 0.518, when measured in the same condition. 	8 6		
5.	What is the requirement for a molecule to be IR active? Write two examples for IR active and inactive molecules.	3	JAN 2021	
6.	Predict number of signals for the following and justify your answer. a)  b) 	3.		
7.	a) Draw the expected NMR spectrum of methyl propanoate and point out how it differs from ethyl acetate b) Write the mathematical representation of the law governing absorption of light by molecules of a solution. Also calculate the concentration of a solution if it shows a transmittance of 20% when taken in a cell of 2.5 cm thickness (Molar absorption coefficient is $12000 \text{ dm}^2 \text{ mol}^{-1}$).	10 4		
8.	a) How can you differentiate NMR spectrum of $\text{CH}_3\text{CH}_2\text{Cl}$ and CH_3CHCl_2 using the concept of spin-spin splitting? b) Comment on the various electronic transitions that are possible in the following molecules (i) C_2H_6 (ii) $\text{CH}_3\text{CH}_2\text{OH}$ and (iii) 1,3 butadiene.	8 6		
9.	CHCl_3 gives a singlet at 7.26 ppm, while CH_3Cl shows singlet at 3.06 ppm in the ${}^1\text{H}$ NMR spectrum. Give reason.	3	JULY 2021	
10.	Explain the reason for broadening of UV-Visible (electronic) spectrum.	3		
11.	a) Draw the molecular orbital energy diagram of i) Ethene, ii) 1, 3-butadiene iii) 1,3,5 hexatriene and iv) benzene to explain their UV-Vis absorption.	8		

	b) Explain the origin of spin-spin splitting and draw the splitting pattern in CH ₃ -CH ₂ -CH ₂ -Cl.	6		
12	a) Discuss the principle of IR spectroscopy. Arrive at the expression for vibrational energy states of a diatomic molecule. Draw the potential energy diagram. b) An organic compound C ₃ H ₆ O contains a carbonyl group. How will its NMR spectrum decide whether it is an aldehyde or a ketone?	8 6		
13	Which of the following molecules can give UV visible spectrum (200nm - 800nm)? a) CH ₄ b) N ₂ c) Butadiene d) Benzene	3	JUNE 2022	
14	How many vibrational modes are possible for CO ₂ molecule? Sketch the vibrational modes	3		
15.	a) Write a note on magnetic resonance imaging (MRI). List applications of it in medical diagnosis b) Predict high resolution ¹ H NMR spectra of 1-Chloroethane and 2-Chloropropane	8 6		
Module 3 INSTRUMENTAL METHODS AND NANOMATERIALS				
Sl. No.	Question	Marks	CO	BL
1.	List two examples each for (i) adsorbent (ii) Eluents.	3	CO 3	L1
2.	Recall any three applications of TGA?	3	CO 3	L1
3.	Name any three applications of DTA?	3	CO 3	L1
4.	Label the chromatographic methods based on physical nature of adsorbent.	3	CO 3	L1
5.	Summarize the differences between DTA and TGA.	3	CO 3	L2
6	Discuss on the visualization techniques used in TLC.	3	CO 3	L2
7.	Explain the instrumentation of TGA	3	CO 3	L2
8	Describe any three applications of TLC?	3	CO 3	L2
9	Illustrate the basic principles of Gas Chromatography.	3	CO 3	L3
10	Illustrate the basic principles of HPLC.	3	CO 3	L3
11.	a) Explain the principle, instrumentation and procedure of gas chromatography. b) Differentiate between Retention Factor (R _f Value) and Retention time (T _R) in chromatography.	10 4	CO 3	L2
12.	a) Discuss the importance of nano materials? b) Classify the nano materials based on raw materials? c) Explain any two chemical methods for the synthesis of nanomaterials?	4 4 6	CO 3	L2
13.	a) Explain the principle, instrumentation and procedure of gas chromatography b) Differentiate between Retention Factor (R _f Value) and Retention time (T _R) in chromatography	10 4	CO 3	L2
14.	a) Explain the instrumentation of TGA? b) Draw the TGA thermogram of CaC ₂ O ₄ . H ₂ O.	10 4	CO 3	L2
PREVIOUS UNIVERSITY QUESTIONS				
1	Write any three differences of TGA and DTA. (3)	December 2020		
2	Explain sol-gel method for the synthesis of nano particles (3)			
3	a) Define chemical shift in NMR and explain the factors affecting chemical shift with examples. (8) b) Calculate the force constant of H-F molecule that is showing IR absorption signal at 4000 cm ⁻¹ . By what factor do you expect this frequency to shift if Deuterium is substituted for Hydrogen in this			

	molecule? Given that atomic masses of H and F are 1u and 19 u, respectively. (6)			
4	a) How many vibrational modes are possible for the molecules CO, NO, CO ₂ and H ₂ O? Draw the vibrational modes of CO ₂ and H ₂ O and explain their IR active modes. (8) b) Each compound gives only one signal in its ¹ H-NMR Spectrum. Propose a structural formula for each. a) C ₈ H ₁₈ and b) C ₈ H ₁₈ O (6)			
5	TGA will not give information regarding phase changes .Give reason.(3)	January 2021		
6	Mention any three applications of SEM. (3)			
7	a) Explain the principle and instrumentation of DTA with a neat diagram. Interpret the DTA thermogram of CaC ₂ O ₄ .H ₂ O. (10) b) Discuss the classification of nanomaterials based on Materials. (4)			
8	a) Describe the principle, instrumentation, procedure and applications of GC. (10) b) Explain hydrothermal method of synthesis of nanomaterials. (4)			
9	Compare the thermal stability of PVC, PMMA, LDPE and PTFE using TG given below. Justify your answer. (3) 	December 2021		
10	Give the principle of TLC. Mention two applications of TLC. (3)			
11	a) Describe the principle and steps to be followed in column chromatography. (10) b) How are nanomaterials classified on the basis of dimension? (4)			
12	a) Sketch the instrumentation of DTA and explain the principle. Explain the DTA of CaC ₂ O ₄ .H ₂ O. (8) b) Briefly explain the principle and instrumentation of SEM with the help of a diagram. (6)			
Module 4 STEREOCHEMISTRY AND POLYMER CHEMISTRY				
Sl. No.	Question	Marks	CO	BL
1	Outline the reason for Geometrical isomerism?	3	CO4	L1
2	What is a meso compound? Give an example.	3	CO4	L1
3	List the information that you get from Fischer projections?	3	CO4	L1
4	Define conducting Polymers? Give examples.	3	CO4	L1
5	Write a note on the applications of OLED's.	3	CO4	L1
6	Describe the properties of Polyaniline?	3	CO4	L2
7	Explain the preparation of the polymer ABS.	3	CO4	L2

8	Explain the working of OLED's.	3	CO4	L2
9	Discuss the synthesis of polyaniline.	3	CO4	L2
10	Describe the applications of Polyaniline?	3	CO4	L2
11	Describe the applications of Polypyrrole?	3	CO4	L2
12	Illustrate the general properties of conducting polymers?	3	CO4	L3
13	Differentiate between Enantiomers and Diastereoisomers.	3	CO4	L4
14	Classify the polymers can be formed by 2 or more different monomers.	3	CO4	L4
15	Explain the synthesis, properties and uses of Kevlar? Explain the uses of ABS?	10 4	CO4	L2
16	Explain the synthesis, properties and uses of ABS? Explain the uses of Kevlar?	10 4	CO4	L2
17	Taking Glyceraldehyde as example, explain R – S system of Nomenclature. Draw the conformational isomers of Butane taking C2 – C3 axis as the axis of rotation.	10 4	CO4	L2
18	Describe the conformational Isomerism of cyclohexane. Draw the energy diagram of the conformers. Draw Sawhorse projection of staggered and eclipsed conformers of Butane.	10 4	CO4	L2
19	Illustrate the stereochemistry of monosubstituted and 1,2-disubstituted cyclohexane. Draw Fischer projection formulae of the isomers of Lactic acid and name them using R-S system.	10 4	CO4	L4
20	Explain the following – Conducting polymers with conjugated π – electrons. Doped conducting polymers. Applications of OLED's.	6 4 4	CO4	L2

Module 5 WATER CHEMISTRY & WASTE WATER TREATMENT

Sl. No.	Question	Marks	CO	BL
1	Illustrate the advantages of water softening by Zeolite process?	3	CO 5	L3
2	Explain water purification by chlorination?	3	CO 5	L2
3	Outline the disinfection of water by UV radiation?	3	CO 5	L1
4	Explain DO determination by Winkler's method?	3	CO 5	L2
5	What is BOD? Describe the importance of BOD?	3	CO 5	L2
6	What is COD? Describe the significance of COD?	3	CO 5	L2
7	Write notes on Trickling Filter.	3	CO 5	L2
8	Explain what do you mean by UASB process?	3	CO 5	L2
9	Explain sewage water treatment process.	3	CO 5	L2
10	Differentiate between temporary hardness and permanent hardness.	3	CO 5	L2
11	Name the six types of salts that cause hardness in water?	3	CO 5	L1
12	Summarize the defects of using hard water in boilers?	3	CO 5	L2
13	Explain carbonate treatment process for removal of hardness of water.	3	CO 5	L2
14	Explain phosphate treatment process for removal of hardness of water.	3	CO 5	L2
15	Define hardness of water. What are the different types of hardness of water?	3	CO 5	L1
16	a) Illustrate two methods each for the removal of temporary and permanent hardness from water.	10	CO 5	L4

	b) A sample of water contains the following dissolved Salts $\text{Ca}(\text{HCO}_3)_2 = 20 \text{ Mg/litre}$, $\text{MgSO}_4 = 30 \text{ mg/litre}$ and $\text{CaCl}_2 = 55.5 \text{ mg/litre}$. Calculate the total and permanent hardness.	4		
17	a) Illustrate the preparation of deionized water? b) Classify the differences between BOD and COD	10 4	CO 5	L4 L4
18	Demonstrate the different steps in the preparation of water for domestic supply? Explain the term reverse osmosis and give its applications	10 4	CO 5	L3 L2
19	Describe the estimation of hardness of a sample of water by EDTA method. Illustrate the structure of EDTA	10 4	CO 5	L2
20	What do you mean by BOD and COD? Illustrate their significance. A water sample contains 204 mg of CaSO_4 per litre. Calculate the hardness of the sample.	10 4	CO 5	L4 L3
UNIVERSITY QUESTIONS				
21	Explain disinfection by chlorination. (3)	DEC 2020		
22	Compare BOD and COD	3		
23	a) Describe the steps involved in municipal water treatment. b) The following data are obtained for a hard water sample from an EDTA experiment i) 20 mL standard hard water (5 g/L CaCO_3) = 25 mL EDTA solution ii) 100 mL of hard water sample = 24 mL EDTA solution iii) 100 mL of boiled hard water sample = 18 mL EDTA solution Calculate the temporary and permanent hardness.	10 4		
24	a) With the help of a flow diagram explain the steps involved in sewage treatment. b) Calculate the temporary and permanent hardness of water sample containing the following dissolved salts. $\text{Ca}(\text{HCO}_3)_2 = 28 \text{ mg/L}$; $\text{CaSO}_4 = 18 \text{ mg/L}$; $\text{Mg}(\text{HCO}_3)_2 = 32 \text{ mg/L}$; $\text{MgCl}_2 = 30 \text{ mg/L}$; $\text{NaCl} = 58 \text{ mg/L}$	10 4		
25	A sample of water on analysis gives the following results. $\text{Ca}^{2+} = 200 \text{ mg/L}$, $\text{Mg}^{2+} = 180 \text{ mg/L}$, $\text{HCO}_3^- = 360 \text{ mg/L}$, $\text{Cl}^- = 200 \text{ mg/L}$ and $\text{Na}^+ = 80 \text{ mg/L}$. Calculate temporary and permanent hardness. (3)	3	DEC 2021	
26	Differentiate between aerobic and anaerobic oxidation. (3)	3		
27	a) Explain the EDTA method for the estimation of hardness of water with calculation steps. b) Write the procedure for estimating COD of a sample of waste water.	10 4		
28	a) Discuss the action of chlorine as a disinfectant. How is it applied? What is break point chlorination? Write any two advantages of breakpoint chlorination. b) A pure water sample is added with 90 mg carbohydrate (CH_2O) per litre find the maximum BOD possible for the water sample.	10 4		
29	What is the chemistry behind the removal of temporary hardness by boiling?	3	JAN 2021	
30	What are the factors that affect DO level in water?	3		
31	a) Explain aerobic and anaerobic methods for the waste water treatment. b) A water sample contains $16.2 \text{ mg/L Ca}(\text{HCO}_3)_2$, $7.3 \text{ mg/L Mg}(\text{HCO}_3)_2$, 9.5 mg/L MgCl_2 and 13.6 mg/L CaSO_4 . Calculate the temporary and permanent hardness of water and what will happen if $10.6 \text{ mg/L NaHCO}_3$ is added?	10 4		
32	a) Explain the complexometric titration method for the estimation of hardness of water. Write necessary calculation steps.	10		

	b) Write any four disadvantages of hard water.	4		
33	What is galvanic series? How is galvanic series advantageous over electrochemical series in corrosion chemistry? (3) 2	3	JULY 2021	
34	Why full charging is not allowed in Li-ion cell	3		
35	a) Explain trickling filter and UASB processes in waste water treatment.	10		
	b) Discuss the procedure for the determination of DO in water.	4		
36	a) Define reverse osmosis. Explain the method for the desalination of water using reverse osmosis. Give its advantages.	8		
	b) Explain the ion exchange process in water treatment. How is the exhausted resin regenerated?	6		

Prepared By : Dr. Jude Martin Mendez

Checked By : Shereeta D'cotha.

Course Code & Name: EST110 & Engineering Graphics**1. Prescribed Syllabus**

Module	Topic	Hours
1	Introduction: Relevance of technical drawing in engineering field. Types of lines, Dimensioning, BIS code of practice for technical drawing. Orthographic projection of Points and Lines: Projection of points in different quadrants, Projection of straight lines inclined to one plane and inclined to both planes. Trace of line. Inclination of lines with reference planes True length of line inclined to both the reference planes.	9
2	Orthographic projection of Solids: Projection of Simple solids such as Triangular, Rectangle, Square, Pentagonal and Hexagonal Prisms, Pyramids, Cone and Cylinder. Projection of solids in simple position including profile view. Projection of solids with axis inclined to one of the reference planes and with axis inclined to both reference planes.	8
3	Sections of Solids: Sections of Prisms, Pyramids, Cone, Cylinder with axis in vertical position and cut by different section planes. True shape of the sections. Also locating the section plane when the true shape of the section is given. Development of Surfaces: Development of surfaces of the above solids and solids cut by different section planes. Also finding the shortest distance between two points on the surface.	8
4	Isometric Projection: Isometric View and Projections of Prisms, Pyramids, Cone, Cylinder, Frustum of Pyramid, Frustum of Cone, Sphere, Hemisphere and their combinations	6
5	Perspective Projection: Perspective projection of Prisms and Pyramids with axis perpendicular to the ground plane, axis perpendicular to picture plane. Conversion of Pictorial Views: Conversion of pictorial views into orthographic views.	6

2. Text Books (T)

T1 Bhatt, N.D., Engineering Drawing, Charotar Publishing House Pvt. Ltd.

T2 John, K.C. Engineering Graphics, Prentice Hall India Publishers.

T3 P. I. Varghese, Engineering Drawing and Graphic, New Age International Publishers.

3. Reference Books (R)

R1. Anilkumar, K.N., Engineering Graphics, Adhyuth narayan Publishers

R2. Benjamin, J., Engineering Graphics, Pentex Publishers- 3rd Edition, 2017

R3. Varghese, P.I., Engineering Graphics, V I P Publishers

4. Course Objectives

To enable the student to effectively perform technical communication through graphical representation as per global standards.

5. Course Pre / Co-requisite

Nil

6. Course Outcomes

After completion of the course, students will be able to

CO1. Draw the projections of points and line in different quadrants

CO2. Prepare multi-view orthographic projections of objects by visualizing them in different positions

CO3. Draw sectional view and develop surface of given object

CO4. Prepare pictorial drawings using principles of isometric and perspective projections to visualise object in three dimensions

CO5. Convert 3D views to orthographic views

CO6. Obtain multi-view projections and solid models of objects using CAD tools

7. Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes

PO/ CO	PO 1	PO 2	PO 3	PO 4	PO5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H														
CO2	H														
CO3	H	L													
CO4	H									L					
CO5	H									M					
CO6	H				H					H					

8. Justification for CO-PO-PSO Correlation

CO	PO/PSO	Justification
CO1	PO1	Students will be able to apply knowledge on projections of points and lines in different quadrants to aid in creating complex engineering drawings. Student will attain in depth knowledge in creating projections of lines required to communicate effectively with use of drawings.
CO2	PO1	Students will be able to prepare multi-view orthographic projections of objects to aid in drawing complex engineering drawings. Student will attain in depth knowledge in creating multi-view orthographic projection required to communicate effectively with use of drawings and solve problems.
CO3	PO1	Students will be able to create and interpret sectional view and develop surface of required object. Student will attain in depth knowledge in creating sectional view and develop surface of given object.
	PO2	Students will be able to draw sectional view and develop surface of a given object for better analysis of an object. Student will attain intermediate knowledge in analysis of inner features of object with the aid of sectional views.
CO4	PO1	Students will be able to apply principles of isometric and perspective projections to aid in drawing and interpreting complex engineering figures. Student will attain in depth knowledge in creating isometric and perspective projections to create easy to understand 3D solutions
	PO10	Students will be able to apply principles of isometric and perspective projections to communicate complex engineering structures with the engineering community and with society at large.

CO5	PO1	Students will be able to convert 3D views to orthographic views to aid in solving complex engineering problems. Student will attain in depth knowledge on 3D views and orthographic views required to effectively
	PO10	Students will be able to convert 3D views to orthographic views and communicate effectively with complex engineering drawings with the engineering community. Student will attain intermediate knowledge required design documentation
CO6	PO1	Students will attain in depth knowledge to apply CAD tools to create complex engineering drawings and obtain design solutions.
	PO5	Students will attain in depth knowledge to use CAD tools to create, elect, and apply appropriate techniques for modelling complex engineering drawings.
	PO10	Students attain in depth know how on CAD tools to create and communicate effectively using engineering drawings with the engineering community, society at large and create design reports and effective presentations.

9. Curricular gaps (if any)

Nil

10. Course Enrichment Activities*

Sl No	Description	Proposed Activities **	Relevance to POs and PSOs
1	Solid model	Familiarise different simple solids with actual models	PO1, PO2

11. Internal Assessment mark allocation (as per university curriculum)

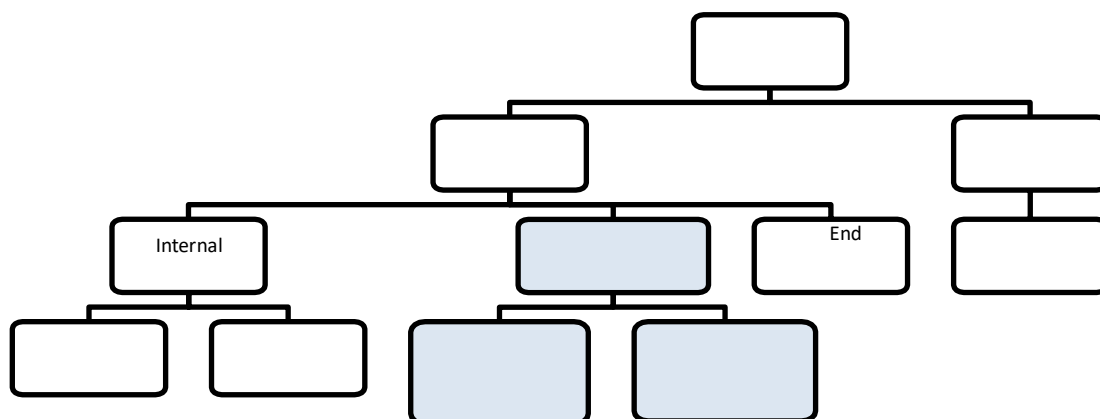
(Provide details as mentioned in the syllabus)

Attendance	- 10 marks
Continuous Assessment Test	- 25 marks
<u>Assignment (s)/ Course Project</u>	<u>- 15 marks</u>
<u>Total</u>	<u>- 50 marks</u>

12. Assessment – CO Mapping (Put ‘ x’ if mapping is present)

	Tools		Weightage [#]	CO1	CO2	CO3	CO4	CO5	CO6
Direct Assessment Tools**	Internal Exam(s) 40%	Series 1	60%	x	x				
		Series 2	40%		x	x	x	x	x
	Assignment (s)/ Course Project /Quiz etc. 30%	Classwork 1	15%	x	x	x			
		Classwork 2	15%				x	x	x
	End Semester Exam		30%	x	x	x	x	x	
Indirect Assessment Tool	Course Exit Survey		100%	x	x	x	x	x	x

13. Assessment Configuration



14. Course Plan

Hour	Topic	Module	Reference(s)	Teaching Pedagogy
1	Introduction: Relevance of technical drawing in engineering field. Types of lines	1	T1	Lecture
2	Dimensioning, BIS code of practice for technical drawing. (No questions for the end semester examination)	1	T1	Lecture
3	Projection of points in different quadrants	1	T1	Practical
4	Projection of straight lines inclined to one plane and inclined to both planes	1	T1	Practical
5	Projection of straight lines inclined to one plane and inclined to both planes	1	T1	Practical
6	Trace of a line	1	T1	Lecture
7	Inclination of lines with reference planes.	1	T1	Practical
8	True length and true inclinations of line inclined to both the reference planes	1	T1	Lecture
9	True length and true inclinations of line inclined to both the reference planes	1	T1	Practical
10	Projection of Simple solids such as Triangular, Rectangle Prisms.	2	T1	Practical
11	Projection of Simple solids such as Square, Pentagonal and Hexagonal Prisms.	2	T1	Lecture
12	Projection of Simple solids such as Triangular, Rectangle, Pyramids.	2	T1	Practical
13	Projection of Simple solids such as Square, Pentagonal and Hexagonal Pyramids.	2	T1	Practical
14	Projection of Simple solids such as Cone and Cylinder only.	2	T1	Lecture
15	Projection of solids in simple position including profile view.	2	T1	Practical
16	Projection of solids with axis inclined to one of	2	T1	Lecture

	the reference planes.			
17	Projection of solids with axis inclined to both reference planes.	2	T1	Practical
18	Projection of solids with axis inclined to both reference planes.	2	T1	Practical
19	Sections of Solids: Sections of Prisms.	3	T1	Lecture,
20	Sections of Solids: Sections of Pyramids.	3	T1	Lecture
21	Sections of Cone and Cylinder only	3	T1	Lecture
22	Sections of Solids with axis in vertical position and cut by different section planes.	3	T1	Practical
23	True shape of the sections. (Exclude true shape given problems)	3	T1	Practical
24	Development of Surfaces: Development of surfaces of the solids and solids cut by different section planes.	3	T1	Lecture
25	Development of Surfaces: Development of surfaces of the solids and solids cut by different section planes.	3	T1	Practical
26	Development of Surfaces: Development of surfaces of the solids and solids cut by different section planes.	3	T1	Practical
27	Isometric Projection: Isometric scale	4	T1	Lecture
28	Isometric View and Projections of Prisms	4	T1	Lecture
29	Isometric View and Projections of Prisms	4	T1	Practical
30	Isometric View and Projections of Pyramids	4	T1	Lecture
31	Isometric View and Projections of Pyramids	4	T1	Practical
32	Isometric View and Projections of Cone, Cylinder	4	T1	Practical
33	Isometric View and Projections of Hemisphere.	4	T1	Practical
34	Isometric View and Projections of Prisms, Pyramids, Cone, Cylinder, Sphere, Hemisphere and their combinations.	4	T1	Lecture
35	Isometric View and Projections of Prisms, Pyramids, Cone, Cylinder, Sphere, Hemisphere and their combinations.	4	T1	Practical

15. Question Bank

Module 1				
Sl. No	Question	Marks	CO	BL
1	A line AB 70mm long has its end A 15mm in front of VP & 20mm above HP. Other end B is 60mm in front of VP & 50mm above HP. Draw the projections of the line AB & find its inclinations with both the reference planes. Also locate its traces.	20	CO1	L2
2	Draw the projections of line PQ 75mm long lying 30° to VP & 45° to HP. End P of the line is 15mm above HP & 20mm in front of VP.	20	CO1	L2

	Locate the traces of line.			
3	The end projectors of a line AB is 60mm apart. End A is 20mm above HP & 30mm in front of VP. Other end B is 70mm above HP & 45mm behind VP. Draw the projections and find its true length and true inclinations. Also locate its traces.	20	CO1	L3
4	The end A of a line AB, 80mm long is 10mm above HP & 20mm in front of VP. The end B is 35mm below HP & 30mm behind VP. Draw the projections of the line AB & find its inclinations with reference planes. Also locate its traces.	20	CO1	L3
5.	Point A is 20mm above HP and 65mm in front of VP. Point B is 70mm above HP and 30mm in front of VP. The distance between the projectors is 65mm. Draw the projections of the line and hence find its true length, inclinations with coordinate planes and projections of the traces.	20	CO1	L3
6.	Point A is 20mm above HP and 30mm in front of VP. The front view is inclined 45° to ground line and measures 70mm. The end B is 75mm in front of VP. Draw the projections of the line and its traces. Also find its true length and inclinations with HP and VP..	20	CO1	L3
7.	Point M is 25mm in front of VP and 30mm above HP. The distance between the end projectors of line MN is 50mm The top view and front view measures 70mm and 65mm respectively. Draw the projections of the line and true length and its traces.	20	CO1	L3
8.	A line AB 65mm long has its end 20mm above HP and 25mm in front of VP. The end B is 50mm above HP and 65mm in front of VP. Draw projections of line AB and show its inclination with HP and VP.	20	CO1	L2
9.	The top view of a line makes 30° with ground line. The horizontal trace is 60mm in front of VP and vertical trace is 70mm above HP. One end point of the line is 10mm behind VP while the other end is 30mm above HP. Draw the projections.	20	CO1	L3
10.	A line AB , 80mm long, is inclined 30° to HP and 45° to VP. Draw its projections when end A lies on HP and end B lies on VP.	20	CO1	L2
11.	The FV of a line AB measures 75mm & makes an angle of 50° with XY. The end A is in horizontal plane & VT of the line is 25mm above HP. The line is inclined at 35° to the VP. Draw the projections of the line & find its true length & inclination with HP.	20	CO1	L3
12.	The FV of a line AB makes an angle of 30° with XY line. The HT of the line is 36mm behind VP & the VT is 30mm above HP. One end of the line is 10mm below HP, while the other end is 20mm in front of VP. Draw the projections of the line determine the true inclinations.	20	CO1	L3
13	The projectors through traces of a line are 110mm apart & those through the ends of the line are 50mm apart. The end A of the line is 20mm below HP & is in front of VP. The TV & FV of the line make 30° & 45° with the XY line respectively. Draw the projections of the line determine the true inclinations.	20	CO1	L3
14	A line AB, 70mm long is inclined at 45° to HP & 30° to VP. A point M on the line is at a distance of 30mm from B is 50mm above HP & 60mm in front of VP. Draw the projections of the line and mark its traces.	20	CO1	L3

15.	A line AB 90mm long is inclined 30° to HP. Its end A is 10mm above HP & 20mm in front of VP. Its FV measures 65mm. Draw the TV of the line AB & measure its length. Determine the inclination of the line with VP & locate its traces.	20	CO1	L3
16.	One end point of a line AB is 12 mm above HP and is 15 mm in-front of VP. Other end point is 50 mm above HP and is 42 mm in front of VP. Draw the projections of the line AB if its elevation measures 70mm. Find out its true length and the true inclinations with respect to the reference planes.	20	CO1	L3
17.	One end point P of a line PQ, 75 mm long, is 10 mm above HP and 20 mm in front of VP. The line is inclined 45° to HP and its plan is inclined 35° to x-y line. Draw the projections of the line PQ and find out true inclination of the line with respect to VP.	20	CO1	L3
Module 2				
Sl. No.	Question	Marks	CO	BL
1.	A square prism of base 40 mm side and height 65 mm, has its axis inclined at 45° to the HP and has an edge of base on HP and inclined at 30° to VP. Draw its projections.	20	CO2	L3
2.	A hexagonal prism side of base 20 mm side and axis 60 mm long is resting on one of its edges of the base on HP, which is inclined at 45° to VP. Draw the projections of the prism if the axis makes an angle of 75° with HP.	20	CO2	L3
3.	A pentagonal prism side of base 20 mm side and axis 60 mm long is resting on one of its edges of the base on HP, which is inclined at 45° to VP. Draw the projections of the prism if the axis makes an angle of 75° with HP	20	CO2	L3
4.	A right regular pentagonal pyramid, with sides of base 30 mm and height 65 mm rests on the edge of its base on the horizontal plane, the base being tilted until the vertex is at 60 mm above the HP. Draw the projections of the pyramid when the edge on which it rests is made parallel to Front reference plane (FRP)(Draw the projections when the base of the pyramid is visible in the Front View).	20	CO2	L3
5.	A pentagonal pyramid, base 25 mm side and axis 50 mm long has one of its triangular faces in the VP and the edge of the base contained by that face makes an angle of 30° with the HP. Draw its projections.	20	CO2	L3
6.	Draw the projections of a cube of 25 mm long edges resting on HP on one of its corner with a solid diagonal perpendicular to VP.	20	CO2	L3
7.	A square pyramid, base 38 mm side and axis 50 mm long is freely suspended from one of the corners of its base. Draw its projections, when a vertical plane makes an angle of 45° with the VP.	20	CO2	L3
8.	A cone of base diameter 40mm & axis 60mm has its generator on HP. A plane containing that generator & the axis is perpendicular to HP & inclined at 45° to VP. Draw the projections when the base is nearer to VP.	20	CO2	L3
9.	A pentagonal pyramid, height 60mm and base edge 30mm is lying on one of the long edges on HP, which is inclined at 40° with XY in Top View (or a plane containing the axis & the slant edge on which the solid rests makes an angle of 40° with VP). Draw the projections.	20	CO2	L3

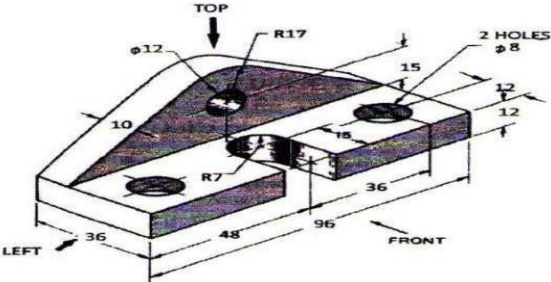
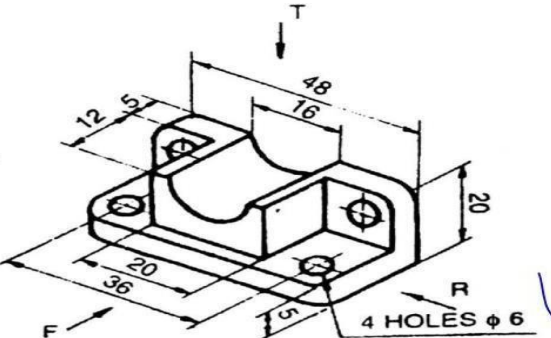
10.	A pentagonal pyramid of 30mm base side axis 60mm long is resting on an edge of its base on the ground so that highest point of the base is 20mm above ground. Draw its projections if the vertical plane containing the axis is inclined at 30° to VP.	20	CO2	L3
11.	A hexagonal prism base 20 mm side and axis 40 mm long is placed with one of its base edges on the HP such that the axis is inclined at 30° to HP and 45° to VP. Draw the projections of the prism	20	CO2	L3
12.	A cone of base diameter 50 mm and axis length 60 mm is resting on VP on one of its generators with the front view of the axis inclined at 40° to HP. Draw its projections.	20	CO2	L3
Module 3				
Sl No.	Question	Marks	CO	BL
1.	A cube of 35 mm long edges is resting on the HP on one of its faces with a vertical face inclined at 30° to the VP. Its cut by a section plane parallel to VP and 9 mm away from the axis and further away from the VP. Draw the sectional front view and the top view	20	CO3	L3
2.	A cylinder of 60 mm height and having its axis vertical is cut by a section plane, perpendicular to the VP, inclined at 45° to the HP and intersecting the axis 32 mm above the base. Draw its front view, sectional top view and true shape of the section.	20	CO3	L3
3.	A hexagonal prism base edge 30 mm and height 60 mm rests on HP with a base edge inclined at 15° to the VP. It is cut by a cutting plane perpendicular to VP and inclined at 40° to the HP and bisecting the axis. Draw the sectional FV and sectional TV and the true shape of the section	20	CO3	L3
4.	A cone, base 75 mm dia and axis 80 mm long is resting on the HP and cutting the axis at a point 35 mm from the apex. Draw its front view, sectional top view and true shape of the section.	20	CO3	L3
5.	A cone of base diameter 60 mm, standing upright is cut by a section plane such that the true shape is a parabola whose double ordinate is 50 mm and abscissa is 70 mm. Draw the front view, top view and the true shape of the section.	20	CO3	L3
6.	A square pyramid of base 50 mm and height 70 mm is rest on its base on HP. It is cut by a sectional plane perpendicular to VP and inclined to HP. The true shape of the section is a trapezium are 40 mm and 30 mm respectively. Draw the sectional view, top view. Find the angle of inclination of section plane.	20	CO3	L3
7.	A hexagonal prism, edge of base 20 mm and axis 50 mm long, rests with its base on HP, such that one of its rectangular faces is parallel to VP. Its cut by a plane perpendicular to VP inclined at 45° to HP and passing through the right corner of the top face of the prism. Develop the lateral surface of the truncated prism.	20	CO3	L3
8.	A cube of 40 mm edge stands on one of its faces on HP with a vertical face making 45° to VP. A horizontal hole of 30 mm diameter is drilled centrally through the cube such that the hole passes through the opposite vertical edges of the cube. Obtain the development of the lateral surface of the cube with the hole.	20	CO3	L3
	A right regular pentagonal prism edge of base 25 mm and height 64			

9.	mm rests on its base with one of its edges perpendicular to VP. An ant moves from the bottom corner to the diagonally opposite corner lying in a vertical face perpendicular to VP. Draw the development of the surface and mark the path of the ant in elevation. Also compare the distance moved by the ant in the clockwise and anticlockwise direction of rotation.	20	CO3	L3
10.	A cone of base 50 mm diameter and 60 mm height rests with its base on HP. Its cut by a section plane perpendicular to VP, parallel to one of the generators and passing through a point on the axis at a distance of 22 mm from the apex. Draw the sectional top view and develop the lateral surface of the remaining portion of the cone.	20	CO3	L3
11.	The vertical section of a right circular cone through the axis is an isosceles triangle of 50 mm base and 60 mm height. A fly sits on the extreme left end of the base and walks around the surface of the cone and returns to the starting point. Find geometrically the length of the shortest path the fly can take, show the path in the front and top view.	20	CO3	L3
12.	A monument in the form of a frustum of a square pyramid of base 1.2 m side, top 0.5 m side and height 1 m. An electrical connection is to be made along the surface of this monument between one corner of the base and diagonally opposite corner on the top. Find the shortest length of the wire required and show the position of the wire in the top and front views.	20	CO3	L3
13.	A hexagonal pyramid, side of base 25 mm and altitude 70 mm long, rests with its base on HP with two of its base sides parallel to VP. It is cut by a section plane perpendicular to VP, inclined at 45° to HP and passing through the axis 15mm from the base. Draw the sectional top view and true shape of the section.	20	CO3	L3
14.	A pentagonal pyramid, side of base 50 mm and height 80 mm rests on its base on the ground with one of its base sides parallel to VP. A section plane perpendicular to VP and inclined at 30° to HP cuts the pyramid, bisecting its axis. Draw the development of the truncated pyramid.	20	CO3	L3
Module 4				
Sl No.	Question	Marks	CO	BL
1.	Draw the isometric projection view of a rectangular prism of base 50 mm x 40 mm and height 75 mm, when its rests with its base on HP and one of its rectangular faces is parallel to VP.	20	CO4	L3
2.	Draw the isometric view/ projection of a hexagonal prism side of base 25 mm and height 60 mm lying on HP with one of its rectangular faces parallel to VP.	20	CO4	L3
3.	A pentagonal pyramid, base 30 mm and axis 65 mm long, rests with its base on HP. An edge of base is parallel to VP and nearer to it. A horizontal section plane cuts the pyramid and passes through a point on the axis at a distance of 25 mm from the apex. Draw the isometric view/ projection of the frustum of pyramid.	20	CO4	L3
4.	A hexagonal prism, side of base 25 mm and height 50 mm rests on HP and one of the edges of its base is parallel to VP. A section plane perpendicular to VP and inclined at 50° to HP bisects the axis of the	20	CO4	L3

	prism. Draw the isometric view/ projection of the prism, showing the cut surface.			
5.	Draw the isometric view/ projection of the bottom portion of the cone of base dia 50 mm and height 80 mm resting on its base in the HP and axis parallel to VP, when its cut by a cutting plane perpendicular to VP and inclined at 30^0 to HP. The cutting plane cuts the axis at 40 mm above its base.	20	CO4	L3
6.	A square pyramid side of base 35 mm and height 70 mm is resting on the HP with the side of base equally inclined to VP. Its cut by an inclined plane perpendicular to the VP and inclined at 30^0 to the HP, through the mid-point of the vertical axis. Draw the projection of the truncated pyramid.	20	CO4	L3
7	A sphere of radius 15 mm is resting centrally on the top surface of a square plate of side 50 mm and of negligible thickness. Draw the isometric projection and view.	20	CO4	L3
8.	Draw the isometric view and projection of a hollow hexagonal prism edge of base 30 mm and height 60 mm, having a through circular hole of diameter 30 mm. The hole is drilled centrally along the axis of the hexagonal prism.	20	CO4	L3
9.	A hexagonal based prism of base edge 30 mm and axis height 80 mm is resting with one of its rectangular faces on HP. A cylinder of dia 30 mm and height 40 mm rests centrally with its base on the top of the rectangular face of the prism. Draw the 2isometric view/ projection for the combination of solids	20	CO4	L3
10.	A hemisphere of dia 80 mm is resting on the ground with its flat surface facing upwards. A square pyramid having side of base 40 mm and axis 60 mm is resting on its base centrally on the top of the hemisphere. Draw the isometric view/ projection of the combinations of the solid.	20	CO4	L3
11.	A square pyramid of base edge 20 mm and height 40 mm is mounted centrally on a face of a cube of base edge 50 mm. Draw the isometric projection of the objects.	20	CO4	L3
12.	Draw the isometric projections of a hexagonal prism with edge of base 30 mm and axis 60 mm when it rests on a rectangular face on the ground.	20	CO4	L3

Module 5

Sl. No.	Question	Marks	CO	BL
1.	A square prism of side 30 mm & height 60 mm is resting on its face on G.P with axis perpendicular to P.P in such a way that the nearest base is parallel to & 10 mm behind the P.P. The S.P is 80 mm to the right of the axis of the solid; 50 mm above G.P; 25 mm in -front of P.P. Draw the perspective view.	20	CO4	L3
2.	A platform of a stage 70*50*30 in size with the nearest vertical edge in the P.P. The longest face containing that edge is inclined 60 degree to the P.P. The S.P is contained in a C.P. passing through 25 mm to the right of the nearest corner. Draw the perspective view of the stage if the station point is 45 mm above G.P and 40 mm in-	20	CO4	L3

	front of P.P?			
3.	Draw the perspective projection of a pentagonal prism of side 25 mm and length 50 mm, lying on one of its rectangular faces on the ground plane and one pentagonal face touching the picture plane . The station point is 55 mm in front of the picture plane and lies in the central plane which is 75 mm to the left of the centre of the prism. Station point is 30 mm above the ground plane.	20	CO4	L3
4.	A square prism of base edge 30 mm and height 60 mm is resting on a face with the axis inclined at 30° with PP and the centre of the nearest base in the PP, SP is 30 mm in front of the PP, 5 mm to the right of the mid-point of the axis and 50 mm above GP. Draw the perspective view of the prism.	20	CO4	L3
5.	Draw the perspective projection of a pentagonal prism of side 25 mm & length 50 mm lying on one of its rectangular face on G.P. & one end face touching P.P. The S.P is 55 mm in-front of P.P & lies in a C.P which is 65 mm to the left of the centre of the prism .The S.P is 30 mm above G.P.	20	CO4	L3
6.	Draw front view, top view and profile view. 	20	CO5	L3
7.	Draw front view, top view and profile view. 	20	CO5	L3
8.	Draw front view, top view and profile view.	20	CO5	L3

9.	Draw front view, top view and profile view.	20	CO5	L3
10.	Draw front view, top view and profile view.	20	CO5	L3
11.	A square pyramid of base side 30 mm and height 45 mm is resting on the ground plane. The nearest edge of the base is parallel to and 20 mm behind the Picture Plane (PP). The station point is situated at a distance of 70 mm in front of the PP, 40 mm to the right of the axis of the pyramid, and 60 mm above the ground. Draw the perspective view of the pyramid.	20	CO5	L3
12.	Draw the front view, top view, and side view of the object given below. Front view should be drawn as seen in the direction of the arrow X.			

		20	CO5	L3

Prepared By : Nisha B Nair

Checked By : Dr. Ramadas T

Course Code & Name: EST 120, Basics of Civil and Mechanical Engineering

1. Prescribed Syllabus

Module	Topic	Hours
1	General Introduction to Civil Engineering: Relevance of Civil Engineering in the overall infrastructural development of the country. Responsibility of an engineer in ensuring the safety of built environment. Brief introduction to major disciplines of Civil Engineering like Transportation Engineering, Structural Engineering, Geo-technical Engineering, Water Resources Engineering and Environmental Engineering. Introduction to buildings: Types of buildings, selection of site for buildings, components of a residential building and their functions. Building rules and regulations: Relevance of NBC, KBR & CRZ norms (brief discussion only). Building area: Plinth area, built up area, floor area, carpet area and floor area ratio for a building as per KBR.	6
2	Surveying: Importance, objectives and principles. Construction materials, Conventional construction materials: types, properties and uses of building materials: bricks, stones, cement, sand and timber Cement concrete: Constituent materials, properties and types. Steel: Steel sections and steel reinforcements, types and uses. Modern construction materials:- Architectural glass, ceramics, Plastics, composite materials, thermal and acoustic insulating materials, decorative panels, waterproofing materials. Modern uses of gypsum, pre-fabricated building components (brief discussion only).	7
3	Building Construction: Foundations: Bearing capacity of soil (definition only), functions of foundations, types – shallow and deep (brief discussion only). Load bearing and framed structures (concept only). Brick masonry: - Header and stretcher bond, English bond & Flemish bond random rubble masonry. Roofs and floors: - Functions, types; flooring materials (brief discussion only). Basic infrastructure services: MEP, HVAC, elevators, escalators and ramps (Civil Engineering aspects only), fire safety for buildings. Green buildings:- Materials, energy systems, water management and environment for green buildings. (brief discussion only).	7
5	Refrigeration: Unit of refrigeration, reversed Carnot cycle, COP, vapour compression cycle (only description and no problems); Definitions of dry, wet & dew point temperatures, specific humidity and relative humidity, Cooling and dehumidification, Layout of unit and central air conditioners. Description about working with sketches of: Reciprocating pump, Centrifugal pump, Pelton turbine, Francis turbine and Kaplan turbine. Overall efficiency, Problems on calculation of input and output power of pumps and turbines (No velocity triangles) Description about working with sketches of: Belt and Chain drives, Gear and Gear trains, Single plate clutches.	7
6	Manufacturing Process: Basic description of the manufacturing processes – Sand Casting, Forging, Rolling, Extrusion and their applications. Metal	6

	Joining Processes: List types of welding, Description with sketches of Arc Welding, Soldering and Brazing and their applications Basic Machining operations: Turning, Drilling, Milling and Grinding. Description about working with block diagram of: Lathe, Drilling machine, Milling machine, CNC Machine. Principle of CAD/CAM, Rapid and Additive manufacturing	

2. Text Books (T)

- T1. Chudley, R., Construction Technology, Vol. I to IV, Longman Group, England
T2. Chudley, R. and Greeno, R., Building Construction Handbook, Addison Wesley, Longman Group, England
T3. Gopi, S., Basic Civil Engineering, Pearson Publishers
T4. Kandya, A. A., Elements of Civil Engineering, Charotar Publishing house
T5. Mamlouk, M. S., and Zaniewski, J. P., Materials for Civil and Construction Engineering, Pearson Publishers
T6. Shibu Nalpat, Basic Civil Engineering, Nalpat Publishers
T7. B. C. Punmia, Basic Civil Engineering, Khanna Publications
T8. Balachandran, Basic Mechanical Engineering, Owl Books
T9. Benjamin, J., Basic Mechanical Engineering, Pentex Books

3. Reference Books (R)

- R1. McKay, W. B. and McKay, J. K., Building Construction Volumes 1 to 4, Pearson India Education Services
R2. Minu, S., Basic Civil Engineering, Karunya Publications
R3. Rangwala, S. C., Essentials of Civil Engineering, Charotar Publishing House
R4. Rangwala, S. C. and Dalal, K. B., Engineering Materials, Charotar Publishing house
R5. Rangwala, S. C. and Dalal, K. B., Building Construction, Charotar Publishing house
R6. Kerala Municipal Building Rules – 1999
R7. B. C. Punmia, Surveying Vol. 1, Laxmi Publications
R8. T.P Kanetkar, S.V Kulkarni, Surveying and levelling Part-I, Vidyarthi Griha Prakashan
R9. Clifford, M., Simmons, K. and Shipway, P., An Introduction to Mechanical Engineering
R10. Roy and Choudhary, Elements of Mechanical Engineering, Media Promoters & Publishers Pvt. Ltd., Mumbai.
R11. Sawhney, G. S., Fundamentals of Mechanical Engineering, PHI
R12. G Shanmugam, M S Palanichamy, Basic Civil and Mechanical Engineering, McGraw Hill

4. Course Objectives

Objective of this course is to provide an insight and inculcate the essentials of Civil and Mechanical Engineering discipline to the students of all branches of Engineering and to provide the students an illustration of the significance of the Civil and Mechanical Engineering Profession in satisfying the societal needs.

5. Course Pre / Co-requisite

Nil

6. Course Outcomes

After completion of the course, student will be able to

- CO1. Recall the role of civil engineer in society and to relate the various disciplines of Civil
a. Engineering.

- CO2. Explain different types of buildings, building components, building materials and building construction.
- CO3. Describe the importance, objectives and principles of surveying.
- CO4. Summarise the basic infrastructure services MEP, HVAC, elevators, escalators and Ramps.
- CO5. Discuss the Materials, energy systems, water management and environment for green buildings.
- CO6. Analyse thermodynamic cycles and calculate its efficiency
- CO7. Illustrate the working and features of IC Engines
- CO8. Explain the basic principles of Refrigeration and Air Conditioning
- CO9. Describe the working of hydraulic machines
- CO10. Explain the working of power transmission elements.
- CO11. Describe the basic manufacturing, metal joining and machining processes

7. Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes

PO/ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	H					H	M	M							
CO2	H	M		L	H			H							
CO3	H	M			H				M						
CO4	H	M			H				M						
CO5	H	M			H	M	H		M						
CO6	H	M													
CO7	H	L													
CO8	H	L													
CO9	H	M													
CO10	H	L													
CO11	H														

8. Justification for CO-PO-PSO Correlation

CO	PO/PSO	Justification
CO1	PO1	Knowledge on fundamentals aspects of civil engineering science will help students to solve Engineering problems in future.
	PO6	Understanding the role of engineer will help students to assess safety and legal issues in professional engineering practices.
	PO7	Knowledge about the responsibilities of an engineer will help students to develop solutions for sustainable development.
	PO8	Understanding the responsibility of an engineer will enable students to apply ethical principles in the engineering practices.
CO2	PO1	Knowledge about building construction will enable students to solve simple civil engineering problems
	PO2	Understanding the components and construction materials used in a building will enable students to analyse problems related with building construction.
	PO4	Knowledge about building materials will help students to develop valid conclusion for engineering problems in building construction.

	PO5	Knowledge on building materials will enable students to identify appropriate materials/resources adopted for the sustainable development.
	PO8	Knowledge on building rules and regulations will enable students to apply ethical principles in engineering practices.
CO3	PO1	Understanding the principles of Surveying will enable students to solve problems in the field of surveying.
	PO2	Understanding surveying principles will help students to analyse simple surveying problems.
	PO5	Knowledge on the principle of surveying will enable the students to select and apply appropriate method for solve real field problems.
	PO9	Knowledge on the principle of surveying will help the students to function effectively as an individual in multidisciplinary settings.
CO4	PO1	Knowledge about basic infrastructure services will enable students to apply in real field situations.
	PO2	Understanding the basic infrastructure services will enable students to analyse the use of this services in the construction.
	PO5	Knowledge on basic infrastructure services will help the students to select appropriate service.
	PO9	Knowledge on basic infrastructure services will help the students to function effectively as an individual in multidisciplinary settings.
CO5	PO1	Knowledge about green buildings will enable students to apply in real field situations.
	PO2	Understanding the concepts of green building will enable students to identify energy efficient materials and construction methods.
	PO5	Knowledge on the concepts of green building will help the students to select appropriate energy efficient services in the building construction.
	PO6	Insight on the concepts of green buildings will help the students to apply appropriate techniques and methods for an economical construction.
	PO7	Knowledge about green buildings will enable the students to apply the concept for a sustainable construction.
	PO9	Knowledge on the concepts of green buildings will help the students to function effectively as an individual in multidisciplinary settings.
CO6	PO1: Acquiring knowledge to solve engineering problems related to thermodynamic cycle and process enables the students to find solutions to engineering problems PO2: Acquiring knowledge to solve engineering problems related to thermodynamic cycle and process enables the students to conduct literature review, formulate and analyse complex engineering problems	
CO7	PO1: Knowledge acquired in principles Energy conversion devices like IC engine enables the students to find solutions to engineering problems. PO2: Acquiring knowledge to solve engineering problems related to IC engine enables the students to conduct literature review, formulate and analyse complex engineering problems	

CO8	PO1: Knowledge acquired in principles of refrigeration and air conditioning enables students to apply engineering specialisation for the solution of complex engineering problems. PO2: Acquiring knowledge to solve engineering problems related to principles of refrigeration and air conditioning enables the students to conduct literature review, formulate and analyse complex engineering problems
CO9	PO1: Knowledge acquired in principles Energy conversion devices like hydraulic machines enables the students to find solutions to engineering problems. PO2: Acquiring knowledge to solve engineering problems related to hydraulic machines enables the students to conduct literature review, formulate and analyse complex engineering problems
CO10	PO1: Knowledge acquired in principles power devices enables the students to find solutions to engineering problems. PO2: Acquiring knowledge to solve engineering problems related to principles power devices enables the students to conduct literature review, formulate and analyse complex engineering problems
CO11	PO1: Awareness about basic understanding of to select different manufacturing process enables students to apply these fundamental knowledge for the solution of complex engineering problems.

9. Curricular gaps (if any)

Nil

10. Course Enrichment Activities*

Sl No	Description	Proposed Activities **	Relevance to POs and PSOs
1	Nil(Civil)		
2	Basics theories and definitions in Thermodynamics (Mechanical)	Additional Classes	PO1

11. Internal Assessment mark allocation (as per university curriculum)

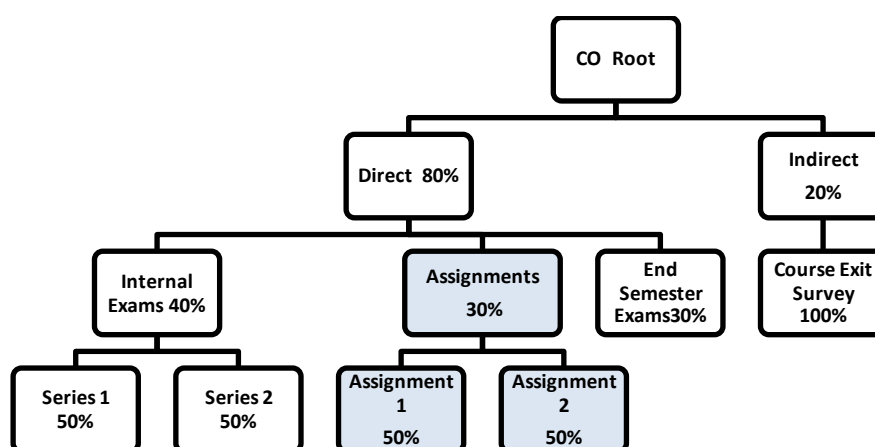
(Provide details as mentioned in syllabus)

Attendance	- 10 marks
Continuous Assessment Test	- 25 marks
<u>Assignment (s)/ Course Project</u>	<u>- 15 marks</u>
<u>Total</u>	<u>- 50marks</u>

12. Assessment – CO Mapping (Put ‘ x’ if mapping is present)

	Tools		Weightage	CO 1	CO 2	CO 3	CO 4	CO 5	CO 6	CO 7	CO 8	CO 9	CO 10	CO 11
Direct Assessment Tools	Internal Exam(s) 25%	Series 1	12.5%	x	x	x			x	x				
		Series 2	12.5%		x		x	x			x	X	x	
	Assignment (s)/ Course Project /Quiz etc. 15%	Assignment 1	7.5%	x		x				x		X		
		Assignment 2	7.5%		x		x	x					x	X
	Attendance		10%	x	x	x	x	x						
	End Semester Exam		30%	x	x	x	x	x	x	x		X	x	X
Indirect Assessment Tool	Course Exit Survey		100%	x	x	x	x	x	x	x		X	x	X

13. Assessment Configuration



14. Course Plan

Hour	Topic	Module	Reference(s)	Teaching Pedagogy
1	General Introduction to Civil Engineering Role and relevance of Civil Engineering in infrastructural development	1	T1	Lecture
2	Responsibilities of Civil Engineers in ensuring safety of structures	1	T1	Lecture
3	Major disciplines: Transportation, Structural, Geotechnical, Water Resources, Environmental Engineering	1	T1	Lecture
4	Buildings – types, site selection, components of residential buildings	1	T1	Lecture

5	Building rules and regulations – NBC, KBR, CRZ (brief)	1	T1	Lecture
6	Building area definitions – plinth, built-up, floor, carpet, FAR	1	T1	Lecture
7	Surveying: objectives, importance, principles	2	T1	Lecture
8	Conventional materials: bricks, stones, cement, sand, timber, types	2	T1	Lecture
9	Cement concrete – materials, properties,	2	T1	Lecture
10	Steel sections and reinforcements	2	T1	Lecture
11	Modern materials: glass, ceramics, plastics, composites, insulation, waterproofing, gypsum, prefabricated components	2	T1	Lecture
12	Foundations: bearing capacity (definition), functions, types – shallow & deep	3	T1	Lecture
13	Load-bearing vs framed structures	3	T1	Lecture
14	Masonry: header, stretcher, English, Flemish bonds; rubble masonry	3	T1	Lecture
15	Roofs and floors: functions, types, flooring	3	T1	Lecture
16	Infrastructure services: MEP, HVAC, elevators, ramps, fire safety	3	T1	Lecture
17	Green buildings: materials, energy systems, water management, environment	3	T1	Lecture
18	Carnot, Otto, Diesel cycles – derivation of efficiency	4	T1	Lecture
19	Problems on heat added, heat rejected, work done, efficiency	4	T1	Lecture
20	IC Engines – SI, CI, 2-Stroke, 4-Stroke	4	T1	Lecture
21	Engine parts and functions	4	T1	Lecture
22	Efficiencies (definitions only)	4	T1	Lecture
23	Air, fuel, cooling and lubrication systems	4	T1	Lecture
24	CRDI, MPFI and hybrid engines	4	T1	Lecture
25	Unit of refrigeration, reversed Carnot cycle	5	T1	Lecture
26	Vapour compression cycle – description	5	T1	Lecture
27	Air properties – dry/wet/dew point temp, humidity, cooling & dehumidification	5	T1	Lecture
28	Layout of unit and central A/C systems	5	T1	Lecture

29	Working of pumps (reciprocating, centrifugal), turbines (Pelton, Francis, Kaplan)	5	T1	Lecture
30	Efficiency, input-output power problems	5	T1	Lecture
31	Drives: belt, chain, gears, single plate clutch	5	T1	Lecture
32	Basic manufacturing methods – sand casting, forging, rolling, extrusion	6	T1	Lecture
33	Metal joining – welding, soldering, brazing (with sketches)	6	T1	Lecture
34	Machining operations – turning, drilling, milling, grinding	6	T1	Lecture
35	Working (block diagrams) – lathe, drilling, milling, CNC machine	6	T1	Lecture
36	Principles of CAD/CAM	6	T1	Lecture
37	Rapid and additive manufacturing	6	T1	Lecture

15. Question Bank

Module 1				
Sl. No.	Question	Marks	CO	BL
1	Explain the relevance of civil engineering in the infrastructure development of the country.	4	CO1	L2
2	List the role of civil engineers in infrastructure development of the country	4	CO1	L1
3	List the responsibilities of an engineer in ensuring the safety of built environment	4	CO1	L1
4	List the various disciplines of civil engineering.	4	CO1	L1
5	List the factors to be considered in the site selection for buildings.	4	CO2	L1
6	Discuss about Group A and Group C buildings as per NBC.	4	CO2	L2
7	Discuss the role of a civil engineer in the infra structural development of a country.	4	CO1	L2
8	Discuss about the minimum size requirements of rooms for a residential building as per NBC.	4	CO2	L2
9	Explain any two major disciplines of civil engineering.	4	CO1	L2

10	Recall the functions of (a) lintels, (b) sunshades and (c) walls in a building.	4	CO2	L1
11	Differentiate between floor area and carpet area.	4	CO2	L2
12	Explain about Kerala building rules and its importance	5	CO2	L2
13	Explain the role of NBC, KBR, CRZ norms in building rules and regulations prevailing in our country.	5	CO2	L2
14	Explain the classification of buildings as per NBC.	5	CO2	L2
15	Explain coastal regulation zone and its classifications.	5	CO2	L2
16	Distinguish between plinth area and carpet area.	5	CO2	L2
17	Explain the term FAR/FSL.	5	CO2	L2
18	Discuss the requisites of a good site plan for a building.	5	CO1	L2
19	List out any five major factors to be considered for the selection of a good site for a residential building.	5	CO1	L2
20	Explain the classification of buildings as per occupancy according to National building code.	5	CO1	L2
21	Explain the components of residential building with neat sketch	5	CO2	L2
22	List out the different activities which are prohibited as per CRZ norms.	6	CO1	L2
23	Explain the different infrastructural facilities necessary for the development of country.	6	CO1	L2
24	With neat sketch explain the different components of a building.	6	CO2	L2
MODULE 2				
	Question	Marks	CO	BL
1	List the modern uses of gypsum	4	CO2	L1
2	List the uses of plastics in construction	4	CO2	L1
3	Explain different types of steel used in the construction and their properties.	4	CO2	L2
4	List the different kinds of cement used in the constructions and write the uses of it.	4	CO2	L1
5	List and explain any five modern construction materials used for constructions.	4	CO2	L1

6	List the properties of good building bricks. Explain any five.	4	CO2	L1
7	List the features of prefabricated construction	4	CO2	L1
8	List the qualities of a building stone.	4	CO2	L1
9	Discuss any four advantages of prefabricated building components.	4	CO2	L2
10	Explain the objectives and principles of surveying	4	CO3	L2
11	Explain the different classifications of timber.	4	CO2	L1
12	Explain the advantages and uses of rapid hardening cement .	4	CO2	L2
13	Illustrate the commercial forms of steels used in construction.	5	CO2	L2
14	Explain the advantages of RCC over PCC.	5	CO2	L2
15	Explain the common defects of timber.	5	CO2	L2
16	Explain the various tests conducted to ensuring the quality of bricks.	5	CO2	L2
17	Classify the different types of waterproofing methods	5	CO2	L2
18	Distinguish between thermal insulators and acoustic insulators	5	CO2	L2
19	List the major constituents of cement and explain its properties.	5	CO2	L2
20	Enumerate the properties and uses of first class bricks	5	CO2	L2
21	With sketches explain any five market forms of steel section and their uses.	5	CO2	L2
22	Explain the types and uses of architectural glass as a construction material.	5	CO2	L2
23	List out any five major qualities of a good timber.	5	CO2	L1
24	List out two uses of any five different types of cement.	5	CO2	L1
25	Explain the properties and uses of any two composite materials used in building construction	6	CO2	L2
26	Discuss about the primary classification of surveying.	6	CO3	L2
27	Explain the classification of survey based on instruments used.	6	CO3	L2
Module 3				
Sl. No.	Question	Marks	CO	BL
1	Define bearing capacity of soil.	4	CO2	L1

2	Define stone masonry. List out the classifications of stone masonry.	4	CO2	L1
3	List the advantages of brick masonry over stone masonry.	4	CO2	L1
4	Define a) Pitch b) Ridge c) Wall plate d) Batten	4	CO2	L1
5	List the factors to be considered for the selection of a flooring material.	4	CO2	L1
6	List out the criteria for the selection of a good roofing material.	4	CO2	L1
7	List out any four acoustic insulation and thermal insulation materials.	4	CO5	L1
8	With neat sketch explain strap footing.	4	CO2	L1
9	List the different materials used in the construction of green building.	4	CO5	L1
10	Enlist the various aspects to be considered in fire safety of buildings?	4	CO2	L1
11	Distinguish between English bond and Flemish bond with neat sketch.	5	CO2	L2
12	Explain the following types of foundations with neat sketches (a) Isolated stepped footing (b) cantilever footing (c) continuous footing	5	CO2	L2
13	Explain the different types of floor and floor coverings.	5	CO2	L2
14	Explain the civil engineering aspects of elevators, escalators and ramps in building.	5	CO4	L2
15	Discuss the importance of fire safety in buildings.	5	CO4	L2
16	Explain the civil engineering aspects of HAVC and MEP in commercial buildings.	5	CO4	L2
17	Discuss the relevance and features of Green Buildings.	5	CO5	L2
18	Explain the energy systems and water management in green building.	5	CO5	L2
19	Draw the elevation and plan of one brick thick wall with English bond.	5	CO2	L2
20	With a neat sketch explain any two types of shallow foundation.	5	CO2	L1
21	With neat sketches compare English bond and Flemish bond.	5	CO2	L2
22	Explain the water management and energy management in green buildings.	5	CO5	L2
23	Explain the different types of roofs with sketches.	5	CO2	L2
24	With neat sketch explain king post roof truss.	6	CO2	L2

25	Explain the importance of green building? List out any four materials used in the construction of green building.	6	CO5	L2
26	Draw the plan and elevation of one brick thick wall with Flemish Bond.	6	CO2	L2
Module 4				
Sl. No.	Question	Marks	CO	BL
1	Explain the fuel system for petrol engines.	4	CO6	L1
2	Explain the working of Air Standard Carnot Cycle.	4	CO6	L1
3	Sketch a Diesel cycle on P-V and T-S diagram and explain.	4	CO6	L1
4	Draw the p-V diagram of a diesel cycle and define the terms (i) Compression ratio, (ii) Expansion ratio, and (iii) Cut-off ratio related to the Diesel cycle. (2019)	4	CO6	L1
5	Draw the p-V diagram of an Otto cycle and define the term Compression ratio.	4	CO6	L1
6	With the help of a block diagram explain the fuel system of CI engines.	4	CO6	L1
7	What is an automobile? Discuss the classification of automobiles.	4	CO7	L1
8	With the help of a block diagram explain the components of an automobile	4	CO7	L1
9	With the help of a neat sketch show the important parts of an internal Combustion engine. (2019)	4	CO7	L1
10	Give the concept of hybrid engines. (2019)	4	CO7	L1
11	Define (i) Brake thermal efficiency (ii) Indicated thermal efficiency (iii) Mechanical efficiency and (iv) Volumetric efficiency of an IC engine.	4	CO7	L1
12	With the help of a neat sketch show the important parts of an internal Combustion engine.	4	CO7	L1
13	Sketch and explain Ideal cycle for petrol engines.	4	CO6	L2
14	“No engine can be made to work on carnot cycle” Justify your answer.	4	CO6	L2
15	Why petrol engines are called as SI engines and diesel engines are called as CI engines?	4	CO6	L2
16	Why the compression ratio of petrol engine is low compared to diesel engines?	4	CO6	L3

17	Explain the fuel system of a petrol engine.	5	CO7	L1
18	Name the Air Standard cycle for Petrol engine. Explain with a neat PV diagram	5	CO6	L2
19	In a Diesel cycle the compression ratio is 13 and cut off occurs at 8% of the stroke. Find the air standard efficiency	5	CO6	L2
20	1 kg of air at temperature 15°C and pressure 100 kPa is taken through a Diesel Cycle. The compression ratio is 15 and heat added is 1850 kJ. Calculate the ideal cycle efficiency.	5	CO6	L2
21	A Carnot engine, working between 650 K and 310 K, produces 150 kJ of work. Find thermal efficiency and heat added during the process.	5	CO6	L2
22	In an Otto cycle, at the beginning of the compression air is at 27°C and 1 bar. The clearance volume is 20% of the swept volume. Find i) Air standard efficiency. ii) Temperature at the end of compression.	5	CO6	L3
23	In an ideal diesel cycle, the temperature at the beginning and end of the expansion is 1850°C and 850°C. Determine the ideal efficiency of the cycle. Take $\gamma = 1.4$. If compression ratio is 15 and pressure at the beginning is 1 bar, calculate the maximum pressure in the cycle.	5	CO6	L3
24	Explain MPFI, CRDI and hybrid engines.	6	CO7	L1
25	Explain the MPFI system with block diagram. Also give its advantages (2019)	6	CO7	L2
26	1 kg of air at temperature of 15°C and pressure of 100 kPa is taken through a Diesel cycle. The compression ratio is 15 and the heat added is 1850 KJ Calculate the ideal cycle efficiency?	8	CO6	L2
27	Explain the Carnot cycle with PV diagram and derive the expression for thermal efficiency.	10	CO6	L1
28	Describe briefly on working and constructional features of a) Lubrication system of an engine b) Cooling system of an engine	10	CO7	L1
29	Explain the working of a 4 stroke SI engine with neat sketches	10	CO7	L1
30	Derive an expression for the air standard efficiency of a diesel cycle.	10	CO6	L2
31	Derive an expression for the air standard efficiency of Otto	10	CO6	L2
32	An engine operating on an air standard Otto cycle has a compression ratio equal to 7. The conditions at the start of compression are 0.1 MPa and 300K. The pressure at the end of heat addition is 4 MPa. Determine the thermal efficiency and network done where $C_v = 0.718 \text{ kJ/Kg}$ and γ for air = 1.4.	10	CO6	L2
33	An engine operating on Carnot cycle between temperature limits 20°C and 800°C rejects heat at the rate 200 KJ/s. Determine (i) the ideal thermal efficiency of the cycle. (ii) Power output of the engine.	10	CO6	L2
34	In a constant volume Otto cycle, the pressure at the end of compression is 15 times that at the start, the temperature of air at the beginning of compression is 38°C and the maximum temperature attained in the cycle is 1950°C. Determine Compression ratio, thermal efficiency of the cycle and work done per kg of air. Take γ for air = 1.4.	10	CO6	L2
	A Carnot cycle works with adiabatic compression ratio of 5 and isothermal expansion ratio of 2. The volume of air at the			

35	beginning of isothermal expansion is 0.3 m ³ . If the maximum temperature and pressure is limited to 550K and 21 bar, determine the minimum temperature in the cycle and efficiency of the cycle.	10	CO6	L2
36	A Carnot engine operates between a source at 1000 K and a sink at 300K. If the engine is supplied with a heat at a rate of 800kJ/min, determine the thermal efficiency and power output of the engine.	10	CO6	L2
37	An engine working on Diesel cycle has diameter 150 mm and stroke 200 mm. The clearance volume is 10 % of the swept volume. Determine the compression ratio and air standard efficiency of the engine if the cut-off takes place at 6 % of the stroke.	10	CO6	L2
	In an air standard Diesel cycle, the compression ratio is 16 and at the beginning of compression the temperature is 150°C and the pressure is 0.1MPa. Heat is added until the temperature at the end of constant pressure process is 1480°C. Calculate (1) The cut off ratio (2) The heat supplied per kg of air (3) The cycle efficiency	10	CO6	L2
39	Calculate the ideal air standard thermal efficiency based on the Otto cycle for a petrol engine with a cylinder bore of 50mm and stroke of 75 mm and a clearance volume of 21.3 cm ³ .	10	CO6	L2
40	Differentiate the working of 4 stroke engine and 2 stroke engine.	10	CO7	L2
41	An engine working on Diesel cycle has diameter 150 mm and stroke 200mm. The clearance volume is 10 % of the swept volume. Determine the compression ratio and air standard efficiency of the engine if the cut-off takes place at 6 % of the stroke. (2019)	10	CO6	L3

Module 5

Sl. No.	Question	Marks	CO	BL
1	What are the different types of gears used in power transmission?	4	CO10	L1
2	Describe the working of a single plate clutch.	4	CO10	L1
3	Explain cooling and dehumidification process. Also show the process in psychrometric chart. (2019)	4	CO8	L1
4	Explain the split air conditioner and its working.	4	CO8	L1
5	Discuss the classification of hydraulic turbines.	4	CO9	L1
6	A centrifugal pump discharges water at a rate of 200 litres/minute against a head of 16 m when running at 300 rpm. Calculate the power required to run the pump if the overall efficiency of the pump is 50 %.	4	CO9	L2
7	Why gear drives are called positive drives, Whereas belt and rope drives are not considered positive?	4	CO10	L2
8	Explain a single plate clutch.	5	CO10	L1
9	Explain the gear terminology with neat sketch.	5	CO10	L1

10	Explain the open belt and cross belt drive in power transmission. Also give the applications. (2019)	5	CO10	L1
11	What are the desirable properties of refrigerants?	5	CO8	L1
12	Write short notes on: i) Psychrometric chart ii) Gear trains iii) Impact of refrigerants on environment	5	CO8	L1
13	Explain the reversed Carnot cycle with PV Diagram.	5	CO8	L1
	with sketches			
15	Distinguish between gear drive and belt drive system.	5	CO10	L2
16	Distinguish between open and closed belt drives.	5	CO10	L2
17	Illustrate the working of an epicyclic gear train	5	CO10	L2
18	Compare and contrast impulse and reaction turbines. (2019)	5	CO9	L2
19	Differentiate between reciprocating and centrifugal pumps.	5	CO9	L2
20	A turbine is to operate under a head of 25 m at 200 rpm. The discharge is 9 m ³ /s. If the overall efficiency of the turbine is 90%. Determine the power developed by the turbine.	5	CO9	L2
21	A centrifugal pump using 1kW of electric motor for pumping water against 3m suction head and 7m delivery head. The discharge of the pump is 100 liters /minute. Find the efficiency of pump.(2019)	5	CO9	L3
22	A turbine is working at a head of 250 m and the discharge through the penstock is 2 m ³ /s. If the efficiency of the turbine is 55 %, find the power developed by the turbine. (2019)	5	CO9	L3
23	Define: COP, Ton of refrigeration, specific humidity, relative humidity, WPT and dew point temperature.	6	CO8	L1
24	Describe the working of a Kaplan turbine with a suitable sketch.	6	CO9	L1
25	With the help of suitable sketch explain the working of a Window Air Conditioner.	6	CO8	L2
26	Draw the schematic diagram of a summer air conditioning system and explain the processes involved in it.	6	CO8	L2
27	A Pelton turbine with a head of 450m generates 13 MW at 450rpm. Calculate discharge of the turbine if the overall efficiency is 80%.	6	CO9	L2

28	With the help of a neat sketch explain the working of a reciprocating pump	6	CO9	L2
29	Explain the working of belt drive and gear drive with the help of neat sketches.	10	CO10	L1
30	Sketch different types of gear trains and explain. (2019)	10	CO10	L1
31	Explain the working of vapour compression refrigeration system.	10	CO8	L1
32	With the help of a neat sketch explain the working of an air conditioning system for hot and humid outdoor conditions.	10	CO8	L1
33	Explain the working principle and construction features of Reciprocating pump.	10	CO9	L1
Module 6				
Sl. No.	Question	Marks	CO	BL
1	How the welding processes are classified? List out the different types of welding methods.	4	CO11	L1
2	Explain the general procedure used in making a sand mould for the casting	4	CO11	L1
3	Describe the working of a cluster rolling mill giving a sketch.	4	CO11	L1
4	Define the terms Rapid prototyping and Additive manufacturing.	4	CO11	L1
5	Differentiate between up-milling and down-milling operations.	4	CO11	L2
6	Explain the functions of runners and risers used in casting.	4	CO11	L2
7	Explain the advantages and disadvantages of rapid manufacturing systems.	4	CO11	L2
8	Compare conventional machine tools and CNC machines.	4	CO11	L2
9	Compare welding, brazing and soldering.	5	CO11	L2
10	Explain the principle of Rapid manufacturing.	5	CO11	L2
11	Explain the principle of Additive manufacturing.	5	CO11	L2
12	Using a block diagram, explain components of a CNC machine.	5	CO11	L2
13	What are the important types of metal joining processes?	5	CO11	L2

14	What are the possible defects of sand casting process?	5	CO11	L2
15	Describe the basic manufacturing operations performed in a machine tool.	5	CO11	L2
16	Describe the arc welding process with a neat sketch. (2019)	6	CO11	L1
17	Describe the direct extrusion and indirect extrusion with sketches	6	CO11	L1
18	Explain the two high, three high, four high and cluster rolling mills with neat sketches.	10	CO11	L1
19	Describe the following terms: a. Rolling b. Extrusion c. Forging	10	CO11	L1
20	With a neat sketch, explain the working and parts of a lathe. List 5 operations performed in a lathe.	10	CO11	L1
21	With a neat sketch, explain the working and parts of a Drilling Machine.	10	CO11	L1
22	Describe the working of a Milling machine. Draw the block diagram of a Milling machine and indicate its main parts.	10	CO11	L1
23	Explain the working of a drilling machine with block diagram.	10	CO11	L1
24	Discuss any four operations that can be performed on a lathe with simple sketches.	10	CO11	L1
25	What is casting? With the help of a neat sketch explain the process of sand mould casting.	10	CO11	L1
26	Describe the operations which can be performed using drilling machine.	10	CO11	L2

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Checked By: Ms. Sherine Justine, Jaison Joseph

Course Code & Name: HUN102 Professional Communication
1. Prescribed Syllabus

Module	Topic	Hours
1	Use of language in communication: Significance of technical communication Vocabulary Development: technical vocabulary, vocabulary used in formal letters/emails and reports, sequence words, misspelled words, compound words, finding suitable synonyms, paraphrasing, verbal analogies. Language Development: subject-verb agreement, personal passive voice, numerical adjectives, embedded sentences, clauses, conditionals, reported speech, active/passive voice. Technology-based communication: Effective email messages, slide presentations, editing skills using software. Modern day research and study skills: search engines, repositories, forums such as Git Hub, Stack Exchange, OSS communities (MOOC, SWAYAM, NPTEL), and Quora; Plagiarism.	8
2	Reading, Comprehension, and Summarizing: Reading styles, speed, valuation, critical reading, reading and comprehending shorter and longer technical articles from journals, newspapers, identifying the various transitions in a text, SQ3R method, PQRS method, speed reading. Comprehension: techniques, understanding textbooks, marking and underlining, Note-taking: recognizing non-verbal cues.	8
3	Oral Presentation: Voice modulation, tone, describing a process, Presentation Skills: Oral presentation and public speaking skills, business presentations, Preparation: organizing the material, self-Introduction, introducing the topic, answering questions, individual presentation practice, presenting visuals effectively. Debate and Group Discussions: introduction to Group Discussion (GD), differences between GD and debate; participating GD, understanding GD, brainstorming the topic, questioning and clarifying, GD strategies, activities to improve GD skills.	8
4	Listening and Interview Skills Listening: Active and Passive listening, listening: for general content, to fill up information, intensive listening, for specific information, to answer, and to understand. Developing effective listening skills, barriers to effective listening, listening to longer technical talks, listening to classroom lectures, talks on engineering /technology, listening to documentaries and making notes, TED talks. Interview Skills: types of interviews, successful interviews, interview etiquette, dress code, body language, telephone/online (skype) interviews, one-to-one interview & panel interview, FAQs related to job interviews.	8
5	Formal writing: Technical Writing: differences between technical and literary style. Letter Writing (formal, informal and semi-formal), Job applications, Minute preparation, CV preparation (differences between Bio-Data, CV and Resume), and Reports. Elements of style, Common Errors in Writing: describing a process, use of sequence words, Statements of Purpose, Instructions, Checklists. Analytical and issue-based Essays and Report Writing: basics of report writing; Referencing Style (IEEE Format),	8

	structure of a report; types of reports, references, bibliography. Lab Activities Written: Letter writing, CV writing, Attending a meeting and Minute Preparation, Vocabulary Building Spoken: Phonetics, MMFS (Multimedia Feedback System), Mirroring, Elevator Pitch, telephone etiquette, qualities of a good presentation with emphasis on body language and use of visual aids. Listening: Exercises based on audio materials like radio and podcasts. Listening to Song. practice and exercises. Reading: Speed Reading, Reading with the help of Audio Visual Aids, Reading Comprehension Skills Mock interview and Debate/Group Discussion: concepts, types, Do's and don'ts- intensive practice.	

2. Text Books (T)

Nil

3. Reference Books (R)

- R1. English for Engineers and Technologists (Combined edition, Vol. 1 and 2), Orient Blackswan 2010.
- R2. Meenakshi Raman and Sangeetha Sharma, "Technical Communication: Principles and Practice", 2nd Edition, Oxford University Press, 2011
- R3. Stephen E. Lucas, "The Art of Public Speaking", 10th Edition; McGraw Hill Education, 2012.
- R4. Ashraf Rizvi, "Effective Technical Communication", 2nd Edition, McGraw Hill Education, 2017.
- R5. William Strunk Jr. & E.B. White, "The Elements of Style", 4th Edition, Pearson, 1999. 6. David F. Beer and David McMurrey, Guide to writing as an Engineer, John Wiley. New York, 2004.
- R6. Goodheart-Willcox, "Professional Communication", First Edition, 2017.
- R7. Training in Interpersonal Skills: Tips for Managing People at Work, Pearson Education, India, 6 edition, 2015.
- R8. The Ace of Soft Skills: Attitude, Communication and Etiquette for Success, Pearson Education; 1 edition, 2013.
- R9. Anand Ganguly, "Success in Interview", RPH, 5th Edition, 2016.
- R10. Raman Sharma, "Technical Communications", Oxford Publication, London, 2004.

4. Course Objectives

Clear, precise, and effective communication has become a sine qua non in today's information driven world given its interdependencies and seamless connectivity. Any aspiring professional cannot but master the key elements of such communication. The objective of this course is to equip students with the necessary skills to listen, read, write, and speak so as to comprehend and successfully convey any idea, technical or otherwise, as well as give them the necessary polish to become persuasive communicators.

5. Course Pre / Co-requisite

Nil

6. Course Outcomes

- CO1. Develop vocabulary and language skills relevant to engineering as a profession.
- CO2. Analyze, interpret and effectively summarize a variety of textual Content.
- CO3. Create effective technical presentations.
- CO4. Discuss a given technical/non-technical topic in a group setting and arrive at generalizations/consensus.
- CO5. Identify drawbacks in listening patterns and apply listening techniques for specific needs.
- CO6. Create professional and technical documents that are clear and adhering to all the necessary conventions.

7. Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes

PO/ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1										H		M			
CO2										L		H			
CO3						L			L	H					
CO4										H		L			
CO5		L							M	H					
CO6	L					L			L	H					

8. Justification for CO-PO-PSO Correlation

CO1	PO10- Learning technical vocabulary enables us to communicate effectively about convoluted engineering problems with the professional community and society through presentations and discussions.
	PO12- developing technical language skills enhances lifelong learning of technological knowledge.
CO 2	PO10- Knowledge of different comprehension techniques, valuation and critical reading helps to communicate with the engineering community and to give and receive clear instructions.
	PO12- Understanding the concepts like reading and comprehending shorter and longer techniques, enhances lifelong learning of engineering aspects in a broader sense.
CO 3	PO6- Learning different techniques of effective technical presentations helps to analyze and find out various societal issues and present it for verification.
	PO9- Knowledge of various presentation skills help to work effectively as a team member.
	PO10- Understanding the basic skills of presentation helps to communicate with the professionals through presentations and documentation of various issues related to engineering and community.

CO 4	PO10- By taking part in different group discussions, it will be easy to communicate effectively with the engineering community and society at large and discuss about the problems and find out the solutions needed.
	PO12 - By developing the capacity to analyze and discuss a technical/non technical topic in a group, enables to recognize the need for life-long learning in the broadest context of technological knowledge.
CO 5	PO2- Developing effective listening skills helps to analyze and understand various engineering problems.
	PO9- By understanding the concepts like active and passive listening it is easy to perform better as a part of diverse teams.
	PO10- Learning effective listening process helps to deliver productive communication with professional community by giving and receiving clear instructions.
CO 6	PO1- Knowledge of technical writing can be applied to formulate solutions for various engineering problems.
	PO6- By learning different techniques of technical writing, it is easy to analyze health, safety and other societal issues through detail reports.
	PO9- Developing effective technical writing skills helps to perform better and be the part of a diverse team.
	PO10- Technical writing helps to communicate about engineering problems, through effective reports and documentation and present clear idea.

9. Curricular gaps (if any)

Nil

10. Course Enrichment Activities*

Sl No	Description	Proposed Activities	Relevance to POs and PSOs

11. Internal Assessment mark allocation (as per university curriculum)

(Provide details as mentioned in syllabus)

Attendance - 10 marks

Regular Assessment - 25 marks

Series Test - 15 marks

Total - 50 marks

Regular assessment – Total- 25 marks

Project report presentation and technical presentation through PPT: 7.5 marks

Listening Test: 5 marks

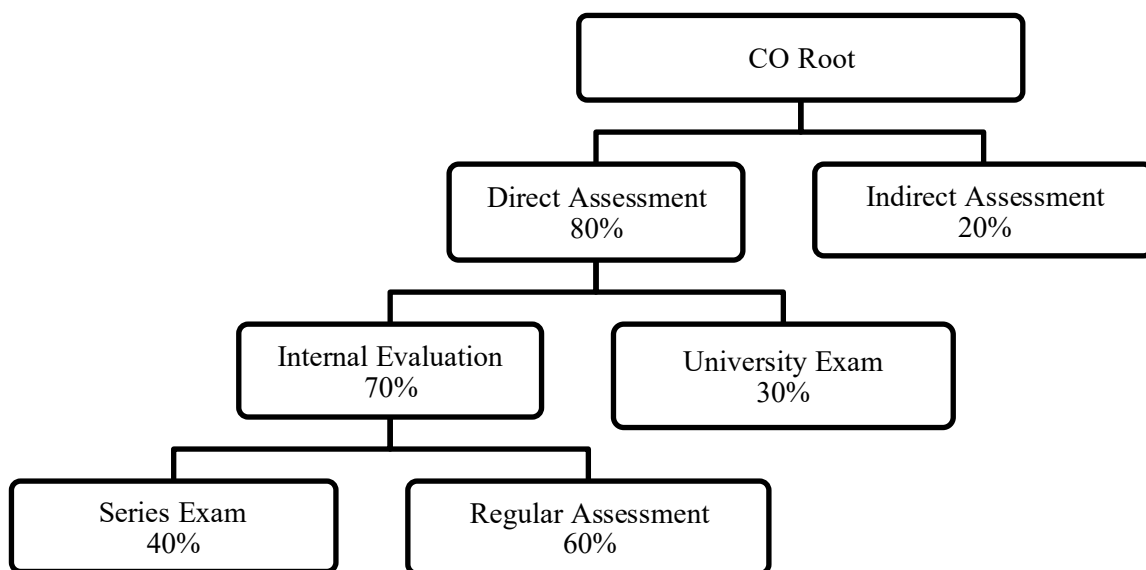
Group discussion/mock job interview: 7.5 marks

Resume submission: 5 marks

12. Assessment – CO Mapping (Put 'x' if mapping is present)

	Tools		Weightage #	CO 1	CO 2	CO 3	CO 4	CO 5	CO 6
Direct Assessment Tools**	Internal Exam(s) 28%	Series 1	14%	x	x				
		Series 2	14%			x	x	x	x
	Regular Assessment 42%	Presentation	12%			x	x		
		Group Discussion	12%	x		x	x		
		Assignment 1 (Listening Test)	9%	x				x	
		Assignment 2 (Resume Submission)	9%						x
	End Semester Exam		30%	x	x	x	x	x	x
Indirect Assessment Tool	Course Exit Survey		100%	x	x	x	x	x	x

13. Assessment Configuration



14. Course Plan

Sl.no	Topic Name	Reference	Module	Teaching Pedagogy
1	Use of language in communication: Significance of technical communication	Professional Communication by Deepak Benjamin (Author), Tintu P Joseph (Author)	1	Lecture
2	conditionals	Benjamin (Author), Tintu P	1	Lecture

		Joseph (Author)		
3	numerical adjectives, embedded sentences, reported speech, active/passive	Professional Communication by Deepak Benjamin (Author), Tintu P Joseph (Author)	1	Lecture
4	compound words, finding suitable	Benjamin (Author), Tintu P Joseph (Author)	1	Lecture
5	Technical vocabulary, vocabulary used in formal letters/emails and reports.	Professional Communication by Deepak Benjamin (Author), Tintu P Joseph (Author)	1	Lecture
6	Effective email messages, slide presentations, editing skills using software.	Professional Communication by Deepak Benjamin (Author), Tintu P Joseph (Author)	1	Lecture
7	search engines, repositories, forums such as Git Hub, Stack Exchange, OSS	Professional Communication by Deepak Benjamin (Author), Tintu P Joseph (Author)	1	Lecture
8	Revision-module 1	Professional Communication by Deepak	1	Lecture
9	Introduction to Reading, Reading Styles	Benjamin (Author), Tintu P Joseph (Author)	2	Lecture
10	valuation, critical reading	Professional Communication by Deepak Benjamin (Author), Tintu P Joseph (Author)	2	Lecture
11	Revision-module 2	Professional Communication by Deepak Benjamin (Author), Tintu P Joseph (Author)	2	Lecture
12	Phonetics	Benjamin (Author), Tintu P Joseph (Author)	3	Lecture
13	describing a process, Elevator pitch	Benjamin (Author), Tintu P Joseph (Author)	3	Lecture
14	public speaking skills, business presentations, Telephone etiquette	Professional Communication by Deepak Benjamin (Author), Tintu P Joseph (Author)	3	Lecture
15	Preparation: Organizing the material, self- Introduction, introducing the topic,	Professional Communication by Deepak Benjamin (Author), Tintu P Joseph (Author)	3	Lecture
16	Individual presentation practice: Techniques for improving your delivery,	Professional Communication by Deepak Benjamin (Author), Tintu P Joseph (Author)	3	Lecture
17	appropriate visuals, formatting and designing slides, integrating visuals into	Professional Communication by Deepak Benjamin (Author), Tintu P Joseph (Author)	3	Lecture
18	Debate and Group Discussions: introduction to Group Discussion (GD)	Professional Communication by Deepak Benjamin, Tintu P Joseph (Aut	3	Lecture
19	Participating GD:understanding	Professional Communication by	3	Lecture

	GD, brainstorming the topic, questioning	Deepak Benjamin (Author), Tintu P Joseph (Author)		
20	Activities to improve GD skills: Building confidence and overcoming nervousness,	Professional Communication by Deepak Benjamin (Author), Tintu P Joseph (Author)	3	Lecture
21	MMFS, Mirroring, Revision-module 3	Benjamin (Author), Tintu P Joseph (Author)	3	Lecture
22	Listening and Interview Skills: The importance of effective listening and	Professional Communication by Deepak Benjamin (Author), Tintu P Joseph (Author)	4	Lecture
23	different types of listening for various purposes such as general content, filling up	Professional Communication by Deepak Benjamin (Author), Tintu P Joseph (Author)	4	Lecture
24	Strategies for overcoming listening barriers, such as distractions, biases, and	Professional Communication by Deepak Benjamin (Author), Tintu P Joseph (Author)	4	Lecture
25	Listening to longer technical talks: Techniques for staying engaged	Professional Communication by Deepak Benjamin (Author), Tintu P Joseph (Author)	4	Lecture
26	staying focused and retaining information during classroom lectures or discussions. Talks on engineering/technology:	Professional Communication by Deepak Benjamin (Author), Tintu P Joseph (Author)	4	Lecture
27	notes: Techniques for taking effective notes while watching documentaries or other educational videos. TED talks:	Professional Communication by Deepak Benjamin (Author), Tintu P Joseph (Author)	4	Lecture
28	Interview Skills: types of interviews, successful interviews, interview etiquette,	Professional Communication by Deepak Benjamin (Author), Tintu P Joseph (Author)	4	Lecture
29	telephone/online (skype) interviews, one-to-one interview & panel interview, FAQs related to job interviews	Professional Communication by Deepak Benjamin (Author), Tintu P Joseph (Author)	4	Lecture
30	Exercises based on audio materials like radio and podcasts. Listening to Song. practice and exercises	Professional Communication by Deepak Benjamin (Author), Tintu P Joseph (Author)	4	Lecture
31	Revision-module 4	Benjamin (Author), Tintu P Joseph (Author)	4	Lecture
32	Formal Writing: The importance of technical writing and the differences between technical and literary style.	Professional Communication by Deepak Benjamin (Author), Tintu P Joseph (Author)	5	Lecture
33	Letter Writing: Formal, informal, and semi-formal letter writing, with examples	Professional Communication by Deepak Benjamin (Author), Tintu P Joseph (Author)	5	Lecture

	and tips for effective communication.			
34	Job Applications: How to prepare a successful job application, including cover letters, resumes, and CVs (differences between Bio-Data, CV, and Resume).	Professional Communication by Deepak Benjamin (Author), Tintu P Joseph (Author)	5	Lecture
35	Minute Preparation: Tips for preparing meeting minutes, including organization, formatting, and content.	Professional Communication by Deepak Benjamin (Author), Tintu P Joseph (Author)	5	Lecture
36	Reports: The elements of a well-written report, including style, structure, and content.	Professional Communication by Deepak Benjamin (Author), Tintu P Joseph (Author)	5	Lecture
37	Elements of Style: Common errors in writing, such as describing a process, use of sequence words, statements of purpose, instructions, and checklists.	Professional Communication by Deepak Benjamin (Author), Tintu P Joseph (Author)	5	Lecture
38	Analytical and Issue-Based Essays: Basics of essay writing, including structure, organization, and effective communication of ideas.	Professional Communication by Deepak Benjamin (Author), Tintu P Joseph (Author)	5	Lecture
39	Report Writing: Types of reports, referencing styles (IEEE format), and the structure and content of reports.	Professional Communication by Deepak Benjamin (Author), Tintu P Joseph (Author)	5	Lecture
40	properly cite sources and create a bibliography for your written work, including examples and tips for effective	Professional Communication by Deepak Benjamin (Author), Tintu P Joseph (Author)	5	Lecture
41	Attending a meeting and Minute Preparation	Professional Communication by Deepak Benjamin (Author), Tintu P Joseph (Author)	5	Lecture
42	Vocabulary Building, Revision-Module 5	Professional Communication by Deepak Benjamin (Author), Tintu P Joseph (Author)	5	Lecture
43	Mock interview and Debate/Group Discussion: concepts, types, Do's and Don'ts- intensive practice	Professional Communication by Deepak Benjamin (Author), Tintu P Joseph (Author)	5	Lecture

15. Question Bank

MODULE 1				
Sl. No	Question	Marks	CO	BL
1	Identify two types of compound words and give its examples.	2	CO1	L1
2	Define the following compound words. a) Wild life b) Son-in- law	2	CO1	L1
3	Identify two types of numeral adjectives and use it in a sentence.	2	CO1	L1
4	State the passive voice of the following sentences: A sound outside woke us all up Who broke the chair?	2	CO1	L1
5	Identify the main clause and embedded clause of the following sentences. The giraffe, which was the tallest in the zoo, towered over the other animals. Luke, as soon as he heard the news, rushed to the hospital.	2	CO1	L1
6	Identify the errors in the following sentences. Many peoples (A)/ attended the funeral (B)/ of the great man. (C)/ No Error (D) I saw Richard (A)/ when I'm (B)/ on the flight. (C)/ No Error (D)	2	CO1	L1
7	Restate as directed. Keerthy said, "Ritu is the topper of our class". (change to reported speech) They know she has been working very hard. (change to impersonal passive voice)	2	CO1	L2
8	State the significance of Technical communication	3	CO1	L1
9	Outline the process of communication.	3	CO1	L1
10	Define 'conditionals' and cite examples	3	CO1	L1
11	Define clause. List the different types of clauses.	3	CO1	L1
12	Identify the suitable sequence words from the given options My sister was in the dentist's office for ten minutes. _____, I sat in the waiting room with an old magazine in my hands. (First, Meanwhile, Later) An hour passed but there was no sign of Mike. _____, we decided to go home. (Until, Before, Finally) We bumped into Salsa during our trip to Lang Island. A few weeks _____, we met him again (after, then, later)	3	CO1	L1
13	Identify the misspelled words from each set of words given. 1) a) acomodate b) accommadate c) accomodate d) accomodate 2) a) deductible b) deductable c) deductuble d) deductabe 3) a) license b) licence c) licens d) lisen	3	CO1	L1

14	Choose the right answer. 1. Ten: Decimal A. Seven: Septet B. Four: Quartet C. Two: Binary D. Five: Quince 2. Army: Logistics A. Business: Strategy B. Soldier: Students C. War: Logic D. Team: Individual 3. Corporeal: Spiritual A. Mesa: Plateau B. Moron: Savant C. Foreigner: Immigrant D. Pedagogue: Teacher	3	CO1	L2
15	The following passage has not been edited. There is one error in each line. Write the incorrect word and the correction in the answer sheet against the correct blank number. a. The aim for development b. must be of improve the c. conditions for the people and d. to ensure freedom of hunger e. and malnutrition. This gave the f. people opportunity in participate in productive endeavours.	3	CO1	L2
16	Fill in the blanks with suitable words. The (1) (earliest/earlier) sighting of this linen cloth (2)..... (is / was / were) in the 14th century in France. The shroud was (3) (believing / believed) to have been the cloth wrapped around Jesus when he (4) (placed / was placed / had placed) in his tomb; when the cloth (5) (is / was / had) removed, it (6) (bear / bore / borne) the image of Christ on it. When a bishop (7) (proclaims / proclaimed / has proclaimed) it to be a scam, an artist confessed to painting the image on it, and Pope Clement VII officially (8) (declares / declared / has declared) the shroud a mere representation of Christ.	3	CO1	L2
17	Rewrite these sentences in passive voice instead of using “somebody” or “they” a. Somebody has cleaned the room b. They have postponed the concert c. They are building a new ring road around the city.	3	CO1	L2
18	Explain the social relevance of language.	3	CO1	L2
19	Explain Technology based communication with relevant examples.	3	CO1	L2
20	Describe the following terms: Repositories Stack Exchange Search Engines	3	CO1	L2
21	Explain the term Plagiarism by citing any two examples.	3	CO1	L2
22	State the importance of Sequence words with relevant examples.	4	CO1	L1
23	Explain the advantages of an effective e-mail and steps to draft an effective e-mail.	4	CO1	L2
24	Explain the advantages of search engines	4	CO1	L2
25	Choose the right answers for each question from the options provided.	4	CO1	L2

	Light: Blind : : Speech: ? Dumb b) deaf c) sound d) voice Ten: Decimal : : Two: ? Double b) binary c) quartet d) pair Odometer: mileage: : Compass: ? Speed b) Hiking c) Direction d) Needle Reptile: Lizard: : Flower: ? Petal b) Stem c) Rose d) Leaves			
26	In the following the questions choose the word which best expresses the meaning of the given word. BRIEF Short b) little c) small d) limited ALERT Energetic b) Observant c) Intelligent d) Watchful WARRIOR Soldier b) Sailor c) Pirate d) Spy DISTANT Far b) removed c) separate d) reserved	4	CO1	L2
27	In each of the following questions, find the correctly spelt word. a) a) Accidentally b) Acidentally c) Accidentaly d) Accedentially b) a) Mischievis b) Misschievious c) Mischievous d) Mischivious c) a) Voluntiers b) Volenteers c) Volunteers d) Volantiers d) a) Nuisance b) Nuisense c) Nooisense d) Nooisance	4	CO1	
28	Fill in the blanks with suitable form of the words given in brackets. [because, really, is, laugh, at, too, interesting, should] One of my favorite vacation places (a) ___ Mexico. I really like the weather there (b) _____ it never gets cold. The people are very nice too. They never (c) _____ at my bad Spanish. The food is (d) _____ good. Mexico City is a very (e) _____ place to visit. It has some great museums and lots of fascinating old buildings. The hotels are (f) _____ expensive to stay but there are more affordable options. For example, you can stay (g) ___ one of the beach resorts like Acapulco. If you are planning to visit Mexico, you (h) _____ definitely see the Mayan temples near Merida.	4	CO1	L2
29	Complete the passage using “was/were” in the blanks. Write the answer in your answer book against the correct blank number. Last summer I visited London. The voyage by plane a) _____ long and tiring. I b) _____ surprised by the size of Heathrow Airport. There c) _____ many people. My friend d) _____ waiting to receive me. In a few minutes we e) _____ in a cab. The city f) _____ fantastic. I g) _____ perplexed by the posh cars and shops in the city. There h) _____ many people walking down the streets.	4	CO1	L2
30	You need to make a Project presentation as a part of your internal evaluation. List the steps that you need to follow for preparing the slides effectively?	4	CO3	L1
31	Recall the benefits of non-linear editing methods.	4	CO3	L1
32	Explain the importance of editing softwares and editing skills	4	CO3	L2

33	Identify the correct form of the verb given in the bracket Somebody ____ waiting at the door for you. (is / are) Two ____ ago, here is the place where the accident took place. (year/years) Fast food, like burgers and street food, ____ harmful to our health. (is/are) All the students ____ excited to visit the museum after school. (is/are) Neither Joseph nor his family ____ French. (speaks/speak) Either Ross or Joey ____ broken the glass. (has/have) If anybody ____ for me, do let me know. (calls/call) The plumber, along with his helper ____, expected to come soon. (is/are) Several neighbours ____ complained about the loud sound coming from that house. (has/have) Neither Penny nor Amy ____ went to work. (has/have) The Olympics ____ held every four years. (is/are) The people ____ lived without electricity for many years. (has/have)	6	CO1	L1
34	Explain Technical vocabulary with relevant examples	6	CO1	L2
35	Expand and explain the following terms: A) MOOC B) NPTEL C) SWAYAM	6	CO1	L2
36	You are applying for a job at a company named ABC. Draft the content of a cover letter to attach with the application, using appropriate technical vocabulary.	6	CO1	L3
37	Choose the correct sequence words and fill in the blanks. (First, Next, Then, Finally, First, After that) a. ____, I heard a loud boom. ____, the lights went out. ____ I tried to use my TV, but it was dead. I wondered what was happening. ____, I realized I had forgotten to pay my electricity bill. b. Let me tell you about how terrible last night was. ____, I lost my wallet. I was so upset I almost cried. ____, I spilled a drink on my favourite shirt. The night got even worse.	6	CO1	L5
MODULE 2				
1	Define Critical Reading.	2	CO2	L1
2	Define the terms: Skimming Scanning	2	CO2	L1
3	Define Reading Evaluation.	2	CO2	L1
4	Describe Speed Reading	2	CO2	L2
5	Explain any two key benefits of note-taking.	2	CO2	L2
6	Explain any two techniques of comprehension	2	CO2	L2
7	Describe Reading speed.	2	CO2	L2
8	List the steps involved in Critical Reading.	3	CO2	L1

9	Recall the differences between Intensive Reading and Extensive Reading.	3	CO2	L1
10	Explain the importance of transitions in a text	3	CO2	L2
11	Explain various Note making strategies.	3	CO2	L2
12	Explain different techniques for speed reading	4	CO2	L1
13	Outline the process of reading and comprehending long technical articles from journals	4	CO2	L1
14	List and define the four types of reading styles.	4	CO2	L1
15	“ The difference between active and passive reading is your goal”. Recall the differences between active and passive reading and prove the statement.	4	CO2	L1
16	Outline the steps involved in effective comprehension of textbooks.	4	CO2	L1
17	List and define any four non-verbal cues.	4	CO2	L1
18	Outline the steps involved in effective comprehension of newspaper articles	4	CO2	L1
19	Explain the SQ3R method of comprehension.	4	CO2	L2
20	Explain the PQRS method of comprehension	4	CO2	L2
21	Identify the key benefits of effective note-taking	6	CO2	L1
22	Read and interpret the given passage to answer the questions below. Mike and Morris lived in the same village. While Morris owned the largest jewelry shop in the village, Mike was a poor farmer. Both had large families with many sons, daughters-in-law and grandchildren. One fine day, Mike, tired of not being able to feed his family, decided to leave the village and move to the city where he was certain to earn enough to feed everyone. Along with his family, he left the village for the city. At night, they stopped under a large tree. There was a stream running nearby where they could freshen up themselves. He told his sons to clear the area below the tree, he told his wife to fetch water and he instructed his daughters-in-law to make up the fire and started cutting wood from the tree himself. They didn't know that in the branches of the tree, there was a thief hiding. He watched as Mike's family worked together and also noticed that they had nothing to cook. Mike's wife also thought the same and asked her husband " Everything is ready but what shall we eat?". Mike raised his hands to heaven and said " Don't worry. He is watching all of this from above. He will help us." The thief got worried as he had seen that the family was large and worked well together. Taking advantage of the fact that they did not know he was hiding in the branches, he decided to make a quick escape. He climbed down safely when they were not looking and ran for his life. But, he left behind the bundle of stolen jewels and money which dropped into Mike's lap. Mike opened it and jumped with joy when he saw the contents. The family gathered all their belongings and returned to the village. There was great excitement when they told everyone how they got rich. Morris thought that the tree was miraculous and this was a nice and quick way to earn some money. He ordered his family to pack some clothes and they set off as if on a journey. They also stopped under the same tree and Morris started commanding everyone as Mike had done. But no one in his family was willing to obey his orders.	6	CO2	L2

	Being a rich family, they were used to having servants all around. So, the one who went to the river to fetch water enjoyed a nice bath. The one who went to get wood for fire went off to sleep. Morris's wife said " Everything is ready but what shall we eat ?" Morris raised his hands and said, " Don't worry. He is watching all of this from above. He will help us." As soon as he finished saying, the thief jumped down from the tree with a knife in hand. Seeing him, everyone started running around to save their lives. The thief stole everything they had and Morris and his family had to return to the village empty handed, having lost all their valuables that they had taken with them. a) Why did Mike and his family decide to rest under the thief's tree? b) Which of the following best describes Morris? c) What did Mike mean when he said "He is watching all this from above"? d) Why did the thief return to the tree? e) How did the fellow villagers react to Mike getting rich overnight?			
23	Explain reading Explain the four kinds of reading styles and when these styles are used.	6	CO2	L2
24	Help your friends to read and comprehend texts by explaining the SQ3R and PQRS methods of comprehension.	6	CO2	L2
MODULE 3				
1	Identify the steps involved in making an effective oral presentation.	3	CO3	L1
2	Define Oral Presentation Skills.	3	CO3	L1
3	List out the key components in a technical presentation.	3	CO3	L1
4	Identify the importance of self-introduction in a presentation.	3	CO3	L1
5	Explain the six steps to be followed for successful public speaking.	3	CO3	L2
6	You are one of the keynote speakers of an international conference. State the important measures you are adopting for making a successful presentation.	4	CO3	L1
7	You, as the sales manager, have to make a business presentation before the management of a company where you plan to sell your new product. What points are to be kept in mind while making the presentation?	4	CO3	L1
8	List the four main types of speech purposes.	4	CO3	L1
9	Recall the steps of preparation required for QnA session of an oral presentation.	4	CO3	L1
10	Explain the steps for practicing an oral presentation.	4	CO3	L2
11	Explain business presentations with examples.	4	CO3	L2
12	Explain the importance of non-verbal communication in making a presentation	4	CO3	L2
13	State the importance of visual aids in an oral presentation.	6	CO3	L1

14	Describe the key elements to consider while preparing for an oral presentation.	6	CO3	L2
15	Define voice modulation.	3	CO4	L1
16	Recall the significance of tone of voice.	3	CO4	L1
17	Define Group Discussion	3	CO4	L1
18	Recall the differences Group Discussion (GD) and debate	3	CO4	L1
19	Explain Brain storming	3	CO4	L2
20	State the importance of brainstorming in a GD	3	CO4	L2
21	List the steps involved in the process of a Group Discussion.	4	CO4	L1
22	List the do's and don'ts in a group discussion.	4	CO4	L1
23	Explain the etiquettes one must follow in GD	4	CO4	L2
24	Explain the strategies to adopt for effective participation in a GD.	4	CO4	L2
25	Define Voice modulation and state the five important elements that aid for effective voice modulation.	6	CO4	L1
26	Explain Group Discussion Explain the components of GD	6	CO4	L2
MODULE 4				
1	State the importance of listening in communication.	3	CO5	L1
2	List and define any three types of interviews.	3	CO5	L1
3	Identify the frequently asked questions in an interview.	3	CO5	L1
4	Give a brief explanation of TED talks.	3	CO5	L2
5	Explain the importance of listening to subject specific talks.	3	CO5	L2
6	Briefly explain the importance of dress code and body language in an interview.	3	CO5	L2
7	Recall the differences between active listening and passive listening.	4	CO5	L1
8	Identify the two types of listening for general content.	4	CO5	L1
9	Identify and define any four types of listening.	4	CO5	L1
10	Describe the steps for developing effective listening skills.	4	CO5	L2
11	Explain the benefits of listening to TED talks.	4	CO5	L2
12	Explain the terms: a) Phone Interview b) Skype Interview	4	CO5	L2
13	Identify the steps involved in gaining ability to listen to longer technical talks.	6	CO5	L1
14	List and define the six modes of documentary.	6	CO5	L1
15	Outline the steps of preparation required for successful interviews.	6	CO5	L1

16	Explain the importance of Effective Listening Explain the various barriers to Effective Listening	6	CO5	L2
17	Explain the types, features and narrative structures of documentaries.	6	CO5	L2
18	Explain: a) Interview b) Types of interview	6	CO5	L2
19	Describe the etiquette to be followed during an interview.	6	CO5	L2
MODULE 5				
1	Define Technical Writing.	3	CO6	L1
2	State the importance of letter writing in a formal setting.	3	CO6	L1
3	Explain literary writing style.	3	CO6	L2
4	Explain the term 'Reference'.	3	CO6	L2
5	Recall the differences between technical writing and literary writing.	4	CO6	L1
6	Identify and define the three types of letter writing.	4	CO6	L1
7	Identify different measures to adopt to avoid common mistakes while writing a document.	4	CO6	L1
8	State the importance of using sequence words in writing.	4	CO6	L1
9	Briefly explain the importance of cover letters for applying for a job.	4	CO6	L2
10	Explain the basic structure of a technical report.	4	CO6	L2
11	Explain checklists and its importance.	4	CO6	L2
12	Describe 'bibliography' and explain its types.	4	CO6	L2
13	Define 'report' and its types.	6	CO6	L1
14	Define the concept of report and outline its structure.	6	CO6	L1
15	Define meeting minutes and the do's and don'ts of preparing mom.	6	CO6	L1
16	Recall the differences among CV, Resume and Biodata	6	CO6	L1
17	Describe the six elements of style in technical writing.	6	CO6	L2
18	Explain the format of semi-formal letters.	6	CO6	L2
19	You are required to apply for a job and submit your details to a firm. In what context you decide to submit a CV or Biodata or Resume. Write your answer explaining the structure of each and focusing on the differences between them.	6	CO6	L2
20	Explain Statement of Purpose.	6	CO6	L2
21	Explain: a) Instructions b) Checklists	6	CO6	L2

22	Explain IEEE Format of referencing style.	6	CO6	L2
23	You have been offered an internship in a much sought-after aerospace company and are very excited about it. However, the dates clash with your series tests. Compose a letter to the Manager – University Relations of the company asking them if they can change the dates to coincide with your vacation.	6	CO6	L6
24	You work in a well-reputed aerospace company as Manager – University Relations. You are in charge of offering internships. A student has sent you a letter requesting you to change the dates allotted to him since he has series exams at that time. But there are no vacancies available during the period he has requested for. Compose an e-mail informing him of this and suggest that he try to arrange the matter with his college.	6	CO6	L6
25	Write a letter to your Principal to grant you permission to attend a seminar on Climate Change at IIT Madras. Give all the information regarding the programme and benefits of attending the same.	6	CO6	L6
26	You are the purchase manager of Highway Plastics Ltd. The consignment you recently received does not meet the quality standards as mentioned in the Purchase order. You have to draft an email to the supplier regarding the issue. What points will you keep in mind while drafting the email?	6	CO6	L6

Prepared By: Merrina Margaret

Checked By: Ms. Merrina Margaret

Course Code & Name: EST102 Programming in C

1. Prescribed Syllabus

Module	Topic	Hours
1	Basics of Computer Hardware and Software Basics of Computer Architecture: processor, Memory, Input& Output devices Application Software & System software: Compilers, interpreters, High level and low level languages Introduction to structured approach to programming, Flow chart Algorithms, Pseudo code (bubble sort, linear search - algorithms and pseudocode)	5
2	Program Basics Basic structure of C program: Character set, Tokens, Identifiers in C, Variables and Data Types, Constants, Console IO Operations, printf and scanf Operators and Expressions: Expressions and Arithmetic Operators, Relational and Logical Operators, Conditional operator, size of operator, Assignment operators and Bitwise Operators. Operators Precedence Control Flow Statements: If Statement, Switch Statement, Unconditional Branching using goto statement, While Loop, Do While Loop, For Loop, Break and Continue statements.(Simple programs covering control flow	7
3	Arrays and strings Arrays Declaration and Initialization, 1-Dimensional Array, 2-Dimensional Array String processing: In built String handling functions (strlen, strcpy, strcat and strcmp, puts, gets) Linear search program, bubble sort program, simple programs covering arrays and strings.	7
4	Working with functions Introduction to modular programming, writing functions, formal parameters, actual parameters Pass by value, Recursion, Arrays as Function Parameters structure, union, Storage Classes, Scope and life time of variables, simple programs using functions.	8
5	Pointers and Files Basics of Pointer: declaring pointers, accessing data through pointers, NULL pointer, array access using pointers, pass by reference effect File Operations: open, close, read, write, append Sequential access and random access to files: In built file handling functions (rewind(), fseek(), ftell(), feof(), fread(), fwrite()), simple programs covering pointers and files.	8

LIST OF LAB EXPERIMENTS

1. Familiarization of Hardware Components of a Computer
2. Familiarization of Linux environment – How to do Programming in C with Linux
3. Familiarization of console I/O and operators in C
 - i) Display “Hello World”
 - ii) Read two numbers, add them and display their sum
 - iii) Read the radius of a circle, calculate its area and display it
 - iv) Evaluate the arithmetic expression $((a - b / c * d + e) * (f + g))$ and display its solution. Read the values of the variables from the user through console.
4. Read 3 integer values and find the largest among them.

5. Read a Natural Number and check whether the number is prime or not
6. Read a Natural Number and check whether the number is Armstrong or not
7. Read n integers, store them in an array and find their sum and average
8. Read n integers, store them in an array and search for an element in the array using an algorithm for Linear Search
9. Read n integers, store them in an array and sort the elements in the array using Bubble Sort algorithm
10. Read a string (word), store it in an array and check whether it is a palindrome word or not.
11. Read two strings (each one ending with a \$ symbol), store them in arrays and concatenate them without using library functions.
12. Read a string (ending with a \$ symbol), store it in an array and count the number of vowels, consonants and spaces in it.
13. Read two input each representing the distances between two points in the Euclidean space, store these in structure variables and add the two distance values.
14. Using structure, read and print data of n employees (Name, Employee Id and salary)
15. Declare a union containing 5 string variables (Name, House Name, City Name, State and Pin code) each with a length of C_SIZE (user defined constant). Then, read and display the address of a person using a variable of the union.
16. Find the factorial of a given Natural Number n using recursive and non-recursive functions
17. Read a string (word), store it in an array and obtain its reverse by using a user defined function.
18. Write a menu driven program for performing matrix addition, multiplication and finding the transpose. Use functions to (i) read a matrix, (ii) find the sum of two matrices, (iii) find the product of two matrices, (iv) find the transpose of a matrix and (v) display a matrix.
19. Do the following using pointers
 - i) add two numbers
 - ii) swap two numbers using a user defined function
20. Input and Print the elements of an array using pointers
21. Compute sum of the elements stored in an array using pointers and user defined function.
22. Create a file and perform the following
 - i) Write data to the file
 - ii) Read the data in a given file & display the file content on console
 - iii) append new data and display on console
23. Open a text input file and count number of characters, words and lines in it; and store the results in an output file.

2. Text Books (T)

- T1. Schaum Series, Gottfried B.S., Tata McGraw Hill, Programming with C
- T2. E. Balagurusamy, McGraw Hill, Programming in ANSI C
- T3. Asok N Kamthane, Pearson, Programming in C
- T4. Anita Goel, Pearson, Computer Fundamentals

3. Reference Books (R)

- R1. Anita Goel and Ajay Mittal, Pearson, Computer fundamentals and Programming in C
- R2. Brian W. Kernighan and Dennis M. Ritchie, Pearson, C Programming Language
- R3. Rajaraman V, PHI, Computer Basics and Programming in C
- R4. Yashavant P, Kanetkar, BPB Publications, Let us C

4. Course Objectives

To prepare the Engineering Graduates capable of writing readable C programs to solve computational problems that they may have to solve in their professional life.

5. Course Pre / Co-requisite

NIL

6. Course Outcomes

After the completion of the course the student will be able to

- CO1. Analyze a computational problem and develop an algorithm/flowchart to find its solution
- CO2. Develop readable* C programs with branching and looping statements, which uses Arithmetic, Logical, Relational or Bitwise operators.
- CO3. Write readable C programs with arrays, structure or union for storing the data to be processed
- CO4. Divide a given computational problem into a number of modules and develop a readable multi-function C program by using recursion if required, to find the solution to the computational problem
- CO5. Write readable C programs which use pointers for array processing and parameter passing
- CO6. Develop readable C programs with files for reading input and storing output

readable* - readability of a program means the following:

1. Logic used is easy to follow
2. Standards to be followed for indentation and formatting
3. Meaningful names are given to variables
4. Concise comments are provided wherever needed

7. Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes

PO/ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO11	PO12
CO1	H	H	H	M		M				M	H	H
CO2	H	H	H	M	H					M		H
CO3	H	H	H	M	H					M		H
CO4	H	H	H	M	H					M	H	H
CO5	H	H			H					M		H
CO6	H	H			H					M		H

8. Justification for CO-PO-PSO Correlation

CO	PO	Justification Statement
CO1	PO1	As they apply knowledge in mathematics and engineering to analyze a computational problem
	PO2	As they analyze a computational problem to develop an algorithm / flowchart to find its solution using first principles of mathematics
	PO3	As they develop an algorithm / flowchart to find a solution for the specified computational problem
	PO4	As they use knowledge in algorithms / flowcharts to design a solution for analysis and interpretation of data to provide valid conclusions.
	PO6	As they develop an algorithm / flowchart to find a solution pertaining to the environment, health, safety, legal and public welfare
	PO10	As they demonstrate the ability to create algorithms / flowcharts to comprehend and communicate the solution procedure for the specified computational problem

	PO11	As they demonstrate an ability to plan and manage projects
	PO12	As they use their knowledge in algorithm and flowcharts to analyse more complex computational problems and develop solutions using advanced technologies.
CO2	PO1	As they apply knowledge in mathematics and engineering to a computational problem with branching and looping statements, which uses Arithmetic, Logical, Relational or Bitwise operators.
	PO2	As they analyse engineering problems with branching and looping statements, which uses Arithmetic, Logical, Relational or Bitwise operators to find solution to a computational problem using first principles of mathematics
	PO3	As they write C programs with branching and looping statements, which uses Arithmetic, Logical, Relational or Bitwise operators to find a solution for the specified computational problem
	PO4	As they use knowledge in programs with branching and looping statements, which uses Arithmetic, Logical, Relational or Bitwise operators to design a solution for analysis and interpretation of data to provide valid conclusions.
	PO5	As they use modern tools to write and execute programs which use branching and looping statements and also Arithmetic, Logical, Relational or Bitwise operators.
	PO10	As they use the concepts of branching and looping and also Arithmetic, Logical, Relational or Bitwise operators which are useful in writing more effective programs and thereby enabling effective communication of the design of solutions.
	PO12	As they are encouraged to engage in independent and lifelong learning with the concepts of branching and looping statements and also Arithmetic, Logical, Relational or Bitwise operators.
CO3	PO1	As they apply knowledge in mathematics and engineering to analyze a computational problem involving the data storage in arrays, structure or union
	PO2	As they analyse the data stored in arrays, structure or union to find solution to a computational problem using first principles of mathematics
	PO3	As they write C programs with arrays, structure or union to find a solution for a specified computational problem
	PO4	As they analyse and interpret data and synthesis information stored in arrays, structure or union while writing readable C programs
	PO5	As they select an appropriate user defined data type for storing data to be processed while writing C programs
	PO10	As they use the concepts of arrays and structure for data storage while designing solutions which is efficient for communicating the design to others
	PO12	As they are encouraged to engage in independent and lifelong learning with the concepts of arrays and structure which are used in all areas of research and industry

CO4	PO1	The concepts of dividing the complex problem into modules forming multi-function programs and the concept of recursive functions are fundamental to our engineering specialization of problem solving.
	PO2	The concepts of dividing the complex problem into modules forming multi-function programs and the concept of recursive functions are needed in analysing complex engineering problems.
	PO3	The concepts of dividing the complex problem into modules forming multi-function programs and the concept of recursive functions are inevitable when designing solutions to complex problems.
	PO4	The concepts of dividing the complex problem into modules forming multi-function programs and the concept of recursive functions are used in the design of experiments and data interpretation.
	PO5	The concepts of dividing the complex problem into modules forming multi-function programs and the concept of recursive functions are useful in usage of different tools since every tool makes use of these fundamentals.
	PO10	The concepts of dividing the complex problem into modules forming multi-function programs and the concept of recursive functions are used in the design of solutions which is efficient for communicating the design to others
	PO11	The concepts of dividing the complex problem into modules forming multi-function programs and the concept of recursive functions are fundamental to any application related to engineering.
	PO12	The concepts of dividing the complex problem into modules forming multi-function programs and the concept of recursive functions are used in all areas of research as well as industry.
CO5	PO1	As they apply knowledge in mathematics and engineering to a computational problem involving the concepts of pointers for array processing and parameter passing.
	PO2	As they analyse complex engineering problems using the concepts of pointers for array processing and parameter passing
	PO5	As they use modern tools to write and execute programs which use concepts of pointers for array processing and parameter passing
	PO10	As they use the concepts of pointers for array processing and parameter passing which are useful in writing more effective programs and thereby enabling effective communication of the design of solutions.
	PO12	As they learn the concepts of pointers for array processing and parameter passing which are important in all areas of research and it also help in adapting to technological changes.
CO6	PO1	As they apply knowledge of Engineering using the concepts of files for data input and output which are very helpful in manipulating large amount of data input and output of complex problems.
	PO2	As they use the concept of files for data input and output in analysing problems and reviewing the output obtained after doing complex programs in C.

	PO5	As they use tools to implement the concepts of files for data input and output which will be useful for data analysis.
	PO10	As they use files for data input and output which helps to store the results in an organized manner so that it can be effectively communicated to outside world.
	PO12	As they learn the concept of files for data input and output which can be used with almost every real-life engineering problem in manipulating the data effectively.

Sl.No	Experiments	Relevant Cos
1	Familiarization of Hardware Components of a Computer	NIL
2	Familiarization of Linux environment – How to do Programming in C with Linux	NIL
3	Familiarization of console I/O and operators in C 1.Display “Hello World” 2.Read two numbers, add them and display their sum 3.Read the radius of a circle, calculate its area and display it 4.Evaluate the arithmetic expression $((a - b / c * d + e) * (f + g))$ and display its solution. Read the values of the variables from the user through console.	CO1, CO2
4	Read 3 integer values and find the largest among them.	CO1, CO2
5	Read a Natural Number and check whether the number is prime or not	CO1, CO2
6	Read a Natural Number and check whether the number is Armstrong or no	CO1, CO2
7	Read n integers, store them in an array and find their sum and average	CO1, CO3
8	Read n integers, store them in an array and search for an element in the array using an algorithm for Linear Search	CO1, CO3
9	Read n integers, store them in an array and sort the elements in the array using Bubble Sort algorithm	CO1, CO3
10	Read a string (word), store it in an array and check whether it is a palindrome word or not	CO1, CO3
11	Read two strings (each one ending with a \$ symbol), store them in arrays and concatenate them without using library functions.	CO1, CO3
12	Read a string (ending with a \$ symbol), store it in an array and count the number of vowels, consonants and spaces in it.	CO1, CO3
13	Read two input each representing the distances between two points in the Euclidean space, store these in structure variables and add the two distance values.	CO1, CO3

14	Using structure, read and print data of n employees (Name, Employee Id and Salary)	CO1,CO3
15	Declare a union containing 5 string variables (Name, House Name, City Name, State and Pin code) each with a length of C_SIZE (user defined constant). Then, read and display the address of a person using a variable of the union.	CO1, CO3
16	Find the factorial of a given Natural Number n using recursive and non-recursive functions	CO1, CO4
17	Read a string (word), store it in an array and obtain its reverse by using a user defined function.	CO1, CO4
18	Write a menu driven program for performing matrix addition, multiplication and finding the transpose. Use functions to read a matrix, find the sum of two matrices, find the product of two matrices, find the transpose of a matrix and display a matrix.	CO1, CO4
19	Do the following using pointers · add two numbers · swap two numbers using a user defined function	CO1, CO5
20	Input and print the elements of an array using pointers	CO1, CO5
21	Compute sum of the elements stored in an array using pointers and user defined functions.	CO1, CO4, CO5
22	Create a file and perform the following · Write data to the file · Read the data in a given file & display the file content on console · append new data and display on console	CO1, CO6
23	Open a text input file and count number of characters, words and lines in it; and store the results in an output file.	CO1, CO6

9. **Curricular gaps (if any) –**
Nil

10. Course Enrichment Activities*

Nil

11. Internal Assessment mark allocation (as per university curriculum)

Attendance	- 10 marks
Continuous Assessment Test 1 (for theory, for 2 hrs)	- 20 marks
Continuous Assessment Test 2 (for lab, internal examination, for 2 hrs)	- 15 marks
<u>Total</u>	<u>- 50 marks</u>

Continuous Assessment Test 1 – Theory - Internal Examination Pattern:

- There will be two parts; Part A and Part B.
- Part A contains 5 questions with 2 questions from each module (2.5 modules x 2 = 5), having 3 marks for each question.
- Students should answer all questions.
- Part B also contains 5 questions with 2 questions from each module (2.5 modules x 2 = 5), of which a student should answer any one.
- The questions should not have subdivisions and each one carries 7 marks

Continuous Assessment Test 2 – Lab – Internal Assessment Method

- The assessment shall be made on 50 marks and the mark is divided as follows:
- Practical Records/Outputs - 20 marks (internal by the College),
- Regular Lab Viva - 5 marks (internal by the College),
- Final Practical Exam – 25 marks (internal by the College).
- The mark obtained out of 50 will be converted into equivalent proportion out of 20 for CIE computation.

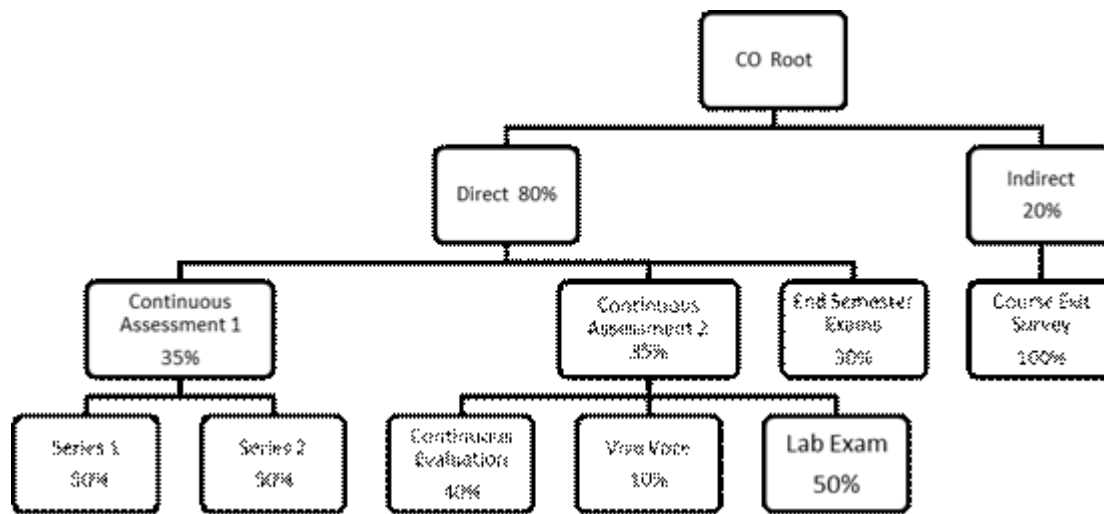
Assessment Pattern

Bloom's Category	Continuous Assessment marks		End Semester Examination Marks
	Test 1 (Marks)	Test 2 (Marks)	
Remember	15	10	25
Understand	10	15	25
Apply	20	20	40
Analyse	5	5	10

12. Assessment – CO Mapping (Put 'x' if mapping is present)

	Tools		Weightage	CO1	CO2	CO3	CO4	CO5	CO6
Direct Assessment Tools**	Continuous Assessment Test 1 - 35%	Series 1 50%	12.5%	x	x	x			
		Series 2 50%	12.5%				x	x	x
	Continuous Assessment Test 2 - 35%	Continuous Evaluation 40%	10%	x	x	x	x	x	x
		Viva Voce 10%	2.5%	x	x	x	x	x	x
		Lab Exam 50%	12.5%	x	x	x	x	x	x
	End Semester Exam 30%		30%	x	x	x	x	x	x
Indirect Assessment Tool	Course Exit Survey		100%	x	x	x	x	x	x

13. Assessment Configuration



14. Course Plan

Hour	Topic	Module	Reference	Teaching Pedagogy
1	Basics of Computer Architecture: processor, Memory	1	R3	Lecture
2	Input & Output devices	1	R3	Lecture
3	Application Software & System software: Compilers, interpreters	1	R3	Lecture
4	Lab-Familiarization of Hardware Components of a Computer	1	T3	Practical
5	Lab-Familiarization of Linux environment – How to do Programming in C with Linux	1	T3	Practical
6	High level and low level languages	1	R3	Lecture
7	Introduction to structured approach to programming	1	R3	Lecture
8	Flow chart	1	R3	Lecture

9	Lab-Familiarization of console I/O and operators in C	2	T3	Practical
10	Lab- Read 3 integer values and find the largest among them.	2	T3	Practical
11	Algorithms, Pseudo code (bubble sort)	1	R3	Lecture
12	Basic structure of C program: Character set, Tokens, Identifiers in C, Variables	2	T2	Lecture
13	Lab-Read a Natural Number and check whether the number is prime or not	2	T3	Practical
14	Lab-Read a Natural Number and check whether the number is Armstrong or not	2	T3	Practical
15	Data Types , Constants, Console IO Operations, printf and scanf	2	T2	Lecture
16	Expressions and Arithmetic Operators, Relational and Logical Operators, Conditional operator	2	T2	Lecture
17	sizeof operator, Assignment operators and Bitwise Operators. Operators Precedence	2	T2	Lecture
18	Lab-Read n integers, store them in an array and find their sum and average	2	T3	Practical
19	Lab-Read n integers, store them in an array and search for an element in the array using an algorithm for Linear Search	2	T3	Practical
20	If Statement, Switch Statement, Unconditional Branching using goto statement, While Loop, Do While Loop	2	T2	Lecture
21	Example programs for loops	2	T2	Lecture
22	For Loop, Break and Continue statements.	2	T2	Lecture
23	Lab-Read n integers, store them in an array and find their sum and average	2	T3	Practical

24	Lab-Read n integers, store them in an array and search for an element in the array using an algorithm for Linear Search	2	T3	Practical
25	Example programs for loops	2	T2	Lecture
26	Arrays Declaration and Initialization, 1-Dimensional Array	3	T2	Lecture
27	2-Dimensional Array	3	T2	Lecture
28	Lab-Read n integers, store them in an array and sort the elements	3	T3	Practical
29	Lab-Sort the array using Bubble Sort algorithm	3	T3	Practical
30	String processing: In built String handling functions	3	T2	Lecture
31	strlen, strcpy, strcat and strcmp, puts, gets	3	T2	Lecture
32	Linear search program	3	T2	Lecture
33	Lab-Read a string (word), store it in an array and check whether it is a palindrome word or not.	3	T3	Practical
34	Lab-Read two strings (each one ending with a \$ symbol), store them in arrays and concatenate them without using library functions.	3	T3	Practical
35	bubble sort program	3	T2	Lecture
36	simple programs covering arrays and strings	3	T2	Others
41	Introduction to modular programming, writing functions	4	T2	Lecture
42	Lab-Read a string (ending with a \$ symbol), store it in an array and count the number of vowels, consonants and spaces in it.	4	T3	Practical

43	Lab-Read two input each representing the distances between two points in the Euclidean space, store these in structure variables and add the two distance values.	4	T3	Practical
44	simple programs using functions	4	T2	Lecture
45	formal parameters, actual parameters	4	T2	Lecture
46	accessing data through pointers, NULL pointer	4	T2	Lecture
47	Lab-Using structure, read and print data of n employees	4	T2	Practical
48	Lab-Declare a union containing 5 string variables (	4	T2	Practical
49	Pass by Value, Recursion	4	T2	Lecture
50	Arrays as Function Parameters	4	T2	Lecture
51	structure, union, Storage Classes	4	T2	Lecture
52	Lab-Find the factorial of a given Natural Number n using recursive and non recursive functions	4	T2	Practical
53	Lab-Read a string (word), store it in an array and obtain its reverse by using a user defined function	4	T2	Practical
54	Scope and life time of variables	4	T2	Lecture
55	Simple programs using functions	4	T2	Lecture
56	Basics of Pointer: declaring pointers	5	T2	Lecture
57	Lab-Write a menu driven program for performing matrix addition, multiplication and finding the transpose(Use functions)	5	T2	Practical
58	Lab- Pointer applications	5	T2	Practical
59	Accessing data through pointers, NULL pointer	5	T2	Lecture

60	array access using pointers, pass by reference effect	5	T2	Lecture
61	File Operations: open, close, read, write, append	5	T2	Lecture
62	Lab-Input and Print the elements of an array using pointers	5	T2	Practical
63	Lab-Compute sum of the elements stored in an array using pointers and user defined function	5	T2	Practical
64	File Operations: open, close, read, write, append	5	T2	Lecture
70	Example programs on Module 2. 3	5	T2	Lecture
71	Lab-Create a file and perform file operations	5	T2	Practical
72	Lab-Open a text input file and count the number of characters, words and lines in it; and store the results in an output file.	5	T2	Practical

16. Question bank

Module 1				
Sl. No.	Question	Marks	CO	BL
1	Describe the structure of a C program.	3	CO2	L1
2	Explain with examples the 'tokens' in C.	3	CO2	L1
3	Explain the syntax of 'scanf()' statement and list out the various format specifiers.	4	CO2	L1
4	Distinguish between 'break' and 'continue' statements with examples.	4	CO2	L1
5	What are library functions in C? List any 5 library functions in C.	3	CO2	L1
6	Explain with examples the data types used in C.	3	CO2	L1
7	Explain the syntax of if- else statements with an example.	3	CO2	L1
8	Explain the use of the 'Switch' statement with an example.	3	CO2	L1
9	Explain loop control statements with examples.	7	CO2	L1
10	Prepare a C program to find the largest among three numbers	7	CO2	L3

11	Prepare a C program to print the multiples of 3 and 5 from 1 to 100.	7	CO2	L3
12	Prepare a C program to find the reverse of a number.	7	CO2	L3
13	Prepare a C program to find the Perimeter and area of a triangle.	7	CO2	L3
14	Prepare a C program that prints the even numbers from 1 to 100.	7	CO2	L3
15	Prepare a C program to find the average of a set of N numbers.	7	CO2	L3
16	Prepare a C program to check whether a number is prime or not.	7	CO2	L3
17	Prepare a C program to print the prime numbers between 1 and 100.	7	CO2	L3
18	Prepare a C program for decimal to binary conversion.	7	CO2	L3
19	Prepare a C program to print the Fibonacci Series.	7	CO2	L3
20	Prepare a C program to check whether a year is Leap Year or not.	7	CO2	L3
21	Prepare a C program to read a character from keyboard and print it in opposite case.	7	CO2	L3
22	Prepare a C program to print first 50 prime numbers.	7	CO2	L3
23	Prepare a C program to check whether a number is Armstrong or not.	7	CO2	L3
24	Prepare a C program to calculate the average of the best three marks from the given four test marks.	7	CO2	L1
25	Prepare a C program to compute the roots of a quadratic equation.	7	CO2	L3
26	Prepare a C program using switch-case statements for checking the corresponding colour for the input character and print the name of the colour (Eg: R for Red, G for Green etc).	7	CO2	L1
27	Prepare a C program to develop a basic calculator.	7	CO2	L3
28	Prepare a C program to swap two values using a temporary variable.	7	CO2	L1
29	Write the difference between 'while' and 'do-while' statements.	3	CO2	L2
30	Explain various formatted I/O statements in C.	3	CO2	L2
31	Write a menu driven program to find the area of square, triangle, circle and rectangle according to the choice given.	10	CO2	L3
32	Explain any four types of operators used in C.	7	CO2	L2
33	Write a program to generate the following pattern 1 1 2 1 2 3 1 2 3 4	7	CO2	L3
Module 2				
Sl. No.	Question	Marks	CO	BL
1	Write a program to read an array of integers and search for the occurrence of a given value.	3	CO3	L3

2	Write a C program to find the product of two matrices.	10	CO3	L3
3	Write a program to reverse a string without using string function.	6	CO3	L3
4	With suitable example, explain any three string manipulating functions in header file 'string.h'.	3	CO3	L2
5	Write a C program to find the transpose of a matrix.	6	CO3	L3
6	Explain different string handling function in C with examples?	3	CO3	L2
7	Explain how to initialize a 1-D numeric array and character array with examples.	3	CO3	L2
8	Write a C program to reverse a string.	6	CO3	L3
9	Explain how a 3-dimensional array is declared and initialised. How is a character array different from a string?	3	CO3	L2
10	Write a C program to count the number of characters, words and lines in a text.	6	CO3	L3
11	Write a C program to read a string and check whether it is palindrome or not.	8	CO3	L3
12	Give the syntax and example for two methods of reading a string.	3	CO3	L2
13	Write a C program to read a sentence through keyboard and to display the count of white spaces in the given sentence.	3	CO3	L3
14	Write a C program to check whether a given matrix is a diagonal matrix.	6	CO3	L3
15	Write a C program to perform bubble sort.	6	CO3	L3
16	Without using any built-in string processing function like strlen, strcat etc., write a program to concatenate two strings.	6	CO3	L3
17	Write a C program read a string (ending with a \$ symbol), store it in an array and count the number of vowels, consonants and spaces in it.	3	CO3	L3
18	What are the different ways of declaring and initialising a single dimensional array.	3	CO3	L1
19	Implement string concatenation without using built in functions.	8	CO3	L3
20	Write a C program to accept a 2-D integer matrix and check whether it is symmetric or not (A matrix 'A' is symmetric if $A=A^T$).	6	CO3	L3
MODULE 3				
1	Differentiate between structure and union using an example.	3	CO4	L2
2	Illustrate the purpose of return statement using an example.	3	CO3	L1
3	What are different storage classes in C? Give examples for each.	7	CO3	L2

4	Write a C program to: (i) Create a structure with fields: Name, Address, Date of birth. (ii) Read the above details for five students from user and display the details	7	CO4	L3
5	What is recursion? Write a C program to display Fibonacci series using recursive function.	7	CO3	L3
6	Write a C program to sort N numbers using functions.	7	CO3	L3
7	Define formal parameters and actual parameters. Illustrate with an example.	3	CO3	L2
8	With examples show how: (i) an array is passed as argument of a function. (ii) individual elements of an array is passed as argument of a function.	3	CO3	L1
9	What is the purpose of function declaration and function definition and function call? With examples illustrate their syntax.	7	CO3	L3
10	Write a C program to : Create a structure containing containing the fields: Name, Price, Quantity, Total Amount. (ii) Use separate functions to read and print the data	7	CO4	L3
11	What are different storage classes in C? Give examples for each.	7	CO3	L2
12	Write a C program to find sum and average of an array of integers using user defined functions.	7	CO3	L3
13	Name the different types of parameter passing. Illustrate each of them with an example.	3	CO3	L2
14	What are the advantages of modular programming?	3	CO2	L2
15	Write a C program to : (i) Create a structure containing the fields: Name, Price, Quantity, Total Amount. (ii) Use separate functions to read and print the data.	7	CO4	L3
16	What are different storage classes in C? Give examples for each.	7	CO3	L2
17	What are the main differences between structures and unions? Which is preferred in what situation? Give examples.	7	CO3	L2
18	What is recursion? Write a C program to display Fibonacci series using recursive function.	7	CO3	L3
19	Define function prototype. Why is it used? Differentiate formal and actual parameters.	3	CO3	L1

20	Mention the difference between structure and union using suitable example	3	CO4	L2
21	Explain different storage classes used in C by providing suitable examp	7	CO3	L2
22	What is meant by recursion? Write a program to find the factorial of a number using recursion	7	CO3	L3
23	Implement linear search using function. Reading the inputs and printing the result must be done in the main function	10	CO3	L3
24	Compare User defined functions with library functions	4	CO3	L2
25	Compare formal parameters and actual parameters with an example.	3	CO3	L1
26	Differentiate between structure and union with an example.	3	CO4	L1
27	Write a C program to read and display data of n employees (Name, Employee, Id and Salary) using structure.	7	CO4	L3
28	Define recursive function. Write a recursive function in C to find the factorial of a given number.	7	CO3	L3
29	Explain various storage classes in C with an example	7	CO3	L2
30	Write a C program to swap two numbers using user defined function	7	CO3	L3
31	Compare and contrast structure with union	3	CO4	L1
32	List out the merits and demerits of recursion. Write a recursive procedure in C to find the factorial of a number	3	CO3	L3
33	Implement a C program to accept Admission number and Name of N students in a class and to prepare a Roll List based on the alphabetical order of their Names.	7	CO4	L3
34	Describe different methods of parameter passing in functions and implement a program.to swap two variables using those methods.	7	CO3	L3
	MODULE 4			
1	Differentiate between char name[] and char *name in C.	3	CO4	L1
2	Explain the use of fseek() function.	3	CO5	L2
3	Explain any 5 file handling functions in C.	7	CO5	L2

4	Write a C program to reverse a string using pointers.	7	CO4	L3
5	Differentiate between array of pointers and pointer to an array.	7	CO4	L2
6	Write a C program to count number of lines in a text file.	7	CO5	L3
7	Write any three file handling functions in C.	3	CO5	L1
8	Differentiate between address operator(&) and indirection(*) operator.	3	CO4	L2
9	Explain the different modes of operations performed on a file in C language.	7	CO5	L2
10	Write a program in C to copy the contents of one file into another.	7	CO5	L3
11	Explain how pointers can be passed to functions in C.	7	CO4	L2
12	Explain any 5 file handling functions in C?	7	CO5	L2
13	Write a C program to replace vowels in a text file with character 'x'.	7	CO3	L3
14	Explain how pointers can be passed to functions in C.	7	CO4	L2
15	Explain any 5 file handling functions in C?	7	CO5	L2
16	Write a C program to print the elements of an array in reverse order using pointers.	7	CO4	L3
17	Distinguish between text mode and binary mode operation of a file.	3	CO5	L2
18	What do you mean by a pointer variable? How is it initialised?	3	CO4	L2
19	Write a program to read and store the details (the name, employee code (integer) and salary) of 'n' employees in a company into a file using structure. Print the details of the employee whose employee code is given as input	14	CO4	L3
20	What is meant by passing arguments into a function by reference? Write a program to swap two numbers using pass by reference.	8	CO4	L3
21	Write a program to copy the content of a file to another	7	CO5	L3
22	what is meant by the scale factor of a pointer variable? Explain using examples.	3	CO4	L2
23	List out the various modes of opening a file in C language	3	CO5	L2
24	Explain call by reference in C with an example	3	CO4	L2

25	Explain different modes of opening a file in C.	3	CO5	L2
26	Explain any four file handling functions used in C	7	CO5	L2
27	Write a C program to swap two numbers using pointer	7	CO4	L3
28	Write a C program to read the data in a given file and display the file content on console.	7	CO5	L3
29	Explain any three file Input and Output functions used in C	7	CO4	L2
30	Explain how a pointer is assigned with a structure in c and how the member variable of structure is accessed using pointer?	3	CO4	L2
31	What is the role of fseek() in C? Solve the given scenarios with fseek0, assume file pointer is at 10 th character and there are 100 characters in the file (a) Set file pointer to the last character in the file. (b) Set file pointer to the beginning of the file.	3	CO5	L3

Prepared By : Dr Saju A

Checked By : Ms. Lima Sebastian

1. Prescribed Syllabus

LIST OF EXPERIMENTS (MINIMUM 8 MANDATORY)

1. Estimation of total hardness of water-EDTA method
2. Potentiometric titration
3. Determination of cell constant and conductance of solutions.
4. Calibration of pH meter and determination of pH of a solution
5. Estimation of chloride in water
6. Identification of drugs using TLC
7. Determination of wavelength of absorption maximum and colorimetric estimation of Fe^{3+} in solution
8. Determination of molar absorptivity of a compound (KMnO_4 or any water soluble food colorant)
9. Synthesis of polymers (a) Urea-formaldehyde resin (b) Phenol-formaldehyde resin
10. Estimation of iron in iron ore
11. Estimation of copper in brass
12. Estimation of dissolved oxygen by Winkler's method
13. (a) Analysis of IR spectra (minimum 3 spectra) (b) Analysis of ^1H NMR spectra (minimum 3 spectra)
14. Flame photometric estimation of Na^+ to find out the salinity in sand
15. Determination of acid value of a vegetable oil
16. Determination of saponification of a vegetable oil

2. Text Books (T)

Nil

3. Reference Books (R)

- R1. 1. G. Svehla, B. Sivasankar, "Vogel's Qualitative Inorganic Analysis", Pearson, 2012.
R2. R. K. Mohapatra, "Engineering Chemistry with Laboratory Experiments", PHI Learning, 2017.
R3. Muhammed Arif, "Engineering Chemistry Lab Manual", Owl publishers, 2019.
R4. Ahad J., "Engineering Chemistry Lab manual", Jai Publications, 2019.
R5. Roy K Varghese, "Engineering Chemistry Laboratory Manual", Crownplus Publishers, 2019.
R6. Soney C George, Rino Laly Jose, "Lab Manual of Engineering Chemistry", S. Chand & Company Pvt Ltd, New Delhi, 2019.

4. Course Objectives

To impart scientific approach and to familiarize with the experiments in chemistry relevant for research projects in higher semesters

5. Course Pre / Co-requisite

Experiments in chemistry introduced at the plus two levels in schools

6. Course Outcomes

CO 1	Understand and practice different techniques of quantitative chemical analysis to generate experimental skills and apply these skills to various analyses
CO 2	Develop skills relevant to synthesize organic polymers and acquire the practical skill to use TLC for the identification of drugs
CO 3	Develop the ability to understand and explain the use of modern spectroscopic techniques for analysing and interpreting the IR spectra and NMR spectra of some organic compounds

- CO 4 Acquire the ability to understand, explain and use instrumental techniques for chemical analysis
- CO 5 Learn to design and carry out scientific experiments as well as accurately record and analyse the results of such experiments.
- CO 6 Function as a member of a team, communicate effectively and engage in further learning. Also understand how chemistry addresses social, economic and environmental problems and why it is an integral part of curriculum.

7. Mapping of Course Outcomes with Program Outcomes

PO/ CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H				M							H
CO2	H				H							H
CO3	H				H							H
CO4	H				H							H
CO5	H				L							H
CO6	H				L							H

8. Justification for CO-PO-PSO Correlation

CO1	PO 1 Knowledge of qualitative & quantitative estimation methods will help the student to find solutions to many engineering problems. PO 5 The student will be able to solve problems by measuring chemical parameters by applying knowledge of engineering sciences. PO 12 The student will gain the ability to design experiments (like estimation of quality of water) which can meet public health, safety and environmental considerations.
CO2	PO 1 The student will acquire the skill for the preparation of engineering plastics. PO 5 The student will acquire the skill for instrumental techniques that can be used to solve complex engineering problems. PO 12 Problem analysis can be done by the demonstration of theoretical concepts.
CO3	PO 1 The student will acquire basic knowledge to operate instruments like colorimeter, conductivity meter, pH meter etc which can be used for chemical analysis. PO 5 The student will be able to solve problems by measuring chemical parameters by applying knowledge of engineering sciences PO 12 The student will be able to use problem analysis using instruments to arrive at suitable conclusions.
CO4	PO 1 The student will acquire Research based knowledge which can be attained and developed for demonstrating theoretical concepts. PO 5 Analysis and interpretation of data to solve problems can be attained by the students from practical knowledge. PO 12 The students will be able to acquire Theoretical concepts that can be used to develop scientific attitude.
CO5	PO 1 Data obtained from Qualitative & quantitative estimation methods will help the student to arrive at substantiated conclusions to engineering problems. PO 5 Modern instrumental techniques like colorimeter, conductivity meter etc. can be used for chemical analysis. PO 12 Analysis and interpretation of data to solve problems can be attained from practical knowledge.

CO6	PO 1 The student can analyse problems using instruments to arrive at suitable conclusions. PO 5 The student can attain from practical knowledge analysis and interpretation of data to solve problems. PO 12 Quality of water like hardness, amount of chlorine can be estimated with the consideration of public health, safety and environmental considerations.

9. Curricular gaps (if any)

Nil

10. Course Enrichment Activities

Sl No	Description	Proposed Activities **	Relevance to POs and PSOs
1	To bridge the gap between industry and academia	Industry Visit	Will increase PO's
2	To bridge the gap between industry and academia	Expert Talks	Will increase PO's

11. Course Plan / Schedule of experiments

• List of Experiments.

Weeks(W)	Experiments	Relevance to COs
1	Calibration of pH meter and determination of pH of a solution	CO 1, CO 5, CO 6
2	Determination of cell constant and conductance of solutions.	CO 1, CO 4
3	Potentiometric titration	CO 1, CO 4
4	Estimation of total hardness of water-EDTA method	CO 1, CO 5, CO 6
5	Synthesis of polymers - Urea-formaldehyde resin	CO 1, CO 2
6	Synthesis of polymers - Phenol-formaldehyde resin	CO 1, CO 2
7	Analysis of IR spectra	CO 1, CO 3, CO 4
8	Analysis of ¹ H NMR spectra	CO 1, CO 3, CO 4
9	Determination of acid value of a vegetable oil	CO 1, CO 4, CO 6
10	Determination of saponification of a vegetable oil	CO 1, CO 4, CO 6
11	Estimation of dissolved oxygen by Winkler's method	CO 1, CO 5, CO 6
12	Determination of wavelength of absorption maximum and colorimetric estimation of Fe ³⁺ in solution	CO 1, CO 4
Total No. of Hours		24 HOURS

12. Assessment Pattern

Continuous Internal Evaluation Pattern:

Attendance / Class work / Assessment : 60 marks

Viva-voce : 10 marks

End semester examination (Internally by college): 30 marks

End Semester Examination Pattern: Written Objective Examination of one hour.

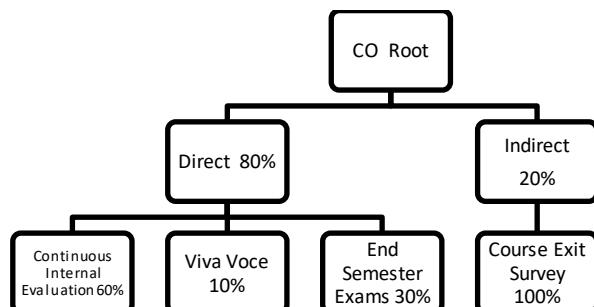
13. Evaluation criteria (as per syllabus)

Sl. No.	Nature of Evaluation**	Evaluation Pattern**	Topics of Evaluation* *	Duration* *	Weightage of marks**
1.	Continuous Internal evaluation (50 marks)				
a.	Attendance	NA	NA	NA	20%
b.	Continuous Evaluation		Each experiment	3 hours	50%
2.	End Semester Examination - by college (30 marks)				
a.	End semester Examination		All Experiments	1 hour	30%

14. Assessment – CO Mapping (Put ‘ x ’ if mapping is present)

	Tools**	Weightage#	CO1	CO2	CO3	CO4	CO5	CO6
Direct Assessment Tools	Continuous Evaluation Experiment wise CO mapping	50%	x	x	x	x	x	x
	Attendance	20%						
	End Semester Exam (by College) – 30%	30%	x	x	x	x	x	
Indirect Assessment Tool	Course Exit Survey	100%	x	x	x	x	x	x

15. Assessment Configuration



Prepared By : Dr. Jude Martin Mendez

Checked By : Prof. Shereeta D’Cotha.

Course Code & Name: ESL 120 Civil & Mechanical Workshop**1. Prescribed Syllabus**

Exp No.	Topic	Hours
1	Use screw gauge and vernier caliper to measure the diameter of the steel rod and thickness of a flat bar.	2
2	Setting out a one room building with a given plan and a measuring tape	2
3	Find the level difference between any two points using dumpy level	2
4	Construct a one and half thick brick wall of 50cm height and 60cm length using English bond	2
5	Transfer the level from one point to another using a water level	2
6	Estimate the number of different building blocks to construct a wall	2
7	Introduce the students to plumbing tools, different types of pipes, types of connections, traps, valves, fixtures and sanitary fittings	2
8	Install a rainwater harvesting installation in the campus	2
9	Calculate the area of built up space and a small parcel of land	2
10	General practices	2
11	Carpentry	2
12	Smithy	2
13	Foundry	2
14	Carpentry	2
15	Fitting	2
16	Smithy	2
17	Sheet metal	2
18	Welding	2

2. Text Books (T)

T1. Hajra Choudhury, Workshop Technology, Media promoters.

3. Reference Books (R)

- R1. Khanna P.N, "Indian Practical Civil Engineering Handbook", Engineers Publishers.
- R2. Bhavikatti. S, "Surveying and Levelling (Volume 1)", I.K. International Publishing House
- R3. Arora S.P and Bindra S.P, " Building Construction", Dhanpat Rai Publications
- R4. S. C. Rangwala, "Engineering Materials," Charotar Publishing
- R5. Raghuvamshi, Workshop Technology, Media promoters.

4. Course Objectives

- To enable the students to identify and manage the tools, materials and methods required to execute an engineering project.
- To introduce students to a team working environment where they develop the necessary skills for planning, preparing and executing an engineering project.
- Students will be introduced to a team working environment where they develop the necessary skills for planning, preparing and executing an engineering project.
- To enable the student to familiarize various tools, measuring devices, practices and different methods of manufacturing processes employed in industry for fabricating components

5. Course Pre / Co-requisite

Nil

6. Course Outcomes

After completion of the course, student will be able to

- CO1. Name different devices and tools used for civil engineering measurements
- CO2. Explain the use of various tools and devices for various field measurements
- CO3. Demonstrate the steps involved in basic civil engineering activities like plot measurement, setting out operation, evaluating the natural profile of land, plumbing and undertaking simple construction work.
- CO4. Choose materials and methods required for basic civil engineering activities like field measurements, masonry work and plumbing.
- CO5. Compare different techniques and devices used in civil engineering measurements
- CO6. Identify Basic Mechanical workshop operations in accordance with the material and objects
- CO7. Apply appropriate Tools and Instruments with respect to the mechanical workshop trades
- CO8. Apply appropriate safety measures with respect to the mechanical workshop trade.

7. Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes

PO/ CO	PO 1	PO 2	PO 3	PO 4	PO5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	L				L	L			M	M					
CO2	L				L	L			M	M					
CO3	L				L	L		M	M	M	L				
CO4	L				L	L		M	M	M	L	L			
CO5	L				L	L			M	M		L			
CO6	M														
CO7	M														
CO8	M														

8. Justification for CO-PO-PSO Correlation

CO	PO/PSO	Justification
CO1	PO1	Understanding the different tools used for taking measurements will enable students to apply the knowledge in identifying the instruments and their application in the construction field.
	PO5	Familiarity with modern tools used in Civil Engineering applications will help students to select suitable tools while using them for field measurements.
	PO6	Knowledge on Civil Engineering measurement tools will help students to understand their responsibilities to follow professional engineering practice considering societal health and safety.
	PO9	Knowledge on various tools and devices related to Civil Engineering measurements will enable students to gain the ability to function effectively in multi-disciplinary teams as individuals or in team.
	PO10	Knowledge obtained by taking field measurements by using different tools will help students in better communication with the Engineering community.
CO2	PO1	Knowledge about the use of various tools and devices for field measurements will enable the students to apply it for various applications in the construction field.
	PO5	Understanding various field measuring tools and devices will help the students to choose appropriate tools for a real field situation.
	PO6	Insight on the use of various field measuring tools and devices will enable the students to apply them suitably to assess safety and the consequent responsibilities relevant to the professional engineering practice.
	PO9	Knowledge on the use of various tools and devices for field measurements will help the students to function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
	PO10	Understanding the concepts of various tools and devices for field measurements will enable the students to communicate effectively with the engineering community
CO3	PO1	Knowledge on steps involved in basic civil engineering activities will enable students to formulate solutions to field problems.
	PO5	Understanding the basic steps involved in civil engineering activities like plot measurement, setting out operation, evaluating the natural profile of land, plumbing works etc. will enable the students to identify appropriate techniques or resources to be used in these situations.
	PO6	Understanding the steps involved in basic civil engineering/construction works will enable the students to apply them suitably to identify the safety aspects relevant to professional engineering practice.
	PO8	Knowledge on the steps involved in basic civil engineering/construction activities as per the norms of engineering field practices will enable the students to exhibit the sense of commitment towards professional ethics.
	PO9	Knowledge on simple construction activities will help the students to function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
	PO10	Familiarization of simple construction works will help the students to

		communicate effectively with the engineering community, and give and receive clear instructions.
	PO11	Familiarization of simple construction works will help the students to manage simple field projects as an individual or a member of a team.
CO4	PO1	Basic aspects of different materials and methods used in civil engineering will enable students to identify their application in the construction field and find solution to Civil Engineering problems.
	PO5	Knowledge of different materials and methods used in civil engineering measurements will help students to apply appropriate techniques in obtaining field measurements, masonry work and plumbing.
	PO6	Understanding of materials and methods used in the civil engineering field will help students to apply them suitably to assess safety and the consequent responsibilities relevant to the professional engineering practice.
	PO8	Knowledge of different materials and methods used in civil engineering/construction activities as per the norms of engineering field practices will enable the students to exhibit a sense of commitment towards professional ethics.
	PO9	Knowledge on different materials and methods used in civil engineering measurements will help the students to function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
	PO10	Understanding of different materials and methods used in civil engineering measurements will enable the students to communicate effectively with the engineering community, and give and receive clear instructions during execution of works.
	PO11	Familiarization of simple construction materials and methods will help the students to manage simple field projects as a member or leader in a team.
	PO12	Knowledge of different materials and methods used in civil engineering measurements will enable students to apply them in real time applications.
CO5	PO1	Basic knowledge of different techniques and devices used in civil engineering measurements will enable students to identify their application in the construction field and find solution to Civil Engineering problems.
	PO5	Knowledge of different techniques and devices used in civil engineering measurements will help students to students to apply appropriate techniques in obtaining field measurements.
	PO6	Understanding of different techniques and devices used in civil engineering measurements will help students to apply them suitably to assess safety and the consequent responsibilities relevant to the professional engineering practice.
	PO9	Knowledge on different techniques and devices used in civil engineering measurements will help the students to function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
	PO10	Understanding of different techniques used in civil engineering measurements will enable the students to communicate effectively with

		the engineering community, and give and receive clear instructions during execution of works.
	PO12	Knowledge on different techniques and devices used in civil engineering measurements will help students to students to engage themselves in independent and lifelong learning.
	PO1	Basic knowledge of different techniques and devices used in civil engineering measurements will enable students to identify their application in the construction field and find solution to Civil Engineering problems.
	PO5	Knowledge of different techniques and devices used in civil engineering measurements will help students to students to apply appropriate techniques in obtaining field measurements.
CO6	PO1	Students will be able to apply the knowledge of mathematics and fundamentals of basic mechanical workshop operations to solve engineering problems.
CO7	PO1	Students will be able to apply appropriate tools and instruments with respect to the mechanical workshop trades to solve engineering problems.
CO8	PO1	Students will be able to apply appropriate safety measures with respect to the mechanical workshop trades to solve engineering problems.

9. Curricular gaps

Nil

10. Course Enrichment Activities*

Sl No	Description	Proposed Activities **	Relevance to POs and PSOs
1	Demonstration of minor instruments.	Explanation in lab	PO1, PO5, PO6, PO8, PO9, PO10.

11. Internal Assessment mark allocation (as per university curriculum)

(Provide details as mentioned in syllabus)

Continuous Internal evaluation	- 20 marks Continuous
Viva	- 5 marks
End Semester Examination	- 15 marks
Attendance	- 10 marks
Total	- 50 marks

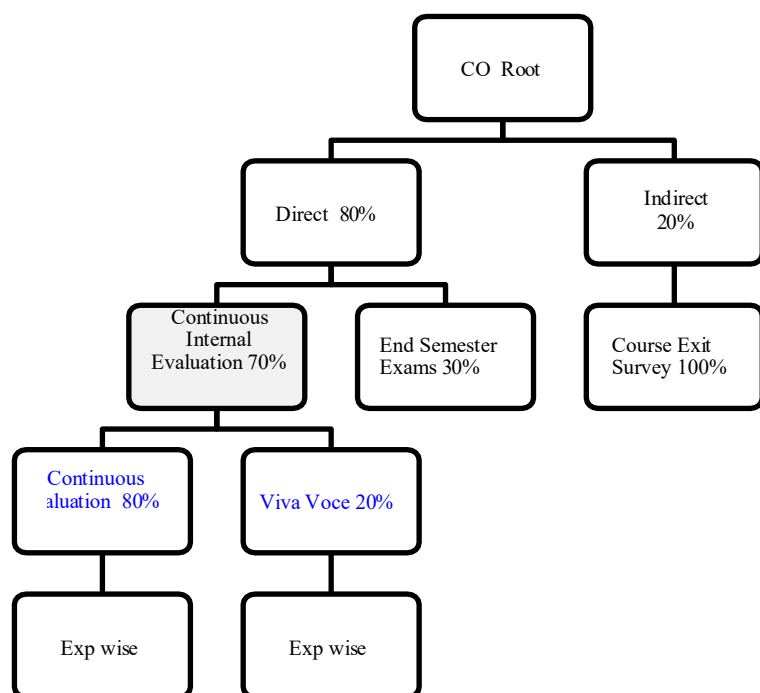
12. Evaluation criteria (as per syllabus)

Sl. No.	Nature of Evaluation	Evaluation Pattern	Topics of Evaluation	Duration	Weightage of marks
1.	Continuous Internal evaluation (35 marks)				
a.	Attendance		Each experiment	2 hours	20%
b.	Continuous Evaluation	Each experiment will be awarded marks out of 20.	Each experiment	2 hours	40%
c.	Viva-voce	Viva for each experiment will be conducted out of 5 marks and the average marks will be taken for internal evaluation marks.	Each experiment		10%
2.	End Semester Examination internal (15 marks)				
a.	End semester Examination	evaluated by written examination of one hour duration conducted internally by the institute out of 15 marks.	All Experiments	3hrs	30%

13. Assessment – CO Mapping (Put ‘ x ’ if mapping is present)

	Tools**	Weightage	CO1	CO2	CO3	CO4	CO5	CO6	CO7	CO8
Direct Assessment Tools	Continuous Evaluation Experiment wise CO mapping	60%	x	x	x	x	x	x	x	x
	Viva – Voce Experiment wise CO mapping	10%	x	x	x	x	x	x	x	x
	End Semester Exam	30%	x	x	x	x	x	x	x	x
Indirect Assessment Tool	Course Exit Survey	100%	x	x	x	x	x	x	x	x

14. Assessment Configuration



15. Course Plan

Weeks(W)	Experiments	Relevance to COs
1	Use screw gauge and vernier caliper to measure the diameter of the steel rod and thickness of a flat bar.	CO1,CO2,CO3,CO4.CO5
2	Setting out a one room building with a given plan and a measuring tape	CO1,CO2,CO3,CO4.CO5
3	Find the level difference between any two points using dumpy level	CO1,CO2,CO3,CO4.CO5
4	Construct a one and half thick brick wall of 50cm height and 60cm length using English bond	CO1,CO2,CO3,CO4.CO5
5	Transfer the level from one point to another using a water level	CO1,CO2,CO3,CO4.CO5
6	Estimate the number of different types of building blocks to construct a wall	CO1,CO2,CO3,CO4.CO5
7	Introduce the students to plumbing tools, different types of pipes, types of connections, traps, valves, fixtures and sanitary fittings	CO1,CO2,CO3,CO4.CO5
8	Install a rainwater harvesting installation in the campus	CO1,CO2,CO3,CO4.CO5
9	Calculate the area of built up space and a small parcel of land	CO1,CO2,CO3,CO4.CO5
10	General practices	CO6,CO7,CO8
11	Carpentry	CO6,CO7,CO8
12	Smithy	CO6,CO7,CO8

13	Foundry	CO6,CO7,CO8
14	Carpentry	CO6,CO7,CO8
15	Fitting	CO6,CO7,CO8
16	Smithy	CO6,CO7,CO8
17	Sheet metal	CO6,CO7,CO8
18	Welding	CO6,CO7,CO8

Prepared By : Sheeja M K, Arun V

Checked By : Vilbin Varghese, Jaison Joseph

Semester: 3

SLOT	COURSE Code	COURSES	L-T-P	HOURS	CREDIT
A	MAT201	Partial Differential Equations and Complex Analysis	3-1-0	4	4
B	ECT 201	Solid State Devices	3-1-0	4	4
C	ECT203	Logic Circuit Design	3-1-0	4	4
D	ECT205	Network Theory	3-1-0	4	4
E	EST200	Design And Engineering	2-0-0	2	2
F	MCN201	Sustainable Engineering	2-0-0	2	--
S	ECL 201	Scientific Computing Lab	0-0-3	3	2
T	ECL 203	Logic Design Lab	0-0-3	3	2

1. Prescribed Syllabus

Module	Topic	Hours
1	(Partial Differential Equations) -Partial differential equations, Formation of partial differential equations–elimination of arbitrary constants-elimination of arbitrary functions, Solutions of a partial differential equations, Equations solvable by direct integration, Linear equations of the first order Lagrange's linear equation, Non-linear equations of the first order -Charpit's method, Solution of equation by method of separation of variables.	8
2	(Applications of Partial Differential Equations)-One dimensional wave equation- vibrations of a stretched string, derivation, solution of the wave equation using method of separation of variables, D'Alembert's solution of the wave equation, One dimensional heat equation, derivation, solution of the heat equation	10
3	(Complex Variable – Differentiation) -Complex function, limit, continuity, derivative, analytic functions, Cauchy-Riemann equations, harmonic functions, finding harmonic conjugate, Conformal mappings- mappings $w = z^2$, $w = e^z$, Linear fractional transformation $w = \frac{1}{z}$, fixed points, Transformation $w = \sin z$ (From sections 17.1, 17.2 and 17.4 only mappings, $w = z^2$, $w = e^z$, $w = \frac{1}{z}$, $w = \sin z$ and problems based on these transformations need to be discussed)	9 hours
4	(Complex Variable – Integration)- Complex integration, Line integrals in the complex plane, Basic properties, First evaluation method-indefinite integration and substitution of limit, second evaluation method-use of a representation of a path, Contour integrals, Cauchy integral theorem (without proof) on simply connected domain, Cauchy integral theorem (without proof) on multiply connected domain Cauchy Integral formula (without proof), Cauchy Integral formula for derivatives of an analytic function, Taylor's series and Maclaurin series.	9 hours
5	(Complex Variable – Residue Integration)-Laurent's series(without proof), zeros of analytic functions, singularities, poles, removable singularities, essential singularities, Residues, Cauchy Residue theorem (without proof), Evaluation of definite integral using residue theorem, Residue integration of real integrals – integrals of rational functions of $\cos\theta$ and $\sin\theta$, integrals of improper integrals of the form $\int_{-\infty}^{\infty} f(x) dx$ with no poles on the real axis. ($\int_A^B f(x) dx$ whose integrand become infinite at a point in the interval of integration is excluded from the syllabus)	9 hours

2. Text Books (T)

T1. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 44th Edition, 2018.

T2. Erwin Kreyszig, Advanced Engineering Mathematics, 10th Edition, John Wiley & sons, 2016.

3. Reference Books (R)

R1. Peter V. O'Neil, Advanced Engineering Mathematics, Cengage, 7th Edition, 2012

4. Course Objectives

This course introduces basic ideas of partial differential equations which are widely used in the modelling and analysis of a wide range of physical phenomena and has got application across all branches of engineering. To understand the basic theory of functions of a complex variable, residue integration and conformal transformation

5. Course Pre / Co-requisite

A basic course in partial differentiation and complex numbers.

6. Course Outcomes

After completion of the course, student will be able to

CO1. Understand the concept and the solution of partial differential equation.

CO2. Analyse and solve one dimensional wave equation and heat equation.

CO3. Understand complex functions, its continuity differentiability with the use of Cauchy Riemann equations.

CO4. Evaluate complex integrals using Cauchy's integral theorem and Cauchy's integral formula, understand the series expansion of analytic function

CO5. Understand the series expansion of complex function about a singularity and apply residue theorem to compute several kinds of real integrals.

7. Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes

PO/ CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	2	1				2		2
CO2	3	3	3	3	2	1				2		2
CO3	3	3	3	3	2	1				2		2
CO4	3	3	3	3	2	1				2		2
CO5	3	3	3	3	2	1				2		2

8. Justification for CO-PO-PSO Correlation

CO/PO	Justification Statement
CO1-PO1	The concept and the solution of partial differential equations will help to solve problems arising in engineering
CO1-PO2	Fundamental knowledge of partial differential equations and its solution will help to formulate and analyze problems with high complexity in Engineering
CO1-PO3	Understanding of solution of partial differential equations helps in the development of solutions for complex engineering problems
CO1-PO4	Knowledge of partial differential equations and its solution will help in the investigations of certain engineering problems.
CO1-PO5	Various methods for the solution of partial differential equation will help to select appropriate techniques in complex engineering activities.
CO1-PO6	The concept of partial differential equations will help to assess the issues related to society
CO1-PO10	Understanding of partial differential equations and its solution will help to communicate effectively on complex engineering activities.
CO1-PO12	Practical application of partial differential equations will enhance the ability to engage in lifelong learning process.
CO2-PO1	Fundamental knowledge of one-dimensional wave equation and heat equation will help to solve problems arising in engineering
CO2-PO2	Application of one-dimensional wave equation and heat equation of helps to analyse problems with high complexity in Engineering.
CO2-PO3	Understanding of one-dimensional wave equation and heat equation are used to design solutions for complex engineering problems
CO2-PO4	The concept of solution of one-dimensional wave equation and heat equation helps to conduct investigation of complex problems
CO2-PO5	The solution of one-dimensional wave equation and heat equation will help to solve complex engineering problems by including the prediction and modelling of those problems.
CO2-PO6	Theory of one-dimensional wave equation and heat equation helps to assess issues and responsibilities relevant to the professional engineering practice
CO2-PO10	Knowledge about solution of one-dimensional wave equation and heat equation will help to communicate effectively on complex engineering activities.
CO2-PO12	The concept of solution of one-dimensional wave equation and heat equation will help to recognise the need for independent and lifelong learning in the broadest context of technological knowledge.
CO3-PO1	The knowledge of complex functions can be used to solve complex problems in electrical engineering
CO3-PO2	The knowledge of Cauchy Riemann equations can be used to identify, formulate and analyse real life problems and provide eco-friendly solutions
CO3-PO3	The concept of complex functions, its continuity, differentiability with the use of Cauchy Riemann equations can be used to design solutions that are at par with the needs of society so as to address societal and environmental concerns

CO3-PO4	The concept of Cauchy Riemann equations can be used to conduct investigations of complex problems involving the synthesis of data to provide valid conclusions
CO3-PO5	The Concept of complex functions and Cauchy Riemann equations will help to select appropriate techniques in complex engineering activities with the understanding of the limitations.
CO3-PO6	The concept of complex functions, its continuity, differentiability with the use of Cauchy Riemann equations can be used to assess the issues related to the society
CO3-PO10	The knowledge of complex functions will help to communicate effectively on complex engineering activities
CO3-PO12	The theory of Cauchy Riemann equations will help to recognise the need for independent and lifelong learning in the broadest context of technological knowledge
CO4-PO1	The fundamental knowledge of Cauchy's integral theorem and Cauchy's integral formula can be used to solve complex engineering problems
CO4-PO2	The concept of evaluation of complex integrals using Cauchy's integral theorem and Cauchy's integral formula can be used to identify, formulate and analyse complex engineering problems
CO4-PO3	The knowledge of series expansion of analytic functions can be used to design solutions for complex engineering problems
CO4-PO4	The concept of evaluation of complex integrals using Cauchy's integral theorem and Cauchy's integral formula can be used to conduct investigation of complex problems including design of experiments, analysis and interpretation of data to provide valid conclusions
CO4-PO5	The concept of evaluation of complex integrals are used to create, select and apply appropriate techniques, modern engineering tools including prediction and modelling to complex engineering activities.
CO4-PO6	The knowledge of Cauchy's Integral Theorem and Cauchy's Integral Formula will help to assess societal health, safety and legal issues involved in various engineering problems
CO4-PO10	The concept of evaluation of complex integrals using Cauchy's integral theorem and Cauchy's integral formula will help to communicate effectively on the stability of electrical systems
CO4-PO12	The knowledge of evaluation of complex integrals using Cauchy's integral theorem and Cauchy's integral formula will give awareness about the need for lifelong learning and continuous upgradation of technical knowledge.
CO5-PO1	The concept of residue Theorem can be used to solve complex engineering problems in Control Theory
CO5-PO2	The knowledge of the series expansion of analytic function about a singularity can be used to identify, formulate and analyse complex engineering problems
CO5-PO3	Theory of residue Theorem can be used to design solutions of electrical systems
CO5-PO4	The knowledge of residue theorem can be used to conduct investigation on complex engineering problems including problems on Quantum mechanics

CO5-PO5	The concept of series expansion of complex functions and applications of residue theorem to compute several kinds of real integrals will help to select appropriate techniques in complex engineering activities.
CO5-PO6	The concept of residue theorem and their applications can be used to apply reasoning to assess issues and responsibilities relevant to the professional engineering practice
CO5-PO10	Methods of solving real integrals using residue theorem will help to communicate effectively on complex engineering activities.
CO5-PO12	Theory of residue Theorem will help to engage in independent and lifelong learning

9. Curricular gaps (if any)

Nil

10. Course Enrichment Activities

SI No	Description	Proposed Activities	Relevance to POs and PSOs
1.	Complex Analysis by Prof. Pranav Hardas https://onlinecourses.nptel.ac.in/noc23_ma51/preview	NPTEL, IIT Madars	PO1, PO2

11. Internal Assessment mark allocation (as per university curriculum)

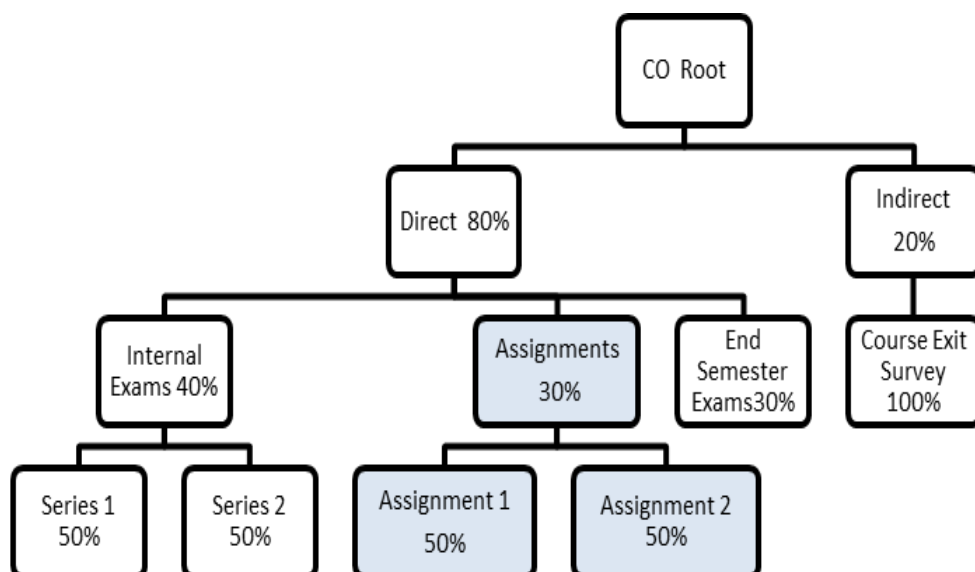
(Provide details as mentioned in syllabus)

Attendance	- 10 marks
Continuous Assessment Test	- 25 marks
<u>Assignment (s)/ Course Project</u>	<u>- 15 marks</u>
<u>Total</u>	<u>- 50 marks</u>

12. Assessment – CO Mapping (Put ‘ x ’ if mapping is present)

	Tools		Weightage [#]	CO1	CO2	CO3	CO4	CO5
Direct Assessment Tools**	Internal Exam(s) 40%	Series 1	20%	x	x			
		Series 2	20%			x	x	
	Assignment (s)/ Course Project /Quiz etc. 30%	Assignment 1	15%	x	x			
		Assignment 2	15%			x	x	x
	End Semester Exam		30%	x	x	x	x	x
Indirect Assessment Tool	Course Exit Survey		100%	x	x	x	x	x

13. Assessment Configuration



14. Course Plan

Hour	Topic	Module	Reference(s)	Teaching Pedagogy
1	Partial differential equations, Formation of partial differential equations –elimination of arbitrary constants-elimination of arbitrary functions	1	T1	Lecture
2	Solutions of a partial differential equations	1	T1	Lecture
3	Equations solvable by direct integration	1	T1	Tutorial
4	Linear equations of the first order- Lagrange's linear equation	1	T1	Lecture
5	Linear equations of the first order- Lagrange's linear equation, Non-linear equations of the first order - Charpit's method	1	T1	Lecture
6	Non-linear equations of the first order - Charpit's method	1	T1	Tutorial
7	Boundary value problems, Method of separation of variables	1	T1	Lecture
8	Boundary value problems, Method of separation of variables	1	T1	Lecture
9	One dimensional wave equation- vibrations of a stretched string, derivation	1	T1	Group Discussion
10	Solution of wave equation using method of separation of variables	2	T1	Lecture

11	Fourier series solution of boundary value problems involving wave equation	2	T1	Lecture
12	Fourier series solution of boundary value problems involving wave equation	2	T1	Lecture
13	D'Alembert's solution of the wave equation	2	T1	Tutorial
14	One dimensional heat equation, derivation	2	T1	Lecture
15	Solution of the heat equation, using method of separation of variables	2	T1	Lecture
16	Fourier series solutions of boundary value problems involving heat equation	2	T1	Lecture
17	Fourier series solutions of boundary value problems involving heat equation	2	T1	Lecture
18	Fourier series solutions of boundary value problems involving heat equation	2	T1	Tutorial
19	Complex function, limit, continuity, derivative	3	T2	Lecture
20	Complex function, limit, continuity, derivative	3	T2	Lecture
21	Analytic functions, Cauchy-Riemann equations	3	T2	Lecture
22	Analytic functions, Cauchy-Riemann equations	3	T2	Tutorial
23	Harmonic functions, finding harmonic conjugate	3	T2	Lecture
24	Harmonic functions, finding harmonic conjugate	3	T2	Tutorial
25	Conformal mappings- mappings of, $w = z^2$, $w = e^z$, $w = \frac{1}{z}$, $w = \sin z$	3	T2	Lecture
26	Conformal mappings- mappings of, $w = z^2$, $w = e^z$, $w = \frac{1}{z}$, $w = \sin z$	3	T2	Lecture
27	Conformal mappings- mappings of, $w = z^2$, $w = e^z$, $w = \frac{1}{z}$, $w = \sin z$	3	T2	Lecture
28	Complex integration, Line integrals in the complex plane, Basic properties	4	T2	Lecture
29	First evaluation method, second evaluation method	4	T2	Lecture
30	Second evaluation method, use of representation of a path	4	T2	Lecture
31	Second evaluation method, use of representation of a path	4	T2	Tutorial

32	Contour integrals, Cauchy integral theorem (without proof) on simply connected domain, on multiply connected domain(without proof) .Cauchy Integral formula (without proof)	4	T2	Lecture
33	Contour integrals, Cauchy integral theorem (without proof) on simply connected domain, on multiply connected domain(without proof) .Cauchy Integral formula (without proof)	4	T2	Lecture
34	Cauchy Integral formula for derivatives of an analytic function	4	T2	Lecture
35	Cauchy Integral formula for derivatives of an analytic function	4	T2	Tutorial
36	Taylor's series and Maclaurin series.	4	T2	Lecture
37	Laurent's series(without proof)	5	T2	Lecture
38	Laurent's series(without proof)	5	T2	Tutorial
39	zeros of analytic functions, singularities, poles, removable singularities, essential singularities	5	T2	Lecture
40	Residues	5	T2	Lecture
41	Cauchy Residue theorem (without proof), Evaluation of definite integral using residue theorem	5	T2	Lecture
42	Cauchy Residue theorem (without proof), Evaluation of definite integral using residue theorem	5	T2	Lecture
43	Residue integration of real integrals – integrals of rational functions of $\cos\theta$ and $\sin\theta$	5	T2	Tutorial
44	Residue integration of real integrals – integrals of rational functions of $\cos\theta$ and $\sin\theta$, integrals of improper integrals of the form $\int_{-\infty}^{\infty} f(x) dx$ with no poles on the real axis	5	T2	Lecture
45	Integrals of improper integrals of the form $\int_{-\infty}^{\infty} f(x) dx$ with no poles on the real axis. ($\int_A^B f(x) dx$ whose integrand become infinite at a point in the interval of integration is excluded from the syllabus)	5	T2	Lecture

15. Question Bank

Module 1				
Sl. No.	Question	Marks	CO	BL
1	What is the difference between complete integral and singular integral of a partial differential equation	3	CO1	L2
2	Solve $\frac{\partial^2 z}{\partial x \partial y} = x^2 y$	3	CO1	L2
3	Solve $\frac{\partial^2 u}{\partial x \partial t} = e^{-t} \cos x$	3	CO1	L2
4	Solve $\frac{\partial^3 z}{\partial x^2 \partial y} = \cos(2x + 3y)$	3	CO1	L2
5	Solve $\frac{\partial^3 z}{\partial x^2 \partial y} = \cos(3x + 4y)$	3	CO1	L2
5	Solve $\frac{\partial^2 z}{\partial x \partial y} = \sin(3x + 4y)$.	3	CO1	L2
6	Solve $3z = xp + yq$	3	CO1	L2
7	Solve $xp + yq = z$.	3	CO1	L2
8	Form a partial differential equation from the relation $z = (x + y)f(x^2 - y^2)$.	3	CO1	L2
9	Form the partial differential equation by eliminating arbitrary functions from the following equation $z = f(x^2 + y^2)$	3	CO1	L2
10	Form the partial differential equation by eliminating arbitrary functions from the following equation $z = f\left(\frac{xy}{z}\right)$	3	CO1	L2
11	Form the partial differential equation by eliminating arbitrary constants from the following equation $\frac{x^2}{a^2} + \frac{y^2}{b^2} + \frac{z^2}{c^2} = 1$.	3	CO1	L2
12	Form the partial differential equation by eliminating arbitrary constants from the following equation $(x - a)^2 + (y - b)^2 = z^2 \cot^2 \alpha$	3	CO1	L2
13	Form the p.d.e by eliminating arbitrary function from $z = f(x + at) + g(x - at)$	3	CO1	L2
14	Find the differential equation of all spheres of fixed radius having their centres in the XY-plane	7	CO1	L2
15	Find the differential equation of all spheres whose centre lie on the z-axis	7	CO1	L2
16	Form the partial differential equations by eliminating arbitrary function from $f(x^2 + y^2, z - xy) = 0$	7	CO1	L2
17	Form the partial differential equation by eliminating the arbitrary function f from the relation $xyz = f(x + y + z)$.	7	CO1	L2

18	Solve $\frac{\partial u}{\partial x} + \frac{\partial u}{\partial y} = u$ with the initial condition $u(x, 0) = e^{2x}$ by applying method of separation of variables.	7	CO1	L2
19	Solve $\frac{\partial^2 u}{\partial x \partial y} = \cos(x) \cos(y)$ given that $\frac{\partial u}{\partial y} = e^{-y}$ when $x = 0$ and $u = 0$ when $y = 0$.	7	CO1	L2
20	Solve $\frac{\partial^2 z}{\partial x^2} + z = 0$ given that when $x = 0, z = e^y$ and $\frac{\partial z}{\partial x} = 1$	7	CO1	L2
21	Using the method of separation of variables, solve $\frac{\partial u}{\partial x} = 2 \frac{\partial u}{\partial t} + u$ where $u(x, 0) = 6e^{-3x}$	7	CO1	L2
22	Solve $\frac{\partial u}{\partial x} = 2 \frac{\partial u}{\partial t} + u$ where $u(x, 0) = 3e^{5x}$ by method of separation of variables.	7	CO1	L2
23	Solve $\frac{\partial^3 z}{\partial x^2 \partial y} + 18xy^2 + \sin(2x - y) = 0$	7	CO1	L2
24	Solve the Lagrange's Linear Equation $p - 2q = 3x^2 \sin(y + 2x)$	7	CO1	L2
25	Solve : $\frac{y^2 z}{x} p + xzq = y^2$	7	CO1	L2
26	Solve : $(mz - ny)p + (nx - lz)q = ly - mx$	7	CO1	L2
27	Solve : $(x^2 - y^2 - z^2)p + 2xyq = 2xz$	7	CO1	L2
28	Solve $pq + 2x(y + 1)p + y(y + 2)q - 2(y + 1)z = 0$.	7	CO1	L2
29	Solve : $p - q = \log(x + y)$	7	CO1	L2
30	Solve : $x^2(y - z) + y^2(z - x) = z^2(x - y)$	7	CO1	L2
31	Solve: $x(y - z)p + y(z - x)q = z(x - y)$	7	CO1	L2
32	Use Charpit's method to solve $q + xp = p^2$	7	CO1	L2
33	Solve : $(p^2 + q^2)y = qz$	7	CO1	L2
34	Solve : $2xz - px^2 - 2qxy + pq = 0$ using Charpit's Method	7	CO1	L2
35	Solve : $pxy + pq + qy = yz$	7	CO1	L2
36	Solve : $xp - yq = y^2 - x^2$	7	CO1	L2
37	Solve the PDE $x(y^2 - z^2)p + y(z^2 - x^2)q = z(x^2 - y^2)$.	7	CO1	L2
38	Solve by Method of Separation of variable $\frac{\partial u}{\partial x} + \frac{\partial u}{\partial t} = 0, u(x, 0) = 4e^{-3x}$.	7	CO1	L2
39	Solve $(y^2 + z^2)p - xyq = xz$	7	CO1	L2
Module 2				
Sl. No.	Question	Marks	CO	BL
1	Write down the possible solutions of one-dimensional wave equation	3	CO2	L1
2	Write down the possible solutions of one-dimensional heat equation	3	CO2	L1
3	Write down the important assumptions used in the derivation of one-dimensional wave equation	3	CO2	L1

4	Write down the fundamental postulates used in the derivation of one-dimensional heat equation	3	CO2	L1
5	Find the deflection of a vibrating string of unit length having fixed ends with initial velocity zero and initial deflection $f(x) = k(\sin x - \sin 2x)$ using D'Alembert's method.	3	CO2	L2
6	Find the steady state temperature distribution in a rod of length 25 cm, if the ends of the rod are kept at 20°C and 70°C .	3	CO2	L2
7	Find the steady state temperature distribution in a rod of length 30 cm if the ends are kept at 100°C and 1000°C .	3	CO2	L2
8	A tightly stretched string of length 50 cm has its ends fastened at $x=0$ and $x=50$. The midpoint of the string is then taken to height h and then released from rest in that position. Find the initial position of the string.	3	CO2	L2
9	Derive one dimensional wave equation	7	CO2	L2
10	Solve one dimensional wave equation $\frac{\partial u}{\partial t} = c^2 \frac{\partial^2 u}{\partial x^2}$ using the method of separation of variables	7	CO2	L2
11	A tightly stretched homogenous string of length ' l ' with its fixed ends fastened at $x = 0, x = l$ executes transverse vibrations. Motion starts with zero initial velocity by displacing the string in the form $f(x) = k(x^2 - x^3)$. Find the deflection $y(x, t)$ at any time t .	7	CO2	L2
12	A tightly stretched string with fixed points $x = 0$ and $x = l$ is initially at rest in the equilibrium position. If each of its points is given a velocity $\lambda x(l - x)$, find the displacement of the string at any distance x from one end at any time t .	7	CO2	L2
13	A tightly stretched string of length l has its ends fastened at $x = 0, x = l$. The midpoint of the string is then taken to height h and then released from rest in that position. Find the lateral displacement of a point of the string at time t	7	CO2	L2
14	A tightly stretched flexible string has its ends fixed at $x=0$ and $x=l$. At time $t=0$, the string is given a shape defined by $f(x) = \mu x(l - x)$ where μ is a constant and then released. Find the displacement of any point x of the string at any time $t > 0$	7	CO2	L2
15	A string is stretched and fastened to two points l apart. Motion is started by displacing the string in the form $y = a \sin\left(\frac{\pi x}{l}\right)$ from which it is released at time $t=0$. Show that the displacement of any point at a distance x from one end at time t is given by $y = a \sin\left(\frac{\pi x}{l}\right) \cos\left(\frac{\pi ct}{l}\right)$	7	CO2	L2
16	A tightly stretched string of length l with fixed ends is initially in equilibrium position. It is set vibrating by giving each point a velocity $V_0 \sin^3\left(\frac{\pi x}{l}\right)$. Find the displacement of the string at any time t .	7	CO2	L2
17	Solve the one dimensional wave equation $\frac{\partial^2 u}{\partial t^2} = c^2 \frac{\partial^2 u}{\partial x^2}$ With the boundary conditions $u(0,t)=0, u(l,t)=0$ for all t and initial conditions $u(x, 0) = f(x), \left(\frac{\partial u}{\partial t}\right)_{t=0} = g(x), 0 < x < l$	7	CO2	L2
18	A uniform elastic string of length 60cm is subjected to a constant tension of 2kg. If the ends are fixed, the initial displacement $u(x, 0) = 60x -$	7	CO2	L2

	$x^2, 0 < x < 60$ and the initial velocity zero, find the displacement $u(x, t)$.			
19	Derive one dimensional heat equation	7	CO2	L2
20	Solve one dimensional heat equation $\frac{\partial u}{\partial t} = c^2 \frac{\partial^2 u}{\partial x^2}$ using the method of separation of variables	7	CO2	L2
21	Find the temperature $u(x, t)$ in a bar which is perfectly insulated laterally whose ends are kept at 0°C and whose initial temperature (in degree Celsius) is $f(x) = x(10 - x)$ given that its length is 10cm and specific heat is 0.05cal/gram deg	7	CO2	L2
22	A homogenous rod of conducting material of length 100cm has its ends kept at zero temperature and the temperature initially is $u(x, 0) = \begin{cases} x, & 0 \leq x \leq 50 \\ 100 - x, & 50 \leq x \leq 100 \end{cases}$. Find the temperature $u(x, t)$ at any time t .	7	CO2	L2
23	Find the temperature distribution in a rod of length 2m whose end points are maintained at temperature zero and the initial temperature $f(x) = 100(2x - x^2)$	7	CO2	L2
24	Find the temperature distribution in a rod of length π which is totally insulated including the ends and the initial temperature distribution is $100 \cos x$	7	CO2	L2
25	An insulated rod of length l has its ends A and B maintained at 0°C and 100°C respectively until steady state condition prevails. If the temperature at B is suddenly reduced to 0°C and maintained at 0°C . Find the temperature at a distance x from A at time t .	7	CO2	L2
26	A tightly stretched string of length one cm is fastened at both ends. Find the displacement of a string if it is released from rest from the position $\sin \pi x + 5 \sin 3\pi x$.	7	CO2	L2
27	A rod of 30 cm long has its ends A and B kept at 30°C and 90°C respectively until steady state temperature prevails. The temperature at each end is then suddenly reduced to zero temperature and kept so. Find the resulting temperature function $u(x, y)$, taking $x = 0$ at A.	7	CO2	L2
28	A tightly stretched homogeneous string of unit length with its fixed ends at $x = 0$ and $x = 1$ executes transverse vibrations. The initial velocity is zero and the initial deflection is given by $u(x, 0) = \begin{cases} 1, & 0 \leq x < \frac{1}{2} \\ -1, & \frac{1}{2} \leq x \leq 1 \end{cases}$. Find the deflection $u(x, t)$ at any time t .	7	CO2	L2
29	Solve the one dimensional heat equation $\frac{\partial u}{\partial t} = c^2 \frac{\partial^2 u}{\partial x^2}$ with boundary conditions $u(0, t) = 0^\circ\text{C}, u(1, t) = 0^\circ\text{C}$ and the temperature initially is $u(x, 0) = x(1 - x)$.	7	CO2	L2

30	A homogeneous rod of conducting material of length l has its ends kept at zero temperature and the temperature initially is $u(x, 0) = f(x)$. Find the temperature $u(x, t)$ at any time.	7	CO2	L2
31	Solve the one dimensional wave equation $\frac{\partial^2 u}{\partial t^2} = c^2 \frac{\partial^2 u}{\partial x^2}$ subject to $u(0, t) = 0, u(1, t) = 0, u(x, 0) = 3\sin(2\pi x), \frac{\partial u}{\partial t}(x, 0) = 0$.	7	CO2	L2
Module 3				
Sl. No.	Question	Marks	CO	BL
1	Separate the real and imaginary part of $f(z) = \frac{1}{1+z}$	3	CO3	L1
2	If $f=u+iv$ is analytic, then show that u and v are harmonic functions	3	CO3	L1
3	Find the real part and imaginary part of the function $f(z) = 5z^2 - 12z + 3 + 2i$ and find their values at $z = 4-3i$.	3	CO3	L1
4	Show that the function $f(z) = \begin{cases} \frac{Im\ z}{ z } & z \neq 0 \\ 0 & z = 0 \end{cases}$ is not continuous at $z = 0$	3	CO3	L1
5	Show that the function $f(z) = \begin{cases} \frac{Re\ z^2}{ z ^2} & z \neq 0 \\ 0 & z = 0 \end{cases}$ is not continuous at $z = 0$	3	CO3	L1
6	Show that the function $f(z) = \begin{cases} \frac{Im\ z^2}{ z ^2} & z \neq 0 \\ 0 & z = 0 \end{cases}$ is not continuous at $z = 0$	3	CO3	L1
7	Show that the function $f(z) = \begin{cases} \frac{Re\ z^2}{ z } & z \neq 0 \\ 0 & z = 0 \end{cases}$ is not continuous at $z = 0$	3	CO3	L1
8	Check whether the function $f(z) = \begin{cases} \frac{Re(z)}{1- z }, & z \neq 0 \\ 0, & z = 0 \end{cases}$ is continuous at $z = 0$.	3	CO3	L1
9	Check whether $f(z) = z - \bar{z}$ is analytic or not.	3	CO3	L1
10	Find the fixed points of $w = \frac{i}{2z-1}$	3	CO3	L1
11	Prove that the function $u(x, y) = x^3 - 3xy^2 - 5y$ is harmonic everywhere. Find its harmonic conjugate.	3	CO3	L1

12	Determine whether $w = \cos z$ is analytic.	3	CO3	L1
13	Check whether the function xy^2 is the real part of an analytic function.	3	CO3	L1
14	Check whether the following function is analytic or not. Justify your answer (i) $f(z) = z + \bar{z}$ (ii) $ z ^2$ (iii) $f(z) = \bar{z}$	3	CO3	L2
15	Determine a so that the function $\omega = e^{-\pi x} \cos ay$ is harmonic. Find its harmonic conjugate.	3	CO3	L2
16	Define an analytic function and prove that an analytic function of constant modulus is constant	7	CO3	L1
17	Show that every analytic function $f(z) = u + iv$ defines two families of curves $u(x, y) = c_1$ and $v(x, y) = c_2$ which forms an orthogonal system	7	CO3	L1
18	Show that function $f(z) = u + iv$ is analytic, if its real part is analytic.	7	CO3	L1
19	Show that function $f(z) = u + iv$ is analytic, if its imaginary part is analytic.	7	CO3	L1
20	Show that $f(z) = e^{-x} \cos y - ie^{-x} \sin y$ is differentiable everywhere and find its derivative.	7	CO3	L2
21	Show that $f(z) = \sin z$ is analytic for all z . Find $f'(z)$	7	CO3	L2
22	Show that $f(z) = \cosh z$ is analytic for all z . Find $f'(z)$	7	CO3	L2
23	Show that $f(z) = e^{x+iy}$ is analytic for all z . Find $f'(z)$	7	CO3	L2
24	Let $f(z) = u(x, y) + iv(x, y)$ be defined and continuous in some neighbourhood of a point $z = x + iy$ and differentiable at z itself. Then prove that the first order partial derivatives of u and v exist and satisfy the Cauchy Riemann equations	7	CO3	L2
25	Show that the function $u = \cos x \cosh y$ is harmonic and find its harmonic conjugate.	7	CO3	L2
26	Show that $f(z) = e^z$ is analytic for all z in the complex plane and find its derivative.	7	CO3	L2
27	Show that the function $f(z) = \frac{1}{z}$ is analytic except at $z=0$.	7	CO3	L2
28	Find all points where the Cauchy-Riemann equations are satisfied for the function $f(z) = xy$ and where it is analytic. Give reasoning for your answers.	7	CO3	L2
29	Show that $u = 2 + 3x - y + x^2 - y^2 - 4xy$ is harmonic. Also find its conjugate harmonic function v .	7	CO3	L2

30	Find image of the circle $\left z - \frac{1}{2}\right \leq \frac{1}{2}$ under the transformation $w = \frac{1}{z}$.	7	CO3	L3
31	Find the image of the semi circle $y = \sqrt{4 - x^2}$ under the transformation $w = z^2$.	7	CO3	L3
32	Show that $u = x^2 - y^2 - y$ is harmonic. Also find the corresponding harmonic conjugate function.	7	CO3	L3
33	Find the image of the circle $ z - 1 = 1$ under the mapping $w = \frac{1}{z}$.	7	CO3	L3
34	If $f(z) = u(x, y) + iv(x, y)$ is analytic and $uv = 2023$, then show that $f(z)$ is a constant	7	CO3	L3
35	Prove that $u = \sin x \cos hy$ is harmonic. Hence find its Harmonic conjugate	7	CO3	L3
36	Find the image of the infinite strip $0 \leq y \leq \pi$ under the mapping $\omega = e^z$	7	CO3	L3
37	Find the image of $\left z - \frac{1}{3}\right \leq \frac{1}{3}$ under the transformation $\omega = 1/z$. Also find the fixed points of the transformation $\omega = 1/z$	7	CO3	L3
38	Find the image of $ z - 2i = 2$ under the transformation $\omega = 1/z$.	7	CO3	L3
39	Find the image of $0 < x < 1, \frac{1}{2} < y < 1$ under the mapping $\omega = e^z$	7	CO3	L3
40	Find the images of the lines $x = a$ and $y = b$ where a and b are constants under the transformation $\omega = z^2$	7	CO3	L4
41	Find the images of the lines $x = c$ and $y = k$, where c and k are constants under the transformation $\omega = \sin z$	7	CO3	L4
42	Under the transformation $\omega = z^2$ find the image of the triangular region bounded by $x = 1, y = 1$ and $x + y = 1$	7	CO3	L4
Module 4				
Sl. No.	Question	Marks	CO	BL
1	Solve $\int_c \tan z \, dz$, where c is $ z =1$	3	CO4	L3
2	Solve $\int_c \frac{e^z}{z^2+9} \, dz$, where c is $ z =2$	3	CO4	L3
3	Solve $\int_c \cos z \, dz$, where c is $ z =\pi$	3	CO4	L3
4	Solve $\int_c \frac{1}{z} \, dz$, where c is $ z =1$	3	CO4	L3
5	Find the Taylor series of $f(z)=\frac{1}{z}$ about $z=2$	3	CO4	L3
6	Evaluate $\int_0^{1+i} (x - iy) \, dz$ along the straight line path from 0 to $1+i$	3	CO4	L3

7	Evaluate $\int_C \frac{dz}{(z^2+1)(z-1)}$ when C is $ z = 0.5$	3	CO4	L3
8	Evaluate $\oint_C \frac{\cos z}{z^2+9} dz$, where C is the circle $ z = 1$.	3	CO4	L3
9	Find the value of the integral $\int_C z dz$ where C is the part of the unit circle from $-i$ to i in the right half plane.	3	CO4	L3
10	Using Cauchy's integral formula, Evaluate $\int_C \frac{z^2+1}{z^2-1} dz$ where C is the circle of unit radius with centre at $z = 1$.	3	CO4	L3
11	Expand $f(z) = \frac{z+1}{z-1}$ as a Taylor series about $z = -1$	7	CO4	L3
12	Find the value of $\int_C \exp(z^2) dz$, where c is $ z =1$	7	CO4	L3
13	Using Cauchy's Integral Formula evaluate $\int_C \frac{5z+7}{z^2+2z-3} dz$, where c is $ z-2 =2$	7	CO4	L3
14	Find the Maclaurin series expansion of $f(z)=\frac{i}{1-z}$ and state the region of convergence	7	CO4	L3
15	Find the Maclaurin series expansion of $f(z) = \cosh z$	7	CO4	L3
16	Find the Maclaurin series expansion of $e^z \sin z$.	7	CO4	L3
17	Expand $f(z)=1/(z+1)$ as a Taylor series about $z = 2$ and state the validity of expansions	7	CO4	L3
18	Expand $f(z)=1/z^2$ as a Taylor series about $z = 3$	7	CO4	L3
19	Find the Taylor series expansion of $f(z)=\sin 2z$ about $z=\pi/2$	7	CO4	L3
20	Verify Cauchy's integral theorem for z^2 taken over the boundary of the rectangle with vertices $-1, 1, 1+i, -1+i$ in the counter clockwise sense	7	CO4	L4
21	Evaluate $\int_C \operatorname{Re} z dz$ where C is a straight line from 0 to $1+2i$.	7	CO4	L5
22	Evaluate $\int_0^{2+i} (\bar{z})^2 dz$, along the real axis to 2 and then vertically to $2+i$	7	CO4	L5
23	Evaluate $\int \operatorname{Im} z^2 dz$ counter clockwise around the triangle with vertices $0, 2, i$.	7	CO4	L5
24	Evaluate $\int_C \operatorname{Re} z^2 dz$ over the boundary C of the square with vertices $0, i, 1+i, 1$	7	CO4	L5
25	Evaluate $\int_C z dz$ where C is the part of the circle $ z = 3$ from 3 to -3 in the upper half plane.	7	CO4	L5
26	Evaluate $\int_C \frac{2z+1}{z^2-2z} dz$ where $ z = 1$.	7	CO4	L5
27	Evaluate $\int_C \frac{e^{3z}}{(z+1)^4} dz$ where C is the circle $ z - 1 = 3$.	7	CO4	L5

28	Evaluate $\int_C \frac{1}{(z+4i)(z+i)} dz$, where C is $ z = 2$ using Cauchy's integral formula.	7	CO4	L5
29	Evaluate $\int_C \frac{z^2+z+1}{(z-1)^2} dz$, where C is the circle $ z = 3$ using Cauchy's integral formula.	7	CO4	L5
30	Evaluate $\int_C \frac{\sin z}{z+4iz} dz$ where C is $ z-4-2i =6.5$	7	CO4	L5
31	Evaluate $\int_C \frac{\sin^2 z}{(z-\frac{\pi}{6})^3} dz$, where c is $ z =1$	7	CO4	L5
32	Evaluate $\oint_C \frac{\ln(z+1)}{z^2+1} dz$ where c: $ z-i =1.4$	7	CO4	L5
33	Using Cauchy's Integral Formula evaluate $\int_C \frac{\sin \pi z^2 + \cos \pi z^2}{(z-1)(z-2)} dz$	7	CO4	L5
34	Using Cauchy's integral formula, Evaluate the integral $\int_C \frac{2z+3}{z^2} dz$, where C is a circle $ z-i =2$ counter clockwise.	7	CO4	L5
35	Evaluate $\int_C (z^2 + 3z) dz$ along the circle $ z = 2$ from (2,0) to (0,2) in counter-clockwise direction.	7	CO4	L5
36	Using Cauchy's integral formula, Evaluate $\oint_C \frac{e^{2z}}{(z+1)^4} dz$ where C is the circle $ z = 2$.	7	CO4	L5
Module 5				
Sl. No.	Question	Marks	CO	BL
1	Find all the singular points and residues of the functions $f(z) = \frac{\sin z}{z^4}$	3	CO5	L2
2	Find the poles and corresponding residues of the functions $f(z) = \tan z$	3	CO5	L2
3	Using Residue Theorem, Evaluate $\oint_C \frac{\tan z}{z^2-1} dz$	3	CO5	L2
4	Evaluate $\oint_C \frac{4-3z}{z(z-1)} dz$ where C is the circle $ z = \frac{3}{2}$	3	CO5	L2
5	State Residue Theorem with examples	3	CO5	L2
6	State Cauchy's integral formula and Cauchy's residue theorem	3	CO5	L2
7	Find the zeros and their order of the function $\sin^2(z)$.	3	CO5	L2
8	Find the Laurent series expansion of $\frac{1}{1-z^2}$ about $z=0$	3	CO5	L2
9	Find the singularities and nature of singularities of the function $f(z) = z^2 \cos \frac{1}{z}$	3	CO5	L2
10	Find the residue of $z \cos\left(\frac{1}{z}\right)$ at $z = 0$	3	CO5	L2

11	Find the Laurent series of $z^2 e^{1/z}$ about $z = 0$ and determine the region of convergence.	3	CO5	L2
12	Find the poles and residues of the function $f(z) = \frac{z^2 - 2z}{(z+1)^2(z^2+4)}$	7	CO5	L2
13	Find the Laurent series expansion of $f(z) = \frac{1}{1-z^2}$ about $z = 1$ in the regions (i) $0 < z - 1 < 2$ (ii) $ z - 1 > 2$	7	CO5	L2
14	Obtain the Laurent series expansion of $\frac{1}{(z-2)(z-3)}$ in the region (i) $ z < 1$ (ii) $2 < z < 3$ (iii) $ z > 3$	7	CO5	L2
15	Find Laurent series expansion $f(z) = \frac{-2z+3}{(z^2-3z+2)}$ valid in i. $1 \leq z \leq 2$ ii. $ z \geq 2$	7	CO5	L2
16	Find all the singular points and residues of the functions $f(z) = \frac{z^2 - 2z}{(z+1)^2(z^2+4)}$	7	CO5	L3
17	Using Residue Theorem, Evaluate $\oint_C \frac{z-23}{z^2-4z-5} dz$ where C: $ z - 2 - i = 3.2$	7	CO5	L3
18	Using Residue Theorem evaluate $\oint_C \frac{z^2}{(z-1)^2(z+2)} dz$	7	CO5	L3
19	Evaluate $\oint_C \frac{dz}{(z^4+1)}$ where C: $ z-1 = 1$	7	CO5	L3
20	Using Residue theorem evaluate $\int \frac{z^2}{(z-1)^2(z+2)} dz$ over the circle $ z = 3$	7	CO5	L3
21	Using Residue theorem evaluate $\int_C \frac{5z+7}{z^2+2z-3} dz$, where C is the circle $ z - 2 = 2$	7	CO5	L3
22	Evaluate $\int \frac{\sin z}{z^6} dz$ over the circle $ z =2$ using Cauchy's residue theorem	7	CO5	L3
23	Evaluate $\int_0^{2\pi} \frac{1}{2+\cos \theta} d\theta$	7	CO5	L3
24	Evaluate $\int_0^{2\pi} \frac{1}{5-3\sin \theta} d\theta$	7	CO5	L3
25	Show that $\int_{-\infty}^{\infty} \frac{1}{(1+x^2)^3} dx = \frac{3\pi}{8}$	7	CO5	L3
26	Evaluate $\int_{-\infty}^{\infty} \frac{x^2}{(x^2+1)(x^2+4)} dx$	7	CO5	L3
27	Evaluate $\int_0^{\infty} \frac{1}{1+x^2} dx$.	7	CO5	L3
28	Find the poles and residues of the function $\frac{1}{z^4-1}$	7	CO5	L3

29	Evaluate $\int_0^{2\pi} \frac{1}{3+2\sin\theta} d\theta$	7	CO5	L3
30	Evaluate $\oint_C \frac{e^z}{z^2(z+1)} dz$, over the circle $ z = 2$	7	CO5	L3
31	Evaluate $\int_C \tan z dz$ where C is circle $ z = 2$.	7	CO5	L3
32	Evaluate $\int_0^{2\pi} \frac{d\theta}{\sqrt{2}-\cos\theta}$	7	CO5	L4
33	Using contour integration, evaluate $\int_{-\infty}^{\infty} \frac{x^2-x+2}{x^4+10x^2+9} dx$	7	CO5	L4
34	Determine and classify the singular points of the following functions $f(z) = \frac{\sin z}{(z-\pi)^2}$ (ii) $g(z) = (z+i)^2 e^{\frac{1}{z+i}}$	7	CO5	L4
35	Evaluate $\oint_C \left(\frac{ze^{\pi z}}{(z^4-16)} + ze^{\pi/z} \right) dz$ where C is the ellipse $9x^2+y^2 = 9$	7	CO5	L5
36	Using Cauchy's Residue theorem, Evaluate $\int_C \frac{30z^2-23z+5}{(2z-1)^2(3z-1)} dz$ where C is the circle $ z = 1$ counter-clockwise.	7	CO5	L5

Prepared By : Prof. Neethu Rose T.H

Checked By : Prof. Shereeta D'Cotha

1. Prescribed Syllabus

Module	Topic	Hours
1	Elemental and compound semiconductors, Intrinsic and Extrinsic semiconductors, concept of effective mass, Fermions-Fermi Dirac distribution, Fermi level, Doping & Energy band diagram, Equilibrium and steady state conditions, Density of states & Effective density of states, Equilibrium concentration of electrons and holes. Excess carriers in semiconductors: Generation and recombination mechanisms of excess carriers, quasi Fermi levels.	10
2	Carrier transport in semiconductors, drift, conductivity and mobility, variation of mobility with temperature and doping, Hall Effect. Diffusion, Einstein relations, Poisson equations, Continuity equations, Current flow equations, Diffusion length, Gradient of quasi Fermi level	8
3	PN junctions : Contact potential, Electrical Field, Potential and Charge distribution at the junction, Biasing and Energy band diagrams, Ideal diode equation. Metal Semiconductor contacts, Electron affinity and work function, Ohmic and Rectifying Contacts, current voltage characteristics. Bipolar junction transistor, current components, Transistor action, Base width modulation.	11
4	Ideal MOS capacitor, band diagrams at equilibrium, accumulation, depletion and inversion, threshold voltage, body effect, MOSFET-structure, types, Drain current equation (derive)- linear and saturation region, Drain characteristics, transfer characteristics.	8
5	MOSFET scaling – need for scaling, constant voltage scaling and constant field scaling. Sub threshold conduction in MOS. Short channel effects- Channel length modulation, Drain Induced Barrier Lowering, Velocity Saturation, Threshold Voltage Variations and Hot Carrier Effects. Non-Planar MOSFETs: Fin FET – Structure, operation and advantages.	7

2. Text Books (T)

T1. Ben G. Streetman and Sanjay Kumar Banerjee, Solid State Electronic Devices, Pearson 6/e, 2010 (Modules I, II and III)

T2. Sung Mo Kang, CMOS Digital Integrated Circuits: Analysis and Design, McGraw-Hill, Third Ed., 2002 (Modules IV and V)

3. Reference Books (R)

R1. Neamen, Semiconductor Physics and Devices, McGraw Hill, 4/e, 2012

R2. Sze S.M., Semiconductor Devices: Physics and Technology, John Wiley, 3/e, 2005

R3. Pierret, Semiconductor Devices Fundamentals, Pearson, 2006

R4. Sze S.M., Physics of Semiconductor Devices, John Wiley, 3/e, 2005

R5. Achuthan, K N Bhat, Fundamentals of Semiconductor Devices, 1e, McGraw Hill, 2015

R6. Yannis Tsividis, Operation and Modelling of the MOS Transistor, Oxford University Press.

R7. Jan M. Rabaey, Anantha Chandrakasan, Borivoje Nikolic, Digital Integrated Circuits - A Design Perspective, PHI.

4. Course Objectives

This course aims to understand the physics and working of solid state devices.

5. Course Pre / Co-requisite

EST130 Basics of Electrical and Electronics Engineering

6. Course Outcomes

- CO1. Apply Fermi-Dirac Distribution function and Compute carrier concentration at equilibrium and the parameters associated with generation, recombination and transport mechanism
- CO2. Explain drift and diffusion currents in extrinsic semiconductors and Compute current density due to these effects.
- CO3. Define the current components and derive the current equation in a pn junction diode and bipolar junction transistor.
- CO4. Explain the basic MOS physics and derive the expressions for drain current in linear and saturation regions.
- CO5. Discuss scaling of MOSFETs and short channel effects.

7. Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes

PO/ CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	H	H											H		
CO2	H	H											H		
CO3	H	H											H		
CO4	H	H											H		
CO5	H												H		

8. Justification for CO-PO-PSO Correlation

CO	PO/PSO	Justification
CO1	PO1	Applying the fundamental concepts of Mathematics and Semiconductor Physics, will help the students to compute carrier concentration at equilibrium and the parameters associated with generation, recombination and transport mechanism. Hence it is highly correlated.
	PO2	Knowledge in Fermi-Dirac Distribution function and semiconductor physics will help the students to analyse the carrier concentration at equilibrium and to reach a substantiate conclusion regarding carrier generation, recombination and transport mechanism. Hence it is highly correlated.

	PSO1	Understanding the contextual knowledge of Semiconductor physics will help the students to design solid state devices. Hence it is highly correlated.
CO2	PO1	Knowledge in fundamental concepts of semiconductor physics will help the students to solve the current density in solid-state devices. Hence it is highly correlated.
	PO2	Understanding the physics of solid-state devices will help the students to analyse the drift and diffusion current density in extrinsic semiconductors. Hence it is highly correlated.
	PSO1	Deep contextual knowledge of Semiconductor Physics will help students to compute current density due to drift and diffusion currents in extrinsic semiconductors. Hence it is highly correlated.
CO3	PO1	Knowledge in fundamental concepts of the current will help the students to derive the current equation in a pn junction diode and bipolar junction transistor. Hence highly correlated.
	PO2	Knowledge of current components in semiconductor physics will help the students to analyse the current equation and current flow in a pn junction diode and bipolar junction transistor. Hence it is highly correlated.
	PSO1	Deep contextual knowledge of elementary solid-state devices like pn junction diodes and bipolar junction transistors will help the students to analyse and design electronics devices. Hence it is highly correlated.
CO4	PO1	Understanding fundamental concepts in engineering physics will help the students to derive the expressions for drain current of a basic MOS transistor. Hence it is highly correlated.
	PO2	Understanding the basic MOS physics will help the students to analyse drain currents in linear and saturation regions and the parameters associated with MOSFETs. Hence it is highly correlated.
	PSO1	Deep contextual knowledge in semiconductor physics will help the students to analyse MOSFETs. Hence it is highly correlated.
CO5	PO1	Knowledge in basics of field effect transistor will help the students to explain the concepts of scaling of MOSFETs and short channel effects. Hence it is highly correlated.
	PSO1	Deep contextual knowledge in scaling of MOSFETs and short channel effects will help the students to develop futuristic solid state devices. Hence it is highly correlated.

9. Curricular gaps (if any)

Nil

10. Course Enrichment Activities

Sl No	Description	Proposed Activities	Relevance to POs and PSOs
1	Advancements in Solid State Devices: Innovations and Applications	Expert Talk	PO1, PSO1

11. Internal Assessment mark allocation (as per university curriculum)

Attendance

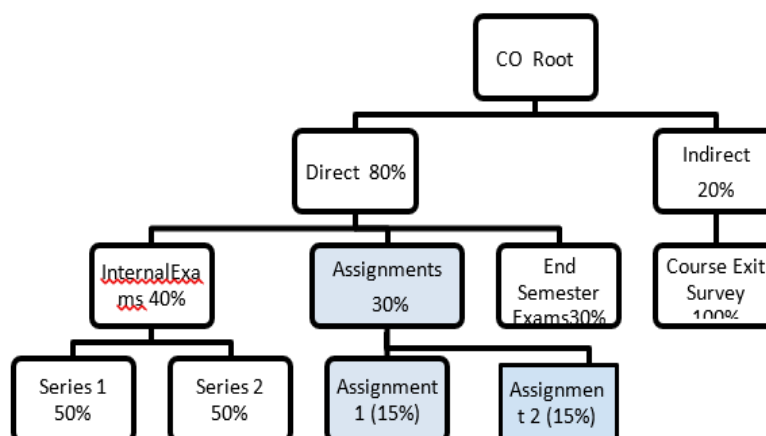
- 10 marks

Continuous Assessment Test	- 25 marks
Assignment (s)/ Course Project	- 15 marks
Total	- 50 marks

12. Assessment – CO Mapping (Put ‘ x’ if mapping is present)

	Tools	Weightage [#]	CO1	CO2	CO3	CO4	CO5
Direct Assessment Tools	Internal Exam(s) 40%	Series 1	20%	x	x		
		Series 2	20%			x	x
	Assignment (s)/ Course Project /Quiz etc. 30%	Assignment 1	15%	x	x		
		Assignment 2	15%			x	x
	End Semester Exam		30%	x	x	x	x
Indirect Assessment Tool	Course Exit Survey		100%	x	x	x	x

13. Assessment Configuration



1. Course Plan

Hour	Topic	Module	Reference(s)	Teaching Pedagogy
1	Elemental and compound semiconductors, Intrinsic semiconductors	1	T1	Lecture
2	Extrinsic semiconductors, Effective mass	1	T1	Lecture
3	Fermions-Fermi Dirac distribution	1	T1	Lecture
4	Fermions-Fermi Dirac distribution	1	T1	Remedial
5	Fermi level, Doping & Energy band diagram	1	T1	Lecture
6	Equilibrium and steady state conditions, Density of states & Effective density of states	1	T1	Tutorial

7	Equilibrium concentration of electrons and holes.	1	T1	Lecture
8	Excess carriers in semiconductors: Generation	1	T1	Lecture
9	Recombination mechanisms of excess carriers, quasi Fermi levels.	1	T1	Tutorial
10	Generation and recombination mechanisms of excess carriers, quasi Fermi levels.	1	T1	Remedial
11	Carrier transport in semiconductors, drift, conductivity	2	T1	Lecture
12	Mobility variation of mobility with temperature and doping.	2	T1	Tutorial
13	Diffusion equation	2	T1	Lecture
14	Einstein relations, Poisson equations	2	T1	Lecture
15	Poisson equations, Continuity equations, Current flow equations	2	T1	Tutorial
16	Poisson equations, Continuity equations, Current flow equations	2	T1	Remedial
17	Diffusion length, Gradient of quasi Fermi level	2	T1	Lecture
18	PN junctions: Contact potential, Electrical Field, Potential distribution	3	T1	Lecture
19	Charge distribution at the junction, Biasing and Energy band diagrams,	3	T1	Lecture
20	Ideal diode equation	3	T1	Lecture
21	Ideal diode equation	3	T1	Remedial
22	Metal Semiconductor contacts, Electron affinity and work function	3	T1	Lecture
23	Ohmic and Rectifying Contacts	3	T1	Tutorial
24	Current voltage characteristics	3	T1	Lecture
25	Bipolar junction transistor – working,, current components	3	T1	Lecture
26	Transistor action, Base width modulation	3	T1	Lecture
27	Derivation of terminal currents in BJT	3	T1	Lecture
28	Derivation of terminal currents in BJT	3	T1	Tutorial
29	Ideal MOS capacitor, band diagrams at equilibrium	4	T1	Lecture
30	Accumulation, depletion and inversion	4	T1	Lecture
31	Threshold voltage, body effect	4	T1	Lecture
32	Threshold voltage, body effect	4	T1	Remedial
33	MOSFET-structure, working	4	T1	Lecture
34	MOSFET- types	4	T1	Tutorial
35	Drain current equation (derive)- linear and saturation region	4	T1	Lecture
36	Drain characteristics, transfer characteristics.	4	T1	Lecture
37	MOSFET scaling – need for scaling	5	T1	Lecture
38	Constant voltage scaling and constant field scaling.	5	T1	Lecture

39	Sub threshold conduction in MOS.	5	T1	Lecture
40	Short channel effects- Channel length modulation	5	T1	Tutorial
41	Drain Induced Barrier Lowering, Velocity Saturation	5	T1	Lecture
42	Drain Induced Barrier Lowering, Velocity Saturation	5	T1	Remedial
43	Threshold Voltage Variations and Hot Carrier Effects.	5	T1	Lecture
44	Non-Planar MOSFETs: Fin FET –Structure, operation and advantages	5	T1	Lecture
45	Revision	1	T1	Lecture
46	Revision	2	T1	Lecture
47	Revision	2	T1	Lecture
48	Revision	3	T1	Lecture
49	Revision	4	T1	Lecture
50	Revision	5	T1	Lecture

Prepared By : Ambily Joseph

Checked By : Tubin T X

1. Prescribed Syllabus

Module	Topic	Hours
1	Number Systems and Codes: Binary and hexadecimal number systems; Methods of base conversions; Binary and hexadecimal arithmetic; Representation of signed numbers; Fixed and floating point numbers; Binary coded decimal codes; Gray codes; Excess 3 code. Alphanumeric codes: ASCII. Basics of verilog -- basic language elements: identifiers, data objects, scalar data types, operators.	12
2	Boolean Postulates and Fundamental Gates Boolean postulates and laws – Logic Functions and Gates De-Morgan's Theorems, Principle of Duality, Minimization of Boolean expressions, Sum of Products (SOP), Product of Sums (POS), Canonical forms, Karnaugh map Minimization. Modeling in verilog, Implementation of gates with simple verilog codes.	7
3	Combinatorial and Arithmetic Circuits Combinatorial Logic Systems - Comparators, Multiplexers, Demultiplexers, Encoder, Decoder. Half and Full Adders, Subtractors, Serial and Parallel Adders, BCD Adder. Modeling and simulation of combinatorial circuits with verilog codes at the gate level.	8
4	Sequential Logic Circuits: Building blocks like S-R, JK and Master-Slave JK FF, Edge triggered FF, Conversion of Flipflops, Excitation table and characteristic equation. Implementation with verilog codes. Ripple and Synchronous counters and implementation in verilog, Shift registers-SIPO, SISO, PISO, PIPO. Shift Registers with parallel Load/Shift, Ring counter and Johnsons counter. Asynchronous and Synchronous counter design, Mod N counter. Modeling and simulation of flipflops and counters in verilog.	11
5	Logic families and its characteristics: TTL, ECL, CMOS - Electrical characteristics of logic gates – logic levels and noise margins, fan-out, propagation delay, transition time, power consumption and power-delay product. TTL inverter - circuit description and operation; CMOS inverter - circuit description and operation; Structure and operations of TTL and CMOS gates; NAND in TTL and CMOS, NAND and NOR in CMOS.	7

2. Text Books (T)

- T1. Mano M.M., Ciletti M.D., "Digital Design", Pearson India, 4th Edition. 2006
- T2. D.V. Hall, "Digital Circuits and Systems", Tata McGraw Hill, 1989
- T3. S. Brown, Z. Vranesic, "Fundamentals of Digital Logic with Verilog Design", McGraw Hill
- T4. Samir Palnikar "Verilog HDL: A Guide to Digital Design and Synthesis", Sunsoft Press
- T5. R.P. Jain, "Modern digital Electronics", Tata McGraw Hill, 4th edition, 2009

3. Reference Books (R)

- R1. W.H. Gothmann, "Digital Electronics – An introduction to theory and practice", PHI, 2nd edition, 2006
- R2. Wakerly J.F., "Digital Design: Principles and Practices," Pearson India, 4th 2008 .
- R3. A. Ananthakumar , "Fundamentals of Digital Circuits", Prentice Hall, 2nd edition, 2016
- R4. Fletcher, William I., An Engineering Approach to Digital Design, 1st Edition, Prentice Hall India, 1980

4. Course Objectives

This course aims to impart the basic knowledge of logic circuits and enable students to apply it to design a digital system.

5. Course Pre / Co-requisite

- EST130 Basics of Electrical and Electronics Engineering

6. Course Outcomes

After the completion of course student will be able to

- CO1. Explain the elements of digital system abstractions such as digital representations of information, digital logic and Boolean algebra
- CO1. Create an implementation of a combinational logic function described by a truth table using and/or/inv gates/ muxes
- CO2. Compare different types of logic families with respect to performance and efficiency
- CO3. Design a sequential logic circuit using the basic building blocks like flip-flops
- CO4. Design and analyze combinational and sequential logic circuits through gate level Verilog models.

7. Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes

PO/ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O 1	PS O2	PS O3
CO 1	H	H											H		
CO 2	H	H	H							M	H	H	H		
CO 3	H	H											H		
CO 4	H	H	H							M	H	H	H		
CO 5	H	H	H		H					M	H	H	H		H

8. Justification for CO-PO-PSO Correlation

CO	PO/PSO	H/M/L	Justification Statement
CO1	PO1	H	Student will be able to apply the basic knowledge of mathematics and engineering fundamentals to understand concepts of digital logic and Boolean algebra
	PO2	H	Student will be able to analyze Boolean algebra in digital logic by using first principles of mathematics.
	PSO1	H	Student will be able to absorb and apply the concept of Boolean algebra for the design and development of digital electronic systems
CO2	PO1	H	Student will be able to apply the basic knowledge of mathematics and engineering fundamentals to understand concepts of combinational logic function described by a truth table using gates
	PO2	H	Student will be able to analyze combinational logic function described by a truth table using gates by using first principles of mathematics.
	PO3	H	Student will be able to design the combinational logic function described by a truth table using gates in digital system.
	PO9	M	Student will be able to contribute in their individual capacity as well as work as an effective team for the fulfilment of their course project.
	PO10	H	Student will be able to demonstrate the ability to use appropriate tools like algorithms / flowcharts for effectively communicating the design and solution to the problem statement formulated
	PO12	H	Student will be able to recognize the need for innovative thinking in digital electronics to engage in independent and lifelong learning
	PSO1	H	Student will be able to absorb and apply the concept of Combinational logic function for the design and development of digital electronic systems
CO3	PO1	H	Student will be able to apply the basic knowledge of mathematics and engineering fundamentals to understand different types of logic families.
	PO2	H	Student will be able to analyze different types of logic families with respect to performance and efficiency by using first principles of mathematics.
	PSO1	H	Student will be able to absorb and apply the concept of logic families like TTL, ECL and CMOS for the design and development of digital electronic systems
CO4	PO1	H	Student will be able to apply the basic knowledge of mathematics and engineering fundamentals to understand concepts of sequential logic function using flip-flops

	PO2	H	Student will be able to analyze sequential logic function and its design by using first principles of mathematics.
	PO3	H	Student will be able to design the synchronous and asynchronous sequential circuits using flip-flops in digital system.
	PO9	M	Student will be able to contribute in their individual capacity as well as work as an effective team for the fulfilment of their course project.
	PO10	H	Student will be able to demonstrate the ability to use appropriate tools like algorithms / flowcharts for effectively communicating the design and solution to the problem statement formulated
	PO12	H	Student will be able to recognize the need for innovative thinking in digital electronics to engage in independent and lifelong learning
	PSO1	H	Student will be able to absorb and apply the concept of sequential logic function for the design and development of digital electronic systems
CO5	PO1	H	Student will be able to apply the basic knowledge of mathematics and engineering fundamentals to understand concepts of digital logic circuits
	PO2	H	Student will be able to analyze combinational and sequential logic circuits through gate level Verilog models using first principles of mathematics.
	PO3	H	Student will be able to design combinational and sequential logic circuits by using gate level Verilog coding.
	PO5	H	Student will be able to apply modern engineering tools to design digital logic circuits by using Hardware description language.
	PO9	H	Student will be able to contribute in their individual capacity as well as work as an effective team for the fulfilment of their course project.
	PO10	M	Student will be able to demonstrate the ability to use appropriate tools like algorithms / flowcharts for effectively communicating the design and solution to the problem statement formulated
	PO12	H	Student will be able to recognize the need for innovative thinking in digital electronics to engage in independent and lifelong learning
	PSO1	H	Student will be able to absorb and apply the concept of digital logic circuits for the design and development of digital electronic systems
	PSO3	H	Student will be able to analyze modern engineering tools to design digital logic circuits by using Verilog coding.

9. Curricular gaps (if any)

Nil

10. Course Enrichment Activities*

Sl No	Description	Proposed Activities	Relevance to POs and PSOs
	Nil		

11. Internal Assessment mark allocation (as per university curriculum)

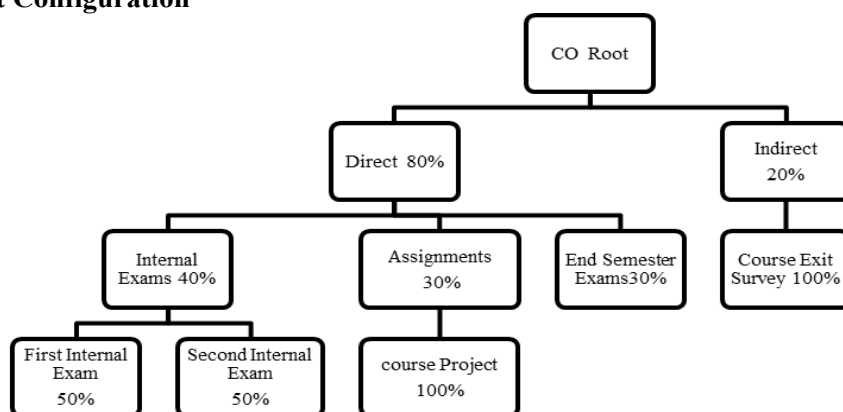
(Provide details as mentioned in syllabus)

Attendance	- 10 marks
Continuous Assessment Test	- 25 marks
Course Project	- 15 marks
<u>Total</u>	<u>- 50 marks</u>

12. Assessment – CO Mapping (Put ‘ x ’ if mapping is present)

	Tools		Weightage	CO1	CO2	CO3	CO4	CO5
Direct Assessment Tools	Internal Exam(s) 40%	Series1	20%	x	x			x
		Series2	20%			x	x	x
	Course Project 30%	Course Project	30%	x	x	x	x	x
	End Semester Exam		30%	x	x	x	x	x
Indirect Assessment Tool	Course Exit Survey		100%	x	x	x	x	x

13. Assessment Configuration



14. Course Plan

Hour	Topic	Module	Reference(s)	Teaching Pedagogy
1.	Binary, octal and hexadecimal number systems	M1	T1, T2	Lecture method
2.	base conversions	M1	T1, T2	Tutorial method
3.	Binary, octal and hexadecimal arithmetic	M1	T1, T2	Lecture method
4.	Representation of signed numbers	M1	T1, T2	Lecture method
5.	Fixed point numbers	M1	T1, T2	Lecture method
6.	Floating point numbers	M1	T1, T2	Lecture method
7.	Binary coded decimal codes, Gray codes, Excess 3 code	M1	T1, T2	Lecture method
8.	Error detection and correction codes: parity check codes	M1	T1, T2	Lecture method
9.	Hamming code	M1	T1, T2	Lecture method
10.	Alphanumeric codes: ASCII	M1	T1, T2	Lecture method
11.	Verilog basic language elements: identifiers	M1	T1, T2	Lecture method
12.	data objects, scalar data types, operators	M1	T1, T2	Lecture method
13.	Boolean postulates and laws – Logic Functions and Gates	M2	T1, T2, T3	Lecture Method
14.	De-Morgan's Theorems, Principle of Duality	M2	T1, T2, T3	Lecture Method
15.	Minimization of Boolean expressions,	M2	T1, T2, T3	Lecture Method
16.	Sum of Products (SOP), Product of Sums (POS)	M2	T1, T2, T3	Lecture Method
17.	Canonical forms, Karnaugh map Minimization	M2	T1, T2, T3	Tutorial Method
18.	Gate level modelling in Verilog: Basic gates	M2	T1, T2, T3	Lecture Method

19.	XOR using NAND and NOR	M2	T1, T2, T3	Lecture Method
20.	Combinatorial Logic Systems - Comparators,	M3	T1, T2, T3	Lecture Method
21.	Multiplexers, Demultiplexers	M3	T1, T2, T3	Tutorial Method
22.	Encoder, Decoder	M3	T1, T2, T3	Lecture Method
23.	Half and Full Adders, Subtractors,	M3	T1, T2, T3	Lecture Method
24.	Serial and Parallel Adders, BCD Adder	M3	T1, T2, T3	Lecture Method
25.	Gate level modelling combinational logic circuits in Verilog: half adder, full adder	M3	T1, T2, T3	Lecture Method
26.	mux, demux	M3	T1, T2, T3	Lecture Method
27.	decoder, encoder	M3	T1, T2, T3	Lecture Method
28.	Building blocks like S-R, JK	M4	T1, T2, T3	Lecture Method
29.	Master-Slave JK FF, Edge triggered FF 2	M4	T1, T2, T3	Lecture Method
30.	Conversion of Flipflops, Excitation table and characteristic equation.	M4	T1, T2, T3	Tutorial Method
31.	Ripple and Synchronous counters	M4	T1, T2, T3	Lecture Method
32.	Shift registers-SIPO. SISO, PISO, PIPO	M4	T1, T2, T3	Lecture Method
33.	Ring counter and Johnsons counter	M4	T1, T2, T3	Lecture Method
34.	Asynchronous counter design	M4	T1, T2, T3	Tutorial Method
35.	Asynchronous counter design	M4	T1, T2, T3	Lecture Method
36.	Mod N counter, Random Sequence generator	M4	T1, T2, T3	Lecture Method
37.	Modelling sequential logic circuits in Verilog: flipflops	M4	T1, T2, T3	Lecture Method
38.	Verilog: counters	M4	T1, T2, T3	Lecture Method

39.	TTL,ECL,CMOS- Electrical characteristics of logic gates – logic levels and noise margins	M5	T1, T2, T3	Lecture Method
40.	fan-out, propagation delay, transition time	M5	T1, T2, T3	Lecture Method
41.	power consumption and power-delay product.	M5	T1, T2, T3	Lecture Method
42.	TTL inverter - circuit description and operation	M5	T1, T2, T3	Lecture Method
43.	CMOS inverter - circuit description and operation	M5	T1, T2, T3	Lecture Method
44.	NAND in TTL	M5	T1, T2, T3	Lecture Method
45.	NAND and NOR in CMOS	M5	T1, T2, T3	Tutorial Method

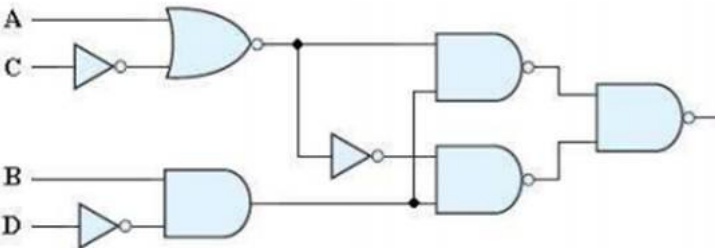
15. Question Bank

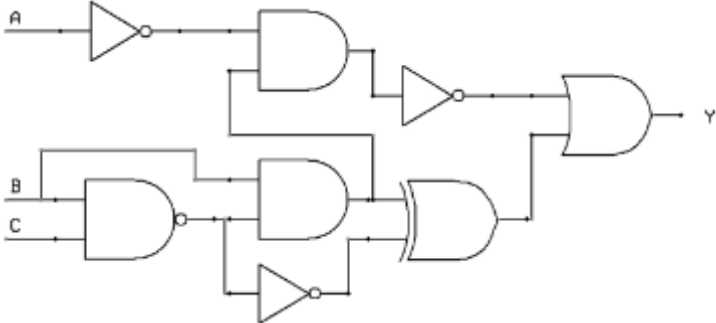
Module 1				
Sl. No.	Question	Marks	CO	BL
1.	Convert 326.87510 to binary, and Hex form	3	CO1	L2
2.	Represent 47810 in BCD and Excess-3 codes.	3	CO1	L2
3.	Perform the arithmetic operation on these unsigned binary numbers. Show intermediate steps. i) 10110.101+101.11 (ii) 100001-1011	3	CO1	L2
4.	Explain number system and different types	3	CO1	L2
5.	Explain the language elements in Verilog	3	CO1	L1
6.	Explain the identifiers in Verilog	3	CO1	L2
7.	Explain the data types in Verilog	3	CO1	L2
8.	Explain operators in Verilog	5	CO1	L2
9.	Convert the following from binary to Decimal a. $(10101)_2 = (\dots)_{10}$ b. $(110110)_2 = (\dots)_{10}$ c. $(1110101)_2 = (\dots)_{10}$	6	CO1	L2
10.	Convert the following from Decimal to binary a. $(205)_{10} = (\dots)_2$ b. $(31)_{10} = (\dots)_2$ c. $(555)_{10} = (\dots)_2$	6	CO1	L2

11.	Convert the following from Hexadecimal to binary $(IEF2)_{16} = (\dots)_2$	5	CO1	L2
12.	Convert the following from binary to Hexadecimal $(01110110111001)_2 = (\dots)_{16}$	5	CO1	L2
13.	Convert the following from binary to Decimal a. $(10101.01110)_2 = (\dots)_{10}$ b. $(111100.0110110)_2 = (\dots)_{10}$	6	CO1	L2
14.	Convert the following from Octal to Decimal d. $(743.61)_8 = (\dots)_{10}$ e. $(421.153)_8 = (\dots)_{10}$	6	CO1	L2
15.	Convert the following from Hexadecimal to Decimal a. $(3B.1C)_{16} = (\dots)_{10}$ b. $(78D.ABC)_{16} = (\dots)_{10}$	6	CO1	L2
16.	Convert the following from Decimal to binary a. $(72.892)_{10} = (\dots)_2$ b. $(356.173)_{10} = (\dots)_2$	6	CO1	L2
17.	Convert the following from Decimal to Octal a. $(112.435)_{10} = (\dots)_8$ b. $(7435.24)_{10} = (\dots)_8$	6	CO1	L2
18.	Convert the following from Decimal to Hexadecimal a. $(112.435)_{10} = (\dots)_{16}$ b. $(7435.24)_{10} = (\dots)_{16}$	6	CO1	L2
19.	Do the following binary Arithmetic a. $(11111010)_2 + (10111110)_2 + (01100010)_2 = (\dots)_2$ b. $(1111010)_2 + (1011001)_2 + (1101010)_2 = (\dots)_2$ c. $(11111010)_2 - (10110110)_2 = (\dots)_2$ d. $(11110)_2 - (10101)_2 = (\dots)_2$ e. $(11110)_2 * (10111)_2 = (\dots)_2$ f. $(10100)_2 / (100)_2 = (\dots)_2$ g. $(100000)_2 / (1000)_2 = (\dots)_2$	14	CO1	L2
20.	Consider the signed binary numbers A = 01110111 and B = 11011111 where B is in 2's complement form. Find the value of the following mathematical expression (i) A + B (ii) A – B	14	CO1	L3
21.	Find the excess -3 code and BCD code of the decimal numbers 55 and 102	5	CO1	L2

22.	Find the truth table for three bit binary numbers and its corresponding gray code numbers	5	CO1	L2
23.	Convert the following into corresponding number system $a. (ABC.33F)_{16} = (\dots)_8$ $b. (77CE.ABB)_{16} = (\dots)_8$ $c. (334.277)_8 = (\dots)_{16}$ $d. (653.121)_8 = (\dots)_{16}$	10	CO1	L2
24.	Convert the following numbers into decimal system $a. (01101.101)_2 = (\dots)_{10}$ $b. (1344.756)_8 = (\dots)_{10}$ $a. (A1A.BB)_{16} = (\dots)_{10}$	10	CO1	L2
25.	Convert the following decimal numbers to corresponding number systems $a. (123.457)_{10} = (\dots)_8$ $b. (765.453)_{10} = (\dots)_2$ $c. (9922.834)_{10} = (\dots)_{16}$ $d. (346.556)_{10} = (\dots)_{16}$	10	CO1	L2
26.	Convert $(AB23)_H = (\dots)_{ASCII}$	5	CO1	L2
27.	Represent the following numbers using sign magnetude form and 2's complement method $a. (-30)$ $b. (+28)$ $c. (-111)$	10	CO1	L3
28.	Subtract the following using 2's complement method $a. (23)_{10} - (12)_{10}$ $b. (123)_8 - (45)_8$ $c. (ABC2)_H - (123)_H$	10	CO1	L3
29.	Convert $(3A9E.B)_{16}$ to binary and decimal. (Dec 2020)	3	CO1	L2
30.	Convert $(25)_{10}$ to binary, gray and BCD. (Dec 2020)	3	CO1	L2
31.	(a) Subtract 27 from 75 using 2's and 1's complement arithmetic (b) Explain fixed and floating point representation of numbers (Dec 2020)	14	CO1	L3
32.	(a) What is Hamming code? How is the Hamming codeword generated? Encode the data bits 1011 into 7-bit even Hamming code. (b) Give a brief description of identifiers and keywords in Verilog (Dec 2020)	14	CO1	L3
33.	Convert $(231.45)_8$ to equivalent decimal and binary (Dec 2021)	3	CO1	L2
34.	Give a brief description of keywords in Verilog (Dec 2021)	3	CO5	L2

35.	(a) Perform the following operations (i) $(A5C)_{16} + (8E4)_{16}$ (ii) $(175.6)_8 - (47.7)_8$ (b) What is Hamming code? The message 1100110 is coded in 7-bit even parity Hamming code which is transmitted through a noisy channel. Decode the message assuming that a single error occurred in the codeword (Dec 2021)	14	CO1	L3
36.	(a) Find 11001-10001 using 1's and 2's complement arithmetic (b) Explain the operators in Verilog (Dec 2021)	14	CO1	L3
37.	Convert the decimal number 215 to following codes (i) BCD code (ii) Excess 3 code (iii) Gray code (Dec 2022)	3	CO1	L2
38.	Convert the decimal number 18.6875 into binary and hexadecimal. (Dec 2022)	3	CO1	L2
39.	a) Find the sum of two hexadecimal numbers $(85C)_{16}$ and $(23C6)_{16}$ b) Convert each decimal number to binary and perform the subtraction $21.510 - 13.2510$ using (i) 1's complement method (ii) 2's complement method c) Explain the main differences between the Verilog terms (i) Wire and Reg (ii) Task and Function (Dec 2022)	14	CO1, CO5	L2
40.	a) How is the Hamming code word generated? The message "1001001" is coded in 7-bit even parity Hamming code, which is transmitted through a noisy channel. Decode the message, assuming that at most a single error occurred in each code word. b) Explain Verilog operators with examples. (Dec 2022)	14	CO1	L2
41.	Convert $(202.625)_{10}$ to binary. (Dec 2023)	3	CO1	L2
42.	With an example explain Binary Coded Decimals. (Dec 2023)	3	CO1	L2
43.	(a) Represent 543.125 using signed 32-bit floating point representation (8-bit exponent) (b) Convert $(123B)_{16}$ to binary and octal. (Dec 2023)	14	CO1	L2
44.	(a) Compute $(232)_{10} - (325)_{10}$ by using 2's complement method. (b) Explain the operators in Verilog. (Dec 2023)	14	CO1	L2
45.	Convert the following: a) $(27AD.9B)_{16}$ to decimal b) $(127)_{10}$ to Octal (June 2024)	3	CO1	L2

46.	Compare Bitwise and Logical Verilog operators. (June 2024)	3	CO5	L2
47.	a) Perform the subtraction $(18)_{10} - (25)_{10}$ using 1's and 2's complement method. b) Explain the Floating point and Fixed point representation of numbers with examples. (June 2024)	14	CO1	L2
48.	a) The message 1001101 coded in the 7 bit even parity Hamming code is transmitted through a noisy channel. Decode the message assuming that a single error has occurred. b) Perform the following operations: 1) Convert $(756.603)_{10}$ to Hex 2) Add $(1247)_{10}$ and $(2053)_{10}$ 3) Convert $(110101101)_2$ to Gray code 4) $(2A7C.30D)_{16}$ and $(8D9.E8B)_{16}$ (June 2024)	14	CO1	L3
Module 2				
1.	Minimize the following logic function using K- maps and realize using NAND gates alone $F(A, B, C, D) = \sum m(0, 5, 8, 9, 11, 15) + d(2, 3)$.	14	CO2	L3
2.	Design EXOR gate using NAND and NOR gates	10	CO2	L3
3.	Explain with figures how NAND gate and NOR gate can be used as Universal gate.	10	CO2	L3
4.	Using 8 to 1 multiplexer, realize the Boolean function $T = f(w, x, y, z) = \sum(0, 1, 2, 4, 5, 7, 8, 9, 12, 13)$	10	CO2	L3
5.	Simplify using K Map $f(w, x, y, z) = \sum(0, 1, 2, 4, 9, 12, 13, 15)$	10	CO2	L2
6.	Simplify the following function using K – map, $f = ABCD + AB'C'D' + AB'C + AB$ & realize the SOP using only NAND gates and POS using only NOR gates	10	CO2	L3
7.	Find a minimal SOP representation for the given expression using K-map method. Draw the circuit of the minimal expression using only NAND. $f(A, B, C, D, E) = \sum m(1, 4, 6, 10, 20, 22, 24, 26) + d(0, 11, 16, 27)$	10	CO2	L3
8.	Simplify the logic circuit shown in figure 	10	CO2	L3

9.	Obtain 3 level NOR – NOR implementation of $F = [AB + CD] EF$	10	CO2	L3
10.	Find a minimal SOP representation for the given expression using K-map method. Draw the circuit of the minimal expression using only NAND $f(A,B,C,D,E) = \sum m(1,4,6,10,20,22,24,26) + d(0,11,16,27)$.	10	CO2	L3
11.	Given $Y(A, B, C, D) = \prod M(0, 1, 3, 5, 6, 7, 10, 14, 15)$, draw the K-map and obtain the simplified expression. Realize the minimum expression using basic gates.	10	CO2	L3
12.	Explain briefly: SOP & POS , minterm & maxterm , canonical form	10	CO2	L3
13.	Simplify the Boolean function: (1) $F = A'B'C' + B'CD' + A'BCD' + AB'C'$ (2) $F = A'B'D' + A'CD + A'BCd + A'BC'D + ACD + AB'D'$ Where “d” indicates Don't care conditions.	10	CO2	L3
14.	Write Verilog coding for the following using behavioural level f. OR g. NOR h. NAND i. XOR j. XNOR k. NOT	10	CO5	L2
15.	Write Verilog coding for the following using gate level, behavioural level and dataflow level 3-input NAND gate	10	CO5	L3
16.	Write Verilog coding for the following using gate level, behavioural level and dataflow level 4 input NOR gate	10	CO5	L3
17.	Write the Verilog coding for the following logic circuits 	10	CO5	L3

18.	Simply the following using Boolean equations a. $Y = \overline{(A + B + C)}.ABC + \bar{A}\bar{B}\bar{C} + \overline{AB\bar{C}.(A + B)}$ b. $Y = \overline{(\overline{AB + CD}).\bar{A}\bar{B} + (A + \bar{B} + C + \bar{D}).\bar{C}}$	10	CO2	L3
19.	State and Prove DeMorgans' Theorem	10	CO2	L3
20.	Simplify the logic function using K map and realize it using logic gates $F(A, B, C, D) = \sum_m (2,3,5,6,7,8,11,14) + d(0,1,12)$	10	CO2	L3
21.	Simplify the logic function using K map and realize it using logic gates $F(A, B, C, D) = \prod_M (1,3,4,5,7,8,12,13,15)$	10	CO2	L3
22.	Realize XOR gate using NAND and NOR gates	10	CO2	L3
23.	Express the boolean function $F(A,B,C) = A + B'C$ as sum of minterms. (Dec 2020)	3	CO2	L2
24.	Write Verilog Code for a NAND gate. (Dec 2020)	3	CO5	L2
25.	(a) Implement an EX-OR gate using universal gates (b) Simplify the Boolean expression $F(A,B,C,D) = \sum m(1,3,10) + d(0,2,8,12)$ using K-Map and implement the simplified expression using universal gates. (Dec 2020)	14	CO2	L3
26.	(a) Reduce the Boolean expression $F = \prod M(1,2,3,4,10,11,15)$ using K-Map (b) Write Verilog code for implementing the above function (Dec 2020)	14	CO2 CO5	L3
27.	Reduce the expression $F = \overline{AB + A + AB}$ using De-Morgan's theorem (Dec 2021)	3	CO2	L2
28.	Write a Verilog code for implementing a NOR gate (Dec 2021)	3	CO5	L2
29.	(a) Obtain the canonical POS expression of $F(A,B,C) = (A' + B)(B' + C)(A + C)$ (b) Simply the expression $Y = \prod M(0,1,4,5,6,8,9,12,13,14)$ using K-Map and implement the simplified expression using NOR logic. (Dec 2021)	14	CO2	L3

30.	For the logical expression $F = A' + AB' + ABD + AB'D' + C$ (i) Obtain Canonical SOP expression (ii) Simplify the expression using K-Map (iii) Write Verilog code for the simplified expression (Dec 2021)	14	CO2	L3
31.	a) Simplify the Boolean expression $F(A, B, C, D) = \sum m(0, 1, 2, 6, 8, 9, 10, 11) + d(3, 7, 14, 15)$ using K-Map and implement the simplified expression using universal gates. b) Prove the following Boolean rules i. $A + AB = A$ ii. $A + A'B = A + B$. (Dec 22)	14	CO2	L3
32.	a) Reduce the following function using Karnaugh map technique $f(A, B, C, D) = \pi M(0, 2, 4, 10, 11, 14, 15)$ and implement the simplified expression using NAND gates. b) Explain the significance of duality principle in Boolean algebra . (Dec 22)	14	CO2	L3
33.	Write Verilog Code for a XOR gate (Dec 22)	3	CO5	L2
34.	Express $f(A, B, C) = AB + AC' + BC$ in standard SOP form (Dec 22)	3	CO2	L3
35.	Simplify the following Boolean expression, $F = ABC + A'B + ABC'$, to a minimum number of literals using algebraic methods alone. (Dec 23)	3	CO2	L3
36.	State De Morgan's theorem (Dec 2023)	3	CO2	L1
37.	(a) Minimise the following function into SoP form. $F(w, x, y, z) = \sum m(0, 6, 8, 13, 14) + d(2, 4, 10)$ (b) Draw the circuit diagram for the minimised expression. (c) Write a Verilog code to implement the same (5)	14	CO2	L3
38.	(a) Minimise the following function into PoS form. $F(w, x, y, z) = \Pi(1, 3, 6, 9, 11, 12, 14)$ (b) Draw the circuit diagram for the minimised expression (c) Write a Verilog code to implement the same. (Dec 2023) (Dec 2023)	14	CO2	L3
39.	a) Reduce the expression $\sum m(2, 8, 9, 10, 11, 12, 14)$ using K Map and implement the simplified expression using logic gates. b) Write the Verilog code for the simplified expression. (June 24)	14	CO2, CO5	L3

40.	a)Obtain the Canonical SOP form for the expression $\bar{A} + B + AC$ b)Simplify the Boolean expression $M(2,3,6,7,8,10,11,13,14)$ using K Map and implement it using logic gates. .(June 24)	14	CO2	L3
41.	Reduce the expression $\Sigma m(0,1,2,4,5,6,8,9,12,13,14)$ using K map (June 2024)	3	CO2	L2
42.	Draw and explain the circuit of a 4 bit Parallel Adder. (June 2024)	3	CO2	L2
Module 3				
1.	Using K map design a 3 bit Binary to Gray code converter.	10	CO2	L3
2.	Design the circuit of a 3-line to 8-line decoder using basic gates.	10	CO2	L3
3.	Design a logic circuit that produces a HIGH output whenever a 3-bit binary number $A_2A_1A_0$ greater than 001 and less than 110 is applied as input (A_2 is MSB).	10	CO2	L3
4.	Implement full adder using decoder.	10	CO2	L3
5.	Design a seven segment decoder circuit to display the numbers from 0 to 3	10	CO2	L3
6.	Design a combination circuits for a full adder and explain it in detail.	10	CO2	L3
7.	Design a combination circuits for a half adder and explain it in detail.	10	CO2	L3
8.	Design a combination circuits for a full subtractor and explain it in detail.	10	CO2	L3
9.	Design a combination circuits for a half subtractor and explain it in detail.	10	CO2	L3
10.	What is meant by Multiplexer? Explain with diagram and truth table the Operation of 4-to-1 line multiplexer	10	CO2	L3
11.	What is meant by Decoder? Explain 3-to-8 line decoder with diagram and truth table	10	CO2	L3
12.	Compare the two types of Digital Circuits	10	CO2	L3
13.	Design full Subtractor with necessary steps	10	CO2	L3
14.	Design 4:1 Data selector circuit with necessary steps	10	CO2	L3
15.	Design a 3 to 8 decoder Circuit and write its Verilog code.	10	CO2	L3
16.	Design a Gray to Binary Code Converter with necessary steps and write its Verilog Code	10	CO2	L3
17.	Design and write the Verilog code of Full adder	10	CO2	L3
18.	Design and write the Verilog code of 3 to 8 decoder	10	CO2	L3
19.	Design and write the Verilog code BCD to Excess 3 code converter	10	CO2	L3
20.	Design and write the Verilog code of 2-bit parallel adder	10	CO2	L3
21.	Design and write the Verilog code of 8:1 multiplexer	10	CO2	L3

22.	Design serial Adder	10	CO2	L3
23.	Design Parallel Adder	10	CO2	L3
24.	Design BCD Adder	10	CO2	L3
25.	Write Verilog code for Half adder	10	CO5	L3
26.	Write Verilog code for Full adder	10	CO5	L3
27.	Write Verilog code for Half Subtractor	10	CO5	L3
28.	Write Verilog code for Full Subtractor	10	CO5	L3
29.	Write Verilog code for 4:1 mux	10	CO5	L3
30.	Write Verilog code for 1:4 demux	10	CO5	L3
31.	Write Verilog code for gray to binary code converter	10	CO5	L3
32.	Write Verilog code for binary to gray code converter	10	CO5	L3
33.	Explain the working of a 4-bit parallel adder. (Dec 2020)	3	CO2	L2
34.	Implement a 4-input binary decoder using basic gates. (Dec 2020)	3	CO2	L2
35.	(a) Design a BCD adder circuit. (b) Write Verilog code for full subtractor circuit. (Dec 2020)	14	CO2	L3
36.	(a) Design a 3-bit magnitude comparator. (b) Implement the logic function $F(A,B,C,D)=\sum m(1,3,4,11,12,13,14,15)$ using 8 : 1 MUX (Dec 2020)	14	CO2	L3
37.	Write a Verilog code for implementing a NOR gate (Dec 2021)	3	CO2	L2
38.	Explain the working of a multiplexer (Dec 2021)	3	CO2	L2
39.	(a) Design a full adder circuit (b) Write a Verilog code for 1:4 demultiplexer (Dec 2021)	14	CO2	L3
40.	(a) Implement the logic function $f(A,B,C)=\sum m(0,2,3,5)$ using (i) 8:1 MUX (ii) 4:1 MUX (b) Design a octal to binary encoder (Dec 2021)	14	CO2	L3
41.	Design a 1-bit comparator circuit using logic gates. (Dec 22)	3	CO2	L3
42.	Realize an 8:1 multiplexer using 4:1 multiplexers and gates. (Dec 22)	3	CO2	L3
43.	a) Implement the following functions using MUX (i) AND (ii) XOR iii) $f(A, B, C) = \sum m(0, 3, 5, 6)$ b) Write a verilog code to implement 4:1 multiplexer. (Dec 22)	14	CO2	L3
44.	a) Implement a Full adder circuit using (i) 3: 8 decoder (ii) 1:8 demultiplexer b) Write a Verilog description for a one-bit full adder circuit (Dec 22)	14	CO2	L3

45.	(a) Implement the boolean function $F(A, B, C, D) = \Sigma(0, 1, 2, 3, 6, 10, 11, 14)$ using an 8X1 mux. (b) Write the verilog code to implement the boolean function $F(A, B, C, D) = \Sigma(0, 1, 2, 3, 6, 10, 11, 14)$ using an 8X1 mux.(Code should contain separate modules for implementing the mux and the function) (Dec 23)	14	CO2	L3
46.	(a) Design a Half Adder (b) Design a Full Adder by taking the Half Adder designed in (a) as the building block (c) Design and implement a BCD Adder. (Dec 23)	14	CO2	L3
47.	Write verilog code for a 1x4 demux.	3	CO5	L3
48.	Design a 2-bit decoder (Dec 23)	3	CO5	L3
49.	Write the Verilog code for Half Adder. (June 24)	3	CO5	L2
50.	Draw and explain the circuit of a 4 bit Parallel Adder. (June 24)	3	CO2	L2
51.	a) Design and implement a 2-bit magnitude comparator. b) Design a 3 to 8 decoder and implement it using basic gates. (June 24)	14	CO2	L3
52.	a) Draw and explain the circuit of a 4-bit PISO shift register. b) Design and implement a Full Subtractor using basic gates. c) Write the Verilog code for Full Subtractor. (June 24)	14	CO2, CO5	L3
Module 4				
1.	Realize a JK flip flop with NAND gates and describe its operation with detailed truth table, characteristic equation and excitation table. Describe the race around problem and suggest the methods to eliminate it.	3	CO4	L2
2.	Convert SR Flip Flop into J K Flip Flop	5	CO4	L3
3.	Design a synchronous 3-bit gray code up counter with the help of excitation table.	14	CO4	L3
4.	Using positive edge triggering SR flip-flops design a counter which counts in the following sequence: 000,111,110,101,100,011,010,001,000,...	14	CO4	L3
5.	Explain BCD Ripple counter and draw its logic diagram and timing diagram.	14	CO4	L3
6.	Design and explain the working of a MOD-11 counter.	14	CO4	L3
7.	Design an asynchronous mod – 6 Counter using JK flipflop	14	CO4	L3
8.	Design an asynchronous mod – 6 Counter using D flipflop	14	CO4	L3
9.	Design an asynchronous mod – 6 Counter using T flipflop	14	CO4	L3
10.	Design an asynchronous mod – 6 Counter using SR flipflop	14	CO4	L3
11.	Design an synchronous mod – 6 Counter using JK flipflop	14	CO4	L3
12.	Design an synchronous mod – 6 Counter using D flipflop	14	CO4	L3
13.	Design an synchronous mod – 6 Counter using T flipflop	14	CO4	L3
14.	Design an synchronous mod – 6 Counter using SR flipflop	14	CO4	L3

15.	Design a four state down counter using T flip flop.	14	CO4	L3
16.	A self starting synchronous binary up-counter having the state sequence 1; 2; 3; 4; 5; 6; 1; 2; : : : is to be implemented using T-flip flops. The flip flop outputs are designated as Q2, Q1 and Q0, where Q0 represents the least significant digit of the count. Give simplified expressions for the required next-state logic and the complete circuit diagram.	14	CO4	L3
17.	Explain JK Flip-flop in detail. What is the disadvantage of it and how it can be eliminated?	14	CO4	L3
18.	Design a combinational circuit with four input lines that represent a decimal digit in BCD and four output lines that generate the 2's complement of the input digit.	14	CO4	L3
19.	With the logic diagram explain the working of a four bit bi-directional Serial in Serial out (SISO) shift register with mode control . write the Verilog code for SISO	14	CO4	L3
20.	Explain PISO with neat diagram. Write the Verilog code also	14	CO4	L3
21.	Explain SIPO with neat diagram. Write the Verilog code also	14	CO4	L3
22.	Explain PIPO with neat diagram. Write the Verilog code also	14	CO4	L3
23.	Draw the logic diagram of a 4-bit ring counter and explain the working with timing diagram	14	CO4	L3
24.	Draw the logic diagram of a 4-bit Johnson counter (twisted ring counter) and explain the working with timing diagram	14	CO4	L3
25.	Compare the two types of Sequential Circuits	14	CO4	L3
26.	Explain the working of Master slave JK flip flop with neat diagram	14	CO4	L3
27.	Explain the working of SR flipflop. Write the characteristic equation also	14	CO4	L3
28.	Explain the working of T flipflop. Write the characteristic equation also	14	CO4	L3
29.	Explain the working of D flipflop. Write the characteristic equation also	14	CO4	L3
30.	Write the Verilog code for SR flipflop	14	CO5	L3
31.	Write the Verilog code for JK flipflop	14	CO5	L3
32.	Write the Verilog code for JK flipflop	14	CO5	L3
33.	Write the Verilog code for JK flipflop	14	CO5	L3
34.	Obtain the excitation table and characteristic equation of a T flip-flop. (Dec 2020)	3	CO4	L3

35.	Convert a JK flip-flop to D flip-flop. (Dec 2020)	3	CO4	L3
36.	Explain the operation of a 4-bit Johnson counter with truth table and waveforms. (b) Design a mod-10 asynchronous counter using T flip-flop. (Dec 2020)	14	CO4	L3
37.	Design a mod -16 synchronous counter using JK flip-flop. (Dec 2020)	14	CO4	L3
38.	Convert a JK flipflop to T flipflop (Dec 2021)	3	CO4	L3
39.	Write a Verilog code for implementing D flipflop (Dec 2021)	3	CO4	L3
40.	(a)Explain the operation of a JK flip-flop using NAND gates (b)Explain the operation of a 4-bit Johnson counter with truth table and waveforms (Dec 2021)	14	CO4	L3
41.	(a)Design a mod-6 synchronous up-counter using JK flip-flop (b)Explain a PISO shift register using LOAD /SHIFT (Dec 2021)	14	CO4	L3
42.	Convert a JK flip-flop to D flip-flop. (Dec 2022)	3	CO4	L3
43.	Realize D latch using gates and write the Verilog code(Dec 2022)	3	CO4	L3
44.	a) Design a 3-bit synchronous up counter using T flip-flop. b) Explain the operation of a 4-bit Ring counter. (Dec 2022)	14	CO4	L3
45.	a) Design a divide by 2N circuit using N number of flip-flops. Draw the truth table and waveforms. (Dec 2022) b) What is a race around condition related to JK Flip Flop? Explain how to eliminate the problem.	14	CO4	L3
46.	Differentiate between Flip Flop and Latch (Dec 23)	3	CO4	L2
47.	Implement a T Flip Flop using D Flip Flop (Dec 23)	3	CO4	L3
48.	(a) Design synchronous 3 bit UP counter using JK Flipflop. (b) Design and implement 4 bit Johnson counter. (Dec 23)	14	CO4	L3
49.	(a) Explain the operation of Master Slave JK Flip flop. (b) Design a mod-10 asynchronous counter. (Dec 23)	14	CO4	L3
50.	a)What is Race around condition? Draw and explain a circuit to eliminate this. b)Design and implement a MOD 8 Synchronous down counter using JK Flip flops. (June 24)	14	CO4	L3

51.	a) Design and implement a MOD 12 Asynchronous counter. b) Explain the operation of a 4 bit Ring counter with truth table and waveforms. (June 24)	14	CO4	L3
52.	Obtain the Characteristic table and excitation table of SR flip flop (June 24)	3	CO4	L3
53.	Convert T flip flop to JK flip flop (June 24)	3	CO4	L3
Module 5				
1.	Draw the circuit and explain the operation of TTL NAND gate	10	CO3	L2
2.	Draw the circuit and explain the operation of CMOS NOR gate	10	CO3	L2
3.	Compare TTL, CMOS logic families in terms of fan-in, fan-out, supply voltage, propagation delay, power dissipation and noise margin	10	CO3	L2
4.	Draw the circuit and explain the operation of CMOS NAND gate	10	CO3	L2
5.	Draw the circuit and explain the operation of CMOS Inverter	10	CO3	L2
6.	Draw the circuit and explain the operation of CMOS OR gate	10	CO3	L2
7.	Draw the circuit and explain the operation of CMOS AND gate	10	CO3	L2
8.	Explain ECL with neat diagram	10	CO3	L2
9.	Explain TTL totem pole circuit	10	CO3	L2
10.	Explain the electrical characteristics of logic family	10	CO3	L2
11.	Distinguish between fan-in and fan-out. (Dec 2020)	3	CO3	L2
12.	Explain noise margin. (Dec 2020)	3	CO3	L2
13.	Explain the working of a transistor level TTL NAND gate. (b) Draw and explain the working of a transistor level CMOS inverter. (Dec 2020)	10	CO3	L2
14.	(a) Explain the working of a transistor level CMOS NOR gate. (b) Compare TTL & CMOS logic families in terms of fan-in, fan-out, supply voltage, power supply and propagation delay and power dissipation. (Dec 2020)	10	CO3	L2
15.	Define noise-margin (Dec 2021)	3	CO3	L2
16.	Define propagation delay and power dissipation (Dec 2021)	3	CO3	L2

17.	(a) Draw the circuit diagram of a transistor level TTL Inverter and explain the working (b) Draw the circuit and explain the operation of transistor level CMOS NAND Gate (Dec 2021)	14	CO3	L2
18.	(a) Compare TTL & CMOS logic families in terms of fan-in, fan-out, supply voltage, propagation delay and noise margin (b) Draw the circuit and explain the operation of transistor level TTL NAND gate (Dec 2021)	14	CO3	L2
19.	Define the following in terms of Logical families i) Propagation delay ii) fan out iii) Noise margin (Dec 2022)	3	CO3	L2
20.	Draw the circuit diagram of a CMOS- NOT gate and explain the working with truth table (Dec 2022)	3	CO3	L2
21.	a) Describe the working of a 2-bit TTL NAND gate with Totem pole configuration. b) Explain the working of a transistor level CMOS NOR gate (Dec 2022)	14	CO3	L2
22.	a) Describe the working of a tristate TTL inverter b) Explain the working of a transistor level CMOS NAND gate. (Dec 2022)	14	CO3	L2
23.	(a) Compare TTL & CMOS logic families in terms of logics levels, noise margin, fan-out, propagation delay, transition time, power consumption and power-delay product. (b) List the applications of CMOS and TTL logic families. Justify their use in those applications based on the comparison given above. (Dec 23)	14	CO3	L2
24.	Draw the circuit diagram and explain the working of the following: a) CMOS NOR gate b) TTL inverter (Dec 23)	14	CO3	L2
25.	With an example explain transition time (Dec 23)	3	CO3	L2
26.	Give the names (full form) of 3 logic families. (Dec 23)	3	CO3	L1
27.	Explain the advantages and disadvantages of CMOS. (June 24)	3	CO3	L2
28.	Explain the need for Totempole configuration. (June 24)	3	CO3	L2
29.	Draw the circuit diagrams and explain the operation of CMOS NAND and NOR gates. (June 24)	14	CO3	L2
30.	a) Explain the characteristics of IC logic families. b) Draw and explain the circuit of TTL NAND gate. (June 24)	14	CO3	L2

Prepared by : Dr. Neenu Joseph

Checked by : Ms. Ambily Joseph

1. Prescribed Syllabus

Module	Topic	Hours
1	Mesh and node analysis of network containing independent and dependent sources. Supermesh and Supernode analysis. Steady-state AC analysis using Mesh and Node analysis.	10
2	Thevenin's theorem, Norton's theorem, Superposition theorem, Reciprocity theorem, Maximum power transfer theorem. (Applied to both dc and ac circuits having dependent source).	7
3	Review of Laplace Transforms and Inverse Laplace Transforms, Initial value theorem & Final value theorem, Transformation of basic signals and circuits into s-domain. Transient analysis of RL, RC, and RLC networks with impulse, step and sinusoidal inputs (with and without initial conditions). Analysis of networks with transformed impedance and dependent sources.	11
4	Network functions for the single port and two port networks. Properties of driving point and transfer functions. Significance of Poles and Zeros of network functions, Time domain response from pole zero plot. Impulse Function & Response. Network functions in the sinusoidal steady state, Magnitude and Phase response.	8
5	Impedance, Admittance, Transmission and Hybrid parameters of two port network. Interrelationship among parameter sets. Series and parallel connections of two port networks. Reciprocal and Symmetrical two port network. Characteristic impedance, Image impedance and propagation constant (derivation not required).	9

2. Text Books (T)

T1. Valkenburg V., "Network Analysis", Pearson, 3/e, 2019.

T2. Sudhakar A, Shyammoohan S. P., "Circuits and Networks- Analysis and Synthesis", McGraw Hill, 5/e, 2015.

3. Reference Books (R)

R1. Ravish R., "Network Analysis and Synthesis", 2/e, McGraw-Hill, 2015.

R2. Edminister, "Electric Circuits – Schaum's Outline Series", McGraw-Hill, 2009.

R3. K. S. Suresh Kumar, "Electric Circuits and Networks", Pearson, 2008.

4. Course Objectives

To analyse the linear time invariant electronic circuits.

5. Course Pre / Co-requisite

- EST130 Basics of Electrical and Electronics Engineering
- MAT102 Vector Calculus, Differential Equations and Transforms (Laplace Transform)

6. Course Outcomes

At the end of the course, student will be able to

CO1. Apply Mesh / Node analysis or Network Theorems to obtain steady-state response of the linear time-invariant networks.

CO2. Apply Laplace Transforms to determine the transient behaviour of RLC networks.

CO3. Apply Network functions and Network Parameters to analyse the single port and two port networks.

7. Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes

PO/ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H	H			M							M	H		M
CO2	H	H			M							M	H		M
CO3	H	H										M	H		

8. Justification for CO-PO-PSO Correlation

CO/PO	Justification Statement
CO1	PO1- knowledge of basic circuit elements, circuit variables, circuit laws and matrix solution methods will help students to do Mesh analysis, Node analysis and use Network simplification theorems.
	PO2- Analysis of various circuits using different network reduction methods & simplification theorems requires the use of first principles of engineering like voltage & current division rules.
	PO12- Understanding the concepts of Mesh & Node analysis & simplification theorems will help students to solve more advanced Linear time invariant networks in real life applications.
	PSO 1- Knowledge of basic circuit laws & theorems will help the students to analyse the circuits in various electrical & electronics systems.
	PSO 3- Applying simulation tools will help students to analyse circuits & networks in electronics systems.
CO2	PO1- Knowledge of mathematics like differential equations, Laplace transforms & its properties helps the students to analyse S- domain circuits.
	PO2- Analysis of RLC circuits and evaluation of network functions are performed using first principles of engineering and mathematics.
	PO12- Understanding RLC circuits will help students to analyse more complicated types of S domain circuits in LTI networks.
	PSO 1- Knowledge of S- domain circuits will help students to design various electrical & electronics systems.
	PSO 3- Applying network simulation tools will help students to analyse the circuits in electronics systems.
CO3	PO1- Knowledge of mathematics & engineering fundamentals will help students to analyse 2 port networks using network functions & parameters.

	PO2- Analysis of 2 port networks & evaluation of different parameters are performed by using Kirchhoff's laws & network reduction methods.
	PO12- knowledge & understanding of network functions & parameters for the analysis of two port networks will help the students to engage in lifelong learning.
	PSO 1- Applying the knowledge of 2 port networks will help the students to design various electrical & electronics systems.

9. Curricular gaps (if any)

Nil

10. Course Enrichment Activities*

Sl No	Description	Proposed Activities	Relevance to POs and PSOs
	NIL		

11. Internal Assessment mark allocation (as per university curriculum)

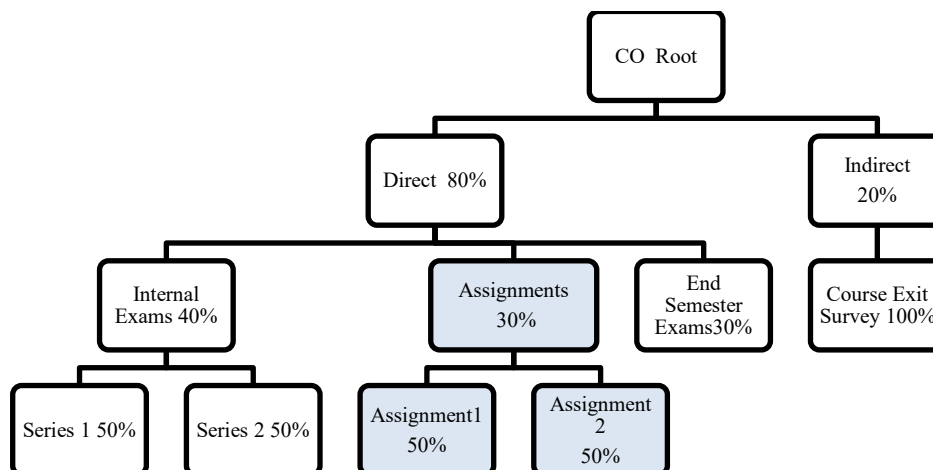
(Provide details as mentioned in syllabus)

Attendance	- 10 marks
Continuous Assessment Test	- 25 marks
Assignment (s)/ Course Project	- 15 marks
Total	- 50 marks

12. Assessment – CO Mapping (Put 'x' if mapping is present)

	Tools		Weightage [#]	CO1	CO2	CO3
Direct Assessment Tools**	Internal Exam(s) 40%	Series 1	20%	X	X	
		Series 2	20%		X	X
	Assignment (s)/ 30%	Assignment 1	15%	X		
		Assignment 2	15%		X	X
	End Semester Exam		30%	X	X	X
Indirect Assessment Tool	Course Exit Survey		100%	X	X	X

13. Assessment Configuration

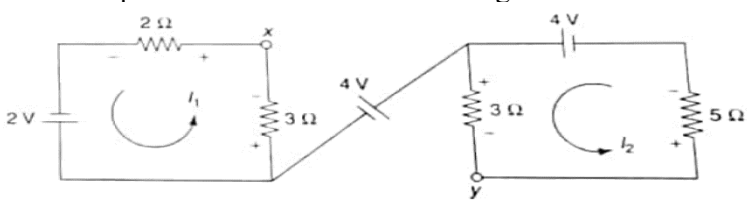
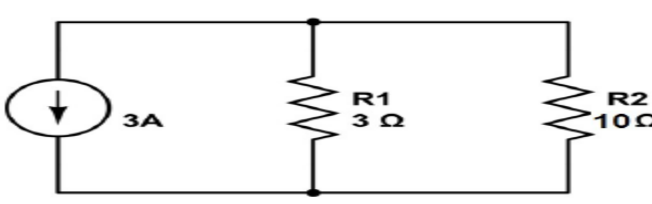
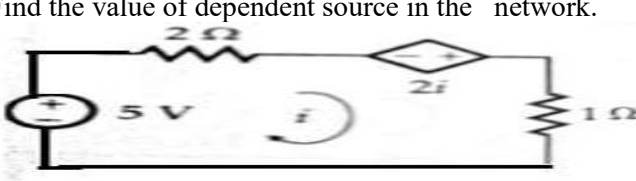


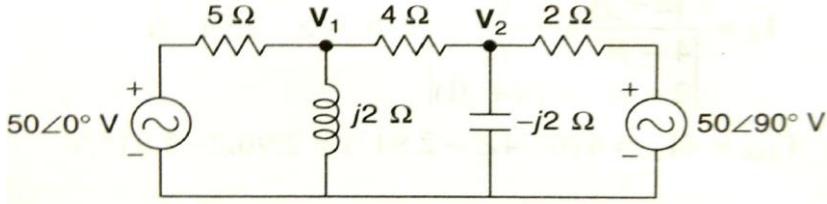
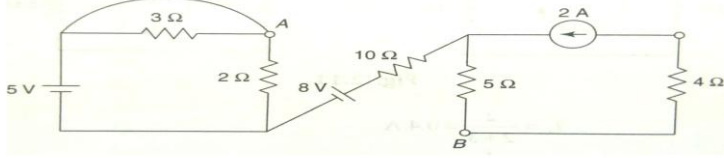
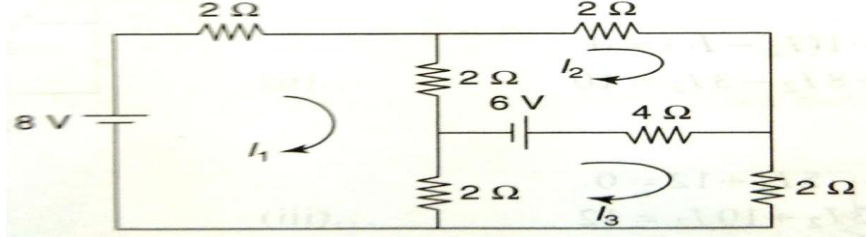
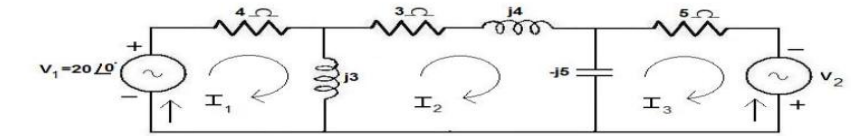
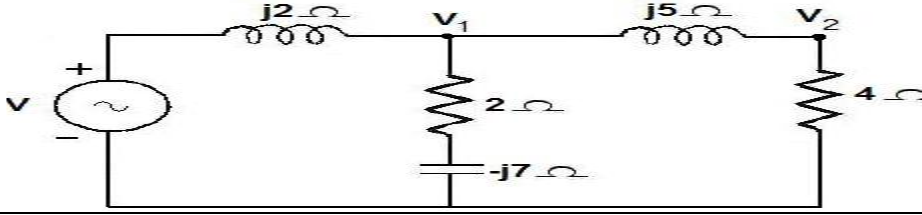
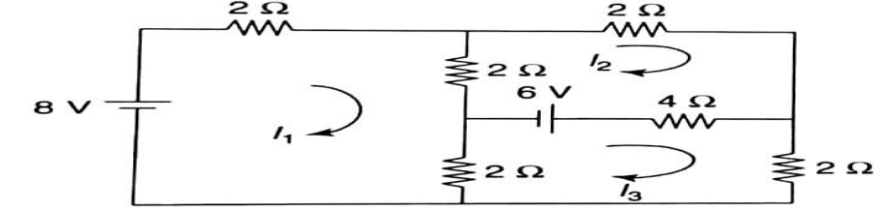
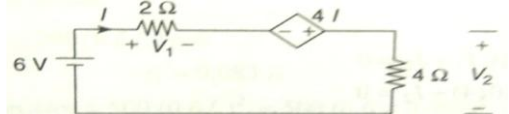
14. Course Plan

Hour	Topic Name	Module	Reference	Teaching Pedagogy
1.	Introduction	1	T2, R1	Lecture
2.	Review of circuit elements and Kirchhoffs Laws	1	T2, R1	Lecture
3.	Node analysis of network containing independent sources	1	T2, R1	Lecture
4.	Mesh analysis of network containing dependent sources	1	T2, R1	Tutorial
5.	Node analysis of network containing independent sources	1	T2, R1	Think Group Share
6.	Node analysis of network containing dependent sources	1	T2, R1	Lecture
7.	Supermesh and Supernode analysis	1	T2, R1	Tutorial
8.	Introduction to Steady-state AC analysis	1	T2, R1	Lecture
9.	Steady-state AC analysis using Mesh analysis	1	T2, R1	Lecture
10.	Steady-state AC analysis using Node analysis	1	T2, R1	Tutorial, Think Group Share
11.	Thevenins theorem	2	T2, R1	Lecture
12.	Nortons theorem	2	T2, R1	Lecture
13.	Superposition theorem	2	T2, R1	Lecture
14.	Superposition theorem- pbms	2	T2, R1	Tutorial
15.	Reciprocity theorem	2	T2, R1	Lecture
16.	Maximum power transfer theorem	2	T2, R1	Lecture
17.	Numerical problems	2	T2, R1	Tutorial, Think Group Share
18.	Review of Laplace Transforms	3	T2, R1	Lecture
19.	Review of Laplace Transforms	3	T2, R1	Tutorial
20.	Initial value theorem & Final value theorem	3	T2, R1	Lecture
21.	Transformation of basic signals and circuits into s-domain	3	T2, R1	Lecture
22.	Transformation of basic signals and circuits into s-domain	3	T2, R1	Tutorial, Think Group Share
23.	Transient analysis of RL Network	3	T2, R1	Lecture
24.	Transient analysis of RC Network	3	T2, R1	Lecture
25.	Transient analysis of RLC network	3	T2, R1	Lecture
26.	Analysis of networks with transformed impedance	3	T2, R1	Lecture
27.	Analysis of networks with dependent sources	3	T2, R1	Lecture
28.	Numerical problems	3	T2, R1	Tutorial, Think Group Share
29.	Network functions for the single port	4	T2, R1	Lecture
30.	Network functions for two port network	4	T2, R1	Lecture
31.	Properties of driving point and transfer functions	4	T2, R1	Lecture
32.	Significance of Poles and Zeros of network functions, Time domain response from pole zero plot	4	T2, R1	Lecture

33.	Impulse Function & Response	4	T2, R1	Tutorial
34.	Network functions in the sinusoidal steady state	4	T2, R1	Lecture
35.	Magnitude Response	4	T2, R1	Lecture
36.	Phase response	4	T2, R1	Lecture
37.	Impedance parameter of two port network	5	T2, R1	Lecture
38.	Admittance parameter of two port network	5	T2, R1	Lecture
39.	Transmission parameter of two port network	5	T2, R1	Lecture
40.	Hybrid parameter of two port network	5	T2, R1	Tutorial
41.	Interrelationship among parameter sets	5	T2, R1	Lecture
42.	Series connections of two port networks	5	T2, R1	Lecture
43.	Parallel connections of two port networks	5	T2, R1	Lecture
44.	Reciprocal and Symmetrical two port network	5	T2, R1	Tutorial
45.	Characteristic impedance, Image impedance and propagation constant	5	T2, R1	Lecture

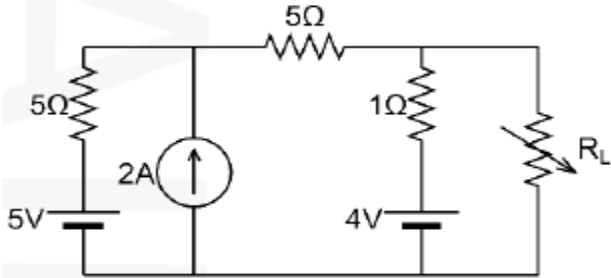
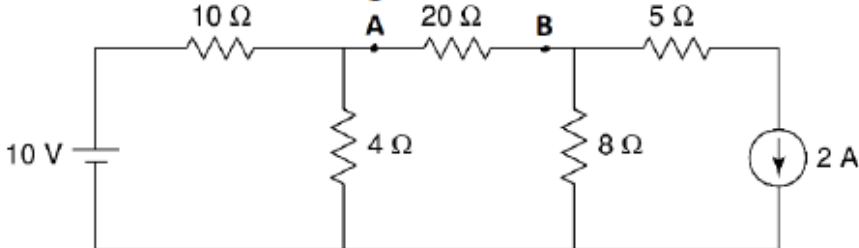
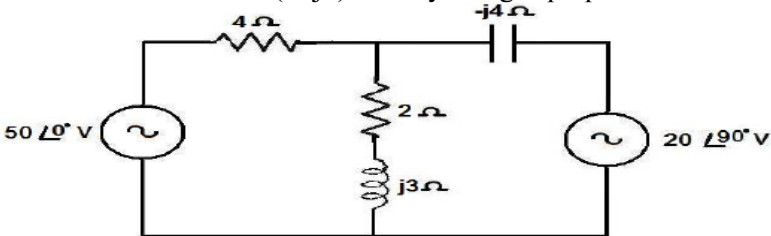
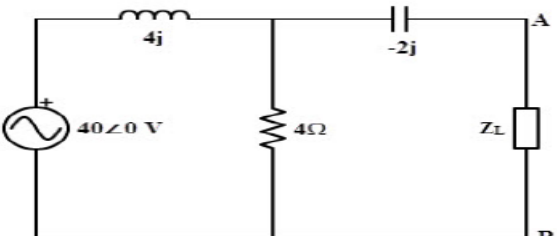
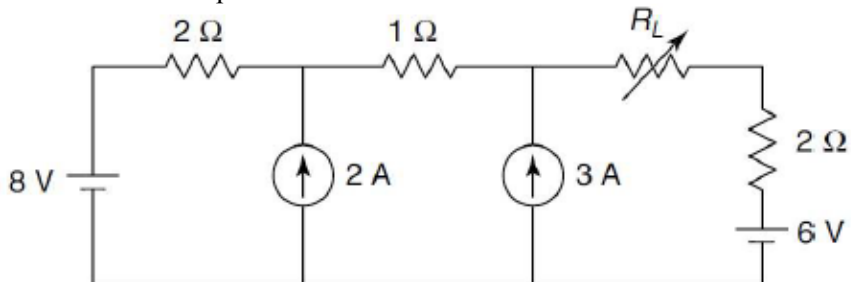
15. Question Bank

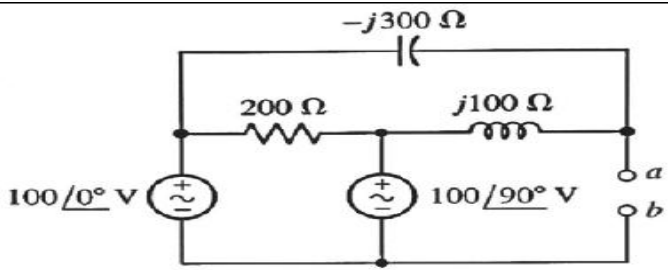
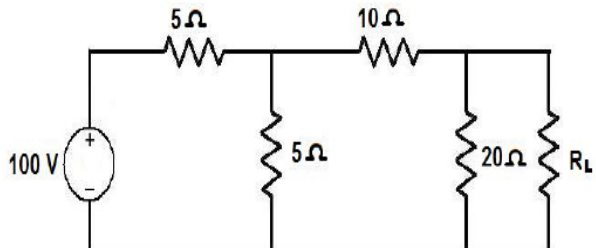
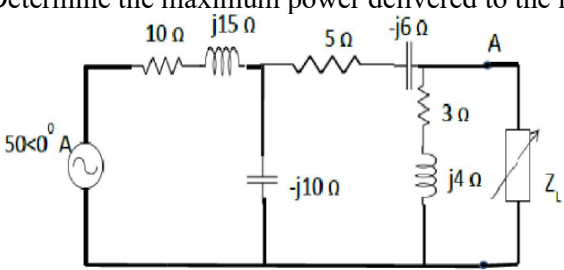
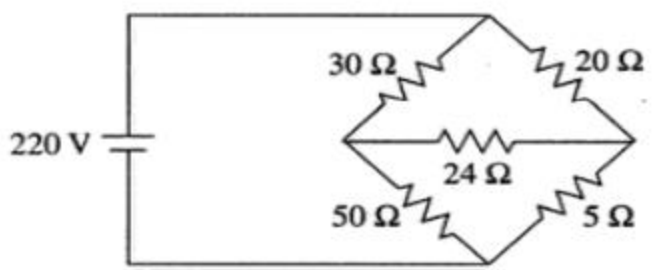
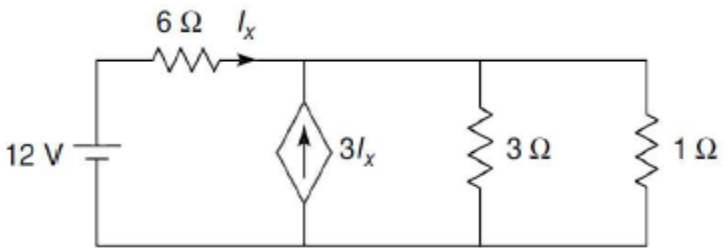
Module 1				
Sl. No.	Question	Marks	CO	BL
1.	State and Explain Kirchoff's current Law and Kirchoff's voltage law	3	CO1	L2
2.	Differentiate dependent and independent sources.	3	CO 1	L1
3.	Describe: (i) Ideal Sources (ii) Controlled Sources	5	CO1	L2
4.	Determine the potential difference V_{AB} for the given network 	3	CO 1	L3
5.	Determine the voltage across 10Ω resistor by applying suitable source transformation. 	3	CO 1	L3
6.	Explain super node analysis with suitable example.	3	CO1	L2
7.	Explain supermesh analysis with suitable example.	3	CO1	L1
8.	Find the value of dependent source in the network. 	3	CO 1	L3
9.	Describe i) Source transformations ii) Voltage division and current division rule	3	CO1	L2

10.	Find the node voltages V_1 & V_2 for the given network. 	7*	CO1	L3
11.	Determine the potential difference V_{AB} for the given network 	5	CO1	L3
12.	Determine the current through 4Ω resistor using mesh analysis. 	6	CO1	L3
13.	Determine the value of V_2 such that the current through the impedance $(3+j4)$ ohm is zero. 	8*	CO1	L3
14.	Solve for V_1 and V_2 using nodal method. Let $V = 100V$. 	6	CO1	L3
15.	Find the current through 4Ω using mesh analysis 	7	CO 1	L3
16.	Find the value of V_1 & V_2 in the network. 	5	CO1	L3

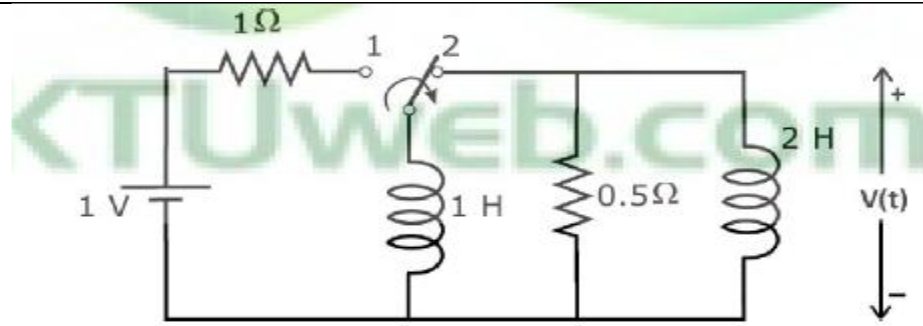
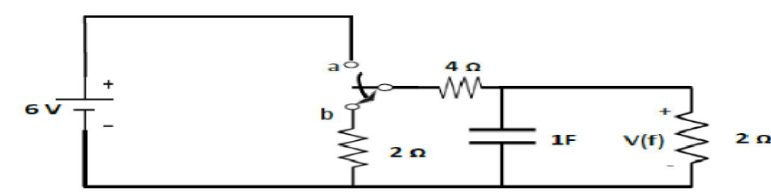
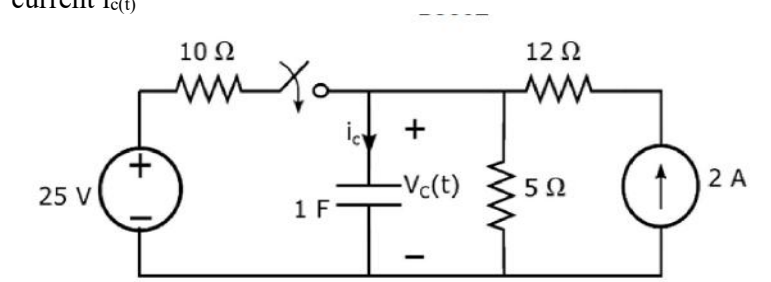
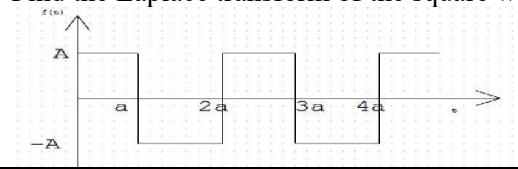
17.	Use Node analysis to find V_x in the circuit.	6	CO1	L3
18.	Find the value of V_0 such that no current flows through 4 ohm.	8	CO1	L3
19.	Find the voltages V_1, V_2 and V_3 using node analysis	7	CO 1	L3
20.	The power supplied by 1A source is 10W. Find V_1 & I.	10	CO1	L3
21.	Find the current I in the network using nodal analysis.	7	CO 1	L3
22.	Solve the circuit and find the loop currents in fig.	5	CO1	L3

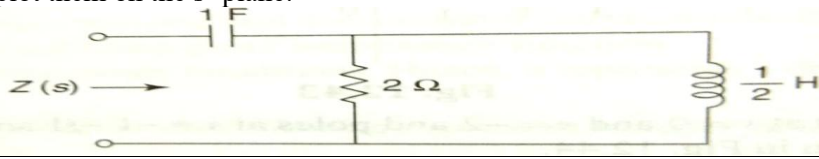
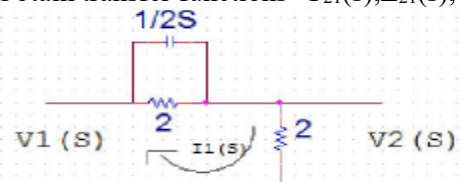
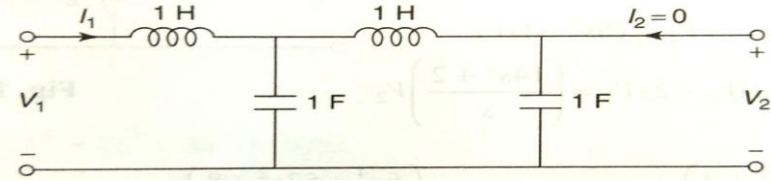
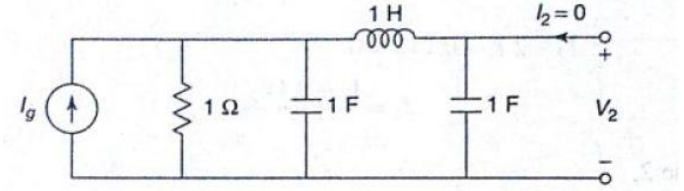
23.	Find the current in the $100\ \Omega$ resistor using Nodal analysis	8	CO1	L3
24.	Determine V_a and V_b, from the given circuit	7*	CO1	L3
25.	Evaluate the voltage across $10\ \Omega$ resistor in the following network.	14	CO 1	L3
Module 2				
Sl. No.		Marks	CO	BL
1	State & Prove Maximum Power Transfer Theorem	3	CO1	L2
2	State and Explain Superposition theorem.	3*	CO1	L1
3	State and explain Reciprocity theorem	3*	CO1	L1

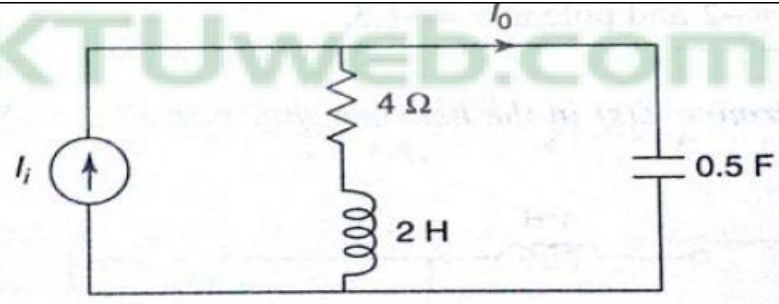
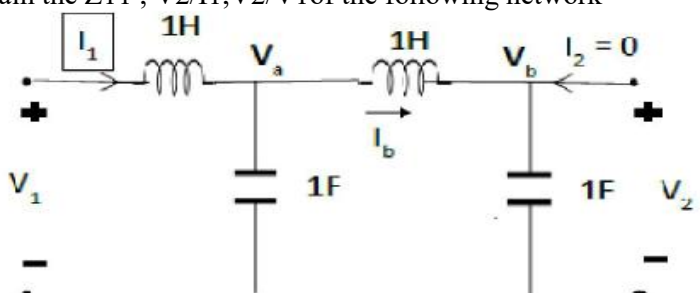
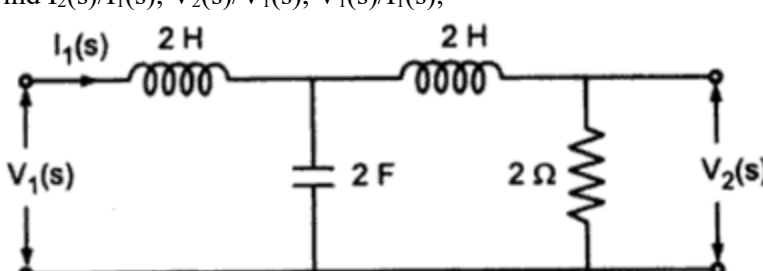
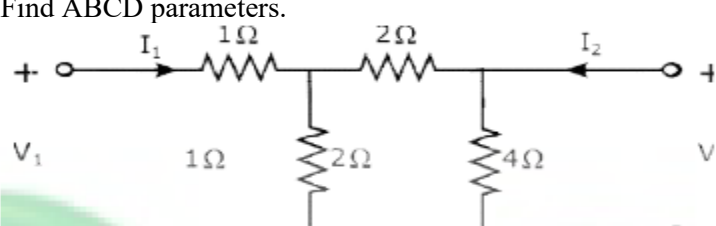
4	Find the value of load resistor, R_L for maximum power transfer and calculate maximum power. 	7	CO 1	L3
5	Find the current through $20\ \Omega$ using Thevenin's Theorem. 	7	CO 1	L3
6	Determine the current in $(2+j3)\ \Omega$ by using superposition theorem. 	7*	CO2	L2
7	Find the value of load and maximum power delivered to load in fig 	7	CO1	L3
8	Find the value of load resistor, R_L for maximum power transfer and calculate maximum power. 	7	CO 1	L3
9	Obtain Thevenin's equivalent circuit across a & b.	7	CO1	L3

				
10	Find the value of R_L so that maximum power is delivered to the load resistance shown in figure. 	8	CO1	L3
11	Determine the maximum power delivered to the load 	8	CO1	L3
12	Using Thevenin's theorem, find the power dissipated across 24Ω resistor . 	7	CO1	L3
13	Find the current through 1Ω resistor using Norton's method. 	8	CO 1	L3
14	Determine current through 4Ω resistor using superposition theorem	7*	CO 1	L3

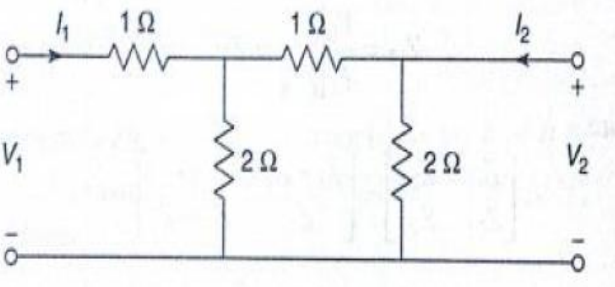
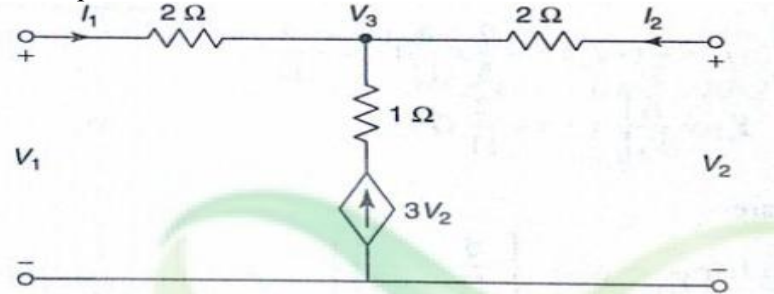
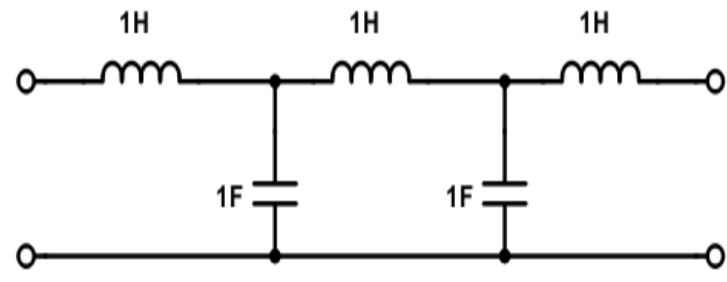
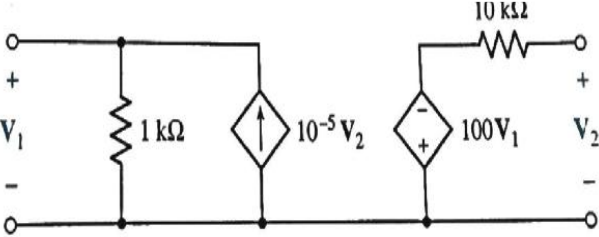
Module3				
Sl. No.	Question	Marks	CO	BL
1	Find the inverse laplace transform of the function $(5S+4)/((S-1)(S^2+2S+5))$	6	CO2	L3
2	Find the inverse Laplace transform of $f=(s^2-15s-11)/((s+1)(s-2)^2)$	6	CO2	L3
3	Find the laplace transform of a) $e^{-3t}(2\cos 5t - 3\sin 5t)$ b) $e^{2t} \cos 2t$	3*	CO2	L2
4	Find the Laplace transform of ramp function and impulse function	3*	CO2	L2
5	State the frequency shifting theorem for Laplace transform	3*	CO2	L1
6	Discuss about the transformation of inductor and Capacitor to S domain	3*	CO2	L2
7	What is time constant? What are the time constants of series RL and RC circuits?	3	CO2	L1
8	State and explain final value theorem	3*	CO2	L2
9	State and explain final value theorem	3*	CO2	L2
10	Obtain the transform representation of an inductor with initial current $i(0-)$ in terms of (i) Impedance (II) Admittance.	3	CO2	L1
11	Find the current $I_L(t)$ for $t > 0$ after the switch opens. The steady state condition achieved when switch is at closed position. 	7	CO2	L3
12	Solve the differential equation using Laplace Transform, given $y(0) = 1$ and $y'(0) = 1$. $y'' - y' - 2y = t$	7	CO2	L3
13	In the circuit shown in figure, switch S is in position 1 for a long time and brought to position 2 at time $t=0$. Determine the circuit current. 	7	CO2	L3
14	The switch is in position 1 for a long time. At $t = 0$, it is moved to position 2. Find $v(t)$ for $t \geq 0$.	7	CO2	L3

				
15	A Series RLC circuits has $R=50\text{ ohm}$, $L= 0.2\text{H}$, and $C = 50\text{ microfarad}$. Constant voltage of 100V is impressed upon the circuit at $t=0$. Find the expression for the transient current assuming initially relaxed conditions.	7	CO2	L3
16	Derive the step response of RC circuit.	6	CO2	L2
17	Derive the impulse response of RL circuit.	5	CO2	L2
18	Obtain the transient current and voltage responses of a RL circuit when subjected to a unit step input.	6	CO2	L2
19	Find the inverse laplace transform of $F(S) = \frac{21S - 33}{(S + 1)(S - 2)^3}$	7	CO2	L3
20	Find Laplace transform of the following: i) $\sin(5t) \cdot \cos(2t)$ ii) $te^{-2t} \cos(t)$	7	CO2	L2
21	In the network shown the switch is moved from a to b (steady state was achieved in position a). Find $V(t)$ 	7	CO2	L3
22	The switch is opened for a long time. The switch is closed for $t \geq 0$. Find expression of capacitor voltage $V_c(t)$, for $t \geq 0$. Then determine capacitor current $i_c(t)$ 	7	CO2	L3
23	Derive the response of a series RLC circuit with step input.	7	CO2	L2
24	Find the Laplace transform of the square wave. 	7	CO2	L3
Module 4				
Sl. No.	Question	Marks	CO	BL

1	What is network function? Define the terms “Driving point impedance” and “driving point admittance” of a one port network.	3	CO3	L1
2	What are the restrictions on pole and zero locations for driving-point functions.	3	CO3	L1
3	Find the poles & zeros of the impedance of the network shown in figure & plot them on the s- plane. 	5	CO3	L3
4	Write any five properties of driving point immittance functions	5	CO3	L1
5	$I(s) = 10s/(s+1)(s+3)$ Plot its pole-zero plot and hence obtain $i(t)$ from the pole-zero plot.	6	CO3	L3
6	Obtain transfer functions $G_{21}(s), Z_{21}(s)$, driving function $Z_{11}(s)$ 	6	CO3	L3
7	Find the network functions $V1/I1$ & $V2/V1$ 	8	CO3	L3
8	Draw the pole zero diagram of system function $(S^3-7s^2+10s)/(s^2+s-6)$	7	CO3	L3
9	Describe Poles and Zeros of network functions .	4	CO3	L2
10	List any five properties of transfer functions.	5	CO3	L1
11	Explain How time domain behaviour obtained from pole zero plot.	5	CO3	L2
12	For the given network function , draw the pole zero diagram and hence obtain time –domain response $V(s)=(5s+4)/((s+2)(s+7))$	6	CO3	L3
13	Obtain the pole –zero plot of the following function $V(s)=\frac{s+4}{(s-2)(s-5)}$	7	CO3	L3
14	Explain the steps to find magnitude & phase response of network function.	5	CO3	L2
15	What is impulse response of a system.	3	CO3	L1
16	Determine $V2/I_g$. Plot the pole zero diagram of $V2/I_g$. 	7	CO3	L3
17	For the network shown plot poles and zeros of function I_o/I_i .	6	CO3	L3

				
18	Obtain the Z_{11}, V_2/I_1, V_2/V_1 of the following network 	6	CO3	L3
19	Plot the magnitude and phase response for the transfer function, V_2/V_1 of an RC two port network (Integrator)	5	CO3	L3
20	Find $I_2(s)/I_1(s)$, $V_2(s)/V_1(s)$, $V_1(s)/I_1(s)$, 	8	CO3	L3
21	Define poles and zeros of a transfer function. For the given transfer function find the poles and zeros and also draw the pole zero plot $I(s) = 20(s+5)/(s^2 + 5s + 6)$	7	CO3	L3
Module 5				
Sl. No.	Question	Marks	CO	BL
1	Explain the Series & Parallel connection of two port networks.	7	CO3	L2
2	What are Y-Parameters and Z-Parameters? Derive the Expression for ZParameters in terms of Y-parameters and vice – versa	8	CO3	L2
3	Derive the expressions for transmission parameters	3	CO3	L2
4	State the conditions for symmetry and reciprocity in Y and h parameters	3	CO3	L1
5	State the conditions for symmetry and reciprocity in ABCD and h parameters.	3	CO3	L1
6	Find ABCD parameters. 	7*	CO3	L3
7	Express Z parameters in terms of transmission & h parameters	7	CO3	L3
8	Find h parametrs for the network given below	7*	CO3	L3

9	Find Y parameters of the network	7*	CO3	L3
10	Find Y parameters of the network	7*	CO3	L3
11	Find the transmission parameters for the network shown below.	7*	CO3	L3
12	Define the terms Characteristic impedance, Image impedance and propagation constant	5	CO3	L1
13	Express Y parameters in terms of h parameters.	5	CO3	L2
14	The Z parameters of a two port network are $Z_{11}=20\Omega$, $Z_{12}=Z_{21}=10\Omega$, $Z_{22}=30\Omega$. Find Y and ABCD parameters.	7	CO3	L3
15	Find h parametrs for the network given below	7*	CO3	L3
16	Find Z Parameters of the network	7	CO3	L3

				
17	Find the relationship between Z and h parameters.	7	CO3	L3
18	Find Y parameters. 	7*	CO3	L3
19	Show that the overall Y parameter, of two 2-port networks when connected in parallel, is the sum of individual Y parameters of the two networks.	7	CO3	L3
20	Find the transmission parameters for the network shown below. 	7	CO3	L3
21	Find h parameter for the network given below 	7	CO3	L3

Prepared By : Mr. Tubin T X

Checked By : Gregorious Jose C

Course Code & Name: MCN201 SUSTAINABLE ENGINEERING**1. Prescribed Syllabus**

Module	Topic	Hours
1	Sustainability: Introduction, concept, evolution of the concept; Social, environmental and economic sustainability concepts; Sustainable development, Nexus between Technology and Sustainable development; Millennium Development Goals (MDGs) and Sustainable Development Goals (SDGs), Clean Development Mechanism (CDM).	4
2	Environmental Pollution: Air Pollution and its effects, Water pollution and its sources, Zero waste concept and 3 R concepts in solid waste management; Greenhouse effect, Global warming, Climate change, Ozone layer depletion, Carbon credits, carbon trading and carbon foot print, legal provisions for environmental protection.	6
3	Environmental management standards: ISO 14001:2015 frame work and benefits, Scope and goal of Life Cycle Analysis (LCA), Circular economy, Bio-mimicking, Environment Impact Assessment (EIA), Industrial ecology and industrial symbiosis.	6
4	Resources and its utilisation: Basic concepts of Conventional and non-conventional energy, General idea about solar energy, Fuel cells, Wind energy, Small hydro plants, bio-fuels, Energy derived from oceans and Geothermal energy.	8
5	Sustainability practices: Basic concept of sustainable habitat, Methods for increasing energy efficiency in buildings, Green Engineering, Sustainable Urbanisation, Sustainable cities, Sustainable transport.	6

2. Text Books (T)

Nil

3. Reference Books (R)

- R1. Allen, D. T. and Shonnard, D. R., Sustainability Engineering: Concepts, Design and Case Studies, Prentice Hall.
- R2. Bradley. A.S; Adebayo,A.O., Maria, P. Engineering applications in sustainable design and development, Cengage learning
- R3. Environment Impact Assessment Guidelines, Notification of Government of India, 2006
- R4. Mackenthun, K.M., Basic Concepts in Environmental Management, Lewis Publication, London, 1998
- R5. ECBC Code 2007, Bureau of Energy Efficiency, New Delhi Bureau of Energy Efficiency Publications-Rating System, TERI Publications - GRIHA Rating System
- R6. Ni bin Chang, Systems Analysis for Sustainable Engineering: Theory and Applications, McGraw-Hill Professional.
- R7. Twidell, J. W. and Weir, A. D., Renewable Energy Resources, English Language Book Society (ELBS).
- R8. Purohit, S. S., Green Technology - An approach for sustainable environment, Agrobios Publication

3. Course Objectives

Objective of this course is to inculcate in students an awareness of environmental issues and the global initiatives towards attaining sustainability. The student should realize the potential of technology in bringing in sustainable practices.

4. Course Pre / Co-requisite

NIL

5. Course Outcomes

CO1. Understand the relevance and concept of sustainability and the global initiatives in this direction

CO2. Explain the different types of environmental pollution problems and their sustainable solutions.

CO3. Discuss the environmental regulations and standards

CO4. Outline the concepts related to conventional and non-conventional energy

CO5. Demonstrate the broad perspective of sustainable practices by utilizing engineering knowledge and principles

6. Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes

PO/ CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1						M	H					M			
CO2						M	H					M			
CO3						M	H					M			
CO4						M	H					M			
CO5						M	H					M			

7. Justification for CO-PO-PSO Correlation

CO	PO	Justification Statement
CO1	PO6	Able to understand the relevance and the concept of social sustainability which is the major part of sustainable development
	PO7	Understand the impact of the professional engineering solutions to ensure environmental sustainability
	PO12	Awareness of the concept of social sustainability can be used and applied in the future course of action.
CO2	PO6	Understand environmental pollution issues and need to address while working as an engineer in a society.
	PO7	The environment will be sustainable if all types of pollutions are restricted within the carrying limit of the nature
	PO12	Sustainable solutions for the environmental issues can be used and applied in the future course of action.

CO3	PO6	Able to learn about various environmental management tools which are used to predict the impacts and also helps to take decisions which are under the law.
	PO7	Environmental management tools help for better implementation of developmental activities in a sustainable way.
	PO12	Knowledge of Environmental management tools can be used and applied in the future course of action.
CO4	PO6	Knowledge on several renewable energy sources helps to decide possible solutions which are safer to society while designing a system.
	PO7	Renewable technologies inspire learner to use and design such systems for the welfare of the environmental sustainability
	PO12	The concepts related to conventional and non-conventional energy will be useful to engage in independent and lifelong learning and gaining knowledge in any area of electrical engineering.
CO5	PO6	Helps to become a socially responsible engineer and aware of their duties to the environment while engineering a product
	PO7	Information of several sustainable Green building materials and concepts motivate students to design sustainable products or buildings.
	PO12	Awareness and knowledge of green buildings and sustainable habitat can be used and applied in the future course of action.

8. Curricular gaps (if any)

Nil

9. Course Enrichment Activities

Sl No	Description	Proposed Activities	Relevance to POs and PSOs
1	Seminar on Sustainable practices by Prof. Neethu Varghese	Seminar	PO6,PO7, PO12

Internal Assessment mark allocation (as per university curriculum)

Attendance - 10 marks

Continuous Assessment Test - 25 marks

Assignment (s)/ Course Project - 15 marks

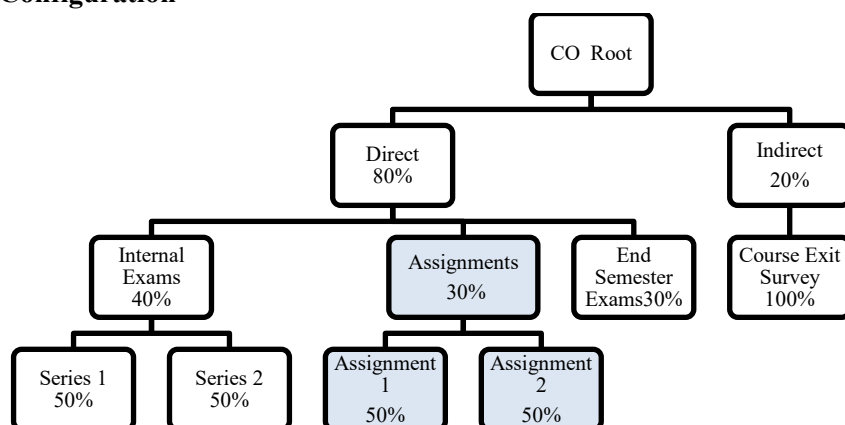
Total - 50 marks

10. Assessment – CO Mapping (Put ‘x’ if mapping is present)

	Tools		Weightage	CO1	CO2	CO3	CO4	CO5
Direct Assessment Tools	Internal Exam(s) 40%	Series 1	20%	x	x	x		
		Series 2	20%			x	X	x
	Assignment (s)	Assignment 1	15%		x	x		

	30%	Assignment 2	15%				X	x
	End Semester Exam		30%	x	x	x	X	x
Indirect Assessment Tool	Course Exit Survey		100%	x	x	x	X	x

11. Assessment Configuration



12. Course Plan

Hour	Topic	Module	Reference(s)	Teaching Pedagogy
1	Introduction, concept, evolution of the concept	1	T1, T2, R1	Lecture
2	Social, environmental and economic sustainability concepts	1	T1, T2, R1	Lecture
3	Sustainable development, Nexus between Technology and Sustainable development	1	T1, T2, R1, R2	Lecture
4	Millennium Development Goals (MDGs) and Sustainable Development Goals (SDGs), Clean Development Mechanism (CDM)	1	T1, T2, R1	Lecture
5	Course Enrichment activity	1		Case Study
6	Air Pollution and its effects	2	T1, T2, R3	Discussion
7	Water pollution and its sources	2	T1, T2, R3	Discussion
8	Zero waste concept and 3 R concepts in solid waste management	2	T1, T2, R3	Lecture

9	Greenhouse effect, Global warming, Climate change, Ozone layer depletion	2	T1, T2, R3	Lecture
10	Carbon credits, carbon trading and carbon foot print.	2	T1, T2, R3	Lecture
11	Legal provisions for environmental protection.	2	T1, T2, R3	Lecture
12	Environmental management standards	3	T1, T2, R3, R4	Lecture
13	ISO 14001:2015 frame work and benefits	3	T1, T2, R4	Lecture
14	Scope and Goal of Life Cycle Analysis (LCA)	3	T1, T2, R3	Lecture
15	Circular economy, Bio-mimicking	3	T1, T2, R4	Lecture
16	Environment Impact Assessment (EIA)	3	T1, T2, R4	Lecture
17	Industrial Ecology, Industrial Symbiosis	3	T1, T2, R4	Lecture
18	Basic concepts of Conventional and non-conventional energy	4	T1, T2, R7	Discussion
19	General idea about solar energy, Fuel cells	4	T1, T2, R7	Lecture
20	Wind energy, Small hydro plants, bio-fuels	4	T1, T2, R6, R7	Lecture
21	Energy derived from oceans and Geothermal energy	4	T1, T2, R7	Lecture
22	Basic concept of sustainable habitat	4	T1, T2, R8	Lecture
23	Methods for increasing energy efficiency of buildings	4	T1, T2, R8	Discussion
24	Green Engineering	4	T1, T2, R8	Lecture
25	Sustainable Urbanisation, Sustainable cities, Sustainable transport	4	T1, T2, R8	Lecture
26	Sustainability practices: Basic concept of sustainable habitat	5	T1,T2	Lecture
27	Methods for increasing energy efficiency in buildings	5	T1,T2	Lecture
28	Green Engineering	5	T1,T2	Lecture
29	Sustainable Urbanisation	5	T1,T2	Lecture
30	Sustainable cities	5	T1,T2	Lecture
31	Sustainable transport.	5	T1,T2	Lecture

13.Question Bank

Module 1				
Sl. No.	Question	Mark	CO	BL
1.	Define sustainable development.	3	CO1	L1

2.	List four strategies for achieving Sustainable Development.	3	CO1	L1
3.	What is the relevance of Kyoto Protocol?	3	CO1	L1
4.	Write a short note on Millennium Development Goals.	3	CO1	L1
5.	Explain the Sustainable Development Goals.	3	CO1	L1
6.	Write a short note on Millennium Development Goals.	3	CO1	L1
7.	Explain the Sustainable Development Goals.	3	CO1	L2
8.	Explain the 3 pillars model of sustainability with schematic diagram.	3	CO1	L2
9.	Comment on the challenges for sustainable development in our country and suggest a way to overcome the same.	3	CO1	L2
10.	CDM is a good tool that can be used by developing countries for boosting up their own development. How?	5	CO1	L2
11.	Discuss the evolution of the concept of sustainability. Comment on its relevance in the modern world.	3	CO1	L2
12.	Explain Clean Development Mechanism	14	CO1	L2
13.	Give an example of any activity where sustainability and technology go hand in hand.	3	CO1	L3
14.	Information technology-enabled paperless office is a big step to achieve sustainable development. Come out with three supporting and three opposing points for this statement.	5	CO1	L3
15.	Illustrate the nexus between agricultural technology and sustainability.	6	CO1	L2
16.	Justify, giving one reason, why sustainability is an essential component in any developmental programs and projects.	6	CO1	L3
17.	Comment on any one challenge experienced in the implementation of Sustainable development principles.	5	CO1	L1
18.	Technology may affect sustainability in positive and negative ways.	5	CO1	L3
Module 2				
Sl. No.	Question	Mar k	CO	BL
1.	Explain water use cycle.	3	CO2	L1

2.	What are the various classes of water pollutants and mention some of their effects.	3	CO2	L1
3.	What are the conventional waste water treatment processes? Explain why they are not considered sustainable.	3	CO2	L1
4.	List out and explain the various sustainable waste water treatment methods.	3	CO2	L1
5.	Mention major control measures to reduce air pollution.	3	CO2	L1
6.	What is water pollution? Mention some sources.	3	CO2	L1
7.	Mention the effects of air pollution on humans, plants, animals and environment and property?	3	CO2	L1
8.	Among the major constituents of municipal solid waste, list any three of the most hazardous waste and highlight their impact on the health/human environment.	3	CO2	L1
9.	Illustrate a typical sustainable waste water treatment system with block diagram	3	CO2	L1
10.	List out some methods of solid waste management.	3	CO2	L1
11.	Explain the concept of ozone layer depletion.	5	CO2	L2
12.	Write a note on carbon footprint.	3	CO2	L1
13.	Explain the measures to check climate change.	5	CO2	L2
14.	Explain the causes of climate change.	6	CO2	L2
15.	Explain the effects of climate change.	5	CO2	L2
16.	What are the measures to control global warming?	3	CO2	L1
17.	What are the principles of zero waste concept and explain technologies towards zero waste concept.	5	CO2	L1
18.	Describe carbon credit. Explain in not more than five sentences.	4	CO2	L2
19.	"Clean energy is necessary for sustainable development". Justify this with three arguments.	5	CO2	L2
20.	State whether the statement "Zero waste concept should be a core strategy in sustainable development" is true or false. How does the 3R concept lead to zero waste concept?	4	CO2	L2

21.	Give an account of climate change and its effect on environment	3	CO2	L2
22.	Give any 3 examples of air pollutants and their effect on human health.	3	CO2	L2
23.	Illustrate a typical sustainable waste water treatment system with block diagram.	3	CO2	L2
24.	Suggest any two methods of sustainable waste water treatment.	3	CO2	L2
25.	Explain the phenomenon of ozone layer depletion	3	CO2	L2
26.	Suggest any three sustainable methods each for the solid waste and waste water management system.	3	CO2	L2
27.	Define air pollution and list out major sources of air pollution.	3	CO2	L2
28.	Explain the major types of air pollutants.	3	CO2	L2
29.	What are the factors to be considered to determine the suitability of a waste water treatment method to be sustainable?	3	CO2	L2
30.	Explain any two sustainable waste water treatment methods.	3	CO2	L2
31.	What is waste? Mention some sources of solid waste.	3	CO2	L2
32.	Explain the concepts of carbon trading and carbon credits.	3	CO2	L2
33.	How does an emissions trading scheme work?	3	CO2	L2
34.	Explain the 3R concept of waste management.	3	CO2	L2
35.	What are the impacts of solid waste on land environment?	3	CO2	L2
36.	What are the impacts of solid waste on water environment?	3	CO2	L2
37.	What are the impacts of solid waste on air environment?	3	CO2	L2
38.	What are the impacts of solid waste on health?	3	CO2	L2
39.	Among the major constituents of municipal solid waste, list any three of the most hazardous waste and highlight their impact on the health/human environment.	6	CO2	L2
40.	Differentiate between greenhouse effect and global warming.	5	CO2	L2
41.	Explain the effects of global warming.	5	CO2	L2

42.	What do you mean by e-waste? What are the possible source of e- waste? How can we dispose e-waste without causing harm to environment?	3	CO2	L2
43.	Explain the global warming and mention its causes and effects.	5	CO2	L2
44.	Give an account of solid waste management in cities.	5	CO2	L2
45.	What are the possible effects of ozone layer depletion?	2	CO2	L2
46.	Mention some actions that can be adopted to protect ozone layer.	2	CO2	L2
47.	List out major water pollutants and their effects.	5	CO2	L2
48.	Explain the concept and causes of global warming.	5	CO2	L2
49.	Distinguish between green house effect, global warming and climate change.	5	CO2	L2
50.	Explain the common sources of water pollution and its harmful effects.	4	CO2	L2
51.	Explain the significance of carbon footprint. Suggest two methods to reduce the carbon footprint in your house.	5	CO2	L3
52.	A comprehensive campaign to address air pollution need to be launched through school children, what programme would you envisage for this. What is the outcome anticipated?	3	CO2	L3
53.	There is a sudden decision to remove all vehicles from the road that fails to meet specified norms of emission level within a specified time period. As part of citizen forum you are requested to give views on the enforced regulation. State your views on this.	3	CO2	L3
54.	A massive campaign on environmental degradation is to be initiated. Bring out a slogan and the key message that need to be addressed.	3	CO2	L3
55.	Suppose you are a Carbon Credit Auditor appointed to assess the greenhouse gas emission reduction strategies. Identify a component of assessment and brief the methodology that could be adopted in connection with this.	5	CO2	L3
56.	Write a short note on any local environmental issues.	5	CO2	L3
57.	What are the activities that can be organized in your college/locality to observe 5th June as the World Environmental Day with theme “Climate Change”?	5	CO2	L3

58.	Densely populated areas are suffering major issues in the field of solid waste and waste water management. Relate this statement with the current situation in our state.	14	CO2	L3
MODULE 3				
1.	List out the procedures of EIA followed in India	3	CO3	L1
2.	What is Environment Management System (EMS). List out functions of EMS.	3	CO3	L1
3.	Write a short note on EMS. Briefly indicate the steps involved in introducing EMS in an industry.	3	CO3	L1
4.	What is bio mimicry? Give three examples in transportation sector clearly stating the species and invention.	3	CO3	L1
5.	How will you relate industrial ecology principles to sustainable engineering?	3	CO3	L1
6.	Discuss the benefits of doing an EIA study. List down any six impacts considered in EIA.	3	CO3	L1
7.	What do you mean by Industrial Symbiosis? Explain its concept and benefits.	9	CO3	L1
8.	What is Bio-mimicking?	3	CO3	L2
9.	What is Life Cycle Analysis (LCA)? Justify the need of LCA.	5	CO3	L2
10.	How does industrial ecology help achieving sustainable development? How does material selection influence industrial processes in achieving sustainability?	5	CO3	L2
11.	List out the advantages and disadvantages of industrial symbiosis.	5	CO3	L1
12.	Write a short note on EMS. Briefly indicate the steps involved in introducing EMS in an industry.	5	CO3	L2
13.	Explain the role played by ISO 14000 towards ensuring sustainability in industrial operations.	5	CO3	L2
14.	What are the benefits gained by an organization in implementing EMS?	5	CO3	L2
15.	List out various procedures of EIA in India.	5	CO3	L2
16.	What steps in EIA involve participation from the public? What are the steps involved after the final public consultation?	5	CO3	L2
17.	List any 5 products developed bases on bio mimics.	5	CO3	L2
18.	What do you mean by Bio-mimicking? Explain any two examples of bio mimicking.	5	CO3	L2
19.	Define circular economy and write its significance in sustainable engineering.	5	CO3	L2

20.	What do you mean by Industrial ecology? Write down the principles and benefits of Industrial ecology.	6	CO3	L2
21.	Can we implement industrial ecology in India? Substantiate your answer. Differentiate industrial ecology and industrial symbiosis with examples. List four set of industries where we can implement industrial symbiosis	9	CO3	L2
22.	Describe the major elements of circular economy.	9	CO3	L2
23.	List out some common practices followed in the construction industry, in Kerala promoting energy efficiency.	3	CO3	L1
24.	What is the concept of industrial ecology? Give an example of a recent product.	3	CO3	L1
25.	‘Are social and technological changes needed for making a sustainable society’; Justify your answer	3	CO3	L3
26.	What is LCA? Illustrate how LCA can be effectively used in the environmental management of industrial production systems.	5	CO3	L2
27.	Can we use life cycle analysis (LCA) as a tool for profit making? How?	5	CO3	L2
28.	With a suitable example, explain the principles of industrial symbiosis.	5	CO3	L2
29.	Explain Industrial Symbiosis. Give an example.	5	CO3	L2
30.	Can the concept of industrial symbiosis be adopted in Kerala? Explain.	5	CO3	L2
31.	Apply idea of industrial symbiosis to the coconut oil industry.	5	CO3	L2
32.	Explain LCA with an example.	10	CO3	L3
33.	Discuss LCA analysis of polythene carry bags.	10	CO3	L3
34.	Conduct a sample life cycle analysis of any product given below- Plastic pet bottles, lead acid batteries or hollow bricks.	10	CO3	L3
35.	A firm named XYZ Pvt Ltd producing mobile phones wants to get itself ISO14001:2015 certified. What are the steps it should adopt in its organisational level to the product level for the certification?	14	CO3	L3
Module-4				
1.	What are limitations in harnessing the tidal energy?	3	CO4	L1
2.	List out major renewable energy sources available.	3	CO4	L1
3.	List out the advantages of using renewable energy sources.	3	CO4	L1
4.	List the different types of renewable energy sources	3	CO4	L1

5.	List out four non conventional sources of energy and explain any two in detail.	6	CO4	L2
6.	List 5 ways in which solar energy could be utilized.	3	CO4	L1
7.	What are the steps involved in bio fuel production.	3	CO4	L1
8.	Suggest two renewable energy sources that can be utilized in automobiles.	3	CO4	L1
9.	List out any 5 methods to improve the energy efficiency in buildings.	3	CO4	L1
10.	Discuss the advantages and disadvantages of nuclear energy.	3	CO4	L1
11.	Explain the measure that can be adopted to achieve ZEB through renewable energy and other technologies.	3	CO5	L2
12.	What are social, economical and environmental advantages gained through utilization of solar energy.	3	CO4	L2
13.	"Large hydro-electric power plant is a sustainable power generation model"—state whether this statement is true or false. Justify your answer in two sentences.	3	CO4	L2
14.	Suggest two renewable energy sources for our state and validate your suggestion.	5	CO4	L2
15.	Explain a solar water heating system with the help of a diagram.	5	CO4	L2
16.	List the different renewable energy sources. What are the challenges that we face to develop renewable sources in India?	5	CO4	L2
17.	List out the advantages and disadvantages of non-conventional sources of energy.	5	CO4	L2
18.	Suggest few measures by which usage of energy can be reduced in residential buildings	5	CO4	L2
19.	Suggest few measures that can be adopted for energy efficiency in green buildings.	5	CO4	L2
20.	Differentiate between conventional and non conventional energy sources. Which will you support? Why?	5	CO4	L2
21.	Write short notes on fuel cells.	5	CO4	L2
22.	Explain a typical wind energy system with a block diagram.	5	CO4	L2
23.	Explain different method using which we can utilize solar energy.	5	CO4	L2
24.	What is bio energy? Explain any 4 methods for converting biomass to energy.	5	CO4	L2
25.	What is bio mass energy? How is it extracted?	3	CO4	L2
26.	Enumerate any 2 impact of bio mass energy on the environment.	3	CO4	L1
27.	What are the methods for increasing energy efficiency of buildings?	5	CO4	L2

28.	List various ways to conserve energy.	5	CO4	L2
29.	Explain the working of a photo voltaic cell with a neat diagram.	5	CO4	L2
30.	What is the possibility of using solar energy in a state like Kerala? List out the various supporting and opposing factors	5	CO4	L2
31.	Explain in detail, the working of a solar power plant Associated with an airport in Kerala.	5	CO4	L2
32.	What are the methods to convert biomass to energy without heating it.	5	CO4	L2
33.	List 2 methods of extracting energy from the oceans. Explain the principle of Geothermal energy generation.	5	CO4	L2
34.	How can oceans be utilized for tapping energy. Discuss.	5	CO4	L2
35.	How can energy be derived from oceans?	5	CO4	L2
36.	Explain any one method to geo thermal energy.	5	CO4	L2
37.	Explain in detail, the working of any one type of fuel cell.	5	CO4	L2
38.	With necessary schematics explain the working of : A Geothermal Power Plant. A Tidal Power Plant.	7	CO4	L2
39.	In future, the sources of fossil fuels become rare and extinct. Suggest some methods to overcome this crisis.	5	CO4	L3
40.	The production of renewable as well as non -renewable energy has carbon foot print. Then why we are promoting renewable energy?	3	CO4	L2
41.	Compare the feasibility of different sources of renewable energy, giving suggestions to KSEB.	3	CO4	L3
42.	How can you make use of renewable energy in your home.	3	CO4	L2
43.	Is there a best energy source that will have the minimum environmental impact? Justify your answer.	3	CO4	L3
44.	Discuss the contribution of coal power to Kerala energy production.	3	CO4	L2
45.	Being an agriculture country, what is the scope of using bio-fuels for meeting the energy needs of India?	3	CO4	L3
46.	Compare and contrast conventional and nonconventional energy with reference to sustainability.	5	CO4	L2
47.	We can create a more Sustainable, cleaner and safer world by making wiser energy choices.” Evaluate the importance of the quote and discuss on the various Non-Conventional Energy Sources.	5	CO4	L3
48.	What are the energy saving opportunities in a house?	5	CO4	L2
49.	If industrial energy use is the dominant consumer of energy. Give any three suggestions for reducing the energy consumption in industries.	5	CO4	L3
50.	Critically analyse the role of renewable energy in the Kerala Context. Compare the feasibility of various sources of renewable energy that can be tapped with special reference to India.	5	CO4	L3

51.	Suggest suitable sustainable systems to generate hot water and electricity for a hostel in Kerala.	5	CO4	L3
52.	There is a remote village on top of a village. Explain any two methods that can be adopted there to generate electricity.	5	CO4	L3
53.	What is the scope of using geothermal energy as a non-renewable energy source? Give suggestions to reduce the power consumption at the place where you are studying, enumerating the unwanted/ wastage of power.	5	CO4	L3
Module -5				
1.	How can sustainable urbanization and poverty reduction be related?	3	CO5	L1
2.	List any three principles of Green Engineering.	3	CO5	L1
3.	List any sustainable materials buildings.	3	CO5	L1
4.	Explain the concept of sustainable Transport.	3	CO5	L1
5.	How can sustainable urbanization and poverty reduction be related.	3	CO5	L1
6.	Which are the three primary green building rating systems in India?	3	CO5	L1
7.	What do you mean by green building design?	3	CO5	L1
8.	What is GRIHA rating?	3	CO5	L1
9.	What are the impacts of non-sustainable transportation system?	3	CO5	L1
10	How the road transport can be made sustainable?	3	CO5	L1
11	How can you promote energy efficiency in the domestic sector?	3	CO5	L1
12	What are the impacts of non-sustainable transportation system?	4	CO5	L1
13	Enumerate the basic features of a sustainable habitat.	4	CO5	L1
14	List top four major challenges faced by cities	5	CO5	L1
15	What are the basic features of a sustainable city?	5	CO5	L1
16	List 5 practices for making the industrial process move towards the goal of sustainability	5	CO5	L1
17	For any industry, material selection is very important. Why?	3	CO5	L2
18	Discuss any three benefits of green engineering.	3	CO5	L2
19	How can sustainable development be communicated successfully?	3	CO5	L2
20	List any two materials that can be green substitutes for conventional buildings materials and explain its features.	3	CO5	L2
21	What are your proposals for a sustainable transport system by integrating road and water transport?	3	CO5	L2
22	What are the causes of rural-urban migration? How it will affect the urban area?	5	CO5	L2
23	Suggest few measures by which usage of energy can be reduced in residential buildings.	5	CO5	L2
24	Explain hybrid power systems with examples.	5	CO5	L2
25	Write a short note on how appropriate material selection can contribute in achieving sustainability in building construction.	5	CO5	L2
26	What are the aspects to take care for a green building? Energy efficiency has been given more weightage in the rating systems than all other aspects. Justify this.	5	CO5	L2

27	What are the impacts of non sustainable transport system. Suggest any method to reduce the impact.	5	CO5	L2
28	What are the benefits achieved when recycled materials used for construction ?	5	CO5	L2
29	Write a short note on green engineering.	5	CO5	L2
30	Take an example of green building. How it differs from a conventional building. Compare in any six aspects.	5	CO5	L2
31	Check whether the "Green Building concept" is related to the "Concept of sustainable habitat". Explain any three key points to justify your answer.	5	CO5	L2
32	Differentiate between green building and conventional building. Compare any seven aspects.	14	CO5	L2
33	Discuss on sustainable transport and sustainable cities.	14	CO5	L2
34	a) Explain different green building rating programs. b) Explain the concept of sustainable cities with suitable examples.	14	CO5	L2
35	Discuss the elements related to sustainable urbanisation.	14	CO5	L2
36	Explain different strategies for achieving sustainable transportation.	14	CO5	L2
37	Discuss methods by which you can increase energy efficiency in buildings.	14	CO5	L2
38	Studies show that the total urban population is expected to rise to 5 billion by the year 2030. What do you think is the reason behind this? How does this affect the sustainability?	3	CO5	L2
39	Explain urbanization. Write two push factors and two pull factors for people moving from rural to urban areas.	3	CO5	L2
40	How does material selection influence industrial processes in achieving sustainability	3	CO5	L2
41	List any two major characteristics of a sustainable city that address the environmental well being of the inhabitants.	3	CO5	L2
42	Suggest two water conserving methods that can be adopted in green buildings	3	CO5	L2
43	Differentiate between green building and conventional building. Compare any seven aspects.	14	CO5	L2
44	Discuss on sustainable transport and sustainable cities.	14	CO5	L2
45	a) Explain different green building rating programs. b) Explain the concept of sustainable cities with suitable examples.	14	CO5	L2
46	Discuss the elements related to sustainable urbanisation.	14	CO5	L2
47	Explain different strategies for achieving sustainable transportation.	14	CO5	L2
48	Discuss methods by which you can increase energy efficiency in buildings.	14	CO5	L2
49	What are the energy saving opportunities in a house?	3	CO5	L3
50	Your neighbour plans to construct a new home. Suggest some green materials.	3	CO5	L3

51	Introduction of metro service in Kochi is a major achievement for the transportation system of the city. Do you think this can be related to sustainable engineering? If so, explain.	3	CO5	L3
52	Electric vehicle (EV) being run on electricity is claimed as emission-free. Still, the fact that significant share of Electrical Energy produced across the globe is of thermal origin put question marks on the emission-free claim. Justify this statement.	4	CO5	L3
53	As an engineer suggest any 5 points to reduce pollution by an industry in your locality.	5	CO5	L3
54	Does green building more expensive than traditional building? Why?	5	CO5	L3
55	Two industries – Industry A and Industry B – emit same amount of CO ₂ . Industry A uses a filter to purify the smoke emitting from the chimney. But Industry B plant more trees near the industry. Which is more sustainable? Why?	5	CO5	L3
56	How LEED Green Building Rating System can function as a benchmark for design, construction and operation of high performance green buildings.	5	CO5	L3
57	A new commercial building is constructing in your city. Suggest some methods to the builder for getting a four star GRIHA rated building.	5	CO5	L3
58	Give your views on the areas of improvement required for an EV to be called as a sustainable transportation option.	14	CO5	L3
59	a) Elaborate the elements contributing to Sustainable Habitat. b) Explain the following terms- • Sustainable Urbanization • Sustainable Cities c) Sustainable Transport	14	CO5	L3
60.	Elaborate the principles of Green Building concept.	14	CO5	L3

Prepared By : Pearl Antonette Mendez

Course Code & Name: EST200 DESIGN & ENGINEERING**1. Prescribed Syllabus**

Module	Topic	Hours
1	Design Process - Introduction to Design and Engineering Design, defining a design process - Detailing Customer Requirements, Setting Design Objectives, Identifying Constraints, Establishing Functions, Generating Design Alternatives and Choosing a Design.	5
2	Design Thinking Approach - Introduction to Design Thinking, Iterative Design Thinking Process Stages: Empathize, Define, Ideate, Prototype and Test. Design Thinking as Divergent- Convergent Questioning. Design Thinking in a Team Environment.	5
3	Design Communication (Languages of Engineering Design) - Communicating Designs Graphically, Communicating Designs Orally and in Writing. Mathematical Modeling in Design, Prototyping and Proofing the Design.	5
4	Design Engineering Concepts - Project-based Learning and Problem-based Learning in Design. Modular Design and Life Cycle Design Approaches. Application of Biomimicry, Aesthetics and Ergonomics in Design. Value Engineering, Concurrent Engineering, and Reverse Engineering in Design.	5
5	Expediency, Economics and Environment in Design Engineering - Design for Production, Use, and Sustainability. Engineering Economics in Design. Design Rights. Ethics in Design.	5

2. Text Books (T)

- T1. YousefHaik, Sangarappillai Sivaloganathan, Tamer M. Shahin, Engineering Design Process, Cengage Learning 2003, Third Edition, ISBN-10: 9781305253285,
T2. Voland, G., Engineering by Design, Pearson India 2014, Second Edition, ISBN 9332535051

3. Reference Books (R)

- R1. Philip Kosky, Robert Balmer, William Keat, George Wise, Exploring Engineering, Fourth Edition: An Introduction to Engineering and Design, Academic Press 2015, 4th Edition.
R2. Clive L. Dym, Engineering Design: A Project-Based Introduction, John Wiley & Sons, New York 2009, Fourth Edition, ISBN: 978-1-118-32458-5
R3. Nigel Cross, Design Thinking: Understanding How Designers Think and Work, Berg Publishers 2011, First Edition, ISBN: 978-1847886361
R4. Pahl, G., Beitz, W., Feldhusen, J., Grote, K.-H., Engineering Design: A Systematic Approach, Springer 2007, Third Edition, ISBN 978-1-84628-319-2

4. Course Objectives

The purpose of this course is to

- introduce the undergraduate engineering students the fundamental principles of design engineering,
- make them understand the steps involved in the design process and
- familiarize them with the basic tools used and approaches in design.

5. Course Pre / Co-requisite

- Nil

6. Course Outcomes

At the end of the course, student will be able to

CO1. Explain the different concepts and principles involved in design engineering.

CO2. Apply design thinking while learning and practicing engineering.

CO3. Develop innovative, reliable, sustainable and economically viable designs incorporating knowledge in engineering.

7. Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes

PO/ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	M	L					L			L					
CO2		M				L		L				M			
CO3			M			L	L		M	M		L			

8. Justification for CO-PO-PSO Correlation

CO	PO/PSO	Justification Statement
CO1	PO1	Knowledge of the different concepts and principles involved in design engineering will help to solve complex engineering problems.
	PO2	Understanding the different concepts and principles involved in design engineering will help to identify engineering problems and develop appropriate solution.
	PO7	Knowledge of the different concepts and principles involved in design engineering will help to develop sustainable engineering solutions.
	PO10	Understanding the different concepts and principles involved in design will help to communicate effectively on complex engineering activities with the engineering community.
CO2	PO2	Understanding the various aspects of design thinking will help to identify engineering problems and develop appropriate solution.
	PO6	The various aspects of design thinking will help to assess societal, health, safety, legal, and cultural issues relevant to the professional engineering practice.
	PO8	The various aspects of design thinking will help to apply moral & ethical principles in professional engineering practice.
	PO1 2	Fundamental aspects of design thinking will help to engage in independent and life-long learning in the broadest context of technological change.

CO3	PO3	The basic idea of developing innovative, reliable, sustainable and economically viable designs will help to develop the most suitable design solution giving appropriate consideration for public health, safety, and environment.
	PO6	Knowledge of developing innovative, reliable, sustainable and economically viable designs will help to assess societal, health, safety, legal, and cultural issues relevant to the professional engineering practice.
	PO7	Knowledge of developing innovative, reliable, sustainable and economically viable designs will help to develop sustainable engineering solutions.
	PO9	Basic understanding of developing innovative, reliable, sustainable and economically viable designs will help to function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

9. Curricular gaps (if any)

Nil

10. Course Enrichment Activities*

Sl No	Description	Proposed Activities	Relevance to POs and PSOs
1	Develop innovative, reliable, sustainable and economically viable designs for a product	Poster competition-Design a product	PO1,PO2,PO3,PO4,PO7, PO9

11. Internal Assessment mark allocation (as per university curriculum)

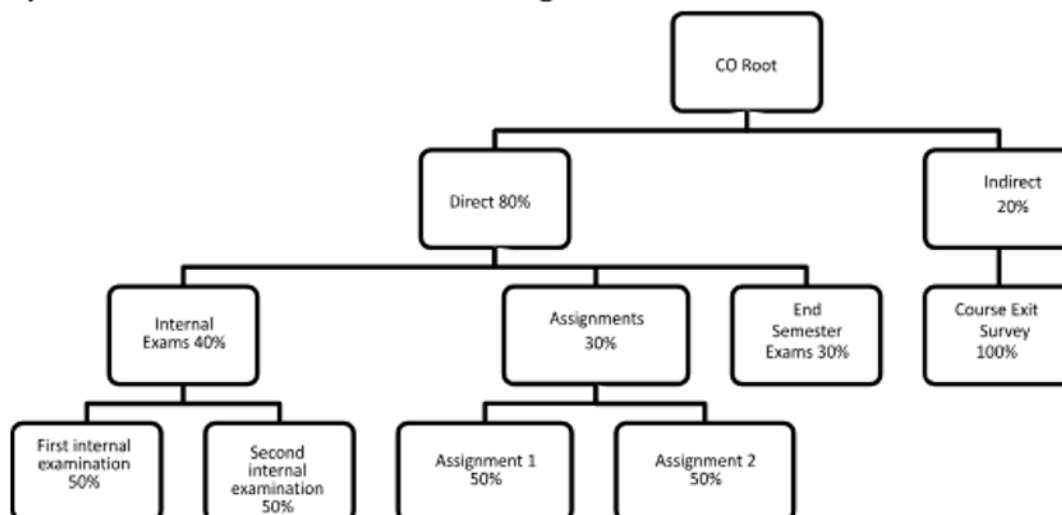
(Provide details as mentioned in syllabus)

Continuous Assessment Test marks	- 25 marks
Assignment (s)/ Course Project	- 15 marks
Attendance marks	- 10 marks
<u>Total marks</u>	<u>- 50 marks</u>

12. Assessment – CO Mapping (Put 'x' if mapping is present)

	Tools		Weightage[#]	CO1	CO2	CO3
Direct Assessment Tools**	Internal Exam(s) 40%	First internal examination	20%	x	x	
		Second internal examination	20%		x	x
	Assignment (s) 30%	Assignment 1	15%	x		
		Assignment 2	15%		x	x
	End Semester Exam		30%	x	x	x
Indirect Assessment Tool	Course Exit Survey		100%	x	x	x

13. Assessment Configuration



14. Course Plan

Hour	Topic	Module	Reference(s)	Teaching Pedagogy
1	Introduction to Design and Engineering Design.	1	T1,T2	PPT
2	Defining a Design Process-: Detailing Customer Requirements	1	T1,T2	PPT
3	Defining a Design Process-: Setting Design Objectives, Identifying Constraints, Establishing Functions.	1	T1,T2	PPT
4	Defining a Design Process-: Generating Design Alternatives and Choosing a Design	1	T1,T2	PPT
5	Case Studies:- Stages of Design Process.	1	T1,T2	Tutorial
6	Introduction to Design Thinking	2	T1,T2	PPT
7	Iterative Design Thinking Process Stages: Empathize, Define, Ideate, Prototype and Test.	2	T1,T2	PPT
8	Design Thinking as Divergent-Convergent Questioning.	2	T1,T2	PPT
9	Design Thinking in a Team Environment.	2	T1,T2	PPT
10	Case Studies: Design Thinking Approach.	2	T1,T2	Tutorial
11	Communicating Designs Graphically.	3	T1,T2	PPT
12	Communicating Designs Orally and in Writing	3	T1,T2	PPT
13	Mathematical Modelling in Design	3	T1,T2	PPT
14	Prototyping and Proofing the Design	3	T1,T2	PPT
15	Case Studies: Communicating Designs Graphically.	3	T1,T2	Tutorial
16	Project-based Learning and Problem-based Learning in Design.	4	T1,T2	PPT
17	Modular Design and Life Cycle Design Approaches.	4	T1,T2	PPT

18	Application of Bio-mimicry, Aesthetics and Ergonomics in Design	4	T1,T2	PPT
19	Value Engineering, Concurrent Engineering, and Reverse Engineering in Design	4	T1,T2	PPT
20	Case Studies: Bio-mimicry based Designs.	4	T1,T2	Tutorial
21	Design for Production, Use, and Sustainability	5	T1,T2	PPT
22	Engineering Economics in Design.	5	T1,T2	PPT
23	Design Rights.	5	T1,T2	PPT
24	Ethics in Design.	5	T1,T2	PPT
25	Case Studies: Design for Production, Use, and Sustainability	5	T1,T2	Tutorial

15. Question Bank

Module 1				
Sl. No.	Question	Marks	CO	BL
1	Explain briefly about design constraints.	6	CO1	L2
2	Explain briefly about design forms.	6	CO1	L2
3	List the characteristics and qualities of a good designer.	6	CO1	L1
4	Discuss the various steps involved in the basic design process.	6	CO1	L2
5	What is Engineering design?	6	CO1	L1
6	State/Demonstrate the role of divergent-convergent questioning in design thinking.	6	CO2	L1
7	How is Engineering design different from other forms of design?	6	CO2	L2
8	Explain design process? Illustrate each step with example and diagrams to support.	6	CO1	L2
9	How do a designer set objectives, constraints and identify constraints?	6	CO2	L2
10	Elaborate on design functions. What is the relation between Science, Engineering and Technology?	10	CO2	L2
11	State the design objectives, design constraints and design function of _____. (<i>Any product like hammer, software, ladder, helmet etc.</i>)	10	CO2	L1
12	Explain briefly about design means and design objectives.	10	CO1	L2

13	“Form follows functions” give your comment on the statement from a designer’s perspective. Give examples for the same. Also give two exceptions.	10	CO2	L3
14	Explain the role of client, user and designer in context of design process of any product.	10/15	CO1	L2
15	Show the designing of a _____(<i>any product like TV stand, Remote, cloth hanger, water bottle, software, wrist watch, bookshelf, factory layout etc...</i>) going through the various stages of the design process. (<i>Use hand sketches to illustrate the processes.</i>)	10/15	CO3	L3
Module 2				
Sl. No.	Question	Marks	CO	BL
1	Illustrate with example, different stages iterative design thinking process.	6	CO1	L2
2	What are the aims of design thinking approach?	6	CO1	L1
3	List the qualities required for a design engineer for design thinking approach in a group. Also brief on brainstorming and brain writing techniques.	6	CO1	L1
4	Explain the following in context of design thinking:- (consider each stage as separate question of 6 marks each) (a)Empathize (b)Define (c)Ideate (d)Prototype (e)Test	6	CO1	L1
5	State the role of divergent-convergent questioning in design thinking.	3	CO1	L1
6	Explain briefly the design thinking in team environment.	3	CO2	L1
7	Illustrate the design thinking approach for designing _____(<i>any product like bag, walking stick, skipping rope, chair etc...</i>) for _____(<i>specific clients like students, old people, sports person, teachers, hospitals etc...</i>) within a limited budget. Describe each stage of the process and the iterative procedure involved. Use hand sketches to support your arguments.	14	CO2	L2
8	Construct a number of possible designs and then refine them to narrow down to the best design for _____(<i>any product like bag, walking stick, skipping rope, chair etc...</i>) for _____(<i>specific clients like students, old people, sports person, teachers, hospitals etc...</i>). Show how the divergent-convergent thinking helps in the process. Provide your rationale for each step by using hand sketches only	14	CO3	L3
9	Distinguish between Emphathise and Define stage in design thinking	3	CO2	L2

10	Distinguish between Ideate and test stage in design thinking	3	CO2	L2
Module 3				
Sl. No.	Question	Marks	CO	BL
1	List various types of engineering Sketches	3	CO1	L1
2	List and explain the several forms of engineering drawing.	3	CO1	L2
3	What is the purpose of communicating design drawing.	3	CO1	L1
4	List the benefits of engineering sketches.	3	CO1	L1
5	List any 6 major components in a detailed drawing to ensure the exact purpose for which the drawings were intended	3	CO1	L1
6	Show how engineering sketches and drawing convey designs	3	CO2	L2
7	List and explain the guidelines for technical communication/report	3	CO2	L2
8	Explain the role of mathematics and physics in design engineering process	3	CO1	L2
9	Give outline for a good technical presentation	3	CO1	L2
10	What is a mathematical model? State the significance?	3	CO1	L1
11	List and explain Mathematical tools for design modelling	3	CO2	L2
12	Explain the role of Prototyping in evaluating a Design.	3	CO2	L2
13	Graphically communicate the design of an office chair to be used by a software engineer. Draw the detailed 2 D drawings of the same with design detailing, material selection, scale drawing, dimensions, tolerances etc. use only hand sketches	14	CO3	L3
14	Graphically communicate the design of a thermo flask used to keep hot coffee. Draw the detailed 2D drawings of the same with design detailing, material selection, scale drawings, dimensions, tolerances, etc. Use only hand sketches.	14	CO3	L2
15	Describe the role of mathematical modelling in design engineering. Show how mathematics and physics play a role in designing a lifting mechanism to raise 100 kg of weight to a floor at a height of 10 meters in a construction site.	14	CO3	L3
15	Design a foldable steel table. Draw the detailed 2D drawings of the same with design detailing, scale drawings and dimensions. Use only hand sketches.	14	CO3	L3

16	Design an integrated water bottle with lunch box. Draw the detailed 2D drawings of the same with design detailing, material selection and dimensions. Use only hand sketches.	14	CO3	L3
17	Prepare a technical report for a newly designed website for online training of students with neat diagrams for presenting to a client.	14	CO3	L3
18	Prepare a technical report for a newly designed portable ladder with neat sketches for presenting to a client.	14	CO3	L3
19	Explain the general guidelines for technical communication. Justify each point with an example.	14	CO3	L2
Module 4				
Sl. No.	Question	Marks	CO	BL
1	Illustrate with an example, what is project based learning	6	CO3	L2
2	Illustrate with an example, what is problem based learning	6	CO3	L2
3	What are the steps involved in problem based learning ?	6	CO3	L1
4	What are the steps involved in project based learning ?	6	CO3	L1
5	Differentiate between Project and problem based learning	6	CO3	L2
6	Design a new waste management system in your residence area, especially for plastic waste	6	CO3	L6
7	What is modularization? List the advantages of modular design?	6	CO3	L1
8	Illustrate with an example, about the modular design process	6	CO3	L2
9	Explain with an example of product life cycle.	6	CO3	L2
10	Explain the ergonomics in design. List out the advantages of ergonomic design.	6	CO3	L2
11	What are the factors considered in ergonomics design	6	CO3	L1
12	Ergonomically design a vegetable knife for your kitchen, consider gripping material, shape, safety and placement of knife	6	CO3	L6
13	Explain the Aesthetics in design. List out the advantages of Aesthetics design.	6	CO3	L2
14	Explain with an example of a Bio-Mimicry in design.	6	CO3	L2

15	What is concurrent engineering? List out the advantages of concurrent engineering	6	CO3	L1
16	What is reverse engineering? List out the advantages of reverse engineering	6	CO3	L1
17	Design a screw driver based on reverse engineering method that can handle any screws without changing the heads. You can change the designs as per your wish.	6	CO3	L6
Module 5				
Sl. No.	Question	Marks	CO	BL
1.	Elaborate on “Design for production” with an example	3/6	CO1	L1
2.	Elaborate on “Design for Use” with an example.	3/6	CO1	L1
3.	Elaborate on “Design for Sustainability” with an example.	3/6	CO1	L1
4.	Illustrate how concepts like value engineering, concurrent engineering and reverse engineering influence engineering designs?	6	CO2	L2
5.	Show how designs are varied based on the aspects of production methods, life span, reliability and environment?	6	CO2	L2
6	Explain how economics influence the engineering designs?	6	CO2	L2
7.	Elaborate on engineering economics in design.	6	CO2	L2
8.	Explain on design rights. (How and when to obtain design rights)	6	CO2	L2
9.	Explain the aspect of ethics in design.	3/6/14	CO2	L2
10.	Examine the changes in design of foot ware with constraints of 1)production method, 2)life span requirement, 3)reliability issues and 4)environmental factors. Use hand sketches and give proper rationalization for the changes in design.	14	CO3	L3
11.	Design a candle light stand (<i>can be any familiar product</i>) for manufacturing and elaborate on each step of DFM. Also brief on DFA.	14	CO3	L3

12.	Describe how to estimate the cost of a particular design using Any of the following: 1)a website, 2)the layout of a plant, 3)elevation of a building, 4)an electrical or electronic system or device, 5)a car. Show how economics will influence the engineering designs. Use hand sketches to support your arguments.	14	CO3	L3

1. Prescribed Syllabus

1. Familiarization of the Computing Tool
2. Familiarization of Scientific Computing
3. Realization of Arrays and Matrices
4. Numerical Differentiation and Integration
5. Solution of Ordinary Differential Equations
6. Simple Data Visualization
7. Simple Data Analysis with Spreadsheets
8. Convergence of Fourier Series
- 9: Coin Toss and the Level Crossing Problem

2. Text Books (T)

NIL

3. Reference Books (R)

NIL

4. Course Objectives

- a. The students shall use Python for realization of experiments. Other softwares such as R/MATLAB/SCILAB/LabVIEW can also be used.
- b. The experiments will lay the foundation for future labs such as DSP lab.
- c. The first two experiments are mandatory and any six of the rest should be done.

5. Course Pre / Corequisite

- MAT 101 Linear Algebra and Calculus
- MAT 102 Vector Calculus, Differential Equations and Transforms

6. Course Outcomes

After completion of the course, student will be able to

- CO1. Describe the needs and requirements of scientific computing and to familiarize one programming language for scientific computing and data visualization.
- CO2. Approximate an array/matrix with matrix decomposition.
- CO3. Implement numerical integration and differentiation.
- CO4. Solve ordinary differential equations for engineering applications
- CO5. Compute with exported data from instruments
- CO6. Realize how periodic functions are constituted by sinusoids
- CO7. Simulate random processes and understand their statistics.

7. Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes

PO/ CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO 2	PSO 3
CO1	H	H			H				H	H		M	M		H
CO2	H	H	M	H	H				H	H		M	M	M	H
CO3	H	H	M		H				H	H		M	M		H
CO4	H	H	M		H				H	H		M	M		H
CO5	H	H	H		H				H	H		M	M		H
CO6	H	H	M		H				H	H		M	M		H
CO7	H	H	M		H				H	H		M	M		H

8. Justification for COPOPSO Correlation

CO	PO/PSO	Justification
CO1	PO1	As they apply their knowledge in basic engineering to familiarize python for scientific computing and data visualization
	PO2	As they analyse the problem statements using first principles of mathematics to familiarize python for scientific computing and data visualization
	PO5	As they use Python programming to familiarize python for scientific computing and data visualization and be able to comprehend professional and ethical responsibility in computing
	PO9	As they function effectively as an individual in diverse teams
	PO10	As they are able to comprehend and write effective reports and give and receive clear instructions.
	PO12	As it will equip students with the ability to apply computational tools and techniques in scientific research areas like of signal processing, communication engineering, control systems or to develop projects
	PSO1	Absorb and apply contextual knowledge of Engineering to develop and implement the given problem statements.
	PSO3	As they apply python programming to implement the given problem statements.
CO2	PO1	As they apply their basic knowledge in electronics engineering to Approximate an array/matrix with matrix decomposition.
	PO2	As they design and analyse the problem statements using first principles of mathematics to Approximate an array/matrix with matrix decomposition.

	PO3	As they develop programs to meet specified needs as per the problem statement.
	PO4	As they apply their knowledge to analyse and interpret data, and synthesis of the information to provide valid conclusions.
	PO5	As they use Python programming to Approximate an array/matrix with matrix decomposition.
	PO9	As they function effectively as an individual in diverse teams
	PO10	As they are able to comprehend and write effective reports and give and receive clear instructions.
	PO12	As it cultivates students' proficiency in employing advanced computational methods to approximate an array/matrix with matrix decomposition and fostering their ability to address realworld challenges through technological problemsolving and data manipulation skills.
	PSO1	Absorb and apply contextual knowledge of Engineering to develop and implement the given problem statements.
	PSO3	As they apply python to analyse complex the given problem statements.
CO3	PO1	As they apply their basic knowledge in electronics engineering to Implement numerical integration and differentiation.
	PO2	As they design and analyse the problem statements using first principles of mathematics to Implement numerical integration and differentiation.
	PO3	As the develop programs to meet specified needs as per the problem statement.
	PO5	As the use Python programming to Implement numerical integration and differentiation.
	PO9	As they function effectively as an individual in diverse teams
	PO10	As they are able to comprehend and write effective reports and give and receive clear instructions.
	PO12	As it will equip students with the ability to apply computational tools and techniques to implement numerical integration and differentiation using Python.
	PSO1	Absorb and apply contextual knowledge of Engineering to develop and implement the given problem statements.
CO4	PSO3	As they apply python to analyse complex the given problem statements.
	PO1	As they apply their basic knowledge in electronics engineering to Solve ordinary differential equations for engineering applications
	PO2	As they design and analyse the problem statements using first principles of mathematics to Solve ordinary differential equations for engineering applications
	PO3	As the develop programs to meet specified needs as per the problem statement.
	PO5	As the use Python programming to Solve ordinary differential equations for engineering applications
	PO9	As they function effectively as an individual in diverse teams
	PO10	As they are able to comprehend and write effective reports and give and receive clear instructions.

	PO12	As it will equip students with the ability to apply computational tools and techniques to solve ordinary differential equations for engineering applications
	PSO1	Absorb and apply contextual knowledge of Engineering to develop and implement the given problem statements.
	PSO3	As they apply python to analyse complex the given problem statements.
CO5	PO1	As they apply their basic knowledge in electronics engineering to Compute with exported data from instruments
	PO2	As they design and analyse the problem statements using first principles of mathematics, electronics engineering sciences to Compute with exported data from instruments
	PO3	As the develop programs to meet specified needs as per the problem statement.
	PO5	As they use Python programming to compute with exported data.
	PO9	As they function effectively as an individual in diverse teams
	PO10	As they are able to comprehend and write effective reports and give and receive clear instructions.
	PO12	As it equips students with the skill to utilize technological tools for processing and analysing real world data generated by instruments.
	PSO1	Absorb and apply contextual knowledge of Engineering to develop and implement the given problem statements.
CO6	PSO3	As they apply python to analyse complex the given problem statements.
	PO1	As they apply their basic knowledge in electronics engineering to Realize how periodic functions are constituted by sinusoids
	PO2	As they design and analyse the problem statements using first principles of mathematics, electronics engineering sciences to Realize how periodic functions are constituted by sinusoids
	PO3	As the develop programs to meet specified needs as per the problem statement.
	PO5	As they use Python programming to Realize how periodic functions are constituted by sinusoids
	PO9	As they function effectively as an individual in diverse teams
	PO10	As they are able to comprehend and write effective reports and give and receive clear instructions.
	PO12	As it will equip students with the ability to apply computational tools and techniques in scientific research areas like of signal processing, communication engineering, control systems or to develop projects
	PSO1	Absorb and apply contextual knowledge of Engineering to develop and implement the given problem statements.
CO7	PSO3	As they apply python to analyse complex the given problem statements.
	PO1	As they apply their basic knowledge in electronics engineering to Simulate random processes and understand their statistics.
	PO2	As they design and analyse the problem statements using first principles of mathematics, electronics engineering sciences to Simulate random processes and understand their statistics.

	PO3	As they develop programs to meet specified needs as per the problem statement.
	PO5	As they use Python programming to Simulate random processes and understand their statistics.
	PO9	As they function effectively as an individual in diverse teams
	PO10	As they are able to comprehend and write effective reports and give and receive clear instructions.
	PO12	As it empowers students with the ability to utilize computational tools to model and analyse random process and their statistics.
	PSO1	As they Absorb and apply contextual knowledge of Engineering to develop and implement the given problem statements.
	PS3	As they apply python to analyse complex the given problem statements.

9. Curricular gaps (if any)

Nil

10. Course Enrichment Activities

Sl No	Description	Proposed Activities	Relevance to POs and PSOs
1	Basics of Programming	One day workshop	PO1, PO2, PO4, PO5, PO10, PO12, PSO1, PSO 3

11. Internal Assessment mark allocation (as per university curriculum)

(Provide details as mentioned in syllabus)

Continuous Internal evaluation - 75 marks

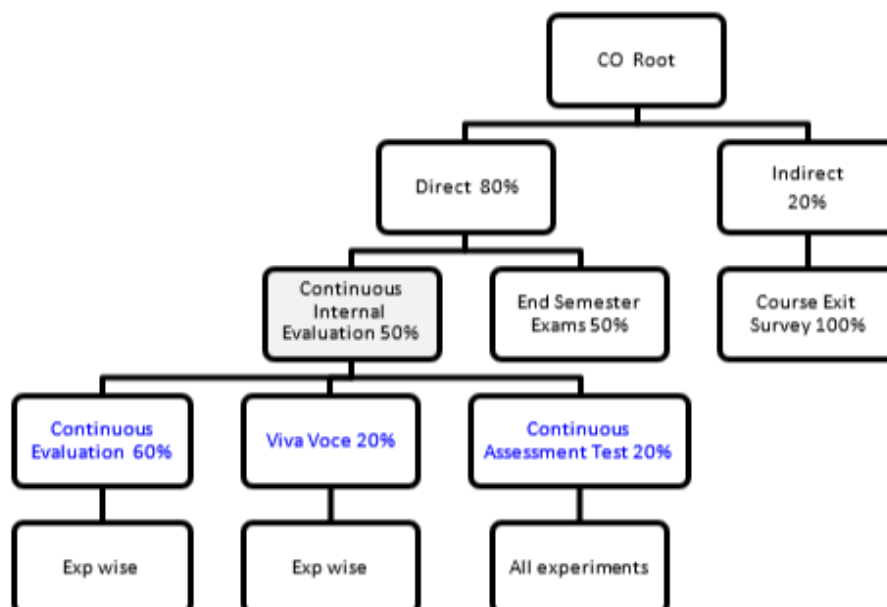
End Semester Examination - 75 marks

Total -150 marks

12. Assessment – CO Mapping (Put 'x' if mapping is present)

	Tools	Weightage	CO1	CO2	CO3	CO4	CO5	CO6	CO7
Direct Assessment Tools	Continuous Evaluation Experiment wise CO mapping	30%	x	x	x	x	x	x	x
	Viva – Voce Experiment wise CO mapping	10%	x	x	x	x	x	x	x
	Continuous Assessment Test	10%	x	x	x	x	x	x	x
	End Semester Exam – 50%	50%	x	x	x	x	x	x	x
Indirect Assessment Tool	Course Exit Survey	100%	x	x	x	x	x	x	x

13. Assessment Configuration



15. Course Plan

Hour	Topic
1	Familiarization of the Computing Tool
2	Familiarization of Scientific Computing
3	Realization of Arrays and Matrices
4	Numerical Differentiation and Integration
5	Solution of Ordinary Differential Equations
6	Simple Data Visualization
7	Simple Data Analysis with Spreadsheets
8	Convergence of Fourier Series
9	Coin Toss and the Level Crossing Problem

Prepared By : Ms. Sonu K Varghese

Checked By : Dr. Saju A

1. Prescribed Syllabus

PART A

1. The following experiments can be conducted on breadboard or trainer kits.
2. Realization of functions using basic and universal gates (SOP and POS forms).
3. Design and Realization of half /full adder and subtractor using basic gates and universal gates.
4. 4 bit adder/subtractor and BCD adder using 7483.
5. Study of Flip Flops: S-R, D, T, JK and Master Slave JK FF using NAND gates.
6. Asynchronous Counter: 3 bit up/down counter
7. Asynchronous Counter: Realization of Mod N counter
8. Synchronous Counter: Realization of 4-bit up/down counter.
9. Synchronous Counter: Realization of Mod-N counters.
10. Ring counter and Johnson Counter. (using FF & 7495).
11. Realization of counters using IC's (7490, 7492, 7493).
12. Multiplexers and De-multiplexers using gates and ICs. (74150, 74154)
13. Realization of combinational circuits using MUX & DEMUX.
14. Random Sequence generator using LFSR.

PART B (Any 5)

The following experiments aim at training the students in digital circuit design with verilog and implementation in small FPGAs. Small, low cost FPGAs, that can be driven by open tools for simulation, synthesis and place and route, such as TinyFPGA or Lattice iCEstick can be used. Open software tools such as yosis (for simulation and synthesis) and arachne (for place and route) may be used. The experiments will lay the foundation for digital design with FPGA with the objective of increased employability.

1. Experiment 1. Realization of Logic Gates and Familiarization of FPGAs
 - (a) Familiarization of a small FPGA board and its ports and interface.
 - (b) Create the .pcf files for your FPGA board.
 - (c) Familiarization of the basic syntax of Verilog
 - (d) Development of verilog modules for basic gates, synthesis and implementation in the above FPGA to verify the truth tables
 - (e) Verify the universality and non associativity of NAND and NOR gates by uploading the corresponding verilog files to the FPGA boards.
2. Experiment 2: Adders in Verilog
 - (a) Development of verilog modules for half adder in 3 modeling styles (dataflow/structural/behavioural).
 - (b) Development of verilog modules for full adder in structural modeling using half adder.
3. Experiment 3: Mux and Demux in Verilog
 - (a) Development of verilog modules for a 4x1 MUX.
 - (b) Development of verilog modules for a 1x4 DEMUX.
4. Experiment 4: Flipflops and counters
 - (a) Development of verilog modules for SR, JK and D flipflops.

- (b) Development of verilog modules for a binary decade/Johnson/Ring counters
- 5. Experiment 5. Multiplexer and Logic Implementation in FPGA
 - (a) Make a gate level design of an 8 : 1 multiplexer, write to FPGA and test its functionality.
 - (b) Use the above module to realize the logic function $f(A, B, C) = \sum m(0, 1, 3, 7)$ and test it.
 - (c) Use the same 8 : 1 multiplexer to realize the logic function $f(A, B, C, D) = \sum m(0, 1, 3, 7, 10, 12)$ by partitioning the truth table properly and test it.
- 6. Experiment 6. Flip-Flops and their Conversion in FPGA
 - (a) Make gate level designs of J-K, J-K master-slave, T and D flip-flops, implement and test them on the FPGA board.
 - (b) Implement and test the conversions such as T to D, D to T, J-K to T and J-K to D
- 7. Experiment 7: Asynchronous and Synchronous Counters in FPGA
 - (a) Make a design of a 4-bit up down ripple counter using T-flip-flops in the previous experiment, implement and test them on the FPGA board.
 - (b) Make a design of a 4-bit up down synchronous counter using T-flip-flops in the previous experiment, implement and test them on the FPGA board.
- 8. Experiment 8: Universal Shift Register in FPGA
 - (a) Make a design of a 4-bit universal shift register using D-flip-flops in the previous experiment, implement and test them on the FPGA board.
 - (b) Implement ring and Johnson counters with it.
- 9. Experiment 9. BCD to Seven Segment Decoder in FPGA
 - (a) Make a gate level design of a seven-segment decoder, write to FPGA and test its functionality.
 - (b) Test it with switches and seven segment display. Use output ports for connection to the display.

2. Text Books (T)

- T1. Mano M.M., Ciletti M.D., "Digital Design", Pearson India, 4th Edition. 2006
- T2. D.V. Hall, "Digital Circuits and Systems", Tata McGraw Hill, 1989
- T3. S. Brown, Z. Vranesic, "Fundamentals of Digital Logic with Verilog Design", McGraw Hill
- T4. Samir Palnikar "Verilog HDL: A Guide to Digital Design and Synthesis", Sunsoft Press
- T5. R.P. Jain, "Modern digital Electronics", Tata McGraw Hill, 4th edition, 2009

2. Reference Books (R)

- R1. W.H. Gothmann, "Digital Electronics – An introduction to theory and practice", PHI, 2nd edition, 2006
- R2. Wakerly J.F., "Digital Design: Principles and Practices," Pearson India, 4th 2008
- R3. A. Ananthakumar, "Fundamentals of Digital Circuits", Prentice Hall, 2nd edition, 2016

3. Objectives

This course aims to (i) familiarize students with the Digital Logic Design through the implementation of Logic Circuits using ICs of basic logic gates (ii) familiarize students with the HDL based Digital Design Flow.

4. Course Pre / Co-requisite

Nil

6. Course Outcomes

After the completion of the course the student will be able to

- CO1. Design and demonstrate the functioning of various combinational circuits using ICs
- CO2. Design and demonstrate the functioning of various sequential circuits using ICs
- CO3. Apply an industry compatible hardware description language to implement digital circuits
- CO4. Implement digital circuits on FPGA boards and connect external hardware to the boards

7. Mapping of Course Outcomes with Program Outcomes

PO/ CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H	H	H	M	H				H	H		M	H	M	H
CO2	H	H	H	M	H				H	H	H	H	H	M	H
CO3	H	H	H		H				H	H		M	H		H
CO4	H	H	H		H				H	H		M	H		H

8. Justification for CO-PO-PSO Correlation

CO	PO/PSO	H/M/L	Justification Statement
CO1	PO1	H	By applying your knowledge of mathematics, science, engineering fundamentals, and your engineering specialization to understand the theoretical principles and logic behind combinational circuits and the ICs used in them.
	PO2	H	The student will be able to analyze Boolean algebra in digital logic by using first principles of mathematics.
	PO3	H	The student will be able to design basic digital circuits using Boolean algebra as well as logic gates.
	PO4	M	The student will be able to use research-based knowledge and methods to experiment with and analyze your combinational circuits. Interpret the data and synthesize information to draw valid conclusions regarding the circuit's performance.
	PO5	H	The student will be able to apply modern engineering tools to design combinational logic circuits by using Hardware description language.
	PO9	H	The student will be able to contribute in their individual capacity as well as work as an effective team for the fulfilment of each experiment.
	PO10	H	The student will be able to demonstrate the ability to use appropriate tools like circuit diagrams and its design for effectively communicating the design and solution to the digital design

	PO12	M	The student will be able to recognize the need for innovative thinking to engage in independent and lifelong learning in the field of digital electronics.
	PSO1	H	The student will be able to absorb and apply the concept of Boolean algebra for the design and development of digital electronic systems
	PSO2	M	The student will be able to use digital design and analysis tools to design experiments, analyse and interpret data to provide solution for modern electronic systems.
	PSO3	H	The student will be able to use modern engineering tools like Xilinx ISE to design Combinational digital logic circuits by using Verilog coding
CO2	PO1	H	The student will be able to apply the basic knowledge of mathematics and engineering fundamentals to understand concepts of combinational logic function described by a truth table using gates
	PO2	H	The student will be able to analyze combinational logic function described by a truth table using gates by using first principles of mathematics.
	PO3	H	The student will be able to design the combinational logic function described by a truth table using gates in digital system.
	PO4	M	The student will be able to use modern design and analysis tools to design experiments, analyse and interpret data to provide solution for complex problems.
	PO5	H	The student will be able to apply modern engineering tools to design sequential digital logic circuits by using Hardware description language.
	PO9	H	The student will be able to contribute in their individual capacity as well as work as an effective team for the fulfilment of each experiment.
	PO10	H	The student will be able to demonstrate the ability to use appropriate tools like circuit diagrams and its design for effectively communicating the design and solution to the digital design.
	PO12	M	The student will be able to recognize the need for innovative thinking to engage in independent and lifelong learning in the field of digital electronics.
	PSO1	H	The student will be able to absorb and apply the concept of Combinational logic function for the design and development of digital electronic systems.

	PSO2	M	The student will be able to use digital design and analysis tools to design experiments, analyse and interpret data to provide solution for modern electronic systems.
	PSO3	H	The student will be able to use modern engineering tools like Xilinx ISE to design Sequential digital logic circuits by using Verilog coding.
CO3	PO1	H	The student will be able to apply the basic knowledge of mathematics and engineering fundamentals to understand different types of logic families.
	PO2	H	The student will be able to analyze different types circuits using logic families with respect to performance and efficiency by using first principles of mathematics.
	PO3	H	The student will be able to design and analysis to find the solutions for complex digital problems.
	PO5	H	The student will be able to select and apply appropriate techniques and modern design and analysis IT tools in design, analysis and evaluation of complex problems in digital systems.
	PO9	H	The student will be able to contribute in their individual capacity as well as work as an effective team for the fulfilment of each experiment.
	PO10	H	The student will be able to demonstrate the ability to use appropriate tools like algorithms / flowcharts for effectively communicating the design and solution to the digital design.
	PO12	M	The student will be able to recognize the need for innovative thinking to engage in independent and lifelong learning.
	PSO1	H	The student will be able to absorb and apply the concept of logic families like FPGA for the design and development of digital electronic systems.
	PSO3	H	The student will be able to use modern engineering tools like Xilinx ISE to design digital logic circuits by using Verilog coding.
CO4	PO1	H	The student will be able to the basic knowledge of mathematics and engineering fundamentals to understand concepts of sequential logic function using flip-flops.
	PO2	H	The student will be able to analyze sequential logic function and its design by using first principles of mathematics.

	PO3	H	The student will be able to design the synchronous and asynchronous sequential circuits using flip-flops in digital system.
	PO5	H	The student will be able to select and apply appropriate techniques and modern design and analysis IT tools in design, analysis and evaluation of complex problems in digital systems.
	PO9	H	The student will be able to contribute in their individual capacity as well as work as an effective team for the fulfilment of each experiment.
	PO10	H	The student will be able to demonstrate the ability to use appropriate tools like algorithms / flowcharts for effectively communicating the design and solution to the digital design
	PO12	M	The student will be able to recognize the need for innovative thinking to engage in independent and lifelong learning in the field of digital system design.
	PSO1	H	The student will be able to absorb and apply the concept of sequential logic function for the design and development of digital electronic systems.
	PSO3	H	The student will be able to use modern engineering tools like Xilinx ISE to design digital logic circuits by using Verilog coding.

9. Curricular gaps (if any)

Nil

10. Course Enrichment Activities

Sl No	Description	Proposed Activities	Relevance to POs and PSOs
	Nil		

10. Course Plan / Schedule of experiments

List of Experiments.

Weeks(W)	Experiments	Relevance to COs
1	Realization of functions using basic and universal gates (SOP and POS forms).	CO1
2	Design and Realization of half /full adder and Subtractor using basic gates and universal gates.	CO1

3	Study of Flip Flops: S-R, D, T, JK and Master Slave JK FF using NAND gates.	CO2
4	Asynchronous Counter:3 bit up/down counter	CO2
5	Asynchronous Counter: Realization of Mod N counter	CO2
6	Synchronous Counter: Realization of 4-bit up/down counter.	CO2
7	Synchronous Counter: Realization of Mod-N counters.	CO2
8	Multiplexers and De-multiplexers using gates and ICs. (74150, 74154)	CO1
9	Realization of Logic Gates and Familiarization of FPGAs	CO3,CO4
10	Adders in Verilog	CO3,CO4
11	mux in Verilog	CO3,CO4
12	De mux in Verilog	CO1, CO4
13	Mux on FPGA	CO1, CO4
14	Flipflops and counters	CO2,CO3,CO4
15	Asynchronous and Synchronous Counters in FPGA	CO2,CO3,CO4
Total No. of Hours	45	

11. Assessment Pattern

Continuous Internal evaluation	- 75 marks
<u>End Semester Examination</u>	<u>- 75 marks</u>
<u>Total</u>	<u>-150 marks</u>

12. Evaluation criteria (as per syllabus)

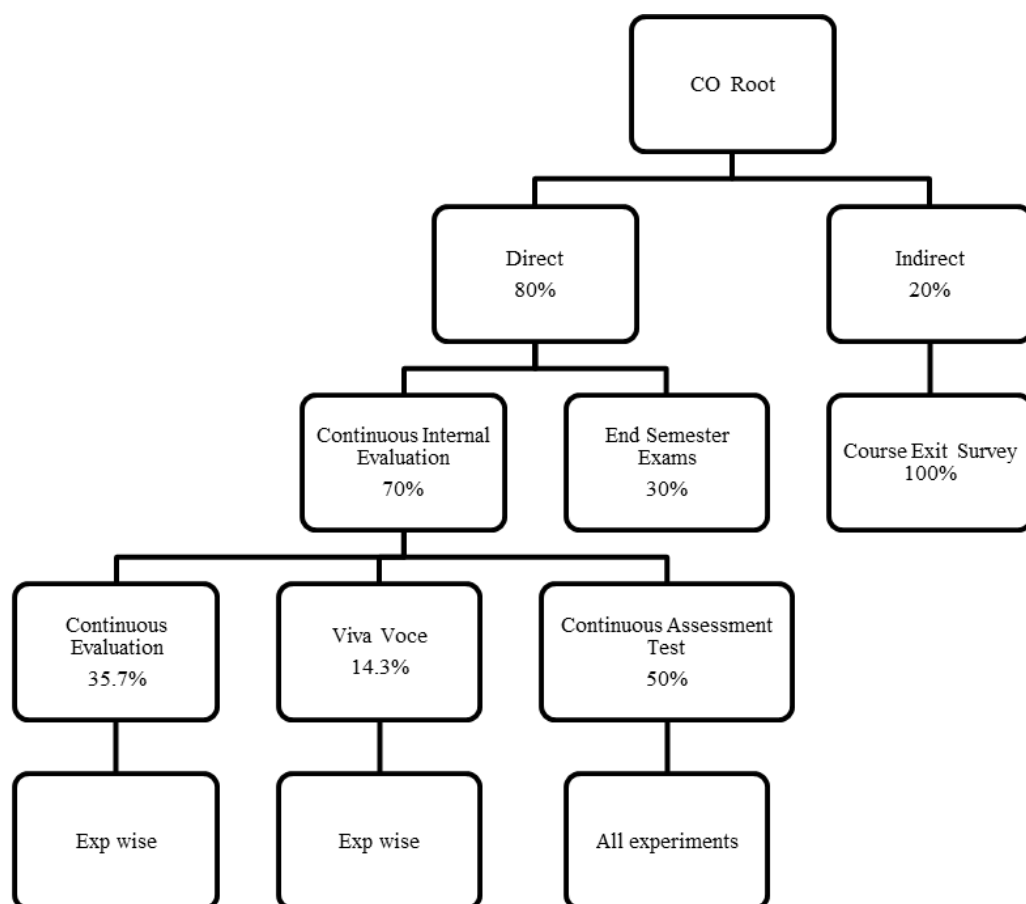
Sl. No.	Nature of Evaluation	Evaluation Pattern	Topics of Evaluation	Duration	Weightage of marks
1.	Continuous Internal evaluation (75 marks)				
a	Attendance	NA	NA	NA	10%
b.	Continuous Evaluation		Each experiment	3 hours	13.3%
c.	Viva-voce		Each experiment		6.7%

d.	Continuous Assessment Test	Performance & implementation-15 marks Viva- 10 marks Result -5 marks Total- 30 marks	All Experiments		20%
2.	End Semester Examination (75 marks)				
	End semester Examination	Preliminary work – 15 marks Implementing the work – 10 marks, Performance and result – 25 marks viva – 20 marks Record – 5 marks Total 75 marks	All Experiments	3hrs	50%

13. Assessment – CO Mapping (Put ‘ x’ if mapping is present)

	Tools	Weightage	CO1	CO2	CO3	CO4	CO5
Direct Assessment Tools	Continuous valuation Experiment wise CO mapping	30%	x	x	x	x	x
	Viva Voce Experiment wise CO mapping	10%	x	x	x	x	x
	Continuous Assessment Test	10%	x	x	x	x	x
	End Semester Exam – 50%	50%	x	x	x	x	x
Indirect Assessment Tool	Course Exit Survey	100%	x	x	x	x	x

14. Assessment Configuration



Prepared by : Dr. Neenu Joseph

Checked by : Ms. Ambily Joseph

Semester: 4

CONTENTS

SLOT	COURSE CODE	COURSES	L-T-P	HOURS	CREDIT
A	MAT 204	PROBABILITY, RANDOM PROCESS AND NUMERICAL METHODS	3-1-0	4	4
B	ECT 202	ANALOG CIRCUITS	3-1-0	4	4
C	ECT 204	SIGNALS AND SYSTEMS	3-1-0	4	4
D	ECT 206	COMPUTER ARCHITECTURE AND MICROCONTROLLERS	3-1-0	4	4
E	HUT200	PROFESSIONAL ETHICS	2-0-0	2	2
F	MCN202	CONSTITUTION OF INDIA	2-0-0	2	--
S	ECL 202	ANALOG CIRCUITS AND SIMULATION LAB	0-0-3	3	2
T	ECL 204	MICROCONTROLLER LAB	0-0-3	3	2

Course Code & Name: MAT 204 Probability, Random Processes and Numerical methods

1. Prescribed Syllabus

Module	Topic	Hours
1	(Discrete probability distributions) Discrete random variables and their probability distributions, Expectation, mean and variance, Binomial distribution, Poisson distribution, Poisson approximation to the binomial distribution, Discrete bivariate distributions, marginal distributions, Independent random variables, Expectation -multiple random variables	9
2	(Continuous probability distributions) Continuous random variables and their probability distributions, Expectation, mean and variance, Uniform, exponential and normal distributions, Continuous bivariate distributions, marginal distributions, Independent random variables, Expectation-multiple random variables, i.i.d random variables and Central limit theorem (without proof).	9
3	(Random Processes) Random processes and classification, mean and autocorrelation, wide sense stationary (WSS) processes, autocorrelation and power spectral density of WSS processes and their properties, Poisson process-distribution of inter-arrival times, combination of independent Poisson processes(merging) and subdivision (splitting) of Poisson processes (results without proof).	9
4	(Numerical methods -I) Errors in numerical computation-round-off, truncation and relative error, Solution of equations – Newton-Raphson method and Regula-Falsi method. Interpolation-finite differences, Newton's forward and backward difference method, Newton's divided difference method and Lagrange's method. Numerical integration-Trapezoidal rule and Simpson's 1/3rd rule (Proof or derivation of the formulae not required for any of the methods in this module)	9
5	(Numerical methods -II) Solution of linear systems-Gauss-Siedal and Jacobi iteration methods. Curve fitting-method of least squares, fitting straight lines and parabolas. Solution of ordinary differential equations-Euler and Classical Runge-Kutta method of second and fourth order, Adams Moulton predictor-correction method (Proof or derivation of the formulae not required for any of the methods in this module)	9

2. Text Books (T)

- T1. Jay L. Devore, Probability and Statistics for Engineering and the Sciences, 8th edition, Cengage,
 T2. Oliver C. Ibe, Fundamentals of Applied Probability and Random Processes, Elsevier, 2005.
 T3. Erwin Kreyszig, Advanced Engineering Mathematics, 10th Edition, John Wiley & Sons, 2016.
 T4. Advanced Engineering Mathematics, 10th Edition, John Wiley & sons, 2016.

3. Reference Books (R)

- R1. Hossein Pishro-Nik, Introduction to Probability, Statistics and Random Processes,
 Kappa Research, 2014 (Also available online at www.probabilitycourse.com)

Department of ECE

- R2. V.Sundarapandian, Probability, Statistics and Queueing theory, PHI Learning, 2009
 R3. Gubner, Probability and Random Processes for Electrical and Computer Engineers, Cambridge University Press, 2006.
 R4. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 36 Edition, 2010.

4. Course Objectives

This course introduces students to the modern theory of probability and statistics, covering important models of random variables and analysis of random processes using appropriate time and frequency domain tools. A brief course in numerical methods familiarises students with some basic numerical techniques for finding roots of equations, evaluating definite integrals solving systems of linear equations and solving ordinary differential equations which are especially useful when analytical solutions are hard to find

5. Course Pre / Co-requisite

A basic course in one-variable and multi-variable calculus.

6. Course Outcomes

After completion of the course, student will be able to

CO1: Understand the concept, properties and important models of discrete random variables and using them, analyse suitable random phenomena.

CO2: Understand the concept, properties and important models of continuous random variables and using them, analyse suitable random phenomena.

CO3: Analyse random processes using autocorrelation, power spectrum and Poisson process model as appropriate.

CO4: Compute roots of equations, evaluate definite integrals and perform interpolation on given numerical data using standard numerical techniques

CO5: Apply standard numerical techniques for solving systems of equations, fitting curves on given numerical data and solving ordinary differential equations.

7. Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes

PO/ CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO 9	PO 10	PO 11	PO1 2	PSO 1	PSO2	PSO 3
CO1	H	M	M	M	M					M		L			
CO2	H	M	M	M	M					M		L			
CO3	H	M	M	M	M					M		L			
CO4	H	M	M	M	M					M		L			
CO5	H	M	M	M	M					M		L			

8. Justification for CO-PO-PSO Correlation

CO/PO	Justification Statement
CO1-PO1	The knowledge of discrete random variables will help to deal with complex problems related to randomness
CO1-PO2	The concept of discrete random variables will help to analyse random phenomena associated with complex engineering problems
CO1-PO3	The concept of discrete probability density functions and special probability distributions are used to design systems that meet the specific needs with appropriate consideration for public health and environmental issues
CO1-PO4	The concept of discrete probability density functions and special probability distributions can be used to conduct investigations of complex problems involving the synthesis of data to provide valid conclusions
CO1-PO5	The concept of discrete probability density functions and special probability distributions can be used to create, select and apply appropriate techniques, modern engineering and IT tools including prediction and modelling to complex engineering activities
CO1-PO10	The knowledge of discrete random variables and their distributions will help to explain effectively on different types of discrete distributions
CO1-PO12	The knowledge of discrete random variables and their distributions will help to understand its broadest context by lifelong learning process
CO2-PO1	The fundamental knowledge of continuous probability distributions is used to solve complex engineering problems
CO2-PO2	The concept of continuous random variables will help to identify, formulate and analyse random phenomena associated with complex engineering problems and provide economical solutions
CO2-PO3	The concept of continuous probability density functions and special probability distributions are used to design solutions of complex engineering problems
CO2-PO4	The concept of continuous probability density functions and special probability distributions can be used to conduct investigations of complex problems involving design of experiments, analysis and interpretation of the data to provide valid conclusions
CO2-PO5	The concept of continuous probability density functions and special probability distributions can be used to apply appropriate techniques including prediction and modelling to complex engineering activities
CO2-PO10	The knowledge of continuous probability density functions and special probability distributions will help to communicate effectively on various continuous distributions
CO2-PO12	The concept of continuous probability density functions and special probability distributions can be used and applied in the future course of action

CO3-PO1	Fundamental knowledge of random processes will help to simplify several problems in Engineering.
CO3-PO2	Autocorrelation, power spectrum and Poisson process are used to analyse problems with high complexity in Engineering.
CO3-PO3	Theory of random processes using autocorrelation, power spectrum and Poisson process are used to design solutions for complex engineering problems.
CO3-PO4	Concept of random processes using autocorrelation, power spectrum and Poisson process are used to conduct investigation of complex problems.
CO3-PO5	Theory of random processes using autocorrelation, power spectrum and Poisson process will help to select appropriate techniques in complex engineering activities.
CO3-PO10	Concept of random processes will help to communicate effectively on complex engineering activities.
CO3-PO12	The knowledge of random processes will help to understand its broadest context by lifelong learning process.
CO4-PO1	The knowledge of numerical techniques can be used to solve engineering problems
CO4-PO2	The methods to compute roots of equations, evaluate definite integrals and perform interpolation on given numerical data can be used to formulate and analyse complex engineering problems.
CO4-PO3	Numerical integration, interpolation and numerical techniques to find solution of equations can be used in the development of solutions for various problems in engineering.
CO4-PO4	The knowledge of standard numerical techniques is used to conduct investigations of complex problems involving the synthesis of data to provide valid conclusions.
CO4-PO5	Various methods to compute roots of equations, evaluate definite integrals and interpolation will help to select and apply appropriate numerical techniques in complex engineering activities with an understanding of the limitations.
CO4-PO10	Standard numerical techniques to compute roots of equations, evaluate definite integrals and perform interpolation on given numerical data will help in the effective communication on issues related to engineering community.
CO4-PO12	The knowledge of standard numerical techniques will enhance the ability to engage in independent and lifelong learning.
CO5-PO1	Fundamental knowledge of various numerical techniques will help to solve problems arising in engineering
CO5-PO2	Application of standard numerical techniques for solving systems of equations, fitting curves on given numerical data and solving ordinary differential equations helps to analyse problems with high complexity in Engineering.
CO5-PO3	Various numerical techniques are used to design solutions for complex engineering problems

CO5-PO4	The concept of numerical methods of solution helps to conduct investigation of complex problems
CO5-PO5	Application of standard numerical methods will help to select appropriate techniques in complex engineering activities.
CO5-PO10	Knowledge of various numerical techniques will help to communicate effectively on complex engineering activities.
CO5-PO12	The concept of standard numerical methods can be used and applied in the future course of action.

9. Curricular gaps (if any)

Nil

10. Course Enrichment Activities

Sl No	Description	Proposed Activities	Relevance to POs and PSOs
1.	Report on NPTEL video -Introduction to Probability and Statistics- IIT Madras	Submit a report that summarizes key points from an NPTEL video on Binomial Distribution	PO1, PO2, PO3, PO10, PO12

**11. Internal Assessment mark allocation (as per university curriculum)
(Provide details as mentioned in syllabus)**

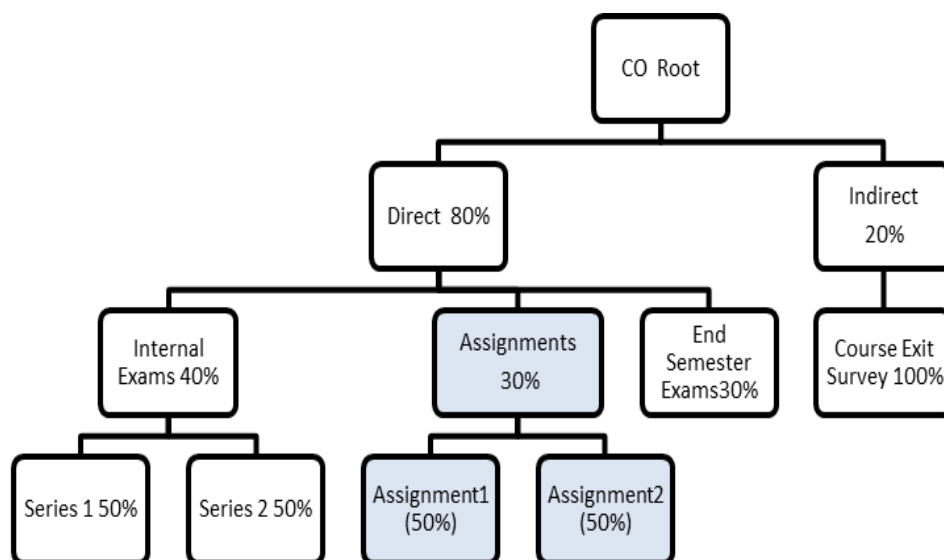
Attendance	- 10 marks
Continuous Assessment Test	- 25 marks
<u>Assignment (s)/ Course Project</u>	<u>- 15 marks</u>
<u>Total</u>	<u>- 50 marks</u>

12. Assessment – CO Mapping (Put ‘ x’ if mapping is present)

	Tools		Weightage [#]	CO 1	CO 2	CO 3	CO 4	CO 5
Direct Assessment Tools	Internal Exam(s) 40%	Series 1	20%	x	x			
		Series 2	20%			x	x	x
	Assignment (s)/ Course Project /Quiz etc. 30%	Assignment 1	15%	x	x			
		Assignment 2	15%			x	x	x

	End Semester Exam	30%	x	x	x	x	x
Indirect Assessment Tool	Course Exit Survey	100%	x	x	x	x	x

13. Assessment Configuration



14. Course Plan

Hour	Topic	Module	Reference(s)	Teaching Pedagogy
1	Discrete random variables and probability distributions	1	T1	Lecture
2	Expected value, mean and variance (discrete)	1	T1	Lecture
3	Expected value, mean and variance (discrete)	1	T1	Lecture
4	Binomial distribution-mean, variance	1	T1	Lecture
5	Poisson distribution-mean, variance	1	T1	Tutorial
6	Poisson approximation to binomial	1	T1	Lecture
7	Discrete bivariate distributions, marginal distributions	1	T1	Lecture
8	Discrete bivariate distributions, marginal distributions, Independence of random variables (discrete), Expected values	1	T1	Lecture

9	Discrete bivariate distributions, marginal distributions, Independence of random variables (discrete), Expected values	1	T1	Tutorial
10	Continuous random variables and probability distributions	2	T1	Lecture
11	Expected value, mean and variance (continuous)	2	T1	Lecture
12	Uniform distribution, mean and variance	2	T1	Lecture
13	Exponential distribution, mean and variance	2	T1	Tutorial
14	Normal distribution, mean and variance	2	T1	Lecture
15	Normal distribution, mean and variance	2	T1	Lecture
16	Continuous bivariate distributions, marginal distributions, Independent random variables, Expected values	2	T1	Lecture
17	Continuous bivariate distributions, marginal distributions, Independent random variables, Expected values, Central Limit Theorem	2	T1	Lecture
18	Central Limit Theorem	2	T1	Tutorial
19	Random process -definition and classification, mean ,autocorrelation	3	T2	Lecture
20	Random process -definition and classification, mean ,autocorrelation	3	T2	Lecture
21	WSS processes its autocorrelation function and properties	3	T2	Lecture
22	WSS processes its autocorrelation function and properties	3	T2	Tutorial
23	Power spectral density	3	T2	Lecture
24	Power spectral density	3	T2	Tutorial
25	Poisson process, inter-distribution of arrival time, merging and splitting	3	T2	Lecture
26	Poisson process, inter-distribution of arrival time, merging and splitting	3	T2	Lecture
27	Inter-distribution of arrival time, merging and splitting	3	T2	Lecture
28	Roots of equations- Newton-Raphson, Regula-falsi methods	4	T2	Lecture
29	Roots of equations- Newton-Raphson, Regula-falsi methods	4	T2	Lecture
30	Interpolation-finite differences	4	T2	Lecture
31	Newton's forward and backward formula	4	T2	Lecture
32	Newton's forward and backward formula	4	T2	Tutorial

33	Newton's divided difference method, Lagrange's method	4	T2	Lecture
34	Newton's divided difference method, Lagrange's method	4	T2	Lecture
35	Numerical integration-trapezoidal rule and Simpson's 1/3-rd rule	4	T2	Lecture
36	Numerical integration-trapezoidal rule and Simpson's 1/3-rd rule	4	T2	Tutorial
37	Solution of linear systems-Gauss-Siedal method, Jacobi iteration method	5	T2	Lecture
38	Solution of linear systems-Gauss-Siedal method, Jacobi iteration method	5	T2	Lecture
39	Curve-fitting-fitting straight lines and parabolas to pairs of data points using method of least squares	5	T2	Lecture
40	Curve-fitting-fitting straight lines and parabolas to pairs of data points using method of least squares	5	T2	Tutorial
41	Solution of ODE-Euler	5	T2	Lecture
42	Classical Runge-Kutta method of second order	5	T2	Lecture
43	Classical Runge-Kutta method fourth order	5	T2	Lecture
44	Classical Runge-Kutta method fourth order	5	T2	Tutorial
45	Adams-Moulton predictor-corrector methods	5	T2	Lecture

15. Question Bank

Module 1				
Sl. No	Question	Marks	CO	BL
1	In a binomial distribution, if the mean is 6, and the variance is 4, find $P[X \leq 6]$	3	CO1	L1
2	X follows Poisson distribution with mean 6. Find $P[X=1]$, Variance (x)	3	CO1	L1

3	The probability mass function of a random variable X is given below: <table><tr><td>x</td><td>0</td><td>1</td><td>2</td><td>3</td></tr><tr><td>$f(x)$</td><td>c</td><td>$2c^2$</td><td>c^2</td><td>$3c^2$</td></tr></table> Determine (i) the value of c (ii) $P(X \geq 1)$	x	0	1	2	3	$f(x)$	c	$2c^2$	c^2	$3c^2$	3	CO1	L1		
x	0	1	2	3												
$f(x)$	c	$2c^2$	c^2	$3c^2$												
4	A random variable X has the following PMF <table><tr><td>X</td><td>0</td><td>1</td><td>2</td><td>3</td></tr><tr><td>$f(x)$</td><td>$\frac{k}{2}$</td><td>$\frac{k}{3}$</td><td>$\frac{k+1}{3}$</td><td>$\frac{2k-1}{6}$</td></tr></table> Find (i) the value of k (ii) Mean of X.	X	0	1	2	3	$f(x)$	$\frac{k}{2}$	$\frac{k}{3}$	$\frac{k+1}{3}$	$\frac{2k-1}{6}$	3	CO1	L1		
X	0	1	2	3												
$f(x)$	$\frac{k}{2}$	$\frac{k}{3}$	$\frac{k+1}{3}$	$\frac{2k-1}{6}$												
5	A pair of dice is thrown 4 times. If X denotes the random variable of number of doublets shown, find $V(3X + 1)$.	3	CO1	L1												
6	The probability distribution of a random variable is given by $f(x) = \frac{c}{2x}; x = 1, 2, 3.$ Find (i) the value of c (ii) $P[X \neq 1]$.	3	CO1	L1												
7	8 coins are tossed 256 times. In how many tosses do you expect no heads?	3	CO1	L1												
8	The probability mass function of a discrete random variable is $f(x) = kx$, $x=1,2,3$ where k is a constant. Find the value of k and $P(X \leq 2)$	3	CO1	L1												
8	Let X and Y have the following probability distribution. <table><tr><td>XY</td><td>1</td><td>2</td></tr><tr><td>1</td><td>0.15</td><td>0.10</td></tr><tr><td>2</td><td>0.30</td><td>0.20</td></tr><tr><td>3</td><td>0.15</td><td>0.10</td></tr></table> Check whether X and Y are independent or not.	XY	1	2	1	0.15	0.10	2	0.30	0.20	3	0.15	0.10	3	CO1	L2
XY	1	2														
1	0.15	0.10														
2	0.30	0.20														
3	0.15	0.10														
9	If a random variable X takes the values 1,2,3,4 such that $2P[X=1]=3P[X=2]=P[X=3]=5P[X=4]$, find the probability distribution.	3	CO1	L2												

10	If a random variable X takes values $\{-1,0,1\}$ such that $P[X=-1]=2P[X=0]=P[X=1]$. Find the mean of $3X+7$.	3	CO1	L2																
11	In a random experiment of throwing a die, let X denote the number turned up. Find its mean.	3	CO1	L2																
12	If X and Y are independent with $P_X(0) = 0.5, P_X(1) = 0.3, P_X(2) = 0.2, P_Y(0) = 0.6, P_Y(1) = 0.1, P_Y(2) = 0.3$, display the joint pmf of (X,Y) in a table. Also compute $P[X \leq 1, Y \leq 1]$.	3	CO1	L2																
13	The probability distribution function of a random variable X is given below. <table border="1"><tr><td>X</td><td>0</td><td>1</td><td>2</td><td>3</td></tr><tr><td>$f(x)$</td><td>0.1</td><td>0.3</td><td>0.4</td><td>0.2</td></tr></table> Find (Y) where $Y = X^2 + X$.	X	0	1	2	3	$f(x)$	0.1	0.3	0.4	0.2	3	CO1	L2						
X	0	1	2	3																
$f(x)$	0.1	0.3	0.4	0.2																
14	The probabilities that there will be 0, 1, 2, 3 power failures for a certain machine in the month of June are 0.4, 0.3, 0.2, 0.1 respectively. Find the mean and variance for the number of failures.	3	CO1	L2																
15	The joint distribution of X and Y is as follows: <table border="1"><tr><td>$X \backslash Y$</td><td>-1</td><td>0</td><td>1</td></tr><tr><td>-1</td><td>3/20</td><td>1/10</td><td>1/10</td></tr><tr><td>0</td><td>1/10</td><td>1/10</td><td>1/5</td></tr><tr><td>1</td><td>1/20</td><td>3/20</td><td>1/20</td></tr></table> Find $E(X+Y)$	$X \backslash Y$	-1	0	1	-1	3/20	1/10	1/10	0	1/10	1/10	1/5	1	1/20	3/20	1/20	3	CO1	L2
$X \backslash Y$	-1	0	1																	
-1	3/20	1/10	1/10																	
0	1/10	1/10	1/5																	
1	1/20	3/20	1/20																	
16	If X is a Poisson variable such that $P[X = 1] = P[X = 2]$, then find $P[X = 3]$.	3	CO1	L2																
17	A continuous random variable X is uniformly distributed in $(-k, k)$. Find $P[X \geq 2] = 0.25$.	3	CO1	L2																
18	Given that $f(x) = \frac{K}{2^x}$ is a probability mass function of a random variable that can take the values $x = 0, 1, 2, 3$ and 4, find (i) K and (ii) $P(X \leq 2)$.	3	CO1	L2																
19	Suppose X is a binomial random variable with parameters $n=100$ and $p=0.02$. Find $P[X < 3]$ using Poisson approximation to X .	3	CO1	L2																

20	A random variable X takes the values $-3, -2, -1, 0, 1, 2, 3$ such that $P(X=0) = P(X=1) = P(X=2) = P(X=3)$ and $P(X<0) = P(X=-3) = P(X=-2) = P(X=-1) = P(X=1) = P(X=2) = P(X=3)$. Find the probability mass function and distribution function of X .	7	CO1	L2
21	The probability mass function of a discrete random variable is $p(x) = kx, x = 1, 2, 3$ where k is a positive constant. Find (i) the value of k (ii) $P(X \leq 2)$ (iii) $E[X]$ and (iv) $\text{var}(1 - X)$.	7	CO1	L2
22	A lot of 10 items contain 3 defectives from which a sample of 4 items are drawn without replacement. Let X denote the number of defectives in the sample. Find (i) the probability distribution of X (ii) $P[X < 1]$ (iii) $P[0 < X < 2]$	7	CO1	L2
23	A coin is biased so that its head is twice as likely to appear as its tail. If the coin is tossed 6 times, find the probability of getting (i) exactly 2 heads (ii) at least 3 heads (iii) at most 4 heads	7	CO1	L2
24	Find the mean and variance of a Binomial random variable.	7	CO1	L2
25	Derive mean and variance of Poisson distribution.	7	CO1	L2
26	The joint probability distribution of X and Y is given by $f(x, y) = \frac{2x+3y}{54}$ for $x = 1, 2; y = 1, 2, 3$. Find (i) the marginal distributions of X and Y	7	CO1	L2
27	The joint distribution of a two-dimensional random variable (X, Y) is given by $p(x, y) = c(2x+3y)$, $x=0, 1, 2; y=1, 2, 3$. Find (i) the value of c (ii) the marginal distributions (iii) Are X and Y independent?	7	CO1	L2
28	The joint probability distribution of X and Y is given by, $f(x, y) = \frac{1}{27}(2x + 3y)$, $x=0, 1, 2$ and $y=0, 1, 2$. (i) Find the marginal distributions of X and Y . (ii) Are X and Y independent random variables.	7	CO1	L2

29	The pdf of a random variable X is given below. $k, P(X < 4), E(X), Var(X).$ <table><tr><td>X</td><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td></tr><tr><td>$f(x)$</td><td>k</td><td>$3k$</td><td>$5k$</td><td>$7k$</td><td>$9k$</td><td>$11k$</td><td>$13k$</td></tr></table>	X	0	1	2	3	4	5	6	$f(x)$	k	$3k$	$5k$	$7k$	$9k$	$11k$	$13k$	7	CO1	L2		
X	0	1	2	3	4	5	6															
$f(x)$	k	$3k$	$5k$	$7k$	$9k$	$11k$	$13k$															
30	A random variable X has the following probability mass function <table><tr><td>x</td><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td></tr><tr><td>$f(x)$</td><td>0</td><td>k</td><td>$2k$</td><td>$2k$</td><td>$3k$</td><td>k^2</td><td>$2k^2$</td><td>$7k^2 + k$</td></tr></table> Find (i) the value of k (ii) $P(0 < X < 5).$	x	0	1	2	3	4	5	6	7	$f(x)$	0	k	$2k$	$2k$	$3k$	k^2	$2k^2$	$7k^2 + k$	7	CO1	L2
x	0	1	2	3	4	5	6	7														
$f(x)$	0	k	$2k$	$2k$	$3k$	k^2	$2k^2$	$7k^2 + k$														
31	The joint probability mass function of two random variables X and Y is given $p(x, y) = \begin{cases} k(x + 2y) & \text{for } x = 1, 2, 3 \text{ } y = 1, 2 \\ 0 & \text{otherwise} \end{cases}$ where k is a constant (i) Find the value of k (ii) Find $P[X + Y \leq 3]$ (iii) Find the marginal density functions of X and Y and (iv) Are X and Y independent?	7	CO1	L2																		
32	Find a, b if $Y = aX + b$ has mean 4 and variance 16, where X is a random variable with mean 8 and variance 4.	7	CO1	L2																		
33	a) A random variable X has the following probability distribution: <table><tr><td>X</td><td>-2</td><td>-1</td><td>0</td><td>1</td><td>2</td><td>3</td></tr><tr><td>$f(x)$</td><td>0.1</td><td>$15k^2$</td><td>0.2</td><td>$2k$</td><td>0.3</td><td>$3k$</td></tr></table> (i) Find the value of k, (ii) the mean and variance of X.	X	-2	-1	0	1	2	3	$f(x)$	0.1	$15k^2$	0.2	$2k$	0.3	$3k$	7	CO1	L2				
X	-2	-1	0	1	2	3																
$f(x)$	0.1	$15k^2$	0.2	$2k$	0.3	$3k$																
34	The joint pdf of X, Y is given by $f(x, y) = k(x + 2y), x = 1, 2, 3; y = 1, 2, 3.$ (i) k (ii) marginal pdf of X, Y (iii) $P(X < 3, Y \geq 2).$	7	CO1	L2																		
35	Out of 600 families with 3 children each, how many families would be expected to have (i) 2 boys and 1 girl (ii) 3 boys (iii) 3 girls	7	CO1	L2																		
36	The joint density function of two random variables X and Y are given by $f(x, y) = \begin{cases} c(2x + y), & x = 1, 2; \quad y = 1, 2 \\ 0, & \text{otherwise} \end{cases}$ Compute (i) value of c (ii) Cumulative distribution functions of X and Y	7	CO1	L2																		
37	Show that Poisson distribution is a limiting case of Binomial distribution.	7	CO1	L2																		

38	The probability of a bomb hitting a target is $1/5$. Two bombs are enough to destroy a bridge. If 6 bombs are aimed at the bridge, find the probability that the bridge is destroyed.	7	CO1	L2																												
39	In a certain industrial facility, it is known that the probability of an accident on any given day is 0.005 and accidents are independent of each other. Use Poisson distribution to find the probability that in any given period of 400 days (i) there will be an accident on one day (ii) there are at most three days with an accident?	7	CO1	L3																												
40	A random variable X takes values 0,1,2 and 3 with probabilities $P(x = 0) = \frac{8}{15}$, $P(x = 1) = \frac{1}{3}$, $P(x = 2) = P(x = 3) = \frac{1}{15}$. Find the mean and variance of X . If $Y = 1000 + 300X$ find $P(Y \geq 1500)$ & $E(Y)$.	7	CO1	L3																												
41	In a certain factory turning out razor blades there is a small chance $1/500$ for a blade to be defective. The blades are supplied in packets of 10. Use Poisson distribution to calculate the approximate number of packets containing (i) no defective (ii) one defective (iii) two defective blades in a consignment of 10,000 packets.	7	CO1	L3																												
42	The joint probability distribution of X and Y is given in the following table <table border="1"> <tr> <td></td> <td>Y=1</td> <td>Y=2</td> <td>Y=3</td> <td>Y=4</td> <td>Y=5</td> <td>Y=6</td> </tr> <tr> <td>X=0</td> <td>0</td> <td>0</td> <td>1/32</td> <td>2/32</td> <td>2/32</td> <td>3/32</td> </tr> <tr> <td>X=1</td> <td>1/16</td> <td>1/16</td> <td>1/8</td> <td>1/8</td> <td>1/8</td> <td>1/8</td> </tr> <tr> <td>X=2</td> <td>1/32</td> <td>1/32</td> <td>1/64</td> <td>1/64</td> <td>0</td> <td>2/64</td> </tr> </table> Evaluate the following (i) $P[X \leq 1]$ (ii) $P[Y \leq 3]$ (iii) $P[X \leq 1, Y \leq 3]$ (iv) $P[X + Y \leq 4]$		Y=1	Y=2	Y=3	Y=4	Y=5	Y=6	X=0	0	0	1/32	2/32	2/32	3/32	X=1	1/16	1/16	1/8	1/8	1/8	1/8	X=2	1/32	1/32	1/64	1/64	0	2/64	7	CO1	L3
	Y=1	Y=2	Y=3	Y=4	Y=5	Y=6																										
X=0	0	0	1/32	2/32	2/32	3/32																										
X=1	1/16	1/16	1/8	1/8	1/8	1/8																										
X=2	1/32	1/32	1/64	1/64	0	2/64																										
43	A random variable X takes values 0,1, 2 and 3 with probabilities $P(X = 0) = \frac{8}{15}$, $P(X = 1) = \frac{1}{3}$, $P(X = 2) = P(X = 3) = \frac{1}{15}$ (i) Find the mean and variance of X . If $Y = 1000 + 300X$ find $P(Y \geq 1500)$ and $E[Y]$	7	CO1	L3																												
44	The probability of an item produced by a certain machine will be defective is 0.05. If the produced items are sent to the market in packets of 20, find the number of packets containing (i) atleast 2 (ii) exactly 2 (iii) atmost 2 defective items in a consignment of 1000 packets using Poisson distribution.	7	CO1	L3																												

45	The probability that an electric component manufactured by a firm is defective is 0.01. If the produced items are sent to the market in packets of 10, find the number of packets containing exactly two defectives and at most two defectives in a consignment of 1000 packets using (i) binomial distribution and (ii) Poisson approximation to binomial distribution.	7	CO1	L3
46	A complex electronic system is built with a certain number of backup components in its subsystems. One subsystem has four identical components, each with a probability of 0.2 of failing in less than 1000 hours. The subsystem will operate as long as any two of the four components are operating. Assume that the components operate independently. Find the probability that i) exactly two of the four components last longer than 1000 hours. ii) the subsystem operates longer than 1000 hours.	7	CO1	L3
47	A gambler plays a game of rolling a die with the following rules. He will win Rs. 200 if he throws a 6, but will lose Rs. 40 if he throws 4 or 5 and lose Rs. 60 if he throws 1, 2 or 3. Find the expected value that the gambler may gain.	7	CO1	L3
48	Two fair dice are rolled. Let X denote the number on the first die and $Y = 0$ or 1 , according to whether the first die shows an even number or odd number. Find (i) the joint probability distribution of X and Y , (ii) the marginal distributions, (iii) Are X and Y independent?	7	CO1	L3
49	The number of gamma rays emitted per second by a certain radioactive substance follows a Poisson distribution with mean 8. Determine the probability that (i) three particles are emitted in one second (ii) at most one particle is emitted in one second (iii) more than one particle is emitted in one second.	7	CO1	L3
50	It is known that 2% of the bolts produced by a company are defective. The bolts are supplied in boxes of 200 bolts. What is the probability that a randomly chosen box contains not more than 5 defective bolts? In a consignment of 1000 such boxes, how many can be expected to have more than 5 defective bolts? (Use Poisson distribution)	7	CO1	L3
Module 2				
Sl. No	Question	Marks	CO	BL
1	A random variable X has the probability density function $f(x) = kx(2x - 1), 0 < x < 2$. Find the value of k and mean.	3	CO2	L2

2	Find the mean and variance of the continuous random variable X with probability density function $f(x) = \begin{cases} 2x - 4, & 2 \leq x \leq 3 \\ 0, & \text{otherwise} \end{cases}$	3	CO2	L2
3	Find the mean and variance of the probability density $f(x) = \begin{cases} \cos x, & 0 < x < \frac{\pi}{2} \\ 0, & \text{elsewhere} \end{cases}$	3	CO2	L2
4	The time in hours, required to repair a machine is exponentially distributed with mean 4. What is the probability that the repair time exceeds 4 hours?	3	CO2	L2
5	The error involved in making a certain measurement is a continuous random variable X with pdf $f(x) = \begin{cases} 0.09375(4 - x^2) : -2 \leq x \leq 2 \\ 0 : \text{otherwise} \end{cases}$. Compute (i) P (X > 0). (ii) P (-1 < X < 1).	3	CO2	L2
6	If random variable X has a uniform distribution in (-3,3), find P (X - 2	3	CO2	L2
7	A continuous random variable X is uniformly distributed with mean 1 and variance 4/3. $P(X < 0)$	3	CO2	L2
8	A random variable X follows exponential distribution with mean 3. $P(X > 3), \text{Variance}(X)$	3	CO2	L2
9	A random variable X follows exponential distribution with mean 6. Find the probability of (i) $P(X \leq 10)$ (ii) $P(5 \leq X \leq 10)$.	3	CO2	L2
10	The joint density of two random variables is given by $f(x, y) = \begin{cases} ke^{-2x-3y}, & x \geq 0, y \geq 0 \\ 0, & \text{otherwise} \end{cases}$ Find the value of k.	3	CO2	L2
11	A continuous random variable X is uniformly distributed in $(-k, k)$. Find $P[X \geq 2] = 0.25$.	3	CO2	L2
12	The time for a superglue to set can be treated as a random variable having a normal distribution with mean 30 seconds.	3	CO2	L3

	Find its standard deviation if the probability is 0.20 that it will take on a value greater than 39.2 seconds.			
13	If $X_1, X_2, \dots, X_n$ are random variables with mean $\mu = 2$ and variance σ^2 then use central limit theorem to estimate $P[110 \leq S_n \leq 150]$, where $S_n = X_1 + X_2 + \dots + X_n$ and $n = 75$.	3	CO2	L3
14	The random variable X is exponentially distributed with mean 3. Find $P(X > t + 3 X > t)$ where t is any positive real number.	3	CO2	L3
15	Find the mean and variance for the pdf $f(x) = \begin{cases} kx^2, & 0 < x < 1 \\ 0, & \text{elsewhere} \end{cases}$	7	CO2	L2
16	If a continuous random variable has pdf $f(x) = \begin{cases} k e^{-3x}, & x > 0 \\ 0, & x = 0 \end{cases}$ Find (i) value of k (ii) $P[0 < X \leq 2]$ (iii) $P[X > 1.5]$	7	CO2	L2
17	Find the mean and variance of a random variable X which is uniformly distributed in the interval $[a, b]$	7	CO2	L2
18	Derive mean and variance of exponential distribution.	7	CO2	L2
19	Suppose that the length of a phone call in minutes is an exponential random variable with parameter $\lambda = \frac{1}{10}$. If someone arrives immediately ahead of you at a telephone booth, find the probability that you will have to wait: i) More than 10 minutes ii) Between 10 and 20 minutes.	7	CO2	L2
20	A continuous random variable has the distribution function $F(x) = \begin{cases} 0 & \text{if } x < 0 \\ k(x-1)^3 & \text{if } 0 \leq x \leq 4 \\ 1 & \text{if } x > 4 \end{cases}$ Find (i) value of k (ii) probability density function $f(x)$ of $F(x)$ and (iii) $P[X \geq 1]$.	7	CO2	L2
21	If X is a random variable with PDF $f(x) = \begin{cases} \frac{x^2}{3}, & -1 < x < 2 \\ 0, & \text{elsewhere} \end{cases}$. Find (i) Mean of X (ii) Variance of X (iii) Cdf of X .	7	CO2	L2

22	A random variable X has probability density function $f(x) = \begin{cases} \frac{3}{4}(1 - x^2), & -1 \leq x \leq 1 \\ 0, & \text{otherwise} \end{cases}$ Find the mean and variance of $Y = 2X - 3$.	7	CO2	L2
23	The time in hours required to repair a machine is exponentially distributed with mean 20. What is the probability that the required time (i) exceeds 30 hours? (ii) between 16 hours and 24 hours?	7	CO2	L2
24	If $f(x) = kx^2e^{-x}$, $x > 0$, find k , mean and variance of the random variable.	7	CO2	L2
25	Let X follows an exponential distribution with pdf $f(x) = \begin{cases} \frac{1}{5}e^{-x/5}, & x > 0 \\ 0, & \text{otherwise} \end{cases}$ Evaluate (i) $P[X > 5]$ (ii) $P[3 \leq X \leq 6]$ (iii) Mean (iv) Variance	7	CO2	L2
26	On a large group of men, 5% are under 60 inches in height and 40 % are between 60 and 65 inches. Assuming normal distribution, find the mean and standard deviation of the height.	7	CO2	L3
27	The joint probability density function of a two-dimensional random variable (X, Y) is given by $f(x, y) = xy^2 + \frac{x^2}{8}$, $0 \leq x \leq 2$, $0 \leq y \leq 1$. Compute (i) $P(X > 1)$ (ii) $P\left(Y < \frac{1}{2}\right)$ (iii) $P(X < Y)$	7	CO2	L3
28	If X follows a normal distribution with mean 65 and SD 9, Find (a) $P(X < 54)$ (b) $P(X \geq 80)$ (c) $P(70 < X < 86)$	7	CO2	L3
29	In a test on 2000 electric bulbs, it was found that the life of a particular make was normally distributed with an average of 2040 hours and Standard deviation of 60 hours. Estimate the number of bulbs likely to burn for (i) more than 2150 hours (ii) less than 1950 hours (iii) more than 1920 hours but less than 2160 hours.	7	CO2	L3
30	The number of miles that a particular car can run before its battery wears out is exponentially distributed with an average of 10,000 miles. The owner of the car needs to take a 5000 miles trip. He wants to know the probability p that he will be able to complete the trip without having to replace the car battery. Find	7	CO2	L3

	p if he starts the journey (i) with a fresh battery (ii) with a battery that has already covered 2000 miles.			
31	The lifetime of a certain type of electric bulb may be considered as an exponential random variable with mean 50 hours. Using central limit theorem, find the approximate probability that 100 of these electric bulbs will provide a total of more than 6000 hours of burning time.	7	CO2	L3
32	A bus arrives every 10 minutes at a bus stop. Assuming that the waiting time X for a bus is uniformly distributed, find the probability that the person has to wait (i) For more than 7 minutes (ii) Between 2 to 7 minutes	7	CO2	L3
33	The monthly salary (in Rs.) of 1000 employees in a factory are normally distributed with mean 20,000 and standard deviation 5000. Estimate the number of employees whose monthly salary will be (i) between 18,000 and 22,000 (ii) less than 18,000	7	CO2	L3
34	The IQ of an individual randomly selected from a population is a normal distribution with mean 100 and standard deviation 15. Find the probability that an individual has IQ (i) above 140 (ii) between 120 and 130.	7	CO2	L3
35	The actual amount of instant coffee that a filling machine puts into 4 ounce jars may be looked upon as a random variable having a normal distribution with $\sigma = 0.04$ ounce. If only 2% of the jars are to contain less than 4 ounces, what should be the mean fill of these jars.	7	CO2	L3
36	In an examination 30% of the candidates obtained marks below 40 and 10% of the candidates got above 75 marks. Assuming that the marks are normally distributed, find the mean and standard deviation of the distribution.	7	CO2	L3
37	The time to microwave a bag of popcorn using the automatic setting can be treated as a random variable having a Normal distribution with standard deviation 10 seconds. If the probability is 0.8212 that the bag will take less than 282.5 seconds to pop, find the probability that it will take longer than 258.3 seconds to pop.	7	CO2	L3
38	The joint probability density function of two continuous random variables X and Y is given by $f(x, y) = \begin{cases} kx^2y & \text{if } 1 \leq x \leq 4, 0 \leq y \leq 4 \\ 0 & \text{otherwise} \end{cases}$. Find (i) value of k (ii) $P[X \geq 2, Y \leq 2]$ and (iii) $P[X + Y < 3]$.	7	CO2	L3

39	The time (in hours) required to repair a machine is exponentially distributed with mean 2. (i) What is the probability that the repairing time exceeds 2 hours? (ii) What is the conditional probability that a repair takes at least 10 hours given that its duration exceeds 9 hours?	7	CO2	L3
40	Suppose the diameter at breast height (in.) of trees of a certain type is normally distributed with mean 8.8 and standard deviation 2.8 (i) What is the probability that the diameter of a randomly selected tree will be at least 10 in.? (ii) What is the probability that the diameter of a randomly selected tree will exceed 20 in.? (iii) What is the probability that the diameter of a randomly selected tree will be between 5 in and 10 in.?	7	CO2	L3
41	Buses arrived at a specified stop at 15 minute intervals starting at 7 am and 7.30 am. A passenger arrives at the stop at random time between 7 am and 7.30 am. Find the probability that he waits (i) less than 5 minutes, (ii) at least 12 minutes.	7	CO2	L3
42	For a normally distributed population, 31% of the items have their values less than 45 and 8% are above 64. Find the mean and standard deviation of the distribution.	7	CO2	L3
43	The lifetime of a certain type of machine follows an exponential distribution with mean 50 hours. Use Central Limit Theorem to find the probability that 100 of these machines will provide a total life time of more than 6000 hours.	7	CO2	L3
44	In a Normal distribution 17% of items are below 30 and 17% of the items are above 60. Find mean and variance	7	CO2	L3
45	The mean height of students follows a normal distribution with mean 68.22 inches and variance of 10.8 inches. How many students out of 1000 would you expect to be over 72 inches height?	7	CO2	L3
46	The joint probability density function of two random variables X and Y is given by $f(x, y) = \begin{cases} \frac{1}{3}(3x^2 + xy), & 0 < x < 1; 0 < y < 2 \\ 0, & \text{otherwise} \end{cases}$ Evaluate (i) $E[X]$ (ii) $E[Y]$ (iii) $P[X + Y \geq 1]$	7	CO2	L4

47	The joint density function of two continuous random variables X, Y is given by $f(x, y) = \begin{cases} K(1 - x - y), & 0 < x < \frac{1}{2}; 0 < y < \frac{1}{2} \\ 0, & \text{otherwise} \end{cases}$ Find (i) the value of K (ii) $P\left(X < \frac{1}{4}, Y > \frac{1}{4}\right)$ (iii) the marginal distributions of X, Y (iv) check whether X, Y are independent.	7	CO2	L4
48	The joint density function of random variables X and Y is given by $f(x, y) = \begin{cases} e^{-(x+y)}, & x > 0, y > 0 \\ 0 & \text{otherwise.} \end{cases}$ Find $P(X + Y \leq 1)$. Are X and Y independent? Justify.	7	CO2	L4
49	The joint pdf of (X, Y) is $f(x, y) = \begin{cases} 8xy, & 0 < y < x < 1 \\ 0, & \text{otherwise} \end{cases}$ i) Check whether X and Y are independent ii) Find $P(X + Y < 1)$	7	CO2	L4
50	The joint density function of 2 continuous random variable X and Y is $f(x, y) = \begin{cases} cxy; & 0 < x < 4, 1 < y < 5 \\ 0; & \text{otherwise} \end{cases}$ (i) Find the value of the constant c. (ii) Find $P(X \geq 3, Y \leq 2)$ (iii) Find the marginal density of X.	7	CO2	L4
51	The cumulative distribution function of a continuous variable X is given by $F(x) = \begin{cases} 0, & x \leq 2 \\ c(x - 2), & 2 < x < 6 \\ 1, & x \geq 6 \end{cases}$ Find (i) p.d.f (ii) value of c (iii) $P(1 \leq X \leq 5)$	7	CO2	L4
52	Examine whether the random variables X and Y are independent, whose joint probability density function is $f(x, y) = xe^{-x(y+1)}, 0 < x; y < \infty$	7	CO2	L4
53	A distribution with unknown mean μ has variance equal to 1.5. By using central limit theorem, find how large a sample should be taken in order that the probability will be at least 0.95 that the sample mean will be within 0.5 of the population mean.	7	CO2	L5

54	The life time of a certain brand of tube light may be considered as a random variable with mean 1200 hours and standard deviation 250 hours. Using Central limit theorem, find the probability that the average life time of 60 lights exceeds 12500 hours.	7	CO2	L5
55	If $X_1, X_2, \dots, X_n$ are Poisson variables with parameter $\lambda=2$, use the central limit Theorem to estimate $P(120 < S_n < 160)$ where $S_n = X_1 + X_2 + \dots + X_n$ with $n=75$.	7	CO2	L5
56	A random sample of size 100 is taken from a population with mean 60 and variance 400. Using Central limit Theorem, with what probability can we assert that the mean of the sample will not differ from $\mu=60$ by more than 4.	7	CO2	L5

Prepared By : Prof. Neethu Rose T.H

Checked By : Prof. Shereeta D'Cotha

1. Prescribed Syllabus

Module	Topic	Hours
1	Wave shaping circuits: First order RC differentiating and integrating circuits, First order RC low pass and high pass filters. Diode Clipping circuits - Positive, negative and biased clipper. Diode Clamping circuits - Positive, negative and biased clamper. Transistor biasing: Need, operating point, concept of DC load line, fixed bias, self-bias, voltage divider bias, bias stabilization.	16
2	BJT Amplifiers: RC coupled amplifier (CE configuration) – need of various components and design, Concept of AC load lines, voltage gain and frequency response. Small signal analysis of CE configuration using small signal hybrid-pi model for mid frequency and low frequency. (gain, input and output impedance). High frequency equivalent circuits of BJT, Miller effect, Analysis of high frequency response of CE amplifier.	11
3	MOSFET amplifiers: MOSFET circuits at DC, MOSFET as an amplifier, Biasing of discrete MOSFET amplifier, small signal equivalent circuit. Small signal voltage and current gain, input and output impedance of CS configuration. CS stage with current source load, CS stage with diode-connected load. Multistage amplifiers - effect of cascading on gain and bandwidth. Cascode amplifier.	7
4	Feedback amplifiers: Effect of positive and negative feedback on gain, frequency response and distortion. The four basic feedback topologies, Analysis of discrete BJT circuits in voltage-series and voltage-shunt feedback topologies - voltage gain, input and output impedance. Oscillators: Classification, criterion for oscillation, Wien bridge oscillator, Hartley and Crystal oscillator. (working principle and design equations of the circuits; analysis of Wien bridge oscillator only required).	9
5	Power amplifiers: Classification, Transformer coupled class A power amplifier, push pull class B and class AB power amplifiers, complementary-symmetry class B and Class AB power amplifiers, efficiency and distortion (no analysis required) Regulated power supplies: Shunt voltage regulator, series voltage regulator, Short circuit protection and fold back protection, Output current boosting.	7

2. Text Books (T)

T1. Robert Boylestad and L Nashelsky, “Electronic Devices and Circuit Theory”, 11/e Pearson, 2015.

T2. Sedra A. S. and K. C. Smith, “Microelectronic Circuits”, 6/e, Oxford University Press, 2013.

3. Reference Books (R)

- R1. Razavi B., “Fundamentals of Microelectronics”, Wiley, 2015
 R2. Neamen D., “Electronic Circuits, Analysis and Design”, 3/e, TMH, 2007.
 R3. David A Bell, “Electronic Devices and Circuits”, Oxford University Press, 2008.
 R4. Rashid M. H., “Microelectronic Circuits - Analysis and Design”, Cengage Learning, 2/e, 2011
 R5. Millman J. and C. Halkias, “Integrated Electronics”, 2/e, McGraw-Hill, 2010.

4. Course Objectives

This course aims to develop the skill of analyse and design of different types of analog circuits using discrete electronic components.

5. Course Pre / Co-requisite:

EST130 Basics of Electrical and Electronics Engineering

6. Course Outcomes

After the completion of the course the student will be able to

CO1: Design analog signal processing circuits using diodes and first order RC circuit

CO2: Analyze basic amplifiers using BJT and MOSFET

CO3: Apply the principle of oscillator and regulated power supply circuits

7. Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes

PO/ CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	H	H	H						M	M		M	H		
CO2	H	H	H	M	H					M		M	H	M	H
CO3	H	H	H	M	H					M		M	H	M	H

8. Justification for CO-PO-PSO Correlation

CO	Justification Statement
	PO1 - They apply basic knowledge on working of active and passive components to analyses various circuits.
	PO2 - They involve in Identifying and analyzing electronic circuits reaching substantiated conclusions using first basic concepts of electronics

CO1	PO3 - They involve in providing solutions by analyzing circuits using active and passive components.
	PO12 - They apply knowledge of elementary circuits to analyze more complex electronics and communication systems.
	PSO1 - They absorb and apply contextual knowledge of Electronics and Communication Engineering in design and development of various electronic circuits
CO2	PO1 - They apply basic knowledge in mathematics and working of active and passive components to analyze various circuits.
	PO2 - They involve Identifying and analyzing electronic circuits reaching substantiated conclusions using first principles of mathematics, and basic concepts of electronics
	PO3 - They analyze circuits using elementary components that meet the given specifications
	PO5 – It involves use of modern engineering and IT tools to simulate circuits.
	PO12 - They apply knowledge of elementary circuits to analyze more complex electronics and communication systems.
	PSO1 - They absorb and apply contextual knowledge of Electronics and Communication Engineering in design and development of various electronic circuits
	PSO2 - They Analyze and synthesize the experimental data from electronic system to validate the design.
CO3	PSO3 - They apply modern engineering tools to analyze and to simulate circuits.
	PO1 - They apply basic knowledge in mathematics and working of active and passive components to analyze various circuits..
	PO2 - They involve in Identifying and analyzing electronic circuits reaching substantiated conclusions using first principles of mathematics, and basic concepts of electronics
	PO3 - They design circuits using elementary components that meet the given specifications
	PO5 - It involves use of modern engineering and IT tools to simulate circuits.
	PO12 - They apply knowledge of elementary circuits to analyze more complex electronics and communication systems.
	PSO1 - They absorb and apply contextual knowledge of Electronics and Communication Engineering in design and development of various electronic circuits
	PSO2 - They Analyze and synthesize the experimental data from electronic system to validate the design.
	PSO3- They apply modern engineering tools to analyze and to simulate circuits.

9. Curricular gaps (if any):

Nil

10. Course Enrichment Activities:

Special Circuit Simulation in the lab

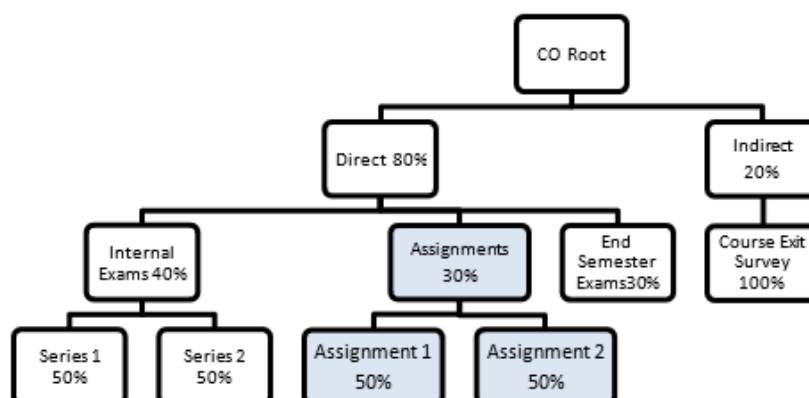
11. Internal Assessment mark allocation (as per university curriculum)

Attendance	- 10 marks
Continuous Assessment Test	- 25 marks
Assignment (s)/ Course Project	- 15 marks
<u>Total</u>	<u>- 50 marks</u>

12. Assessment – CO Mapping (Put ‘ x ’ if mapping is present)

	Tools		Weightage [#]	CO1	CO2	CO3
Direct Assessment Tools**	Internal Exam(s) 40%	Series 1	20%	x	x	
		Series 2	20%		x	x
	Assignment(s)/ Course Project /Quiz etc. 30%	Assg 1		x	x	
		Assg 2			x	x
	End Semester Exam		30%	x	x	x
Indirect Assessment Tool	Course Exit Survey		100%	x	x	x

13. Assessment Configuration



14. Course Plan

Hour	Topic	Module	Reference(s)	Teaching Pedagogy
1	Need of biasing, operating point, bias stabilization, concept of load line	1	T1	Lecture
2	Need of biasing, operating point, bias stabilization, concept of load line	1	T1	Lecture
3	Design of fixed bias, self bias	1	T1	Lecture
4	Design of voltage divider bias.	1	T1	Lecture
5	Analysis and design of First order RC Differentiator and high pass filters	1	T1	Lecture

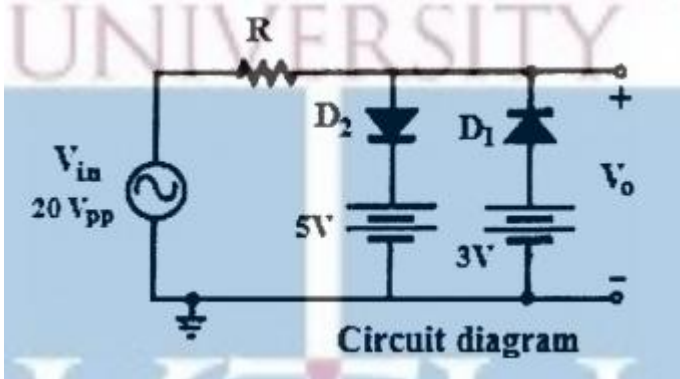
6	Analysis and design of First order RC Integrator and low pass filters	1	T1	Lecture
7	Design of RC Integrator and Differentiator	1	T1	Tutorial
8	Clipping circuits - Positive, negative and biased clipper	1	T1	Lecture
9	Clamping circuits - Positive, negative and biased clamper	1	T1	Lecture
10	Clipping circuits - Positive, negative and biased clipper	2	T1	Lecture
11	Classification of amplifiers, RC coupled amplifier (CE configuration)	2	T1	Lecture
12	need of various components and design, Concept of AC load lines in RC coupled Amplifier	2	T1&T2	Lecture
13	Small signal analysis of CE configuration using small signal hybrid $\tilde{h}$ model for mid frequency. (gain, input and output impedance).	2	T1&T2	Lecture
14	Small signal analysis of CE configuration using small signal hybrid $\tilde{h}$ model for mid frequency. (gain, input and output impedance).	2	T1&T2	Tutorial
15	Small signal analysis of CE configuration using small signal hybrid $\tilde{h}$ model for mid frequency. (gain, input and output impedance).	2	T1&T2	Lecture
16	High frequency equivalent circuits of BJT	2	T1&T2	Lecture
17	Miller effect	2	T1&T2	Flipped Classroom
18	Analysis of high frequency response of CE amplifier. voltage gain and frequency response	2	T1&T2	Lecture
19	MOSFET circuits at DC, MOSFET as an amplifier	3	T1&T2	Flipped Classroom
20	Analysis of high frequency response of CE amplifier. voltage gain and frequency response	3	T1&T2	Tutorial
21	Biasing of discrete MOSFET amplifier	3	T1&T2	Lecture
22	Small signal equivalent circuit. Small signal voltage and current gain, input and output impedances of CS configuration	3	T1&T2	Lecture

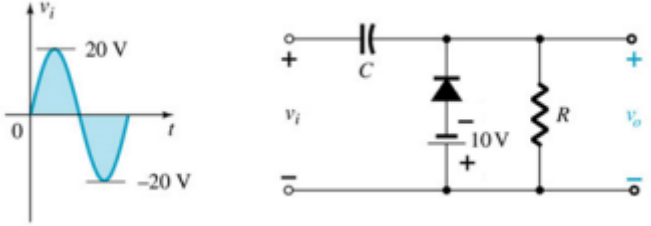
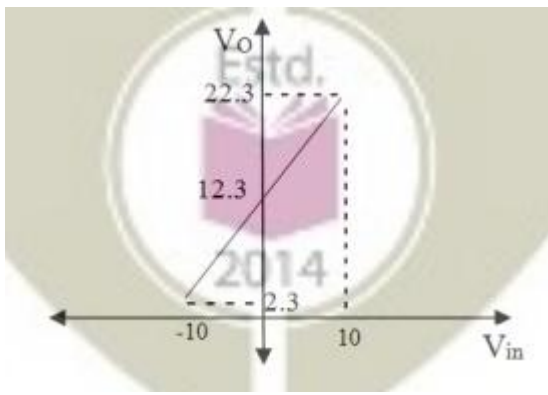
23	Small signal equivalent circuit. Small signal voltage and current gain, input and output impedances of CS configuration	3	T1&T2	Tutorial
24	CS stage with diode-connected load.	3	T1&T2	Lecture
25	CS stage with current source load	3	T1&T2	Lecture
26	Multistage amplifiers - effect of cascading on gain and bandwidth	3	T1&T2	Lecture
27	Cascode amplifier.	3	T1&T2	Lecture
28	Properties of positive and negative feedback on gain, frequency response and distortion.	4	T1&T2	Lecture
29	Analysis of discrete circuits in each feedback topologies -voltage gain, input and output impedance	4	T1&T2	Lecture
30	Analysis of the four basic feedback topologies	4	T1&T2	Flipped Classroom
31	Analysis of discrete circuits in each feedback topologies -voltage gain, input and output impedance	4	T1&T2	Lecture
32	Analysis of discrete circuits in each feedback topologies -voltage gain, input and output impedance	4	T1&T2	Tutorial
33	Classification, criterion for oscillation	4	T1&T2	Lecture
34	Hartley oscillator.	4	T1&T2	Lecture
35	Wien bridge oscillator,	4	T1&T2	Lecture
36	Crystal oscillator.	4	T1&T2	Lecture
37	Classification, Transformer coupled class A power amplifier	5	T1&T2	Flipped Classroom
38	push pull class B and class AB power amplifiers efficiency and distortion	5	T1&T2	Lecture
39	Principle of Linear Regulated power supplies, Shunt voltage regulator	5	T1&T2	Lecture
40	Complementary symmetry class B and Class AB power amplifiers, efficiency and distortion	5	T1&T2	Lecture
41	Series voltage regulator, Short circuit protection and fold back protection, Output current boosting	5	T1&T2	Lecture
42	Series voltage regulator, Short circuit protection and fold back protection, Output current boosting	5	T1&T2	Lecture

43	Series voltage regulator, Short circuit protection and fold back protection, Output current boosting	5	T1&T2	Tutorial

15. QUESTION BANK

Module 1				
Sl. No.	Question	Marks	CO	BL
1.	Define wave shaping circuits.	3	CO1	L1
2.	Differentiate linear and non-linear wave shaping circuits.	3	CO1	L1
3.	Explain cross over distortion.	3	CO1	L1
4.	Write a short note on Bias stabilization.	3	CO1	L1
5.	List some applications of clamper circuits.	3	CO1	L1
6.	Explain load line in transistor biasing.	3	CO1	L1
7.	List some applications of clipper circuits.	3	CO1	L2
8.	Show that a low pass circuit with a time constant acts as Integrator?	3	CO1	L2
9.	Define Series clipper and shunt clipper.	3	CO1	L2
10.	Brief on transistor DC biasing.	3	CO1	L2
11.	Differentiate AC and DC load line.	3	CO1	L2
12.	Brief on first order RC low pass filter.	3	CO1	L2
13.	Explain the need of the biasing circuit.	3	CO1	L2
14.	Explain the criteria for which a high pass filter acts as an Differentiator.	3	CO1	L2
15.	Design an integrator for an input frequency of 1kHz.	3	CO1	L2
16.	Describe the role of DC load line in locating the operating point of transistor.	3	CO1	L2
17.	Justify that a clamping circuit is a dc inserter.	3	CO1	L3
18.	Justify that a clamping Circuit is a Non-linear Wave Shaping Circuit?	3	CO1	L3
19.	Design a circuit using passive components to convert a 1 KHz triangular wave to a square wave.	5	CO1	L3
20.	Brief on first order RC high pass filter.	6	CO1	L2

21.	Explain the response of RC High Pass circuit for the following input waveforms A) Step B) Pulse.	6	CO1	L2
22.	Explain voltage divider bias with the help of a neat circuit diagram.	6	CO1	L2
23.	Brief on fixed biasing with the help of a neat circuit diagram.	6	CO1	L2
24.	Determine the stability factor of a fixed bias CE-BJT amplifier with $V_{CC}=12V$, $R_C=10K$, $R_B=5k$ and $\beta=120$	6	CO1	L2
25.	Design a differentiator circuit for a square wave signal with $V_{pp}=10$ and frequency 10KHz	6	CO1	L2
26.	Design an RC low pass filter with 1 khz cut-off frequency and plot its frequency response.	8	CO1	L2
27.	Draw and explain the working of First order RC differentiating circuits.	8	CO1	L2
28.	Design the circuit diagram of Slicer? Explain its operation.	10	CO1	L2
29.	Explain the operation of RC circuits as Integrators and differentiators for a square wave input with the circuit diagram and waveforms.	14	CO1	L2
30.	Draw and explain the working of Diode Clipping circuits - Positive, negative and biased clipper.	14	CO1	L2
31.	Draw and explain the working of Diode Clamping circuits - Positive, negative and biased clamper.	14	CO1	L2
32.	Draw the output waveform and transfer characteristics of the given clipper circuit.  Circuit diagram	6	CO1	L3

33.	Consider the clamper circuit given below and draw the output waveform. 	6	CO1	L3
34.	Design a clamper circuit to get the following transfer characteristics, assuming voltage drop across the diode is 0.7V. 	10	CO1	L3
35.	Design a clipper circuit that clips the 10 V input at +3.5V and -4.2 volt.	10	CO1	L3
Module 2				
1.	Explain the working of common emitter RC coupled amplifier.	3	CO2	L1
2.	Draw the ac equivalent circuit of RC coupled amplifier.	3	CO 2	L1
3.	Justify the statement that 'AC load line is steeper than that of the DC load line'.	3	CO 2	L3
4.	State Miller theorem. Also, explain the effect of feedback impedance on input and output impedance.	3	CO 2	L1
5.	Explain Miller's theorem.	3	CO2	L2
6.	Justify the statement that 'Frequency response of RC coupled amplifier decreases at low frequencies'.	3	CO2	L2
7.	Derive the effect of feedback impedance on input and output impedance.	3	CO 2	L2

8.	Construct the small signal model of CE amplifier at mid frequency.	3	CO 2	L2
9.	Define AC load line.	3	CO2	L2
10.	Draw and explain the frequency response of RC coupled amplifier.	9	CO2	L2
11.	Justify the statement that 'AC load line is steeper than that of the DC load line'.	3	CO 2	L3
12.	Draw the high frequency hybrid π model of BJT in CE configuration.	3	CO 2	L2
13.	Justify the statement that 'Frequency response of RC coupled amplifier decreases at low frequencies'	3	CO 2	L1
14.	Draw and explain the small signal high frequency hybrid π model of a common emitter amplifier with and without bypass capacitor.	10	CO2	L2
15.	Perform the small signal analysis of CE configuration using small signal hybrid-pi model for mid frequency.	10	CO2	L2
16.	Perform the small signal analysis of CE configuration using small signal hybrid-pi model for low frequency.	10	CO2	L2
17.	Draw and explain the high frequency equivalent circuits of BJT	10	CO2	L2
18.	Perform the analysis of high frequency response of CE amplifier.	14	CO2	L3
19.	Obtain the input resistance, output resistance and voltage gain of the given circuit using hybrid pi model. [Given $V_{cc}=15V$, $R_S=1K$, $R_1=22K$, $R_2=15K$, $R_C=8K$, $R_E=2K$, $C_E=C_C=C_B=0.01\mu F$, $\beta=100$ and $V_{BE}=0.7V$].	14	CO2	L3

20.	For the circuit shown below, Base biased amplifier - Draw DC load line - Mark Q point - Draw AC load line - Find the slope of ac and dc load line.	14	CO 2	L3
21.	Analyse the effect of base capacitor and coupling capacitor for an RC coupled amplifier in CE configuration at low frequency (Use hybrid π model) .	14	CO 2	L2
22.	For the circuit shown in figure, find R_i , A_v , R_o , A_i for the transistor with $\beta = 50$ and $h_{ie} = 1.1K\Omega$.	14	CO 2	L3

23.	Analyse BJT RC coupled amplifier in CE configuration at mid frequency using hybrid $\pi\pi$ model with un-bypassed base emitter resistance.	14	CO 2	L2
Module 3				
1.	Explain MOSFET as an amplifier.	3	CO3	L1
2.	Distinguish between enhancement type and depletion type MOSFET.	3	CO3	L1
3.	Explain the effect of cascading in amplifier's gain & bandwidth.	3	CO3	L2
4.	Explain effect of cascading on gain and bandwidth.	3	CO3	L2
5.	Explain Cascode amplifier.	3	CO3	L2
6.	Brief on the biasing of discrete MOSFET amplifier.	8	CO3	L2
7.	Obtain the small signal equivalent circuit of MOSFET.	8	CO3	L2
8.	Obtain the small signal voltage and current gain, input and output impedance of CS configuration.	14	CO3	L2
9.	Perform the analysis of CS stage with current source load.	14	CO3	L2
10.	Perform the analysis CS stage with diode-connected load.	14	CO3	L2
11.	Explain the construction, principle of operation, and characteristics of MOSFETs.	14	CO3	L2
Module 4				
1.	Explain feedback in amplifiers. Give the different types of feedbacks used in amplifier circuits.	3	CO4	L1

2.	Differentiate amplifiers and oscillators	3	CO4	L1
3	Describe how the Oscillations can be produced using an oscillator circuit.	3	CO4	L2
4	Discuss the role of tank circuit in oscillator circuit.	3	CO4	L2
5	Compare RC oscillators with LC oscillators.	3	CO4	L2
6	Explain barkhausen criteria as applicable to oscillator circuits.	3	CO4	L2
7	Define feedback factor or feedback ratio.	3	CO4	L2
8	List out the advantages of introducing negative feedback in amplifiers.	3	CO4	L2
9	We can't use LC oscillator for low frequency oscillations. Justify the statement .	3	CO4	L3
10	Design a Hartley oscillator to generate a frequency of 150KHz.	6	CO4	L3
11	Explain the working of Crystal oscillator.	6	CO4	L2
12.	Explain the working of Hartley oscillator with neat diagram.	6	CO4	L2
13.	Derive the expression for the frequency of oscillation of Wien bridge oscillator using BJT	10	CO4	L2
14.	Explain the working of Hartley oscillator circuit with the help of a neat diagram.	9	CO 4	L2
15.	State Barkhausen criteria for sinusoidal oscillators.	3	CO 4	L1
16.	Explain why positive feedback and not negative feedback is necessary to produce oscillations.	3	CO 4	L2
17.	List the characteristics of an amplifier that get modified by negative feedback.	3	CO 4	L1
18.	Calculate the feedback ratio, if an amplifier has a gain of 300. When negative feedback is applied, the gain is reduced to 240.	3	CO 4	L2
19.	Explain why LC oscillators are impractical at audio frequencies.	3	CO 4	L2

20.	An amplifier has an open loop gain of 90. When a negative feedback of feedback factor 0.6 is applied to it, find the overall gain.	3	CO 4	L2
21.	Explain the block diagram of four basic feedback topologies.	10	CO4	L2
22.	With the help of the circuit diagram of a Wien bridge oscillator explain its working. Also explain how Barkhausen criterion for oscillation is satisfied by the circuit .	14	CO4	L2
23.	Explain how negative feedback acts on gain, distortion, stability and frequency response of a circuit.	14	CO4	L2
24.	Perform the analysis of discrete BJT circuits in voltage-series feedback topologies (voltage gain, input and output impedance).	14	CO4	L3
25.	Perform the analysis discrete BJT circuits in voltage-shunt feedback topologies (voltage gain, input and output impedance).	14	CO4	L3
26.	In a transistorized Hartley oscillator , the tank circuit has the capacitance of 100pF. The value of inductance between collector and tapping point is 30mH and value of inductance between tapping point and transistor is 1×10^{-8} H. Determine the frequency of oscillation.(Neglect mutual inductance).	5	CO4	L2
27.	An amplifier with negative feedback has a voltage gain of 100. It is found that without feedback an input signal of 50mV is required to produce a given output whereas with feedback, the input signal must be 0.6 V for the same output. Calculate the value of voltage gain without feedback and feedback ratio.	3	CO 4	L3
28.	Explain the concept of negative feedback and draw the schematic diagrams of four basic negative feedback configurations.	3	CO 4	L2

29.	Explain feedback in amplifiers with the help of block diagram. Derive the effect of positive and negative feedback on gain of an amplifier.	14	CO 4	L2
Module 5				
1.	Differentiate regulated and unregulated power supply.	3	CO5	L1
2.	Define the term collector efficiency of power amplifiers.	3	CO5	L1
3.	Brief on complementary symmetric push pull amplifiers.	3	CO5	L2
4.	Explain crossover distortion in class B push-pull amplifiers.	3	CO5	L2
5.	Discuss on simple series voltage regulator.	3	CO5	L2
6.	Explain how impedance matching is achieved in a transformer coupled class A power amplifier.	3	CO5	L2
7.	Differentiate single ended and doubled ended push pull power amplifiers.	3	CO5	L2
8.	Explain, why power amplifiers are considered as large signal amplifier?	3	CO5	L2
9.	Mention the limitations of class B push pull amplifier.	3	CO5	L2
10.	Compare series fed and transformed coupled class A amplifiers.	3	CO5	L2
11.	List out some advantages that the transformer provides in a transformer coupled power amplifier.	3	CO5	L3
12.	Show that maximum collector efficiency of Class A Transformer coupled power amplifier is 50%?	6	CO5	L2
13.	Brief on line regulation and load regulation.	6	CO5	L2
14.	Show that a negative feedback amplifier can be made work as an oscillator.	6	CO5	L3
15.	Describe fold back protection in voltage regulators with the help of neat circuit diagram.	10	CO5	L2
16.	Explain regulated power supply with a neat block diagram.	10	CO5	L2

17.	Describe short circuit protection in voltage regulators with the help of neat circuit diagram.	10	CO5	L2
18.	Discuss on transistor series voltage regulator with a neat diagram.	14	CO5	L2
19.	Explain transistor shunt voltage regulator with the help of a neat diagram.	14	CO5	L2
20.	Compare power amplifiers with reference to conduction angle and efficiency.	14	CO5	L2
21.	Explain on classification of power amplifiers.	14	CO5	L2
22.	Discuss on series fed transistor class A power amplifier and perform its efficiency analysis.	14	CO5	L3
23.	Discuss on transformer coupled class A power amplifier and perform its efficiency analysis.	14	CO5	L3
24.	Discuss on class B push pull power amplifier and perform its efficiency analysis.	14	CO5	L3
25.	Discuss on complementary symmetric class B push pull power amplifier and perform its efficiency analysis.	14	CO5	L3

1. Prescribed Syllabus

Module	Topic	Hours
1	Elementary Signals, Classification and representation of continuous time and discrete time signals, Signal operations Continuous time and discrete time systems – Classification, Properties. Representation of systems: Differential equation representation of continuous time systems. Difference equation representation of discrete systems. Continuous time LTI systems and convolution integral. Discrete time LTI systems and linear convolution. Stability and causality of LTI systems. Correlation between signals, Orthogonality of signals.	16
2	Frequency domain representation of continuous time signals - continuous time Fourier series and its properties. Continuous time Fourier transform and its properties. Convergence and Gibbs phenomenon Review of Laplace Transform, ROC of Transfer function, Properties of ROC, Stability and causality conditions. Relation between Fourier and Laplace transforms.	11
3	Analysis of LTI systems using Laplace and Fourier transforms. Concept of transfer function, Frequency response, Magnitude and phase response. Sampling of continuous time signals, Sampling theorem for lowpass signals, aliasing.	7
4	Frequency domain representation of discrete time signals, Discrete time fourier series for discrete periodic signals. Properties of DTFS. Discrete time fourier transform (DTFT) and its properties. Analysis of discrete time LTI systems using DTFT. Magnitude and phase response.	9
5	Z transform, ROC , Inverse transform, properties, Unilateral Z transform. Relation between DTFT and Z-Transform, Analysis of discrete time LTI systems using Z transforms, Transfer function. Stability and causality using Z transform.	7

2. Text Books (T)

- T1. Alan V. Oppenheim and Alan Willsky, Signals and Systems, PHI, 2/e, 2009
T2. Simon Haykin, Signals & Systems, John Wiley, 2/e, 2003

3. Reference Books (R)

- R1. Anand Kumar, Signals and Systems, PHI, 3/e, 2013.
R2. B P. Lathi, Principles of Signal Processing & Linear systems, Oxford University Press.
R3. Gurung, Signals and System, PHI.

4. Course Objectives

This course aims to lay the foundational aspects of signals and systems in both continuous time and discrete time, in preparation for more advanced subjects in digital signal processing, image processing, communication theory and control systems.

5. Course Pre / Co-requisite

Nil

6. Course Outcomes

At the end of the course, student will be able to

CO1. Apply properties of signals and systems to classify them

CO2. Analyse signals and systems with the help of time and frequency domain representations

CO3. Apply convolution and to analyse correlations to describe orthogonality of signals

CO4. Apply transfer function to compute the LTI response to input signals.

CO5. Apply sampling theorem to discretize continuous time signals

7. Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes

PO/ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H	H	L	M	H	M	H		M	M		M	H	M	H
CO2	H	H	H	M	H	M	H		M	M		L	H	M	H
CO3	H	H	M	M	H		H		M	M		L	H	M	H
CO4	H	H	H	L	H		H		M	M		M	H	L	H
CO5	H	H	M	L			H						H		H

8. Justification for CO-PO-PSO Correlation

CO	PO/PSO	Justification
CO1	PO1	Application of knowledge in mathematical techniques will enable the students to understand the properties and to classify various signals and systems. Hence high correlation as it involves application mathematical techniques to solve problems
	PO2	Knowledge in properties of continuous and discrete time signals and systems will help the students to analyse different types of CT and DT signals and systems. Hence highly correlated
	PO3	Classifying signals and systems involves identifying patterns, behaviors, and characteristics of problem-solving skills and so low correlation is given
	PO4	Classifying signals and systems often involves delving into their properties through analytical investigation and so the Students need to thoroughly analyze the characteristics of signals and systems to classify them correctly. So medium correlation is given
	PO5	Ability to classify signals and system will help the students to generate various type of signals using a simulation tool. Hence highly correlated
	PO6	Classification of signals and systems is essential for the development of technology that directly impacts society and so medium correlation has been given
	PO9	Applying properties of signals and systems to classify them emphasizes both individual and teamwork skills through a combination of theoretical understanding, practical application, and collaborative projects and hence the correlation is given as medium
	PO10	Applying properties of signals and systems to classify them emphasizes various aspects of communication, including technical report writing, presentation skills, visual communication, collaborative communication and hence the correlation is given as medium
	PO12	Applying properties of signals and systems equip the students with strong problem-solving skills can adapt and learn new concepts independently, and hence the correlation is given as medium
	PSO1	Knowledge of different types of CT and DT signals and systems will help the students in the design, analysis and development of various electronic systems. Hence highly correlated.
	PSO2	The skills developed in classifying signals contribute directly to the ability to validate electronic system designs through practical experimentation and data analysis and hence the correlation is given as medium
	PSO3	Ability to classify signals and system will help the students will help the students to apply appropriate modern tools to generate signals. Hence highly correlated.
CO2	PO1	Understanding the Fourier series and Fourier Transform will help the students to represent signals and systems in frequency domain. High correlation is due to the fact that this involves application of Mathematical techniques such as calculus, linear algebra and statistics
	PO2	Knowledge in Fourier series and Fourier Transform will help the students to analyse signals and systems in frequency domain. Hence high correlation

	PO3	Ability to analyse signals and systems in frequency domain will help the students to design solutions based on system responses. Hence high correlation
	PO4	Analysing signals and systems involves dealing with complex problems, especially when considering both time and frequency domain representations and hence the correlation is given as medium
	PO5	Knowledge in frequency domain representation of signals and systems will help the students to analyse magnitude and phase spectra of signals using a simulation tool. Hence highly correlated
	PO6	Engineers, by understanding time and frequency domain representations, can contribute to the development and improvement of systems that directly impact society and hence the correlation is given as medium
	PO9	The analysis of signals and systems in the time and frequency domains requires individual skills or as a team in data interpretation, mathematical modeling, and problem-solving and hence the correlation is given as medium
	PO10	Analyzing signals and systems help the students to document their findings, methodologies, and results in technical reports which emphasizes on communication and hence the correlation is given as medium
	PO12	Analysis of signals and systems involves the application and development of technical skills which encourages students to pursue continuous skill development throughout their careers and hence the correlation is given as low
	PSO1	Knowledge in frequency domain representation of signals and systems will help the students to design, analyse and develop of various electronic systems and hence highly correlated.
	PSO2	Analyzing signals provides insights into the behavior of electronic systems. and thereby the Students can interpret experimental data, can identify patterns, anomalies, and characteristics that are crucial for validating the design and hence the correlation is given as medium
	PSO3	Knowledge in frequency domain representation of signals and systems will help the students to analyse magnitude and phase spectra of signals using appropriate modern tools. Hence highly correlated.
CO3	PO1	Understanding of convolution operation will help the students to determine LTI System response and hence high correlation is given.
	PO2	Knowledge in convolution will help the student to outline the relation between convolution and correlation of signals and hence its highly correlated
	PO3	Understanding the relation between convolution and correlation of signals will help the students to describe orthogonality of signals and hence its highly correlated
	PO4	Understanding Convolution and correlation involve analytical investigations into the properties and behaviors of signals and hence the correlation is given as medium
	PO5	Knowledge in convolution operation will help the students to compute the output response of systems using a simulation tool. Hence highly correlated

	PO9	Students can apply convolution and correlation techniques to analyze signals and describe their orthogonality. This individual application or in a team contributes to their skill development and focus on individual contributions to signal processing projects and hence the correlation is given as medium
	PO10	Students by applying convolution and correlation, develop the ability to communicate the concepts effectively, and hence the correlation is given as medium
	PO12	Students with the help of application of convolution and correlation adapt to new methodologies and remain current with emerging trends, and hence the correlation is given as low
	PSO1	Knowledge in convolution operation will help the students to design, analyse and develop of various electronic systems and hence highly correlated.
	PSO2	Students, by applying convolution and correlation techniques, contribute to the synthesis of experimental data, providing insights that can be crucial for validating the design of electronic systems. Hence highly correlated
	PSO3	Knowledge in convolution operation will help the students to compute the output response of system using appropriate modern tools. Hence highly correlated.
CO4	PO1	Understanding transformation operations will enable the students to compute transfer functions of LTI systems and hence high correlation is given
	PO2	Knowledge in transforms and transfer functions will help the students to analyse the LTI system response to input signals and hence high correlation is given
	PO3	Students, by applying transfer functions to compute the LTI response, learn to practically implement theoretical concepts in the context of system analysis, and hence the correlation is given as medium
	PO4	The application of transfer functions to compute the response of Linear Time-Invariant (LTI) systems to input signals involves a thorough investigation of complex problems in the field of control systems and signal processing, and hence the correlation is given as low
	PO5	Knowledge to apply transfer functions concepts will help the students to analyse the LTI system response to input signals using a simulation tool. Hence highly correlated
	PO9	Understanding how to apply transfer functions to compute the response of an LTI system is directly applicable to real-world engineering problems and hence the correlation is given as medium
	PO10	Applying transfer functions to compute the LTI response helps students develop skills and knowledge that are essential for success in their chosen field and hence the correlation is given as medium
	PO12	Application of transfer functions to compute the Linear Time-Invariant (LTI) response allows students to connect theoretical concepts to real-world applications, where systems often exhibit LTI behavior and hence the correlation is given as medium
	PSO1	Knowledge in transforms and transfer functions will help the students to design, analyse and develop of various electronic systems and hence highly correlated

	PSO2	Applying transfer functions to compute the LTI response involves problem-solving skills extended to analyzing experimental data, students learn to troubleshoot and refine their designs based on real-world observations , and hence the correlation is given as low
	PSO3	Knowledge in transforms and transfer functions will help the students to analyse the LTI system response to input signals using appropriate modern tools. Hence highly correlated.
CO5	PO1	Knowledge in frequency domain representation of signals and systems will help the students to explain sampling theorem and reconstruction process and hence highly correlated
	PO2	Knowledge in sampling theorem will enable the students to analyse various signals and spectrums to determine Nyquist sampling rate and hence its highly correlated
	PO3	Knowledge in sampling theorem will enable the students to apply sampling theorem to discretize continuous time signals and to analyse the aliasing effects for designing solutions and high correlation is given
	PO4	Understanding the concepts of will help the students to analyse and interpret data and to synthesize the information to provide valuable solutions and so low correlation has been given.
	PSO1	Knowledge in sampling theorem will help the students to design, analyse and develop of various electronic systems and hence highly correlated

9. Curricular gaps (if any)

nil

10. Course Enrichment Activities*

Sl No	Description	Proposed Activities **	Relevance to POs and PSOs
1	Simulation Assignments	In software Python	PO1, PO2, PO3, PO5, PSO1, PSO3

11. Internal Assessment mark allocation (as per university curriculum)

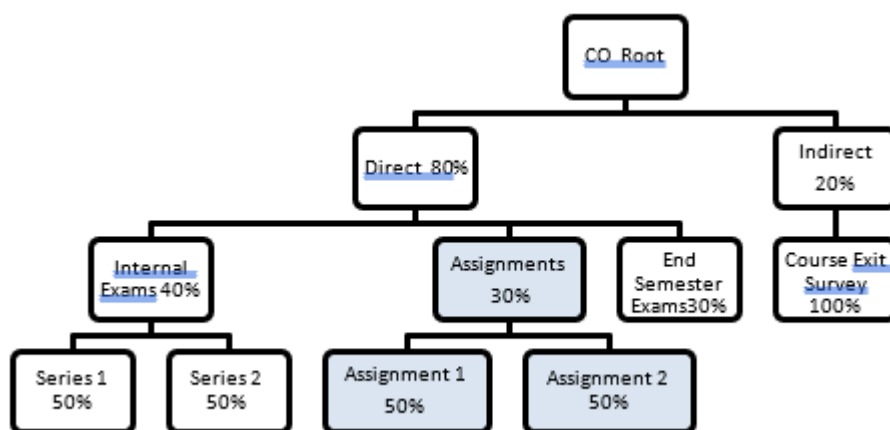
(Provide details as mentioned in syllabus)

Attendance	- 10 marks
Continuous Assessment Test	- 25 marks
<u>Assignment (s)/ Course Project</u>	<u>- 15 marks</u>
<u>Total</u>	<u>- 50 marks</u>

12. Assessment – CO Mapping (Put ‘ x ’ if mapping is present)

	Tools		Weightage	CO1	CO2	CO3	CO4	CO5
Direct Assessment Tools**	Internal Exam(s)40%	Series 1	20%	x	x	x		
		Series 2	20%		x		x	x
	Assignment (s)/30%	A1	15%	x	x			
		A2	15%				x	x
	End Semester Exam		30%					
Indirect Assessment Tool	Course Exit Survey		100%	x	x	x	x	x

13. Assessment Configuration



14. Course Plan

Hour	Topic	Module	Reference(s)	Teaching Pedagogy
1	Elementary Signals	1	R1	Lecture
2	Classification and representation of continuous time signals	1	R1	Lecture
3	Classification and representation of discrete time signals	1	R1	Lecture
4	Signal operations	1	R1	Lecture
5	Continuous time and discrete time systems and its classification	1	R1	Lecture
6	Properties of continuous time system	1	R1	Lecture
7	Properties of discrete time system	1	R1	Lecture
8	Differential equation representation of	1	R1	Lecture

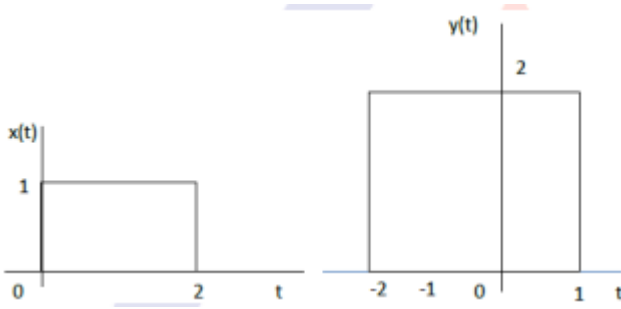
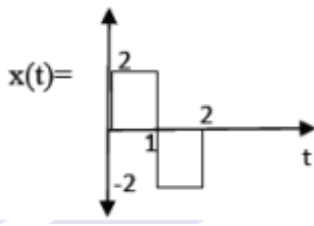
	continuous time systems			
9	Difference equation representation of discrete systems	1	R1	Lecture
10	Continuous time LTI systems	1	R1	Lecture
11	Convolution integral	1	T2	Lecture
12	Discrete time LTI systems and linear convolution.	1	T2	Lecture
13	Stability and causality of LTI systems	1	T2	Lecture
14	Correlation between signals, Orthogonality of signals	1	R1	Lecture
15	Frequency domain representation of continuous time signals	2	T2	Lecture
16	Continuous time Fourier series	2	T2	Lecture
17	Properties of continuous time Fourier series	2	T2	Lecture
18	Continuous time Fourier transform	2	T2	Lecture
19	Properties of continuous time Fourier transform	2	T2	Lecture
20	Convergence and Gibbs phenomenon	2	T2	Lecture
21	Review of Laplace Transform	2	T2	Lecture
22	ROC of Transfer function	2	T2	Lecture
23	Properties of ROC	2	R2	Lecture
24	Stability and causality conditions	2	R2	Lecture
25	Relation between Fourier and Laplace transforms	2	R2	Lecture
26	Analysis of LTI systems using Laplace and Fourier transforms	3	R2	Lecture
27	Concept of transfer function	3	R2	Lecture
28	Frequency response, Magnitude and phase response	3	T1	Lecture
29	Sampling of continuous time signals	3	T1	Lecture
30	Sampling theorem for lowpass signals	3	T1	Lecture
31	Aliasing	3	T1	Lecture
32	Frequency domain representation of discrete time signals	3	T1	Lecture
33	Discrete time Fourier series for discrete periodic signals.	4	T1	Lecture
34	Properties of DTFS	4	T1	Lecture
35	Discrete time Fourier transform (DTFT)	4	T1	Lecture
36	Properties of DTFT	4	T1	Lecture
29	Sampling of continuous time signals	3	T1	Lecture
30	Sampling theorem for lowpass signals	3	T1	Lecture

31	Aliasing	3	T1	Lecture
32	Frequency domain representation of discrete time signals	3	T1	Lecture
33	Discrete time Fourier series for discrete periodic signals.	4	T1	Lecture
34	Properties of DTFS	4	T1	Lecture
35	Discrete time Fourier transform (DTFT)	4	T1	Lecture
36	Properties of DTFT	4	T1	Lecture
37	Analysis of discrete time LTI systems using DTFT	4	T1	Lecture
38	Magnitude and Phase response	4	T1	Lecture
39	Introduction to Z transform	4	T1	Lecture
40	Concept of ROC	4	T1	Lecture
41	Inverse z transform and properties of z transform	4	T1	Lecture
42	Unilateral Z transform, Relation between DTFT and Z-Transform	4	T1	Lecture
43	Analysis of discrete time LTI systems using Z transforms	4	T1	Lecture
44	Transfer function, Stability and causality using Z transform	4	T1	Lecture
45	Unilateral Z transform, Relation between DTFT and Z-Transform	4	T1	Lecture

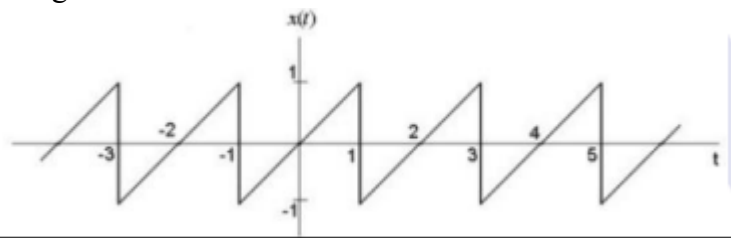
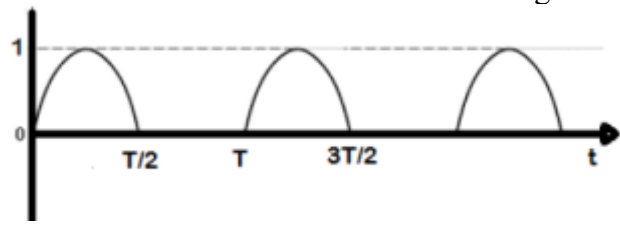
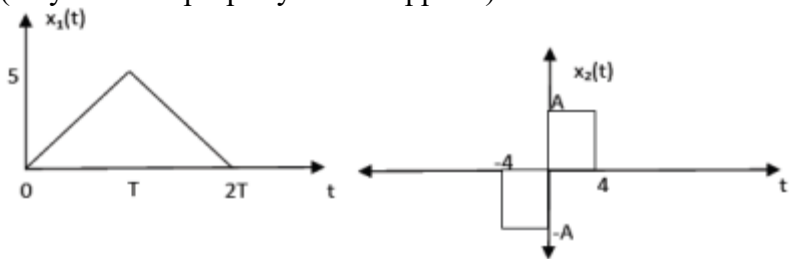
15. Question Bank

Module 1				
Sl. No.	Question	Marks	CO	BL
1	Define deterministic and random signals	3	CO1	L1
2	Define step function and delta function	3	CO1	L1
3	Define periodic and Aperiodic signals	3	CO1	L1
4	Distinguish between energy and power signals	3	CO1	L2
5	Define continuous time, discrete time and digital signals	3	CO1	L1
6	Find even and odd components of the signal, $x(t)=e^{jt}$	3	CO1	L2
7	Determine whether following signals are causal or non causal. a. $x_1(n)=u(n+3) - u(n-2)$ b. $x(t)=\text{sinc } t$	3	CO1	L2
8	Determine whether following signals are causal or non causal. a. $x(t)=e^{2t}u(-t)$ b. $x(n)=(1/2)^n u(n+2)$	3	CO1	L2

9	Find whether following signals are energy signals or power signals. a. $x(t) = \cos t$ b. $x(t) = e^{-3t} u(t)$	3	CO1	L2
10	Determine whether following systems are causal or not a. $y(t) = x(t) x(t-1)$ b. $y(t) = x(t/2)$ c. $y(n) = \cos[x(n)]$	3	CO1	L2
11	Determine whether the system is time invariant or not a. $y(t) = tx(t)$ b. $y(t) = x(t^2)$	3	CO1	L2
12	Determine whether following system is linear or not a. $\frac{dy}{dt} + 3ty(t) = t^2 x(t)$ b. $y(n) = Ax(n) + B$ c. $y(n) = nx(n)$	3	CO1	L2
13	Determine whether the system is time invariant or not a. $y(t) = x(-t)$ b. $y(t) = x(t) \cos 50\pi t$	3	CO1	L2
14	Explain about BIBO stability criterion	3	CO1	L2
15	Find whether following systems are stable or not a. $y(t) = (t+5)u(t)$ b. $h(t) = e^{2t}u(t)$	3	CO1	L2
16	Define , sketch and list the properties of continuous time impulse function	3	CO1	L1
17	Show that any signal can be represented as the summation of an odd and even signal . Write down the expression for the odd and even components of the signals $x(t)$ and $x(n)$.Find the odd and even components of the signal $X(n) = \{-2, 1, 2, -1, 3\}$	6	CO1	L2
18	Describe the condition for the the system to be dynamic, causal, linear, time invariant and stable	8	CO1	L2
19	Distinguish between energy and power signals. Calculate the energy and power of the given signal and find whether the signal is energy signal or power signal	6	CO1	L2
20	Compute the power and energy of the following signals and check whether they are power signals or energy signals: (i) $x(n) = \left(\frac{1}{3}\right)^n u(n)$ (ii) $y(t) = (1 + e^{-5t})u(t)$	5	CO1	L2
21	Find the even and odd components of the following signals (1) e^{jt} (2) $\cos t + \sin t + \cos t \sin t$	6	CO1	L2

22	Determine whether the signal $x[n] = 1 + \sin\left(\frac{5\pi n}{3} + \frac{\pi}{2}\right)$ is periodic. Find the fundamental period if its periodic	5	CO1	L2
23	Find the convolution of the given signals and sketch the result : 	10	CO3	L3
24	Find the output of an LTI system whose impulse response is $h(t) = u(t) - u(t-1)$ to the input $x(t)$. 	8	CO3	L3
25	Let $f(t) = 2(u(t) - u(t-2))$ and $g(t) = e^t(u(t) - u(t-2))$ (i) Sketch the functions $f(t)$ and $g(t)$ (ii) Compute $f(t) * g(t)$. Here * denotes convolution	6	CO3	L3
26	Find the convolution of the signal $x[n] = \{1, -1, 1, -1\}$ with itself	6	CO3	L3
28	An LTI system is characterised by $h(n) = [1 \ 2 \ 1]$. Find the system response for the given input $x(n) = [3, -1, 2, 0, 1]$	7	CO3	L3
29	Given $x_1(n) = \{1, 1, 1\}$ and $x_2(n) = \{1, 2\}$. Find the convolution of the sequences graphically.	8	CO3	L3
30	What is the output sequence of an LTI system with impulse response $h[n] = [3, 2]$ to the input $x[n] = [1, 2, 3, 3]$	7	CO3	L3
31	Derive the relation between correlation and convolution between two sequences. Find the cross correlation of two finite length sequences $x(n) = [1 \ 3 \ 2 \ 2]$ and $y(n) = [1 \ 2 \ 3 \ 2]$	8	CO3	L3
32	Compute the autocorrelation of the signal $x(n) = a^n u(n)$ for $0 < a < 1$	6	CO3	L3
33	Define cross correlation function $\phi_{XY}(\tau)$ for two signals $x(t)$ and $y(t)$. What is its connection with convolution?	6	CO1	L1
MODULE 2				

Sl. No.	Question		CO	BL
1.	Give a short note on Gibb's phenomenon	3	2	L2
2.	Explain Dirichlets conditions for the existence of Fourier Transform of a continuous time signal.	3	CO2	L1
3.	Find the Fourier transform of unit step function	3	CO2	L1
4.	Evaluate the Fourier Transform of $x(t) = \text{sgn}(t)$. Plot magnitude and phase response.	3	CO2	L1
5.	Derive the relation between Laplace transform and Continuous Time Fourier transform.	3	CO2	L1
6.	State and prove time-shifting property of Laplace transform.	3	CO2	L2
7.	State and prove Final value theorem of Laplace transform.	3	CO2	L1
8.	State and prove Initial value theorem of Laplace transform.	3	CO2	L1
9.	Give the equations for trigonometric Fourier series	3	CO2	L1
10.	Determine the Nyquist rate of sampling for the signals (i) $2\sin(250t)3\cos^2 500t$ (ii) $10\text{sinc}(500t)$	3	CO2	L1
11.	Obtain the transfer function of an ideal integrator in s domain.	3	CO2	L1
12.	A signal $x(t)=2\cos(400\pi t)+6\cos(600\pi t)$ is sampled with a sampling frequency 800Hz. Write the resultant discrete time signal.	3	CO2	L2
13.	State and prove Final value theorem of Laplace transform.	3	CO2	L1
14.	State and prove Initial value theorem of Laplace transform.	3	CO2	L1
15.	Give the equations for trigonometric Fourier series	3	CO2	L1
16.	Determine the Nyquist rate of sampling for the signals (i) $2\sin(250t)3\cos^2 500t$ (ii) $10\text{sinc}(500t)$	3	CO2	L1
17.	Obtain the transfer function of an ideal integrator in s domain.	3	CO2	L1
18.	A signal $x(t)=2\cos(400\pi t)+6\cos(600\pi t)$ is sampled with a sampling frequency 800Hz. Write the resultant discrete time signal.	3	CO2	L2
19.	A signal is given by $x(t)=2\cos(400\pi t)+6\cos(640\pi t)$. What is the minimum sampling frequency required to avoid aliasing? If the signal is ideally sampled with sampling frequency of 500 Hz, what are the frequency components present at the output?	7	CO2	L2
20.	Determine the Fourier Series Representation for $x(t)-2\sin(2t-3)\sin(6t)$	6	CO2	L2
21.	Determine the complex exponential Fourier Series representation of the signal, $x(t)=\cos(4t)+\sin(6t)$	6	CO2	L1

22.	Determine the Fourier series representation of the signal shown in figure. 	8	CO2	L2
23.	State and prove Parseval's theorem for Fourier series.	6	CO2	L3
24.	Determine the exponential Fourier series representation of half wave rectified sine wave as shown in the figure below. 	6	CO2	L2
25.	State and prove Parseval's theorem for Fourier series.	6	CO2	L1
26.	State and prove the Parseval's theorem for continuous time Fourier transforms.	8	CO2	L2
27.	Find Fourier Transform of signal $x(t) = te^{at} u(t)$	8	CO2	L2
28.	Find the CTFT of the signal $x(t) = te^{-at} u(t)$ at using an appropriate property. State and prove the property used.	8	CO2	L2
29.	Find the Fourier Transform of following signals $x_1(t)$ and $x_2(t)$. (Any relevant property can be applied) 	6	CO2	L2
30.	State and prove the Parseval's theorem for continuous time Fourier transforms.	6	CO2	L1
Module 3				
Sl. No.	Question		CO	BL
1.	State the sampling theorem for low pass signals	3	CO5	L1
2.	A signal $x(t) = 2\cos(400\pi t) + 6\cos(600\pi t)$ is sampled with a sampling frequency 800Hz. Write the resultant discrete time signal.	3	CO5	L1
3.	Describe about Anti aliasing filter	3	CO5	L2
4.	Explain about the effects of undersampling	3	CO5	L2

5.	Discuss about Nyquist rate of sampling	3	CO5	L2
6.	Define interpolation	3	CO5	L2
7.	Explain about the effects of sampling rate	3	CO5	L2
8.	State the sampling theorem for band limited signals	3	CO5	L2
9.	Discuss about the term frequency response in Fourier transform wrt a LTI system	3	CO2	L2
10.	Explain the concept of transfer function wrt a LTI system	3	CO2	L2
11.	Determine the Nyquist rate of sampling for the signals (i) $2\sin(250t)3\cos^2 500t$ (ii) $10\text{sinc}(500t)$	5	CO5	L2
12.	An LTI system has $h(t)$ such that $L\{h(t)\} = H(s) = \frac{1}{s+1}$, $\text{Re}\{s\} > -1$ Determine the system output $y(t)$ if the input is $x(t) = (e^{-t/2} + 2e^{-t/3})u(t)$	3	CO4	L1
13.	Show that the spectrum of the sampled signal is the infinite sum of shifted replicas of the spectrum of original signal.	8	CO5	L3
14.	An LTI system is characterized with the transfer function $H(s) = \frac{s^2 + 3s + 2}{s^5}$. Find the response of the system to the input $x(t) = \cos(2t)u(t)$	6	CO4	L2
15.	Find the response of a system with transfer function $H(s) = \frac{1}{(s+1)(s+0.5)}$ for unit step input.	6	CO4	L2
16.	The step response of an LTI system is by $(1 - e^{-t})u(t)$. For an input $x(t)$, the output is observed to be $(2 - 3e^{-t})u(t)$. For this observed measurement, determine the input to the system using Laplace transform.	10	CO3	L2
Module 4				
Sl NO	Question		CO	BL
26.	Give Parseval's theorem for DTFT and prove it	3	CO2	L1
27.	State and prove convolution property of DTFT.	3	CO2	L1
28.	Mathematically explain how DTFT is related with Z-transform.	3	CO2	L1
29.	Determine the DTFT of the signal $x[n] = u[n] - u[n-N]$	3	CO2	L1

30.	Find the DTFT of unit step function and impulse function	3	CO2	L1
31.	List the differences between Fourier transform of discrete time signal and analog signal	3	CO2	L1
32.	Give some applications of DTFT	3	CO2	L1
33.	State the sufficient condition for the existence of DTFT.	3	CO2	L1
34.	State the parseval's theorem for discrete time aperiodic signals	3	CO2	L2
35.	$x[n]$ is a discrete time periodic square wave with period N and amplitude 1. Nonzero samples extends from $-N/2$ to $+N/2$. Find the Fourier coefficients.	7	CO2	L2
36.	Find the discrete time Fourier series coefficients of the signal $x(n) = 5 + \sin\left(\frac{n\pi}{2}\right) + \cos\left(\frac{n\pi}{4}\right)$. Plot the magnitude and phase spectrum.	8	CO2	L2
37.	Explain the relation between DTFT and z-transform. Explain whether DTFT can be obtained from z-transform for (i) $x(n)a^n u(n)$ (ii) $x(n)u(n)$	6	CO2	L2
38.	Compute the DTFT of the signal $x(n) = \begin{cases} 10 & n \leq N \\ 0 & n > N \end{cases}$	5	CO2	L2
39.	A signal $x(n)$ has DTFT $X(e^{j\omega}) = \frac{1}{1 - ae^{-j\omega}}$ $ a < 1$. Determine the DTFT of $x(n+2)e^{j\frac{\pi}{2}n}$	6	CO2	L2
Module 5				
1.	Establish the correspondence between s-plane and z-plane	3	CO2	L1
2.	Write down properties of ROC for Z transform	3	CO2	L1
3.	List any three properties of Z-transform, state and prove the convolution property of Z transforms.	3	CO2	L1
4.	Prove that convolution in time domain is equivalent to multiplication in Z domain	3	CO2	L1
5.	Find the Z transform of $x(n)2(3)^n u(n)$	3	CO2	L1

6.	Explain how discrete time systems are analysed using Z-transforms?	3	CO2	L1
7.	State the condition for the existence of z-transform	3	CO2	L1
8.	State the initial value and final value theorem of z-transform	3	CO2	L1
9.	Define system function of LTI discrete system	3	CO4	L1
10.	State the stability and causality condition for a linear time Invariant system	3	CO4	L1
11.	Define ROC wrt Z-transform	3	CO2	L1
12.	Using Z- transform, determine the output of an LTI system with impulse response $h(n) = \{1, 2, -1, 0, 3\}$ for the input $x(n) = \{1, 2, -1\}$	8	CO2	L3
13.	Determine the z-transform and plot the ROC of the signal starting from definition of z-transform $x(n)a^nu(n)b^nu(n+1)$	6	CO2	L2
14.	Find the z-transform and ROC of the following signals: (i) $x(n)a^n$; $a < 1$	6	CO2	L2
15.	Find the Z transform and ROC of the following signals. (i) $x(n)2^nu(n)$ (ii) $x(n)(n)$	6	CO2	L2
16.	Evaluate the inverse Z-transform of $X(z) = \log\left(\frac{1}{1-az^{-1}}\right) \quad a < z $	6	CO2	L2
17.	Find all possible time domain signals for the Z- transform $X(z) = \frac{1}{1 - \frac{1}{6}z^{-1} - \frac{1}{6}z^{-2}}$	6	CO2	L3

Prepared By: Ms. Reshma K J

Checked By : Ms. Ambily Joseph

1. Prescribed Syllabus

Module	Topic	Hours
1	Computer Arithmetic and Processor Basics: Algorithms for binary multiplication and division Fixed- and floating-point number representation in computers., Functional units of a computer, Von Neumann and Harvard computer architectures, CISC and RISC architectures, Processor Architecture — General internal architecture, Address bus, Data bus, control bus. Register set — status register, accumulator, program counter, stack pointer, general purpose registers. Processor operation — instruction cycle, instruction fetch, instruction decode, instruction execute, timing response, instruction sequencing and execution (basic concepts), data path.	9
2	8051 Architecture: Microcontrollers and Embedded Processors. Architecture – Block diagram of 8051, Pin configuration, Registers, Internal Memory, Timers, Port Structures, Interrupts. Assembly Language Programming - Addressing Modes, Instruction set (Detailed study of 8051 instruction set is required).	9
3	Programming and Interfacing of 8051: Simple programming examples in assembly language. Interfacing with 8051 using Assembly language programming: LED, Seven segment LED display. Programming in C - Declaring variables, Simple examples – delay generation, port programming, code conversion. Interfacing of – LCD display, Keyboard, Stepper Motor, DAC and ADC -- with 8051 and its programming.	12
4	Advanced Concepts: 8051 Timers/Counters - Modes and Applications. Serial Data Transfer – SFRs of serial port, working, Programming the 8051 to transfer data serially. Introduction to ARM - ARM family, ARM 7 register architecture. ARM programmer's model. System software Assembler, Interpreter, Compiler, Linker, Loader, Debugger.	8
5	Memory System - Types of memory - RAM, ROM. Memory Characteristics and Hierarchy, Cache memory — The basics of Caches, Mapping techniques, Improving Cache performance, Virtual memory — Overlay, Memory management, Address translation, Input/Output Organization — Introduction, Synchronous vs. asynchronous I/O, Programmed I/O, Interrupt driven I/O, Direct Memory Access.	9

2. Text Books (T)

T1. Muhammed Ali Mazidi & Janice Gilli Mazidi, R.D. Kinley, The 8051 microcontroller and Embedded System, Pearson Education, 2nd edition.

T2. Subrata Ghoshal, Computer Architecture and Organization: From 8085 to Core2Duo and beyond, Pearson, 2011.

T3. Steve Furber, ARM System - on-chip Architecture, Pearson Education

3. Reference Books (R)

R1. Mano M M, Computer System Architecture, 3rd Ed, Prentice Hall of India.

R2. Computer organization and design: The Hardware/Software interface/David A. Patterson, John L. Hennessy. — 5th ed.

R3. Computer Organisation V. Carl Hamacher, Zvonko G. Vranesic, Safwat G. Zaky.

R4. John P Hayes, Computer Architecture and Organization, McGraw Hill.

R5. Ramesh S Goankar, 8085 Microprocessor Architecture, Applications and Programming, Penram International, 5/e.

R6. The 8051 Microcontrollers: Architecture Programming and Applications, K Uma Rao & Andhe Pallavi, Pearson, 2011. R7. Stallings W., Computer Organisation and Architecture, 5/e, Pearson Education.

4. Course Objectives

To impart knowledge of basic computer architectures and modern microcontrollers.

5. Course Pre / Co-requisite

ECT203 Logic circuit design

6. Course Outcomes

The student will be able to

CO1. Explain the functional units, I/O and memory management w.r.t a typical computer architecture.

CO2. Understand the processor operation and to distinguish between microprocessor and microcontroller.

CO3. Develop simple programs using ALP/Embedded C.

CO4. Interface 8051 microcontroller with peripheral devices using ALP/Embedded C.

CO5. Familiarize system software and advanced RISC machine architecture.

7. Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes

PO/ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H											H	H		
CO2	H											H	H		
CO3	H	H	H		H				H	H		H	H		H
CO4	H	H	H		H				H	H		H	H		H
CO5	H												H		

8. Justification for CO-PO-PSO Correlation

CO	PO/ PSO	Justification
CO1	PO1	Understanding the fundamental knowledge in functional units of computer hardware will help the students to explain computer architecture. Hence a high correlation is given.
	PO12	Knowledge in functional units & different memory management of a computer will help the student to understand advancements in computing systems. Hence a high correlation is given.
	PSO1	Deep knowledge in hardware architecture will help the students to develop various computing devices. Hence a high correlation is given.
CO2	PO1	Understanding the basic knowledge in engineering will help the students to distinguish between microprocessors and microcontrollers. Hence a high correlation is given.
	PO12	Knowledge of different microcontrollers will encourage students to build various embedded applications in future. Hence a high correlation is given.
	PSO1	Applying the knowledge of different microprocessors and microcontrollers will help the students to develop embedded systems. Hence a high correlation is given.
CO3	PO1	Knowledge in programming languages will help the students to develop various microcontroller applications. Hence a high correlation is given.
	PO2	Developing programs for microcontrollers involves problem analysis, design, and debugging, which can help students to develop critical thinking and problem-solving skills. Hence a high correlation is given.
	PO3	Developing the programs/codes using assembly language will help students to build different user defined applications related to embedded systems. Hence a high correlation is given.
	PO5	Using IDE tools in microcontroller programming, will help the students to model complex embedded system applications. Hence a high correlation is given.
	PO9	Students will gain hands-on experience in programming microcontrollers and will develop technical skills, including coding, debugging, and testing as an individual and as in a team while doing projects. Hence a high correlation is given.

	PO10	Developing programs provides opportunities for students to work on course projects that will develop their ability to collaborate with others and communicate effectively and to make effective presentation and documentations. Hence a high correlation is given.
	PO12	Deep contextual knowledge in assembly language programming will encourage the students to design and develop future embedded applications. Hence a high correlation is given.
	PSO1	Deep knowledge in programming languages will help the students to develop different embedded system applications. Hence a high correlation is given.
	PSO3	Knowledge in different IDE tools will help the students to analyse complex embedded system applications. Hence a high correlation is given.
CO4	PO1	Interfacing of microcontrollers with peripheral devices will help the students to attain in depth knowledge in microcontroller programming. Hence a high correlation is given.
	PO2	Identifying different peripheral devices for interfacing with microcontrollers will help the students to design solutions for embedded applications. Hence a high correlation is given.
	PO3	Designing various microcontroller-based systems will help the students to build programming skill in assembly language/C. Hence a high correlation is given.
	PO5	Using IDE tools in interfacing microcontrollers with peripherals will help the students to model complex embedded system applications. Hence a high correlation is given.
	PO9	Students will gain hands-on experience in interfacing microcontrollers with peripherals and will develop technical skills, including coding, debugging, and testing as an individual and as in a team while doing projects. Hence a high correlation is given.
	PO10	Interfacing programs provides opportunities for students to work on course projects, where they can learn teamwork skills such as communication and to make effective presentation and documentations. Hence a high correlation is given.
	PO12	Interfacing various peripheral devices with microcontrollers will encourage the students to develop advanced embedded systems in future. Hence a high correlation is given.
	PSO1	Deep contextual knowledge in microcontroller programming will help the students to interface different peripheral devices. Hence a high correlation is given.
CO5	PSO3	Knowledge in different IDE tools in interfacing microcontrollers with peripherals will help the students to analyse complex embedded system applications. Hence a high correlation is given.
	PO1	Understanding the concepts of system software and RISC architecture will help the students to attain in depth knowledge in fundamentals of embedded system. Hence a high correlation is given.
	PSO1	Understanding the concepts of RISC machines will help the students to design and develop various embedded systems. Hence a high correlation is given.

9. Curricular gaps (if any)

Nil

10. Course Enrichment Activities

Sl No	Description	Proposed Activities	Relevance to POs and PSOs
1	Embedded C	Session on “Introduction to programming to Embedded C” by Ms. Reshma Mary Jose	PO1, PO2, PO3, PO5, PO9, PO10, PO12, PSO1, PSO3

11. Internal Assessment mark allocation (as per university curriculum)

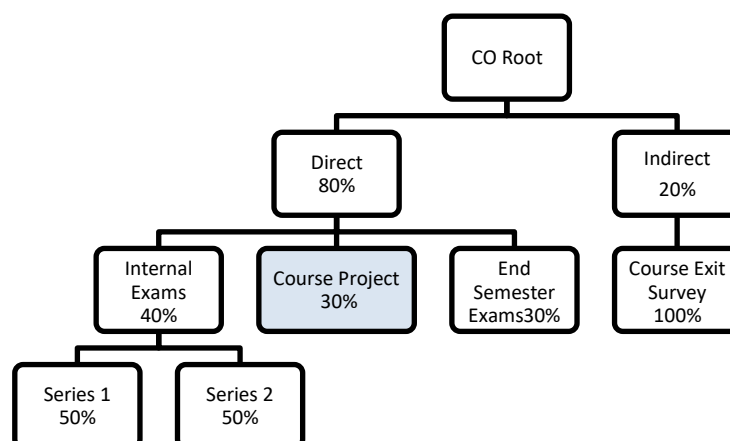
(Provide details as mentioned in syllabus)

Attendance	- 10 marks
Continuous Assessment Test	- 25 marks
Assignment (s)/ Course Project	- 15 marks
<u>Total</u>	<u>- 50 marks</u>

12. Assessment – CO Mapping (Put 'x' if mapping is present)

	Tools		Weightage	CO1	CO2	CO3	CO4	CO5
Direct Assessment Tools	Internal Exam(s) 40%	Series 1	20%	x	x	x		
		Series 2	20%			x	x	x
	Assignment (s)/ Course Project /Quiz etc. 30%	Course Project	30%	x	x	x	x	x
	End Semester Exam		30%	x	x	x	x	x
Indirect Assessment Tool	Course Exit Survey		100%	x	x	x	x	x

13. Assessment Configuration



14. Course Plan

Hour	Topic	Module	Reference(s)	Teaching Pedagogy
1	Algorithms for binary multiplication and division	1	T2	Lecture
2	Algorithms for division	1	T2	Tutorial
3	Fixed- and floating-point number representation in computers.	1	T2	Lecture

4	Functional units of a computer, Von Neumann and Harvard computer architectures, CISC and RISC architectures.	1	R3	Lecture
5	Processor Architecture – General internal architecture, Address bus, Data bus, control bus.	1	R3	Lecture
6	Register set – status register, accumulator, program counter, stack pointer, general purpose registers.	1	R3	Lecture
7	Register set – status register, accumulator, program counter, stack pointer, general purpose registers.	1	R3	Remedial
8	Processor operation – instruction cycle, instruction fetch, instruction decode	1	R3	Lecture
9	instruction execute, timing response, instruction sequencing	1	R3	Lecture
10	Execution (basic concepts), data path	1	R3	Lecture
11	Microcontrollers and Embedded Processors and Applications	2	T1	Lecture
12	Architecture – Block diagram of 8051, Pin configuration	2	T1	Lecture
13	Registers, Internal Memory	2	T1	Lecture
14	Timers, Port Structures, Interrupts.	2	T1	Lecture
15	Addressing Modes of 8051	2	T1	Lecture
16	Instruction sets (Detailed study of 8051 instructions)	2	T1	Lecture
17	Instruction sets (Detailed study of 8051 instructions)	2	T1	Lecture
18	Instruction sets (Detailed study of 8051 instructions)	2	T1	Lecture
19	Instruction sets (Detailed study of 8051 instructions)	2	T1	Tutorial
20	Instruction sets	2	T1	Remedial
21	Simple programming examples in assembly language.	3	T1	Lecture
22	Simple programming examples in assembly language.	3	T1	Lecture
23	Interfacing programming in Assembly language	3	R6, R7	Lecture
24	Interfacing programming in Assembly language	3	R6, R7	Lecture
25	Programming in C - Declaring variables	3	R6, R7	Lecture
26	Simple examples – delay generation	3	R6, R7	Lecture
27	Simple examples – delay generation	3	R6, R7	Remedial
28	Port programming, code conversion.	3	R6, R7	Tutorial
29	Interfacing of 7 segment LCD display	3	R6, R7	Lecture
30	Interfacing of Keyboard	3	R6, R7	Lecture
31	Interfacing of stepper motor	3	R6, R7	Lecture
32	Interfacing of DAC	3	R6, R7	Lecture
33	Interfacing of ADC	3	R6, R7	Lecture
34	8051 Timers/Counters - Modes and Applications	4	T1	Lecture

35	8051 Timers/Counters - Modes and Applications	4	T1	Lecture
36	Serial Data Transfer – SFRs of serial port, working	4	R6, R7	Lecture
37	Programming the 8051 to transfer data serially	4	R6, R7	Tutorial
	Introduction to ARM - ARM family, ARM 7 register architecture.	4	T3	Lecture
38	ARM programmer's model	4	T3	Lecture
39	System software - Assembler, Interpreter	4	R3	Lecture
40	Introduction to ARM - ARM family, ARM 7 register architecture.	4	T3	Remedial
41	Compiler, Linker, Loader, Debugger.	4	R3	Lecture
42	Types of memory - RAM, ROM.	5	R3	Lecture
43	Memory Characteristics and Hierarchy	5	R3	Lecture
44	Cache memory – The basics of Caches Mapping techniques, Improving Cache performance	5	R3	Lecture
45	Virtual memory – Overlay,	5	R3	Lecture
46	Memory management, Address translation	5	R3	Lecture
47	Mapping techniques, Improving Cache performance	5	R3	Remedial
48	Input/Output Organization – Introduction	5	R3	Lecture
49	Synchronous vs. asynchronous I/O, Programmed I/O	5	R3	Tutorial
50	Interrupt driven I/O, Direct Memory Access.	5	R3	Lecture

Prepared By: Ms. Ambily Joseph

Checked By : Dr. Saju A

Course Code & Name: HUT200 PROFESSIONAL ETHICS

1. Prescribed Syllabus

Module	Topic	Hours
1	Morals, values and Ethics – Integrity- Academic integrity-Work Ethics-Service Learning- Civic Virtue-Respect for others- Living peacefully- Caring and Sharing- Honestly- courage-Cooperation commitment-Empathy-Self Confidence -Social Expectations	5
2	Senses of Engineering Ethics - Variety of moral issues- Types of inquiry-Moral dilemmas –Moral Autonomy –Kohlberg’s theory- Gilligan’s theory-Consensus and Controversy-Profession and Professionalism- Models of professional roles-Theories about right action –Self- interest-Customs and Religion- Uses of Ethical Theories.	5
3	Engineering as Experimentation – Engineers as responsible Experimenters-Codes of Ethics- Plagiarism-A balanced outlook on law - Challenges case study- Bhopal gas tragedy	5
4	Collegiality and loyalty – Managing conflict- Respect for authority- Collective bargaining- Confidentiality-Role of confidentiality in moral integrity-Conflicts of interest- Occupational crime- Professional rights-Employee right- IPR Discrimination.	5
5	Multinational Corporations- Environmental Ethics- Business Ethics-Computer Ethics -Role in Technological Development-Engineers as Managers- Consulting Engineers- Engineers as Expert witnesses and advisors-Moral leadership.	5

2. Text Books (T)

- T1. M Govindarajan, S Natarajan and V S Senthil Kumar, Engineering Ethics, PHI Learning Private Ltd, New Delhi, 2012.
- T2. R S Naagarazan, A text book on professional ethics and human values, New age international (P) limited, New Delhi, 2006.

3. Reference Books (R)

- R1. Mike W Martin and Roland Schinzinger, Ethics in Engineering, 4th edition, Tata McGraw Hill Publishing Company Pvt Ltd, New Delhi, 2014.
- R2. Charles D Fleddermann, Engineering Ethics, Pearson Education/ Prentice Hall of India, New Jersey, 2004.
- R3. Charles E Harris, Michael S Protchard and Michael J Rabins, Engineering Ethics- Concepts and cases, Wadsworth Thompson Learning, United states, 2005.
- R4. <http://www.slideword.org/slidestag.aspx/human-values-and-Professional-ethics>.

4. Course Objectives

This course aims

- To create awareness on professional ethics for engineers
- To instill human values and integrity
- To respect the rights of others and develop a global perspective

5. Course Pre / Co-requisite

Nil

6. Course Outcomes

After the completion of the course the student will be able to

- CO1. Understand the core values that shape the ethical behaviour of professional.
- CO2. Adopt a good character and follow an ethical life.
- CO3. Explain the role and responsibility in technological development by keeping personal ethics and legal ethics
- CO4. Solve moral and ethical problems through exploration and assessment by established experiments.
- CO5. Apply the knowledge of human values and social values to contemporary ethical values and Global issues.

7. Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes

PO/ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
CO1								M			M				
CO2								M			M				
CO3								H			M				
CO4								H			M				
CO5								H			M				

8. Justification for CO-PO-PSO Correlation

CO	PO/ PSO	Justification
CO1	PO8	By understanding Morals, Values and Ethics properly they can apply them to fulfill their social responsibilities and expectations.
	PO11	Understanding of Professional Ethics and human values enables them to apply and prove their knowledge and understanding of Engineering and Management principles in multi-disciplinary environments
CO2	PO8	An ethical life and good character makes them committed to Professional Ethics, responsibilities and norms of their Engineering practice.
	PO11	By acquiring an understanding of ethical principles and adoption of good character they can prove their might in engineering and management principles. It will help them to be a good member of a team or leader, managing projects in various environments.
	PO8	Learning and understanding the importance of human and social values will enable to apply ethical principles to the engineering practice.

CO3	PO11	Understanding the importance of professional and personal ethics will help to demonstrate and manage principles in multidisciplinary environments.
CO4	PO8	By understanding the ways to solve different moral and ethical problems will helps to get committed to one's profession taking the responsibilities of the engineering practice.
	PO11	Developing the capacity to explore solution for moral and ethical problems, will help to perform better as a leader or member of a team.
CO5	PO8	Developing effective listening skills help to analyses and understand various engineering problems
	PO11	By understanding the ethical principles related to global issues, will enable to understand engineering and management principles and apply these to one's own work.

9. Curricular gaps (if any)

NIL

10. Course Enrichment Activities

Sl No	Description	Proposed Activities	Relevance to POs and PSOs
	Nil		

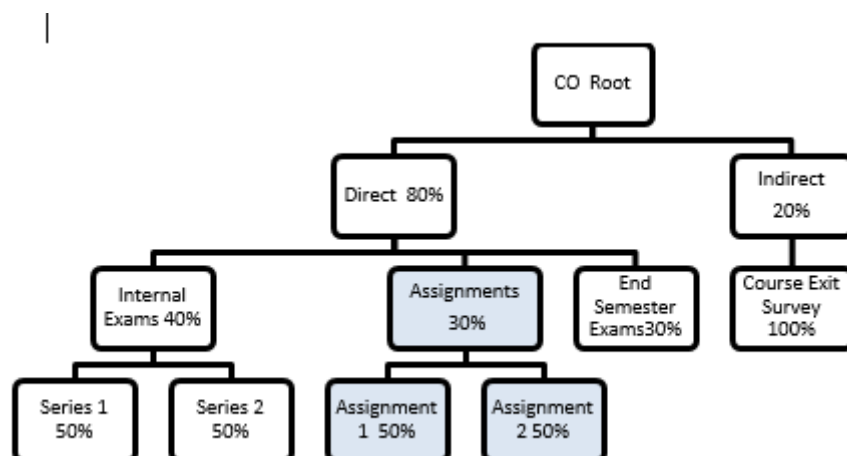
11. Internal Assessment mark allocation (as per university curriculum)

Attendance	- 10 marks
Continuous Assessment Test	- 25 marks
<u>Assignment (s)/ Course Project</u>	<u>- 15 marks</u>
<u>Total</u>	<u>- 50 marks</u>

12. Assessment – CO Mapping

	Tools		Weightage	CO1	CO2	CO3	CO4	CO5
Direct Assessment Tools**	Internal Exam(s)40%	Series 1	20%	x	x			
		Series 2	20%			x	x	
	Assignment (s)/30%	A1	15%	x	x			
		A2	15%			x	x	x
	End Semester Exam		30%	x	x	x	x	x
Indirect Assessment Tool	Course Exit Survey		100%	x	x	X	x	x

13. Assessment Configuration



14. Course Plan

Hour	Topic	Module	Reference(s)	Teaching Pedagogy
1	Morals, values and Ethics, Integrity, Academic Integrity, Work Ethics	1	T1, T2	Lecture
2	Service Learning, Civic Virtue, Respect for others, Living peacefully	1	T1, T2	Lecture
3	Caring and Sharing, Honesty	1	T1, T2	Lecture
4	Courage, Co-operation, commitment	1	T1, T2	Lecture
5	Empathy, Self Confidence, Social Expectations	1	T1, T2	Lecture
6	Senses of Engineering Ethics, Variety of moral issues, Types of inquiry	2	T1, T2	Lecture
7	Moral dilemmas, Moral Autonomy, Consensus and Controversy	2	T1, T2	Lecture
8	Theories about right action, Kohlberg's theory, Gilligan's theory	2	T1, T2	Lecture
9	Profession & Professionalism, Models of professional roles	2	T1, T2	Lecture
10	Self interest-Customs and Religion, Uses of Ethical Theories	2	T1, T2	Lecture
11	Engineering as Experimentation, Engineers as responsible Experimenters	3	T1, T2	Lecture
12	Codes of Ethics, Plagiarism	3	T1, T2, R1	Lecture
13	A balanced outlook on law	3	T1, T2, R1	Lecture
14	Challenger case study	3	T1, T2, R1	Case Study
15	Bhopal gas tragedy	3	T1, T2	Case Study
16	Collegiality and loyalty, Managing conflict, Respect for authority	4	T1, T2	Lecture
17	Confidentiality, Role of confidentiality in moral Integrity	4	T1, T2, R1	Lecture
18	Collective bargaining, Conflicts of interest	4	T1, T2, R1	Lecture
19	Occupational crime, Professional rights, Employee right	4	T1, T2	Lecture
20	IPR Discrimination	4	T1, T2	Lecture

21	Multinational Corporations, Environmental Ethics	5	T1, T2, R1	Lecture
22	Business Ethics, Computer Ethics	5	T1, T2, R1	Lecture
23	Role in Technological Development, Moral leadership	5	T1, T2	Lecture
24	Engineers as Managers, Consulting Engineers	5	T1, T2	Lecture
25	Engineers as Expert witnesses and advisors	5	T1, T2	Lecture

15. Question Bank

Module 1				
Sl. No.	Question	Marks	CO	BL
1	Define academic integrity.	3	CO1	L1
2	Describe civic virtue.	3	CO1	L2
3	What are the suggestions for peaceful living?	3	CO1	L1
4	Define Co-operation.	3	CO1	L1
5	Define 'respect for others'.	3	CO1	L1
6	How does integrity help to build up the value system of a professional?	3	CO1	L2
7	Define the term service learning	3	CO1	L1
8	Examine how service learning is applicable in engineering education.	7	CO1	L2
9	Summarize the importance of empathy in human nature.	7	CO1	L2
10	What are the core ethical elements that define the ethics of an organization?	14	CO1	L1
11	Define Self-confidence, the factors that shape it and the methods that can develop self confidence in an individual	14	CO1	L1
12	How does civic virtue play a vital role in a life of a Professional?	7	CO1	L2
13	Explain the different aspects of honesty?	7	CO1	L2
14	Explain the role of Commitment in the life of a Professional	7	CO1	L2

15	Define and explain the scope and importance of professional ethics in Engineering.	6	CO1	L2
16	Elucidate the relevance of academic integrity in Engineering with examples.	8	CO1	L2
17	List core elements of strong work ethics.	7	CO1	L2
18	Exemplify service learning and its importance. How is it related to experimental learning?	8	CO1	L2
19	Summarize the importance of human values in this era and list out few core human values.	6	CO1	L2
Module 2				
20	Identify different inquiries.	3	CO2	L2
21	Compare moral dilemma and moral autonomy.	3	CO2	L2
22	What is a bribe? Explain with an example.	3	CO2	L1
23	Explain the concept of moral autonomy.	3	CO2	L2
24	State the senses of engineering ethics.	3	CO2	L2
25	What makes engineering Ethics different from general ethics?	3	CO2	L1
26	What do you understand by Resource Crunch?	3	CO2	L1
27	Explain in detail about the characteristics or criteria's to achieve professionalism.	3	CO2	L2
28	Illustrate variety of moral issues in engineering profession with examples.	7	CO2	L2
29	Describe the three main levels of Kohlberg's theory of Moral Development? Also, bring back the limitations of Kohlberg's Theory	7	CO2	L2
30	Compare different theories about right action, and show how it helps in professionalism.	14	CO2	L2
31	Explain the causes of Moral Dilemmas?	7	CO2	L2
32	Interpret the different professional roles that engineers should adopt.	6	CO2	L2

33	Illustrate the importance of consensus and the problem of controversy, while considering moral autonomy in engineering ethics with the help of examples.	6	CO2	L2
Module 3				
34	Illustrate the features of morally responsible Engineering Experimenters.	3	CO3	L2
35	Identify the advantages of code of ethics.	3	CO3	L2
36	Define informed consent.	3	CO3	L1
37	Explain the term balanced outlook on law.	3	CO3	L2
38	Define Accountability.	3	CO3	L1
39	Recall plagiarism and how it could be avoided.	3	CO3	L2
40	Justify on engineering projects being considered as experimentations. Explain the statement with relevant examples.	14	CO3	L2
41	Explain about Bhopal gas tragedy. What are the safety lessons that we can be learned from it?	14	CO3	L2
42	List the essential conditions for valid informed consent.	7	CO3	L2
43	Enumerate the essential roles of codes of ethics.	7	CO3	L2
44	List a few factual issues, conceptual issues, and moral/normative issues in the Bhopal Gas Tragedy.	14	CO3	L2
45	Describe the factual issues, conceptual issues and moral/normative issues in the Challenger space shuttle incident.	8	CO3	L2
46	List and describe any three types of industrial standards with suitable examples.	6	CO3	L2
47	What are the similarities between engineering experiments and standard experiments?	7	CO3	L1
48	Enumerate the responsibility of engineers to the society as an experimenter.	6	CO3	L2
Module 4				
49	Describe about conflicts of interest in professional environment.	3	CO4	L2

50	Cite two examples of employee rights.	3	CO4	L1
51	Differentiate collegiality & loyalty	3	CO4	L2
52	Define Collective Bargaining.	3	CO4	L1
53	Define Gifts and Bribes.	3	CO4	L1
54	Define Occupational crime.	3	CO4	L1
55	What are the two senses of Loyalty?	3	CO4	L1
56	What are Conflicts of Interests?	3	CO4	L1
57	Illustrate collegiality.	3	CO4	L2
58	Conclude how moonlighting leads to conflict of interest.	3	CO4	L2
59	Explain about collective bargaining. Explain the advantages and disadvantages.	7	CO4	L2
60	Describe about intellectual property rights.	7	CO4	L2
61	Explain in detail about the need of confidentiality in the organizations and its impact on moral integrity.	7	CO4	L2
62	Identify the methods to reduce occupational crime in the current professional scenario.	7	CO4	L2
63	Explain the various steps in managing conflicts in an organization. Recall the types of conflicts of interest.	8	CO4	L2
64	Examine the common forms of occupational crime.	6	CO4	L2
65	Describe the professional rights of an engineer. Examine the different provisions protected under professional rights.	7	CO4	L2
66	Explain in detail the 'risk benefit analysis' and reducing risk.	8	CO4	L2
67	Explain the Conflict Management Process.	7	CO4	L2
68	What is meant by 'whistle blowing'? List four aspects of 'whistle blowing' .	7	CO4	L1
Module 5				
69	Recall ethical issues involved in technological developments.	3	CO5	L2
70	Name any three professional societies and their role relevant to engineers.	3	CO5	L1

71	Explain the duties of an engineer as an expert witness.	3	CO5	L2
72	Define Multinational company with an example.	3	CO5	L1
73	Define the characteristics of Engineers as Managers.	3	CO5	L1
74	What are the fundamental duties to be kept in mind while engineers fulfill their professional duties?	3	CO5	L1
75	Define Environmental Ethics. What are the two views on Environmental ethics?	3	CO5	L1
76	Inspect the impact of technology transfer on different institutions/entities.	3	CO5	L2
77	State the requirements for engineers who act as advisors in planning and policy making.	3	CO5	L2
78	Relate how computer ethics and business ethics can impact in the working of multinational corporations.	14	CO5	L2
79	Show that “Engineers as Expert witnesses and advisors” using examples.	14	CO5	L2
80	Examine the importance of engineers as moral leaders.	7	CO5	L2
81	Describe the role of computers in technological development.	7	CO5	L2
82	Define Multinational Companies. Explain the advantages and limitations of MNCs.	14	CO5	L1
83	Explain the role of engineers as ‘Managers.	7	CO5	L2
84	Explain the characteristics of (i) Business Ethics and (ii) Computer Ethics.	14	CO5	L2
85	Point out the responsibilities of consulting engineers?	7	CO5	L2
86	Explain the requirement of moral leadership for engineers.	4	CO5	L2
87	Define environmental ethics. Elucidate the ethical duties of engineers towards environment as experimenters by mentioning the environmental impacts of engineering activity.	10	CO5	L1

Prepared By: Dr Rakesh S

Checked By : Mr. J V C Maliackal

Course Code & Name: MCN202 CONSTITUTION OF INDIA**1. Prescribed Syllabus**

Module	Topic	Hours
1	Definition, historical back ground, features, preamble, territory, citizenship.	5
2	State, fundamental rights, directive principles, duties.	6
3	The machinery of the union government.	5
4	Government machinery in the states	4
5	The federal system, Statutory Institutions, miscellaneous provisions.	5

2. Text Books(T)

T1. D D Basu, Introduction to the constitution of India, Lexis Nexis, New Delhi, 24e,2019

T2. PM Bhakshi, The constitution of India, Universal Law, 14e,2017

3. Reference Books(R)

R1. Ministry of law and justice, The constitution of India, Govt of India, New Delhi,2019.

R2. JN Pandey, The constitutional law of India, Central Law agency, Allahabad, 51e,2019
MV Pylee, India's Constitution, S Chand and company, New Delhi, 16e,2016

4. Course Objectives

The study of their own country constitution and studying the importance environment as well as understanding their own human rights help the students to concentrate on their day today discipline. It also gives the knowledge and strength to face the society and people.

5. Course Pre / Co-requisite None

Nil

6. Course Outcomes

- CO 1 Explain the background of the present constitution of India and features.
- CO 2 Utilize the fundamental rights and duties.
- CO 3 Understand the working of the union executive, parliament and judiciary.
- CO 4 Understand the working of the state executive, legislature and judiciary.
- CO 5 Utilize the special provisions and statutory institutions.
- CO 6 Show national and patriotic spirit as responsible citizens of the country

7. Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes

PO/ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1						M	M	M		M		
CO2						H	H	H		H		
CO3						H	M	H		H		
CO4						H	M	H		H		
CO5						H	M	H		H		
CO6						H	H	H		M		

8. Justification for CO-PO-PSO Correlation

CO1	PO6 - The engineer and society: Understanding the Constitution's background helps students recognize the societal, legal, and cultural contexts in which they operate as engineers.
	PO7 - Environment and sustainability: The Constitution contains provisions related to the environment and sustainable development. By understanding these features, students can appreciate their role in contributing to society and making decisions that align with environmental sustainability.
	PO8 – Ethics: Knowledge of the Constitution forms the basis of ethical responsibility, guiding students to uphold the laws and ethical principles of the nation. It helps them understand the importance of legality, fairness, and justice in their professional and personal lives.
	PO10 – Communication: Understanding the Constitution is essential for effective communication, particularly when discussing legal or civic matters.
CO 2	PO6- The engineer and society: Recognizing and utilizing fundamental rights and duties helps students understand their roles and responsibilities in a democratic society, where they must be aware of their rights and obligations as citizens and engineers.
	PO7- Environment and sustainability: Fundamental duties include respecting public resources and the environment, aligning with the need to promote sustainable practices in both professional and personal settings
	PO8 – Ethics: Fundamental rights and duties are closely tied to ethical behavior. Utilizing these rights and duties fosters respect for justice and fairness, which are vital ethical principles for engineers.
	PO10 – Communication: Understanding and utilizing fundamental rights enables effective communication about the rights and responsibilities of individuals and groups. This awareness allows students to navigate civic discourse and express ideas clearly and responsibly in public and professional contexts.
	PO6- The engineer and society: A clear understanding of the functioning of the union executive, parliament, and judiciary enables students to appreciate how laws and policies are formulated, implemented, and interpreted in society, which is essential for responsible citizenship.

CO 3	PO7- Environment and sustainability: The functioning of the union and state governments plays a crucial role in formulating environmental laws and policies. Understanding these workings helps students align their actions with national and global sustainability goals.
	PO8 – Ethics: Understanding the structure of governance and the roles of various branches of the government enables students to engage ethically with legislative and judicial processes, ensuring they follow legal and ethical norms in their professional activities.
	PO10 – Communication: Understanding the functioning of government institutions is critical for effective communication, especially when addressing political, legal, and social issues. It enables students to articulate their ideas about governance, policies, and reforms clearly.
	PO6- The engineer and society: This understanding helps students connect the state-level legislative and executive processes with their responsibilities as engineers in a particular region. It empowers them to engage with local governance and policies, influencing sustainable development and social well-being.
	PO7- Environment and sustainability: State governments often have specific policies related to regional environmental issues. Understanding the state-level executive, legislature, and judiciary helps students understand how policies related to sustainability are enacted and enforced in different states.
	PO8 – Ethics: Understanding how state institutions work and their ethical standards allows students to engage with local governance in a morally responsible manner, ensuring that their professional actions align with legal and ethical guidelines.
	PO10 – Communication: Effective communication about state policies, laws, and governance is crucial for students, especially when working on regional projects or engaging with local stakeholders.
	PO6- The engineer and society: Special provisions and statutory institutions often regulate industries, educational practices, and research initiatives. Understanding how these institutions function helps students align their professional practices with national laws and frameworks
	PO7- Environment and sustainability: Statutory institutions often include bodies focused on environmental regulations and policies. Familiarity with these institutions enables students to engage in sustainable practices that comply with legal requirements and promote environmental responsibility.
	PO8 – Ethics: Utilizing special provisions and statutory institutions allows students to engage with legal and ethical standards in their professional roles. It reinforces the need for adherence to norms and laws in professional conduct.
	PO10 – Communication: Clear communication of the provisions and regulations governed by statutory bodies ensures students can work effectively within the legal boundaries, and also communicate these provisions to stakeholders, clients, and collaborators.
	PO6 – The engineer and society: CO6 encourages students to take responsibility for societal welfare and participate actively in national progress. It fosters an understanding of how engineers can contribute to societal well-being, national development, and the overall prosperity of the country.

PO7 – Environment and sustainability: A national and patriotic spirit often includes a commitment to sustainable practices, recognizing that a healthy environment is crucial for the nation’s long-term growth. Students are encouraged to contribute to sustainability efforts that benefit both their communities and the nation.
PO8 – Ethics: National pride and patriotic spirit are grounded in ethical responsibility toward one’s country and its people. This mindset fosters integrity, professionalism, and a commitment to contributing positively to society.
PO10 – Communication: Promoting a patriotic spirit includes communicating effectively about national achievements, challenges, and solutions. It enables students to discuss national issues responsibly, showcasing their commitment to their country’s progress and well-being.

9. Curricular gaps

None

10. Course Enrichment Activities

Sl No	Description	Proposed Activities	Relevance to POs and PSOs
	Nil	Nil	

11. Internal Assessment mark allocation (as per university curriculum)

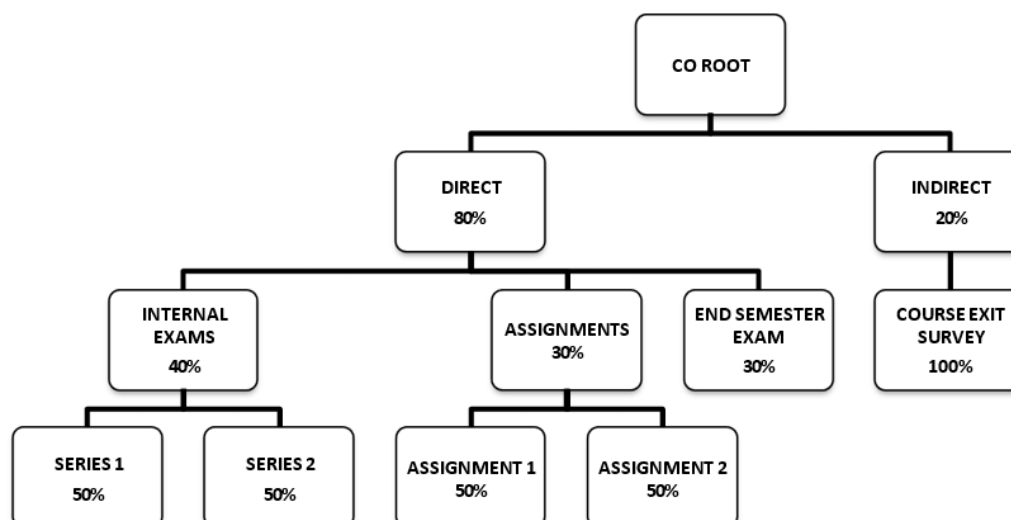
(Provide details as mentioned in syllabus)

Attendance	- 10marks
Continuous Assessment Test	- 25marks
Assignment (s)/Course Project	- 15 marks
Total	- 50marks

12. Assessment – CO Mapping

	Tools		# Weightage	CO1	CO2	CO3	CO4	CO5	CO6
Direct Assessment Tools**	Internal Exam(s) 40%	Series 1	20%	x	x				
		Series 2	20%			x	x		
	Assignment (s) 30%	Assignment 1	15%	x	x				
		Assignment 2	15%			x	x	x	x
	End Semester Exam		30%	x	x	x	x	x	x
Indirect Assessment Tool	Course Exit Survey		100%	x	x	x	x	x	x

13. Assessment Configuration



14. Course Plan

Hour	Topic	Module	Reference(s)	Teaching Pedagogy
1.	Introduction to the course	1		Lecture
2.	Definition of constitution	1	T1	Lecture
3.	historical back ground, salient features of the constitution	1	T1	Lecture
4.	Preamble of the constitution, union and its territory	1	T1	Lecture
5.	Meaning of citizenship, types	1	T1	Lecture
6.	termination of citizenship.	1	T1	Lecture
7.	Definition of state, fundamental rights, general nature, classification	2	T1	Lecture
8.	right to equality, right to freedom, right against exploitation	2	T1	Lecture
9.	Right to freedom of religion, cultural and educational rights,	2	T1	Lecture
10	right to constitutional remedies. Protection in respect of conviction for offences	2	T1	Lecture

11	Directive principles of state policy	2	T1	Lecture
12	classification of directives, fundamental duties.	2	T1	Lecture
13	First Internal Examination			
14	The Union executive, the President, the vice President, the council of ministers	3	T1	Lecture
15	the Prime minister, Attorney-General, functions	3	T1	Lecture
16	The parliament, composition, Rajya Sabha, Lok Sabha	3	T1	Lecture
17	qualification and disqualification of membership, functions of parliament	3	T1	Lecture
18	Union judiciary, the supreme court, jurisdiction, appeal by special leave.	3	T1	Lecture
19	The State executive, the Governor, the council of ministers	4	T1	Lecture
20	the Chief minister, advocate general, union Territories.	4	T1	Lecture
21	The State Legislature, composition, qualification and disqualification of membership, functions	4	T1	Lecture
22	The state judiciary, the high court, jurisdiction, writs jurisdiction	4	T1	Lecture
23	Second Internal Examination			
24	Relations between the Union and the States, legislative relation, administrative relation	5	T1	Lecture
25	financial Relations, Inter State council, finance commission.	5	T1	Lecture
26	Emergency provision, freedom of trade commerce and inter course, comptroller and auditor general of India	5	T1	Lecture
27	public Services, public service commission, administrative Tribunals	5	T1	Lecture

28	Official language, elections, special provisions relating to certain classes, amendment of the Constitution.	5	T1	Lecture
29	Revision	1-5	T1	Discussion

15. Question Bank

Module 1				
Sl. No.	Question	Marks	CO	BL
1.	Define Citizenship by Naturalization.	3	CO1	L1
2.	List out the purpose of Preamble.	3	CO1	L1
3.	Define “Fundamental Right”.	3	CO1	L1
4.	State the meaning of “Equal protection of the laws”.	3	CO1	L1
5.	Define Citizenship	3	CO1	L1
6.	Recall the meaning and significance of Constitution	3	CO1	L1
7.	List any five features of Constitution of India	3	CO1	L1
8.	Define Preamble of Constitution	3	CO1	L1
9	List out the sources borrowed while drafting the Constitution of India.	3	CO1	L1
10	Define the term Constitution and elucidate two fundamental features that distinguish the Indian Constitution.	3	CO1	L1
11	List down four sources of Indian Constitution with relevant sources borrowed while drafting the Constitution of India.	7	CO1	L1
12	Outline the ways of the establishment and formation of new states.	7	CO1	L1
13	Define Constitution of India with comparison with other countries	7	CO1	L1
14	Discuss the term Union and its territories	7	CO1	L1
15	Explain the term Constitution.	3	CO1	L2
16	Explain whether the Preamble is a part of the Constitution or not.	3	CO1	L2
17	Describe the meaning and significance of the constitution.	3	CO1	L2
18	Explain the concept of Union and its territory	3	CO1	L2
19	“India is a Sovereign nation”. Explain.	3	CO1	L2
20	Explain the preamble of Indian Constitution	3	CO1	L2
21	Explain deprivation of citizenship.	3	CO1	L2
22	Explain salient features of Indian Constitution	3	CO1	L2
23	Explain the term partly rigid and partly flexible constitution	4	CO1	L2
24	Explain the term Union and its territory	4	CO1	L2
25	Explain the historical background that led to the framing of Constitution of India	4	CO1	L2
26	Explain why Indian Constitution is sometimes called a “borrowed” constitution.	4	CO1	L2
27	As a citizen of India, interpret the declaration of the preamble of our constitution	7	CO6	L2
28	Explain the term citizenship and its types	7	CO1	L2
29	Describe the process through which Indian Citizenship could be acquired	7	CO1	L2
30	Explain the mode of acquisition and termination of Citizenship	7	CO1	L2

31	Write important provisions of The Indian Independence Act, 1947.	7	CO1	L2
32	Describe four classes of people who were deemed to be citizens of India at the time of the commencement of the constitution.	7	CO1	L2
33	The Constitution of India has provisions borrowed from other Constitutions. Discuss with relevant provisions.	7	CO1	L2
34	Discuss the formation of the Union and its territories.	7	CO1	L2
35	Explain the law respecting the acquisition and loss of Indian Citizenship at the commencement of the Constitution.	7	CO1	L2
36	Explain the modes of acquiring Citizenship under Citizenship Act, 1955.	7	CO1	L2
37	Discuss the term partly rigid and partly flexible constitution.	3	CO1	L3
38	A person who migrated to India from Pakistan after 18th July 1948. Determine whether such a person is a citizen of India or not.	3	CO1	L3
39	Examine the modes of acquisition and termination of citizenship.	7	CO1	L3
40	Examine the Salient Features of Indian Constitution.	7	CO1	L3
41	Explain in detail the salient features of the Indian constitution.	10	CO1	L2
42	Explain the mode of acquisition and termination of citizenship.	10	CO1	L2
43	Discuss the significance of Preamble to the Constitution of India and its role in reflecting the ideals of the Constitution.	10	CO1	L3

MODULE 2

Sl. No.	Question	Marks	CO	BL
1	Define State, under Article 12 of the Constitution	3	CO2	L1
2	Define Uniform Civil code.	3	CO2	L1
3	List down the fundamental rights guaranteed to a citizen by the Constitution of India.	3	CO2	L1
4	State the meaning of "Equality of law".	3	CO2	L1
5	Write a note on abolition of untouchability.	3	CO2	L1
6	Differentiate rights and duties with examples	3	CO2	L1
7	State the meaning of "Equal protection before law".	3	CO2	L1
8	List the protection that are available to the Indian citizen against conviction	3	CO2	L1
9	List the rights of the minorities in India	3	CO2	L1
10	List and explain any three fundamental duties as outlined in the Constitution.	3	CO2	L1
11	Discuss the Right to Constitutional Remedies.	3	CO2	L1
12	List the fundamental duties of an Indian citizen	7	CO2	L1
13	Define Directive principles of state policy	7	CO2	L1
14	Recall the differences between fundamental rights and directive principles of State policy	7	CO2	L1
15	Explain the concept of 'equality before the law'.	3	CO2	L2
16	"No person shall be prosecuted and punished for the same offence more than once." Discuss this clause	3	CO2	L2
17	Discuss the origin of Fundamental Rights.	3	CO2	L2

18	Discuss the Right to Information.	3	CO2	L2
19	Discuss the Right against forced Labour.	3	CO2	L2
20	Discuss whether Judiciary is included in the definition of state.	3	CO2	L2
21	Examine the justifications for constitutional incorporation of Fundamental Rights.	3	CO2	L2
22	Discuss the Freedom of Association.	3	CO2	L2
23	Discuss Equality of Opportunity in Public Employment.	3	CO2	L2
24	As a citizen of India explain the advantages you enjoy	3	CO6	L2
25	Explain the significance of Article 14-18 in Indian Constitution.	3	CO2	L2
26	Explain Secularism	3	CO2	L2
27	Explain Uniform Civil Code	3	CO2	L2
28	“The freedom of speech and expression is subject to reasonable restrictions”. Explain the statement.	4	CO2	L2
29	The Indian constitution is unique in protecting the minorities. Explain	4	CO2	L2
30	Discuss how the Indian Constitution maintains the concept of “equality before law” and “equal protection of law”.	7	CO2	L2
31	Discuss various freedoms under Article 19 of the Constitution.	7	CO2	L2
32	Explain the concept of appeal by special leave	7	CO2	L2
33	Discuss the classification of Directive Principles of State Policy in detail	7	CO2	L2
34	Explain ‘right against exploitation’	7	CO2	L2
35	Explain the term fundamental rights and its classifications	7	CO2	L2
36	Explain the reasonable restrictions against freedom of speech and expression.	7	CO2	L2
37	Discuss the various freedoms under Article 19 of the Constitution.	7	CO2	L2
38	Right to constitutional remedies is the soul of the Indian Constitution. Explain.	7	CO2	L2
39	Describe the rights available to a person accused or convicted of an offence.	7	CO2	L2
40	Explain right against exploitation and right to constitutional remedies	7	CO2	L2
41	a) What are the features of fundamental rights? Explain any two types of fundamental right. b) List out the Gandhian ideology included in directive principle	9 5	CO2	L2
42	Analyse the concept of right to equality with special reference to compensatory and protective discrimination	3	CO2	L3
43	How far the fundamental rights are protected and enforced by the judiciary. Use a relevant example to justify your answer	3	CO2	L3
44	Critically analyse the concept of non-discrimination under Article 15 with special reference to admission in educational institutions. Use relevant case to substantiate your answer.	7	CO2	L3
45	The rights guaranteed under Article 19 are available only to citizens. Substantiate this statement in the light of various freedom provided under Article 19 to citizens.	7	CO2	L3

46	Article 19 (2) connotes reasonable limitations imposed on freedom of Speech. Demonstrate the relevance of the statement in the light of various restrictions that could be imposed on freedom of Speech under the Indian Constitution.	7	CO2	L3
47	Examine critically several tests evolved by the Supreme Court since the commencement of the Indian constitution to bring within its sweep “all other authorities”. Under Article 12.	7	CO2	L3
48	When some children were employed in match factories at Surat, X filed a petition before the High Court under article 226 demanding action against the match factories. The match factories pleaded the right to carry on any trade. Decide the case.	7	CO2	L3
49	Religious tolerance, equal treatment of all groups and protection of their life, property, and places of their worship are an essential part of secularism enshrined in the Indian Constitution”. Explain.	7	CO2	L3
50	Explain the meaning, significance and classification of the Directive Principles of State Policy	10	CO2	L2
51	Explain in detail the Fundamental Rights of Indian citizens.	10	CO2	L2
MODULE 3				
1	List down the qualifications required for the Prime Minister of India.	3	CO3	L1
2	List down the Privileges and Immunities of the President.	3	CO3	L1
3	Recall the five specialities of Supreme Court	3	CO3	L1
4	Compare Lok Sabha and Rajya Sabha	3	CO3	L1
5	List the duties of Attorney General	3	CO3	L1
6	Discuss the qualifications required for an individual to become a member of Parliament in India	3	CO3	L1
7	List down what qualifications must an individual possess to be appointed as a Supreme Court Judge	3	CO3	L1
8	Outline the procedure of election and removal of the President of India.	7	CO3	L1
9	Outline the different functions and powers of the parliament.	7	CO3	L1
10	List the different functions of Parliament	7	CO3	L1
11	Recall the differences between Rajya Sabha and Lok Sabha with at least five points	7	CO3	L1
12	Explain how the President exercises the power of pardon.	3	CO3	L2
13	Distinguish between Lok Sabha and Rajya Sabha.	3	CO3	L2
14	Explain the process of Impeachment of a Judge of the Supreme Court.	3	CO3	L2
15	Describe the Legislative functions of Parliament.	3	CO3	L2
16	Discuss the procedure for impeachment of judges of the Supreme Court.	3	CO3	L2
17	Explain the Functions and Rights of the Attorney General.	3	CO3	L2
18	Describe the constitutional emergency powers granted to the President	3	CO3	L2
19	Explain how Union Executive is elected and formed	7	CO3	L2
20	Discuss how a citizen can be qualified or disqualified as an MP	7	CO3	L2

21	Explain the powers of President of India	7	CO3	L2
22	Describe the constitutional position and essential qualifications of Vice-president of India	7	CO3	L2
23	Explain various jurisdiction of Supreme Court	7	CO3	L2
24	Explain the powers and functions of President of India as outlined in the Constitution.	7	CO3	L2
25	Discuss the Constitutional provisions related to the office of the Prime Minister in India.	7	CO3	L2
26	Explore the grounds and circumstances under which a person may be disqualified from being a member of either Lok Sabha or Rajya Sabha	7	CO3	L2
27	Discuss the jurisdiction and powers of Supreme Court as enshrined in the Constitution of India.	7	CO3	L2
28	Use any example from Indian History to explain the emergency powers of the President	3	CO3	L3
29	Mr. X who was elected as a member of Rajya Sabha has been holding the post of Chairperson of the State Film Development Council. The M.P was not receiving any allowances or honorarium attached to the office of Chairperson. Predict whether it amounts to any disqualification	7	CO3	L3
30	Explain the powers and functions of the Prime Minister Supreme Court may in its discretion to grant to special leave to appeal. Examine the situation	9 5	CO3	L2
31	a) List down the qualifications and disqualifications that the Indian Constitution specifies for someone to become a Member of Parliament b) Mention any two powers and functions of Indian President	10 4	CO3	L1
32	a) Explain the procedure for election and removal of the President of India. b) Explain Special Leave Appeal.	10 4	CO3	L2
Module 4				
Sl. No.	Question	Marks	CO	BL
1	Define Principle of Res Judicata.	3	CO4	L1
2	Define the term discretionary power.	3	CO4	L1
3	Define Writ jurisdiction	3	CO4	L1
4	List the procedures for the appointment of Chief Minister	3	CO4	L1
5	Define Court of Record	3	CO4	L1
6	Mention how are High Court judges appointed and the essential qualifications required to be a High Court judge.	3	CO4	L1
7	List down the responsibilities carried out by the advocate general of the state	3	CO4	L1
8	Write short note on Ex-post facto law and No Double Jeopardy	3	CO4	L1
9	Define the constitution of the High court. List the essential qualifications required for the appointment of High court Judge.	7	CO4	L1

10	Recall the differences between State Government and Union Territory	7	CO4	L1
11	Define State Legislative Assembly in detail	7	CO4	L1
12	Explain the role of Governor	3	CO4	L2
13	Summarize the functions and duties of the Chief Minister.	3	CO4	L2
14	Explain the functions of the State Legislature.	3	CO4	L2
15	Explain the duties of advocate general of the state	3	CO4	L2
16	Discuss the constitution of High Courts	3	CO4	L2
17	Discuss the functions of State Legislature. Discuss the jurisdiction of High Court.	7 7	CO4	L2
18	Discuss the powers of Governor. Discuss the jurisdiction of Supreme court.	7 7	CO4	L2
19	Present a critical view on the Appellate Jurisdiction of the High Court	3	CO4	L3
20	Evaluate the concept of Judicial Review in the context of state laws	3	CO4	L5
21	Present a short essay on the following a. Legislative assembly a. Legislative Council	7 7	CO4	L3
22	b. "Article 226 states that the High Court has the power to issue directions, orders, writs for any purpose". Present the different writs issued by the High court for the protection of Fundamental Rights. c. Present briefly the functions of Speaker and Deputy Speaker of the Legislative Assembly.	7 7	CO4	L3
23	a) Discuss the role of High Courts in state judiciary. b) Discuss the qualifications, appointment process and functions of the Advocate General	8 6	CO4	L2
24	a) List out the different jurisdiction and powers enjoyed by the High Court and explain original and writ jurisdiction in detail b) What are the powers enjoyed by the Governor	10 4	CO4	L2
25	a) Explain the powers and functions of Chief Minister and State Legislature in Indian constitution. b) Explain the qualifications needed for governor?	10 4	CO4	L2
26	a) Explain the qualifications and disqualifications of membership of the state legislature. b) Explain Writ of Habeas Corpus.	10 4	CO4	L2
27	a) Discuss the composition and functions of State Executive. b) Explain the Constitutional provisions outlining the qualifications required for an individual to become a member of state legislature. Also discuss the disqualifications.	10 4	CO4	L2
MODULE 5				
Sl. No.	Question	Marks	CO	BL
1	Enumerate various functions of the Finance Commission.	3	CO5	L1
2	Discuss the functions of CAG of India.	3	CO5	L1

3	List the procedures for amending the Constitution	3	CO5	L1
4	Define Election Commission of India	3	CO5	L1
5	List down the functions of UPSC	3	CO5	L1
6	Define National Emergency	3	CO5	L1
7	Identify the importance of establishment of administrative tribunals	3	CO5	L1
8	State the theory of Basic Structure under Indian Constitution	7	CO5	L1
9	Outline the relation of Central and State Government on economic basis	7	CO5	L1
10	List the functions of Comptroller and Auditor General of India	7	CO5	L1
11	Define administrative tribunals. List the functions of state administrative tribunals.	7	CO5	L1
12	The Tribunal is not a substitute for the High Court. Comment.	3	CO5	L2
13	Explain State Emergency.	3	CO5	L2
14	Explain the 44th Amendment of the Constitution	3	CO5	L2
15	Discuss the purpose behind the establishment of Administrative Tribunals.	3	CO5	L2
16	Discuss the provisions related to declaration of Emergency in India.	3	CO5	L2
17	Explain parliamentary legislation in the state field	7	CO5	L2
18	Discuss the effects of national and financial emergencies	7	CO5	L2
19	State to what extent the Basic Structure theory acts as a limitation on the Amending power of the Parliament of India. Support your answer with relevant case laws.	7	CO5	L2
20	Explain how the constitution handles an emergency situation in the country	7	CO5	L2
21	Discuss the scheme of distribution of revenue sources between Centre and State.	7	CO5	L2
22	Explain the procedures for amendment of the constitution	7	CO5	L2
23	Explain the role of Public Service Commission	7	CO5	L2
24	A government employee was convicted for commission of a crime by a criminal court. Subsequently he was dismissed from the government service without issuing any notice to him. Do you think his suspension is constitutionally valid? Use valid reasons to justify your answer.	3	CO5	L3
25	Comment on the power of Superintendence, direction and control of election-by-Election Commission.	7	CO5	L3
26	Illustrate the Composition, Powers and Functions of the Election Commission of India.	7	CO5	L3
27	a) Explain the composition, functions and powers of Union Public Service Commission. b) Discuss the qualifications, appointment and functions of Comptroller and Auditor General.	6 8	CO5	L2
28	a) What are the five extraordinary circumstances on which the Constitution empowers the Parliament to make laws on any matter	10	CO5	L2

	enumerated in the State list? Briefly explain the grants – in – aid the state	4		
29	Explain three types of emergencies under Indian Constitution b) What are the functions of interstate council	10 4	CO5	L2
30	a) Explain the five extraordinary circumstances on which the Constitution empowers the Parliament to make laws on any matter enumerated in the State list? b) Explain any two functions of Election Commission of India	10 4	CO5	L2
31	a) Explain three types of emergencies under Indian Constitution b) Explain concurrent list	10 4	CO5	L2
32	a) Outline the functions and significance of the Finance Commission. b) Explore Constitutional provisions related to public services in India	6 8	CO5	L3

Course Code & Name: ECL202 ANALOG CIRCUITS LAB

1. Prescribed Syllabus

Part A: List of Experiments using discrete components [Any Six experiments mandatory]

1. RC integrating and differentiating circuits (Transient analysis with different inputs and frequency response)
2. Clipping and clamping circuits (Transients and transfer characteristics)
3. RC coupled CE amplifier - frequency response characteristics
4. MOSFET amplifier (CS) - frequency response characteristics
5. Cascade amplifier – gain and frequency response
6. Cascode amplifier -frequency response
7. Feedback amplifiers (current series, voltage series) - gain and frequency response
8. Low frequency oscillators –RC phase shift or Wien bridge
9. Power amplifiers (transformer less) - Class B and Class AB
10. Transistor series voltage regulator (load and line regulation)

PART B: Simulation experiments [Any Six experiments mandatory]

The experiments shall be conducted using open tools such as QUCS, KiCad or variants of SPICE.

1. RC integrating and differentiating circuits (Transient analysis with different inputs and frequency response)
2. Clipping and clamping circuits (Transients and transfer characteristics)
3. RC coupled CE amplifier - frequency response characteristics
4. MOSFET amplifier (CS) - frequency response characteristics
5. Cascade amplifier – gain and frequency response
6. Cascode amplifier – frequency response
7. Feedback amplifiers (current series, voltage series) - gain and frequency response
8. Low frequency oscillators – RC phase shift or Wien bridge
9. Power amplifiers (transformer less) - Class B and Class AB
10. Transistor series voltage regulator (load and line regulation)

2. Text Books (T)

- T1. Robert Boylestad and L Nashelsky, “Electronic Devices and Circuit Theory”, Pearson 2015.

3. Course Objectives

- (i) Familiarize students with Analog circuits Design through the implementation of basic Analog Circuits using Discrete components.
- (ii) Familiarize students with simulation of basic Analog Circuits.

4. Course Pre / Co-requisite

None

5. Course Outcomes

After the completion of the course the student will be able to

CO1: Design and demonstrate the functioning of basic analog circuits using discrete components.

CO2: Design and simulate the functioning of basic Analog circuits using simulation tools. CO3: Function effectively as an individual and in a team to accomplish the given task.

6. Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes

PO/ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H	H	H	M					H	H		M	H	M	
CO2	H	H	H	M	H				H	H		M	H	M	H
CO3									H	H					

7. Justification for CO-PO-PSO Correlation

CO	PO/ PSO	Justification
CO1	PO1	Knowledge in Design of basic analog circuit using discrete components requires knowledge in basic electronic components and hence highly correlated.
	PO2	Understanding the functioning of basic analog circuits improves the skill of identifying and analysing electronic circuits and hence highly correlated.
	PO3	Knowledge in the functioning of basic analog circuits improves the skill of students to meet the specified need with appropriate considerations and hence highly correlated.
	PO4	Understanding the functioning of basic analog circuits will make use of research-based knowledge and research methods and hence moderately correlated.
	PO9	Knowledge in the functioning of analog circuits will improve to work effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings and hence highly correlated.
	PO10	Understanding the basics of analog circuits will improve the communication skills to effectively work on complex engineering activities and hence highly correlated.
	PO12	Knowledge in the basic analog circuits, students get confidence to analyse more complex electronics and communication systems.
	PSO1	Understanding the basic analog circuits using discrete components students should absorb and apply contextual knowledge of Electronics and communication Engineering.

	PSO2	Understanding the basic analog circuits using discrete components students should absorb and synthesize the experimental data from electronic system to validate the design.
CO2	PO1	Understanding the design and simulation of basic analog circuits using simulation tools requires knowledge in basic electronic components.
	PO2	Understanding to simulate the basic analog circuits using simulation tools improves the skill for identifying and analysing electronic circuits.
	PO3	Knowledge in design and simulation of analog circuits using simulation tools improves the skills of students to meet the specified needs
	PO4	Understanding analog circuits using simulation tools will make use of research-based knowledge and research methods.
CO1	PO1	Knowledge in Design of basic analog circuit using discrete components requires knowledge in basic electronic components and hence highly correlated.
	PO2	Understanding the functioning of basic analog circuits improves the skill of identifying and analysing electronic circuits and hence highly correlated.
	PO3	Knowledge in the functioning of basic analog circuits improves the skill of students to meet the specified need with appropriate considerations and hence highly correlated.
	PO4	Understanding the functioning of basic analog circuits will make use of research-based knowledge and research methods and hence moderately correlated.
	PO9	Knowledge in the functioning of analog circuits will improve to work effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings and hence highly correlated.
	PO10	Understanding the basics of analog circuits will improve the communication skills to effectively work on complex engineering activities and hence highly correlated.
	PO12	Knowledge in the basic analog circuits, students get confidence to analyse more complex electronics and communication systems.
	PSO1	Understanding the basic analog circuits using discrete components students should absorb and apply contextual knowledge of Electronics and communication Engineering.
	PSO2	Understanding the basic analog circuits using discrete components students should absorb and synthesize the experimental data from electronic system to validate the design.
CO2	PO1	Understanding the design and simulation of basic analog circuits using simulation tools requires knowledge in basic electronic components.
	PO2	Understanding to simulate the basic analog circuits using simulation tools improves the skill for identifying and analysing electronic circuits.
	PO3	Knowledge in design and simulation of analog circuits using simulation tools improves the skills of students to meet the specified needs
	PO4	Understanding analog circuits using simulation tools will make use of research-based knowledge and research methods.
	PO5	Knowledge in simulation tools will make use of modern engineering tools in the designing of analog circuits.
	PO9	Knowledge in simulation and functioning of basic analog circuits using simulation tools will improves to work effectively as an individual and as a member or leader in diverse teams.

	PO10	Understanding and demonstrating the functioning of analog circuits will improve communication skill to effectively work on complex engineering activities.
	PO12	Knowledge in simulation tools students will get confidence to analyse more complex electronics and communication systems.
	PSO1	Understanding to design and to simulate the functioning of various analog circuits using simulation tools would help students to gain knowledge in Electronics and communication Engineering.
	PSO2	Understanding to design and to simulate the functioning of basic analog circuits students will be able to synthesise experimental data from electronic system to validate the design.
	PSO3	Understanding the Designing and Simulation Basics students can apply modern engineering tools.
CO3	PO9	Knowledge in analog circuits and their implementation will make students to work as a team to accomplish the given task will improve to work effectively as an individual and as a member or leader in diverse teams and in multidisciplinary settings.
	PO10	Knowledge in analog circuits and their implementation will make students to work as a team which will improve their communication skills effectively work on complex engineering problems.

8. Curricular gaps (if any):

Nil

9. Course Enrichment Activities* Nil

10. Course Plan/Schedule of Experiments

List of Experiments

Week(s)	Experiment	Relevance to COs
Part A: List of Experiments using Discrete components		
1	RC integrating and differentiating circuits (Transient analysis with different inputs and frequency response)	CO1, CO3
2	Clipping and clamping circuits (Transient and Transfer Characteristics)	CO1, CO3
3	RC Coupled CE Amplifier – frequency response characteristics	CO1, CO3
4	Cascade amplifier – gain frequency response	CO1, CO3
5	Low frequency oscillators – RC Phase shift	CO1, CO3
6	Power Amplifiers (Transformer less) – Class B and Class AB	CO1, CO3
Part B: Simulation Experiments		
7	RC integrating and differentiating circuits (Transient analysis with different inputs and frequency response)	CO2
8	Clipping and clamping circuits (Transient and Transfer Characteristics)	CO2
9	RC Coupled CE Amplifier – frequency response characteristics	CO2

10	Cascade amplifier – gain frequency response	CO2
11	Low frequency oscillators – RC Phase shift	CO2
12	Power Amplifiers (Transformer less) – Class B and Class AB	CO2
Total No. of Hours – 36		

11. Assessment Pattern (as per university curriculum)

(Provide details as mentioned in syllabus)

Continuous Internal Evaluation - 75 marks

End Semester Exam - 75 marks

Total - 150 marks

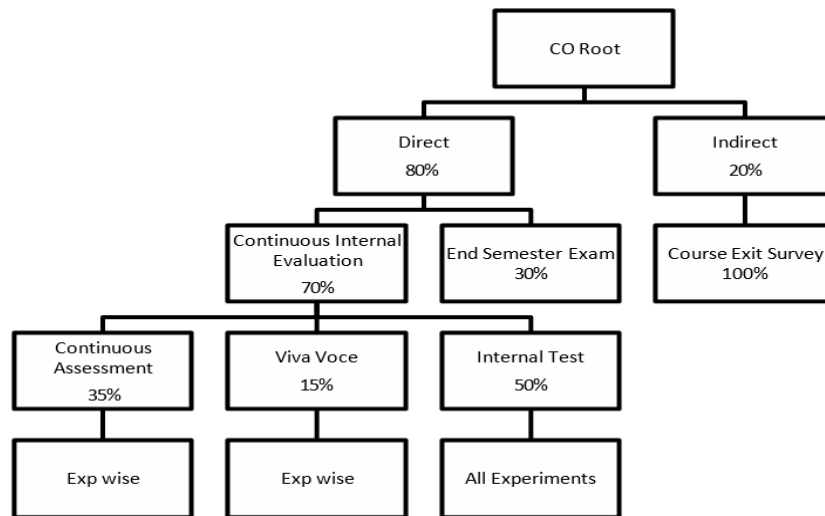
12. Evaluation criteria as (per syllabus)

Sl. No	Nature of Evaluation	Evaluation Pattern	Topics of Evaluation	Duration	Weightage of Marks
1	Continuous Internal Evaluation (75 marks)				
A	Attendance	15 Marks	NA	NA	10%
b	Continuous Assessment (30 Marks)	(a) Performance : 10 marks b) Record : 10 marks (c) Viva Voce : 10 marks	Each Experiment	3 Hours	20%
c	Internal Test (30 Marks)	(a) Preliminary work: 10 marks b) Performance, result and inference: 10 marks (c) Viva Voce: 10 marks	All Experiments	2.5 Hours	20%
2	End semester Examination (75 marks)				
a	End semester Examination	(a) Preliminary work: 15 marks b) Implementing the work/ Conducting the experiment: 10 marks (c) Performance, result and inference: 25 marks (d) Viva Voce: 20 marks (e) Record: 5 marks	All Experiments	2.5 Hours	50%

13. Assessment – CO Mapping (Put, x" if mapping is present)

Tools		Weightage [#]	CO1	CO2	CO3
Direct Assessment Tool	Continuous Assessment	25%	X	x	x
	Viva Voce	10%	X	x	
	Internal Test	35%	X	x	
	End Semester Exam	30%	X	x	
Indirect	Course Exit Survey	100%	X	x	x

14. Assessment Configuration



Prepared by : Dr. Rakesh S

Checked by: Ms. Asha P

1. Prescribed Syllabus

PART – A

(At least 6 experiments are mandatory)

These experiments shall be performed using 8051 trainer kit. The programs shall be written either in embedded C or in assembly language.

1. Data transfer/exchange between specified memory locations.
2. Largest/smallest from a series.
3. Sorting (Ascending/Descending) of data.
4. Addition / subtraction / multiplication / division of 8/16 bit data.
5. Sum of a series of 8 bit data.
6. Multiplication by shift and add method.
7. Square / cube / square root of 8 bit data.
8. Matrix addition.
9. LCM and HCF of two 8 bit numbers.
10. Code conversion – Hex to Decimal/ASCII to Decimal and vice versa.

PART – B

(At least 4 experiments are mandatory.)

Interfacing experiments shall be done using modern microcontrollers such as 8051 or ARM. The interfacing modules may be developed using Embedded C.

1. Time delay generation and relay interface.
2. Display (LED/Seven segments/LCD) and keyboard interface.
3. ADC interface.
4. DAC interface with wave form generation.
5. Stepper motor and DC motor interface.
6. Realization of Boolean expression through port.

2. Text Books (T)

Nil

3. Reference Books (R)

Nil

4. Objectives

- Familiarize the students with Assembly Language Programming of modern microcontrollers.
- Impart the skills for interfacing the microcontroller with the help of Embedded C/Assembly Language Programming.

5. Course Pre / Co-requisite

Nil

6. Course Outcomes

CO1. Write an Assembly language program/Embedded C program for performing data manipulation.

CO2. Develop ALP/Embedded C Programs to interface microcontroller with peripherals.

CO3. Perform programming/interfacing experiments with IDE for modern microcontrollers.

7. Mapping of Course Outcomes with Program Outcomes

PO/ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H	H	H	M					H	H		M	H	M	
CO2	H	H	H	M	H				H	H		M	H	M	H
CO3									H	H					

8. Justification for CO-PO-PSO Correlation

CO	PO	Justification Statement
CO1	PO1	Assembly language programming involves the application of fundamentals in science and engineering thereby developing problem-solving skills. So high correlation is given.
	PO2	Assembly language programming involves breaking down complex problems into smaller, manageable tasks thereby developing problem-solving skills. So high correlation is given.
	PO3	Writing assembly language programs for data manipulation requires students to design a solution to a specific problem. This design process includes defining the problem, considering various approaches, and selecting the most appropriate one. So high correlation is given.
	PO4	Writing assembly language programs for data manipulation often involves solving complex problems that require a deep understanding of computer architecture and low-level programming. So medium correlation is given.
	PO9	Students must collaborate with their teammates to ensure that different parts of the assembly program work together. So high correlation is given.
	PO10	Writing an assembly language program typically involves documenting the code thoroughly. This documentation can include comments explaining the purpose of specific code sections, the algorithm used, and any relevant details about the data manipulation process. So high correlation is given.
	PO12	Writing an assembly language program challenges students to delve into a highly technical and specialized area of computer science. Recognizing the need to learn and master such a complex skill aligns with the spirit of lifelong learning. So medium correlation is given.
	PSO1	Performing data manipulation involves the knowledge in designing and development of microcontroller systems. High correlation is due to the fact that this involves the deep knowledge of design and analysis of various electronic systems

	PSO2	Application of modern engineering tools is required for writing an Assembly language program/Embedded C program for programming Microcontroller systems. High correlation is due to the fact that this involves the deep analysis of complex engineering problems using modern engineering tools.
CO2	PO1	Writing ALP or Embedded C programs to interface a microcontroller with peripherals requires a strong foundation in engineering fundamentals and so high correlation is given
	PO2	Developing ALP or Embedded C programs to interface a microcontroller with peripherals inherently involves the students in identifying and recognizing complex engineering problems and so high correlation is given
	PO3	Developing programs to interface a microcontroller with peripherals involves the design of a technical solution. Students need to plan how the microcontroller will communicate with various peripherals and so high correlation is given
	PO4	Students need to understand the specifications of the microcontroller, peripherals, and the desired functionality thereby applying research based knowledge for the investigation of complex problems and so medium correlation is given
	PO5	Developing ALP or Embedded C programs necessitates the use of modern software development tools and environments and so high correlation is given
	PO9	While developing ALP or Embedded C programs, students are required to contribute individually or as in a team by writing, debugging, and optimizing code and so high correlation is given
	PO10	Writing ALP or Embedded C programs often involves extensive documentation. Students need to document their code, including comments explaining the purpose of specific code sections, the algorithms used, and any relevant details about the microcontroller-peripheral interface and so high correlation is given
	PO12	Students are required to engage in self-directed learning to research, troubleshoot and innovative solutions. High correlation is due to the fact that this involves the deep recognition of the need for independent and life long learning
	PSO1	Students must thoroughly understand the architecture and specifications of the microcontroller, When developing programs to interface a microcontroller with peripherals High correlation is due to the fact that this involves the deep knowledge of design and analysis of various electronic systems
	PSO2	Students conduct experiments to verify the functionality of the microcontroller-peripheral interface and so the correlation is given as medium
	PSO3	Students engaged in developing ALP or Embedded C programs must choose and apply modern engineering tools such as integrated development environments (IDEs), cross-compilers, and debugging software and so the correlation is given as high
CO3	PO9	Students can perform programming/interfacing experiments with IDE for modern microcontrollers effectively as an individual or as a member or leader in diverse teams. High correlation is due to the fact that this involves the deep involvement of individual and team work.
	PO10	Students can identify the tasks required to complete an engineering activity, and the resources required to complete the tasks and apply these for performing interfacing experiments with IDE for modern microcontrollers. High correlation

		is due to the fact that this involves the deep knowledge in understanding of the engineering and management principles.

9. Curricular gaps (if any)

Nil

10. Course Enrichment Activities*

Sl No	Description	Proposed Activities	Relevance to POs and PSOs
	NIL		

11. Course Plan / Schedule of experiments

Weeks(W)	Experiments	Relevance to COs
1	Data transfer/exchange between specified memory locations.	CO1,CO3
2	Largest/smallest from a series.	CO1
3	Sorting (Ascending/Descending) of data.	CO1
4	Addition / subtraction / multiplication / division of 8/16 bit data.	CO1,CO3
5	Sum of a series of 8 bit data.	CO1
6	Square/cube/square root of 8 bit data	CO1
7	ADC Interface	CO2
8	DAC interface with waveform generation	CO2
9	Stepper motor & DC motor interface	CO2
10	LCD Display & keyboard interface	CO2
Total No. of Hours	30	

12. Assessment Pattern

Continuous Internal evaluation	- 75 marks
End Semester Examination	- 75 marks
Total	-150 marks

13. Evaluation criteria (as per syllabus)

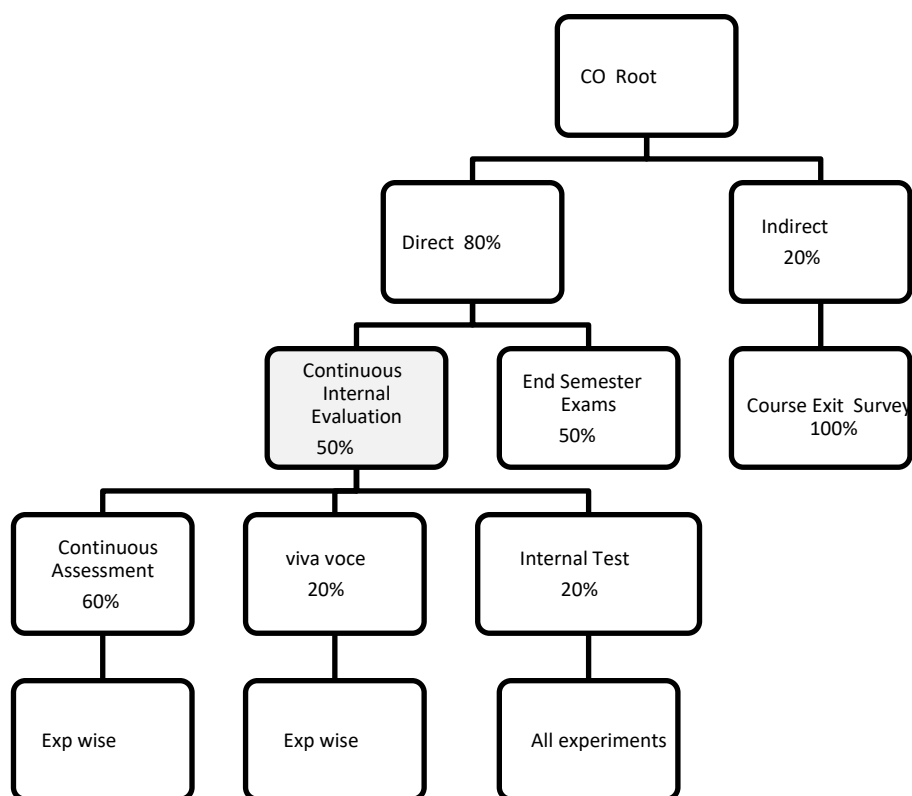
Sl. No.	Nature of Evaluation	Evaluation Pattern	Topics of Evaluation	Duration	Weightage of marks
1.	Continuous Internal evaluation (75 marks)				
a.	Attendance	15 marks	NA	NA	10%
b.	Continuous Evaluation & Viva voce	30 marks	Each experiment	NA	20%
c.	Continuous Assessment test	Design and procedure-10 marks, performance and output-10 marks,, viva – 10 marks- Total-30 marks	All Experiments	3 hours	20%

2.	End Semester Examination (75 marks)				
a.	End semester Examination	Preliminary work- 15 marks,Implementing the experiment – 10 marks, Performance, result & inference – 25 marks, viva – 20 marks, Record-5 marks . Total 75 marks	All Experiments	3hrs	50%

14. Assessment – CO Mapping (Put‘ x’ if mapping is present)

	Tools**	Weightage#	CO1	CO2	CO3
Direct Assessment Tools	Continuous Evaluation Experiment wise CO mapping	25%	x	x	x
	Viva – Voce Experiment wise CO mapping	10%	x	x	x
	Continuous Assessment Test	35%	x	x	x
	End Semester Exam – 30%	30%	x	x	x
Indirect Assessment Tool	Course Exit Survey	100%	x	x	x

15. Assessment Configuration



Prepared By : Ambily Joseph, Gregorious Jose C

Checked By : Dr. Saju A

Semester: 5

CONTENTS

SLOT	COURSE Code	COURSES	L-T-P	HOURS	CREDIT
A	ECT 301	LINEAR INTEGRATED CIRCUITS	3-1-0	4	4
B	ECT 303	DIGITAL SIGNAL PROCESSING	3-1-0	4	4
C	ECT 305	ANALOG AND DIGITAL COMMUNICATION	3-1-0	4	4
D	ECT 307	CONTROL SYSTEMS	3-1-0	4	4
E	HUT300	INDUSTRIAL ECONOMICS AND FOREIGN TRADE	3-0-0	2	2
F	MCN301	DISASTER MANAGEMENT	2-0-0	2	--
S	ECL 331	ANALOG INTEGRATED CIRCUITS AND SIMULATION LAB	0-0-3	3	2
T	ECL 333	DIGITAL SIGNAL PROCESSING LAB	0-0-3	3	2

Course Code & Name: ECT 301 LINEAR INTEGRATED CIRCUITS

1. Prescribed Syllabus

Module	Topic	Hours
1	Operational amplifiers (Op Amps): The 741 Op Amp, Block diagram, Ideal op-amp parameters, typical parameter values for 741, Equivalent circuit, Open loop configurations, Voltage transfer curve, Frequency response curve. Differential Amplifiers: Differential amplifier configurations using BJT, DC Analysis- transfer characteristics; AC analysis- differential and common mode gains, CMRR, input and output resistance, Voltage gain. Constant current bias, constant current source; Concept of current mirror- the two-transistor current mirror, Wilson and Widlar current mirrors.	9
2	Op-amp with negative feedback: General concept of Voltage Series, Voltage Shunt, current series and current shunt negative feedback, Op Amp circuits with voltage series and voltage shunt feedback, Virtual ground Concept; analysis of practical inverting and non- inverting amplifiers for closed loop gain, Input Resistance and Output Resistance. Op-amp applications: Summer, Voltage Follower-loading effects, Differential and Instrumentation Amplifiers, Voltage to current and Current to voltage converters, Integrator, Differentiator, Precision rectifiers, Comparators, Schmitt Triggers, Log and antilog amplifiers	11
3	Op-amp Oscillators and Multivibrators: Phase Shift and Wien-bridge Oscillators, Triangular and Sawtooth waveform generators, Astable and monostable multivibrators. Active filters: Comparison with passive filters, First and second order low pass, High pass, Band pass and band reject active filters, state variable filters.	10
4	Timer and VCO: Timer IC 555- Functional diagram, Astable and monostable operations;. Basic concepts of Voltage Controlled Oscillator and application of VCO IC LM566, Phase Locked Loop – Operation, Closed loop analysis, Lock and capture range, Basic building blocks, PLL IC 565, Applications of PLL.	9
5	Voltage Regulators: Fixed and Adjustable voltage regulators, IC 723 – Low voltage and high voltage configurations, Current boosting, Current limiting, Short circuit and Fold-back protection. Data Converters: Digital to Analog converters, Specifications, Weighted resistor type and R-2R Ladder type. Analog to Digital Converters: Specifications, Flash type and Successive approximation type.	9

2. Text Books (T)

T1. Roy D. C. and S. B. Jain, Linear Integrated Circuits, New Age International, 3/e, 2010

3. Reference Books (R)

R1. D.Franco S., Design with Operational Amplifiers and Analog Integrated Circuits, 3/e, Tata McGraw Hill, 2008

- R2. Gayakwad R. A., Op-Amps and Linear Integrated Circuits, Prentice Hall, 4/e, 2010
 R3. Salivahanan S. and V. S. K. Bhaaskaran, Linear Integrated Circuits, Tata McGraw Hill, 2008.
 R4. Botkar K. R., Integrated Circuits, 10/e, Khanna Publishers, 2010
 R5. .G. Clayton, Operational Amplifiers, Butterworth & Company Publ. Ltd. Elsevier, 1971
 R6. David A. Bell, Operational Amplifiers & Linear ICs, Oxford University Press, 2nd edition, 2010
 R7. R.F. Coughlin & Fredrick Driscoll, Operational Amplifiers & Linear Integrated Circuits, 6th Edition, PHI, 2001
 R8. Sedra A. S. and K. C. Smith, Microelectronic Circuits, 6/e, Oxford University Press, 2013.

4. Course Objectives

This course aims to develop the skill to design circuits using operational amplifiers and other linear ICs for various applications.

5. Course Pre / Co-requisite

EC202 Analog Circuits

6. Course Outcomes

After the completion of the course the student will be able to:

CO1: Understand Op Amp fundamentals and differential amplifier configurations.

CO2: Design operational amplifier circuits for various applications

CO3: Design Oscillators and active filters using op-amps

CO4: Explain the working and applications of timer, VCO and PLL ICs

CO5: Outline the working of Voltage regulator IC's and Data converters

7. Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes

PO/ CO	PO 1	PO 2	PO 3	PO 4	PO5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H	H	L	M								L	M		
CO2	H	H	M	M	M							L	M		
CO3	H	H	M	M	M							L	M		
CO4	H	H	L	M	M							L	M		
CO5	H	H	M	M	M							L			

8. Justification for CO-PO-PSO Correlation

CO	PO/PSO	Justification
CO1	PO1	Knowledge in op-amp fundamentals and differential amplifier configurations will help the students to understand different parameters of op-amps and engineering problems related to op amp circuits.
	PO2	Understanding op-amp fundamentals will help the students analyse complex engineering problems related to op-amp circuits and differential amplifier configurations.
	PO3	Basic knowledge of op-amp fundamentals and differential amplifier configurations will help the students design solutions for complex engineering problems.
	PO4	Research based knowledge and design of experiments using op amps and differential amplifier configurations will help the students to interpret data & provide valuable conclusions.

	PO12	Basic knowledge of op-amp fundamentals and differential amplifier configurations will help the students to improve the present features of op-amps & design better circuits for future applications
	PSO1	Understanding op-amp fundamentals and differential amplifier configurations will help the students to apply contextual knowledge in the design, analysis and development of various electronic systems.
CO2	PO1	Knowledge about operational amplifier circuits for various applications will help the students to solve engineering problems related to different op amp circuits.
	PO2	Analysing operational amplifier circuits for various applications, Students will be able to design circuits for different complex engineering problems.
	PO3	Designing operational amplifier circuits will help students to design solutions for complex engineering problems that meet specified needs.
	PO4	Knowledge in different operational amplifier circuits will help students to provide valid conclusions by interpreting data and synthesizing circuits.
	PO5	Knowledge in modern engineering & IT tools with an understanding of the limitation will help students to design circuits for various applications.
	PO12	Designing operational amplifier circuits for various applications will help the students to improve the functioning of circuits in context of the technological change happening.
	PSO1	By applying contextual knowledge and developing various electronic systems, students will be able to design operational amplifier circuits for different applications.
CO3	PO1	Knowledge about Oscillators and active filters using op-amps will help the students to solve engineering problems related to different op amp circuits.
	PO2	Analysing complex engineering problems, Students will be able design oscillators and active filters using op-amps.
	PO3	Students will be able to design solutions for complex engineering problems by designing oscillators and active filters using op-amps that meet the specified needs.
	PO4	Knowledge in oscillator circuit design and active filters will help students to provide valid conclusions by interpreting data and synthesizing circuits.
	PO5	Designing Oscillators and active filters using op-amps will help the students use modern engineering & IT Tools to complex engineering activities.
	PO12	Knowledge in fundamentals of oscillator and active filter design using op-amps will help students to improve the efficiency and performance of circuits with the change in technology.
	PSO1	Applying contextual knowledge, students will be able to design oscillators and active filter circuits for various electronic systems.
CO4	PO1	Knowledge in science and engineering fundamentals will help students to explain the working and applications of timer, VCO and PLL ICs.
	PO2	Knowledge about the working and applications of timer, VCO and PLL ICs will help the students to analyse complex engineering problems
	PO3	Understanding the working and applications of timer, VCO and PLL ICs, will help students to design solutions for complex engineering problems.
	PO4	Knowledge about the working and applications of timer, VCO and PLL ICs will help the students to use research-based knowledge, analyse and synthesize the information to provide valuable conclusions.
	PO5	Understanding the working and applications of Timer, VCO and PLL ICs, students will be able to apply modern IT Tools to complex engineering problems.

	PO12	Understanding the working and applications of Timer, VCO and PLL ICs, students will be able to improve the efficiency and performance of circuits with the change in technology.
	PSO1	Knowledge about the working and applications of Timer, VCO and PLL ICs will help students to design, analyse and develop various electronic systems
CO5	PO1	Knowledge in science and engineering fundamentals will help students to outline the working of Voltage regulator IC's and Data converters.
	PO2	Understanding the working of Voltage regulator IC's and Data converters will help the students to analyse complex engineering problems.
	PO3	knowledge of Voltage regulator IC's and Data converters will help students to design solutions for complex engineering problems.
	PO4	Knowledge about the working of Voltage regulator IC's and Data converters will help the students to use research-based knowledge, analyse and synthesize the information to provide valuable conclusions.
	PO5	Understanding the working of Voltage regulator IC's and Data converters, students will be able to apply modern engineering & IT tools to explain complex engineering problems.
	PO12	Knowledge in the working of Voltage regulator IC's and Data converters will help the students to improve the efficiency and performance of circuits with the change in technology.

9. Curricular gaps (if any)

Nil

10. Course Enrichment Activities

Sl No	Description	Proposed Activities	Relevance to POs and PSOs
		Nil	

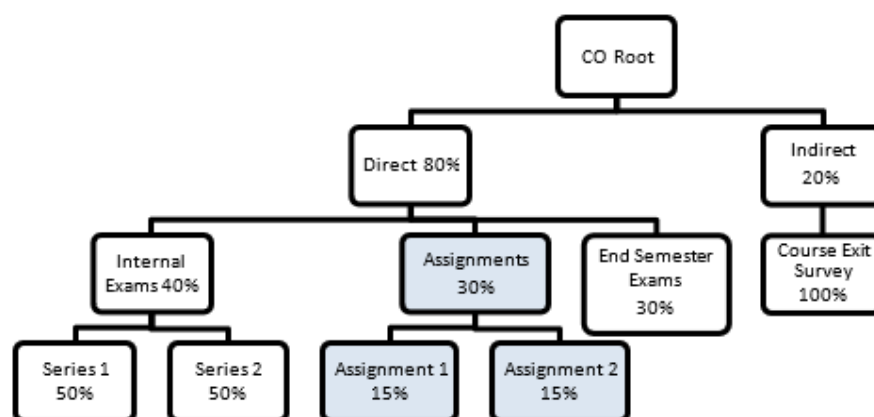
11. Internal Assessment mark allocation (as per university curriculum)

Attendance	- 10 marks
Continuous Assessment Test	- 25 marks
Assignment (s)/ Course Project	- 15 marks
<u>Total</u>	<u>- 50 marks</u>

12. Assessment – CO Mapping (Put 'x' if mapping is present)

	Tools		Weightage [#]	CO1	CO2	CO3	CO4	CO5
Direct Assessment Tools**	Internal Exam(s) 40%	Series 1	20%	x	x	x		
		Series 2	20%			x	x	x
	Assignment (s)/ Course Project /Quiz etc. 30%	Assignment 1	15%	x	x			
		Assignment 2	15%			x	x	x
	End Semester Exam		30%	x	x	x	x	x
Indirect Assessment Tool	Course Exit Survey		100%	x	x	x	x	x

13. Assessment Configuration



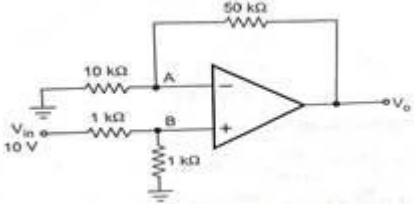
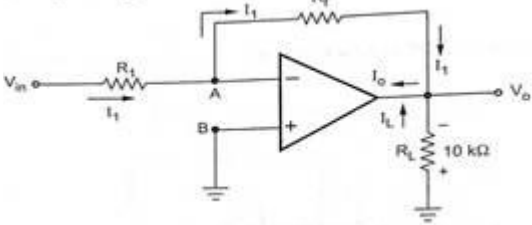
14. Course Plan

Hour	Topic	Module	Reference(s)	Teaching Pedagogy
1	The 741 Op Amp, Block diagram, Ideal op-amp parameters, typical parameter values for 741	1	R1	Lecture
2	Equivalent circuit, Open loop configurations, Voltage transfer curve, Frequency response curve.	1	R1	Lecture
3	Differential amplifier configurations using BJT	1	R1	Lecture
4	DC Analysis- transfer characteristics	1	R1	Lecture
5	AC analysis- differential and common mode gains, CMRR,	1	R1	Lecture
6	input and output resistance, Voltage gain	1	R1	Tutorial
7	Constant current bias and constant current source	1	R1	Lecture
8	Concept of current mirror, the two transistor	1	R1	Lecture
9	current mirror Wilson and Widlar current mirrors.	1	R1	Lecture
10	General concept of Voltage Series, Voltage Shunt, current series and current shunt negative feedback	2	R1, R2	Lecture
11	Op Amp circuits with voltage series and voltage shunt feedback, Virtual ground Concept	2	R1, R2	Lecture
12	Analysis of practical inverting amplifier	2	R1, R2	Tutorial
13	Analysis of practical non-inverting amplifier	2	R1, R2	Lecture
14	Summer, Voltage Follower-loading effect	2	R1, R2	Lecture
15	Differential and Instrumentation Amplifiers	2	R1, R2	Lecture
16	Voltage to current and Current to voltage converters	2	R1, R2	Lecture
17	Integrator, Differentiator	2	R1, R2	Lecture
18	Precision rectifiers-half wave and full wave	2	R1, R2	Lecture
19	Comparators, Schmitt Triggers	2	R1, R2	Lecture
20	Log and antilog amplifier	2	R1, R2	Lecture
21	Phase Shift Oscillators,	3	R2	Lecture

22	Wien-bridge Oscillators	3	R2	Lecture
23	Triangular and Sawtooth waveform generators,	3	R2	Lecture
24	Astable monostable multivibrators	3	R2	Lecture
25	Comparison, design of First order low pass and High pass active filters	3	R2	Lecture
26	Second order low pass and High pass active filters	3	R2	Tutorial
27	Design of Second Order Band pass filter	3	R2	Lecture
28	Design of Second Order band reject filter	3	R2	Lecture
29	State variable filters Introduction	3	R2	Lecture
30	State variable filters Description	3	R2	Lecture
31	Timer IC 555- Functional diagram,	4	R2	Lecture
32	Astable and monostable operations.	4	R2	Tutorial
33	Basic concepts of Voltage Controlled Oscillator	4	R2	Lecture
34	VCO IC LM566	4	R2	Lecture
35	Application of VCO IC LM566	4	R2	Lecture
36	PLL Operation,	4	R2	Lecture
37	Closed loop analysis Lock and capture range.	4	R2	Lecture
38	Basic building blocks, PLL IC 565	4	R2	Lecture
39	Applications of PLL	4	R2	Lecture
40	Fixed and Adjustable voltage regulators	5	T1	Lecture
41	IC 723 – Low voltage and high voltage configurations	5	T1	Lecture
42	IC 723 –high voltage configurations	5	T1	Lecture
43	Current boosting, Current limiting,	5	T1	Lecture
44	Short circuit and Fold-back protection.	5	T1	Lecture
45	Digital to Analog converters, Specifications	5	T1	Lecture
46	Weighted resistor type and R-2R Ladder type	5	T1	Lecture
47	Analog to Digital Converters: Specifications	5	T1	Tutorial
48	Flash type and Successive approximation type.	5	T1	Lecture

15. Question Bank

Sl. No.	Question	Marks	CO	BL
Module 1				
1	List any three ideal characteristics of op amps.	3	CO1	L1
2	Draw the circuit of an inverting amplifier & write the equation for open loop gain.	3	CO1	L1
3	Define the parameter CMRR of an op-amp. Given that an operational amplifier produces an output voltage of 50 mV when the input voltages $V_1 = V_2 = 10V$ and output voltage of 10V when $V_1 = 10\text{ mV}$ and $V_2 = 20mV$. Determine the CMRR in dB.	3	CO1	L1

4	Draw the circuit of a non-inverting amplifier & write the equation for open loop gain.	3	CO1	L1
5	Draw the ideal and practical voltage transfer characteristics of an op-amp. and explain the difference.	3	CO1	L1
6	Design an amplifier with gain of -10 and input resistance equal to $10\text{k}\Omega$.	3	CO1	L1
7	Define Difference mode gain & common mode gain with suitable equations.	3	CO1	L1
8	List different versions of op-amps with their characteristics.	3	CO1	L1
9	Differentiate between inverting and non-inverting amplifiers	3	CO1	L1
10	An input of 3V is fed into the non-inverting terminal of an op-amp. The amplifier has R_i of $10\text{k}\Omega$ and R_f of $10\text{k}\Omega$. Find the output voltage.	3	CO1	L1
11	If the base current for an emitter coupled transistor of a differential amplifier are $180\mu\text{A}$ and $22\mu\text{A}$, determine input bias current and input offset current.	3	CO1	L2
12	For a particular op-amp, the input offset current is 20nA and input bias current is 60nA . Calculate the value of two input bias currents.	3	CO1	L2
13	An op-amp operates as a unity gain buffer with 3V peak to peak square wave input. If the op-amp is ideal with slew rate $0.5\text{V}/\mu\text{s}$, Find the maximum frequency of operation.	3	CO1	L1
14	Explain the need for level shifting in an op-amp. Why aren't op-amps not used in open loop configuration for most of the applications?	3	CO1	L1
15	List the advantages of negative feedback in op-amp circuits.	3	CO1	L1
16	Draw & explain the ideal and practical voltage transfer curve of an op-amp	6	CO1	L1
17	Explain the working of zero crossing detector with suitable waveforms	6	CO1	L1
18	Draw and list the functions of 741 IC pins	5	CO1	L1
19	Find V_0 for the circuit shown below 	5	CO1	L2
20	A load of $10\text{k}\Omega$ is connected to the output of an inverting amplifier with input voltage of 0.7V. Calculate I_1 , V_0 , I_L and total current I_0 . 	6	CO1	L3

21	For a non-inverting amplifier shown, calculate A_{CL}, V_O, I_L and I_O.	6	CO1	L2
22	Determine Output Voltage for the configuration shown below	4	CO1	L2
23	Describe the different parameters of op amp. Give the ideal parameters of op amp. Give the typical values for opamp 741	8	CO1	L1
24	Draw the equivalent circuit of an operational amplifier. Explain voltage transfer characteristics of an operational amplifier.	7	CO1	L1
25	Derive CMRR, input resistance and output resistance of a dual input balanced output differential amplifier configuration.	8	CO1	L1
26	a) Define Slew rate and derive the expression for maximum input frequency at which an undistorted signal is obtained in terms of slew rate. b) Define Input offset voltage and Input offset current,	7	CO1	L3
27	Draw the block diagram of an op-amp & explain the function of each block	7	CO1	L1
28	Describe the frequency response of operational amplifiers	8	CO1	L1
29	Draw the circuit diagram of a Wilson current source and derive an expression for output current in terms of the reference current.	7	CO1	L3
30	Analyse the differential amplifier circuit using BJT and derive an expression for differential mode gain and common mode gain.	7	CO1	L2
Module 2				
1	Explain the principle of operation of a comparator circuit.	3	CO2	L1
2	Differentiate between inverting and non-inverting comparators	3	CO2	L1
3	List the differences between comparators and Schmitt triggers	3	CO2	L1
4	Draw the hysteresis curve of a Schmitt trigger with $UTP = -2V$ and $LTP = -6V$.	3	CO2	L1
5	Define hysteresis. Why is it called dead zone?	3	CO2	L2
6	Draw the circuit diagram of a logarithmic amplifier. Write the equation for its output voltage.	3	CO2	L2
7	List the requirements of a good instrumentation amplifier	5	CO2	L1

8	List the advantages of three amplifier instrumentation amplifier	3	CO2	L1
9	Derive the equation for the output of a differentiator circuit.	5	CO2	L2
10	Derive the equation for the output of an integrator circuit.	5	CO2	L2
11	Explain the two types of V-I converters	5	CO2	L1
12	Explain the working of I-V converters	5	CO2	L1
13	Derive the V-I relationship for a floating load V-I converter with suitable circuit diagram	8	CO2	L2
14	Design a non-inverting amplifier for a gain of 11	5	CO2	L1
15	Design an adder circuit using an op-amp to get the output expression as $V_0 = -(0.1V_1 + V_2 + 10V_3)$	5	CO2	L2
16	Design a circuit to compute the equation $5V_1 - 3V_2$	4	CO2	L2
17	For an instrumentation amplifier, $R_1 = R_2 = 100\Omega$ and $R_F = 470k\Omega$. Determine the value of R_G if the gain required is 1000.	4	CO2	L1
18	Design a practical integrator circuit with a DC gain of 10, to integrate a square wave of 10kHz.	6	CO2	L3
19	For a Schmitt trigger having $R_1 = 51k\Omega$, $R_2 = 120\Omega$ and $V_{cc} = 15V$, calculate threshold Voltage levels and hysteresis assuming $V_{sat} = 0.9V_{cc}$.	7	CO2	L2
20	Design a full wave rectifier to rectify an ac signal of 0.2V peak- to-peak. Explain its principle of operation.	7	CO2	L2
21	Explain the working of an instrumentation amplifier. Derive the equation for its output voltage.	10	CO2	L1
22	Derive the following characteristics of voltage shunt amplifier: i) Closed loop voltage gain ii) Input resistance iii) Output resistance iv) Bandwidth	10	CO2	L2
23	Explain the working of an inverting Schmitt trigger and draw its transfer characteristics.	7	CO2	L1
24	Explain with suitable diagram how voltage Series feedback is implemented in op-amp based circuits and derive the following characteristics	10	CO2	L1
25	With the help of a circuit diagram, derive the equation for load current I_L , for a V to I converter with grounded load	7	CO2	L2
26	Describe the principle and working of (i) Logarithmic amplifier (ii) Differentiator (iii) Integrator (iv) Schmitt Trigger	10	CO2	L1
27	Design a circuit to find average of three input voltages.	7	CO2	L2
28	Explain the working of full wave precision rectifiers with suitable diagram and waveforms	8	CO2	L1
29	Explain the working of a voltage follower circuit.	5	CO2	L1
30	Explain the working of (a) Adder (b) Differential amplifier	8	CO2	L1
Module 3				
1	Draw the circuit diagram of a triangular wave generator using op-amp.	3	CO3	L1
2	Design a first order high pass filter for a cut off frequency of 1kHz and maximum gain of 11.	3	CO3	L1
3	Describe Barkhausen criteria for oscillators	3	CO3	L1

4	Explain the classification of oscillators	3	CO3	L1
5	List the applications of RC phase shift oscillators.	3	CO3	L1
6	Draw the output waveforms of triangular wave and sawtooth wave generators.	3	CO3	L1
7	Draw the output waveforms of monostable multivibrators	3	CO3	L1
8	List applications of multivibrators.	3	CO3	L1
9	Draw the output waveforms of astable multivibrators.	3	CO3	L1
10	Write the expression for the relation between centre frequency f_c and BW in bandpass filters and draw its frequency response.	3	CO3	L1
11	Draw the circuit of an all pass filter and write the expression for its transfer function.	3	CO3	L1
12	Explain the frequency response of bandpass filters.	3	CO3	L1
13	Design a low pass filter with a cut off frequency of 15.9 kHz with a passband gain of 1.5.	3	CO3	L2
14	For an all pass filter, the value of R and C are $7.95k\Omega$ and $0.02 \mu F$ respectively. If the input frequency is 1.5kHz, calculate the phase shift.	3	CO3	L1
15	Design a high pass filter with a cut off frequency of 10kHz with a passband gain of 1.5	5	CO3	L2
16	List the advantages and disadvantages of RC phase shift oscillators.	4	CO3	L1
17	Draw the circuit diagram of a RC phase shift oscillator using op- amp and derive an expression for frequency of oscillations.	7	CO3	L3
18	Draw the circuit diagram of a Band Pass filter and derive an expression for the transfer function.	7	CO3	L2
19	Design a circuit to generate a square wave of frequency 2 kHz and amplitude 10 Vpp using op-amp. Assume that the duty cycle is equal to 50%.	7	CO3	L2
20	Derive the transfer function of a second order Butterworth low pass filter.	8	CO3	L3
21	Derive the transfer function of a first order high pass butterworth filter.	8	CO3	L3
22	Compare passive and active filters	5	CO3	L1
23	What is the condition for sustained oscillations. Derive the equation for frequency of oscillation (f_0) of a Wein Bridge oscillator. Design a Wein Bridge oscillator for $f_0 = 1KHz$.	10	CO3	L2
24	Derive the equation for the transfer function of a first order wide Band Pass filter.	7	CO3	L1
25	With suitable equations, describe state variable filters	8	CO3	L1
26	Design a second order Butterworth Low Pass Filter with $f_H = 2KHz$	5	CO3	L2
27	Explain how a free running square wave form can be obtained using op-amps. (Astable MV)	8	CO3	L1

28	Design a triangular wave generator for frequency 1kHz and ramp output of 5V.	6	CO3	L2
29	Design a sawtooth wave generator for frequency 1kHz and ramp output of 8V.	6	CO3	L2
30	Explain the working of a monostable multivibrator using op- amps.	8	CO3	L1
31	Design an RC phase shift oscillator to have output frequency of 500Hz. Use 12V supply.	8	CO3	L2
32	For an astable multivibrator, if $R_2=100k\Omega$, $R_1=86k\Omega$, $+V_{sat}=15V$, $-V_{sat}=-15V$, $R_f=100k\Omega$ and $C=0.1\mu F$, find (a) VUT, (b)VLT (c)frequency of oscillation	6	CO3	L2
33	Calculate the frequency of oscillation for an astable multivibrator if $R_2=10k\Omega$, $R_1=8.6k\Omega$, $R_f=100k\Omega$ and $C=0.01\mu F$	4	CO3	L1
34	Design an op-amp free running multivibrator with $T_{ON}=1\text{ ms}$ and $T_{OFF}=2\text{ms}$.	8	CO3	L3
35	Design a triangular wave generator such that $f_0=5\text{kHz}$ and $V_o(pp)=7.5V$. The op-amp saturation voltage is 15V.	7	CO3	L2
36	Design a narrow band pass filter with two feedback paths with $f_c=1.5\text{kHz}$, $Q=7$ and $AF=15$.	9	CO3	L3
37	Design a notch filter to eliminate 120Hz hum.	5	CO3	L3
38	Design a wide band pass filter having $f_L=400\text{ Hz}$ and $f_H=2\text{ kHz}$ and pass band gain of 4. Calculate the Q value of the filter.	9	CO3	L3
39	Derive an expression for the transfer function of a first order low pass Butterworth filter.	5	CO3	L3
40	Design a wide band reject filter having $f_H = 400\text{Hz}$ and $f_L=2\text{kHz}$ with a passband gain of 2.	8	CO3	L2
41	Derive the transfer function of an all pass filter.	8	CO3	L2
Module 4				
1	Draw the block schematic of a voltage controlled oscillator using 566 IC.	3	CO4	L1
2	Differentiate between monostable and astable multivibrators.	3	CO4	L1
3	Draw the circuit of a basic timing device using 741C op-amp	3	CO4	L1
4	Write the expression for charging time, discharging time and duty cycle of astable multivibrator.	3	CO4	L1
5	Explain the functions of threshold and trigger pins of 555 IC.	3	CO4	L2
6	List any three features of 555 IC.	3	CO4	L1
7	Draw the block schematic of 555 IC.	3	CO4	L1
8	Name few applications of 555 IC.	3	CO4	L1
9	Why are astable multivibrators called pulse generators?	3	CO4	L2
10	Explain the functions of reset and discharge pins of 555 IC.	3	CO4	L2

11	Explain the function of a VCO	3	CO4	L1
12	Draw the pin diagram of LM 566 and label the pins.	3	CO4	L1
13	Draw the block schematic of 566 VCO IC.	3	CO4	L2
14	Draw the block schematic of 565 PLL IC.	3	CO4	L2
15	Write equations for the lock range and capture range of IC 565 PLL.	3	CO4	L1
16	List any three applications of PLL IC.	3	CO4	L1
17	List few applications of voltage controlled oscillators	3	CO4	L1
18	Define free running, capture range and lock range for a PLL.	3	CO4	L1
19	Draw the block diagram of a PLL & explain the function of each block.	6	CO4	L1
20	Explain the working of a 555 monostable multivibrator with the help of internal block diagram.	8	CO4	L2
21	Derive an expression for the pulse width of an astable multivibrator	6	CO4	L2
22	Derive an expression for the duty cycle of and frequency of an astable multivibrator.	8	CO4	L2
23	Explain the working of a phase locked loop with a block diagram.	6	CO4	L2
24	Explain the working of a 555 astable multivibrator with the help of internal block diagram.	8	CO4	L2
25	Derive an expression for the pulse width of an a monostable multivibrator.	6	CO4	L2
26	With the help of a schematic diagram, Explain the working of 566 IC.	8	CO4	L2
27	Explain the working of a PLL with the help of a block diagram.	8	CO4	L2
28	Explain the closed loop analysis of PLL.	8	CO4	L3
29	Explain any two applications of VCO.	8	CO4	L2
30	Explain the working of VCO as a frequency translator and AM demodulator.	8	CO4	L2
Module 5				
1	List the basic A/D conversion techniques.	3	CO5	L1
2	Define quantization error in ADC. Give its equation.	3	CO5	L1
3	Explain the difference between sampling and quantization with the help of waveforms.	3	CO5	L2
4	List few applications of ADC.	3	CO5	L1
5	Draw the block diagram of successive approximation ADC.	3	CO5	L1
6	Calculate the quantizing error for 12 bit ADC with full scale input voltage 4.095V.	3	CO5	L2
7	Define resolution and quantization error of ADC.	3	CO5	L1
8	Explain conversion time for ADC.	3	CO5	L1
9	Determine the resolution of an 8-bit A/D converter for a 10V input range.	3	CO5	L2

10	Calculate the quantizing error for an 8-bit ADC with full scale input voltage of 2.55V.	3	CO5	L2
11	List different types of A/D converters.	3	CO5	L1
12	Draw the circuit diagram of a flash type ADC.	3	CO5	L1
13	List any three advantages of IC voltage regulators.	3	CO5	L1
14	Draw the pin diagram of IC 723.	3	CO5	L1
15	Name the major functional blocks of IC 723.	3	CO5	L1
16	An 8-bit DAC has an output range of 0-2.55V. Calculate its resolution.	3	CO5	L2
17	Explain the need for protection circuits in voltage regulators.	3	CO5	L1
18	Describe any two performance parameters of DAC.	4	CO5	L1
19	List the important features of IC 723.	5	CO5	L1
20	Explain the working of a successive approximation type ADC.	10	CO5	L2
21	Differentiate between flash type and successive approximation type ADC.	6	CO5	L1
22	Draw the block diagram of ADC and explain the function of each block.	6	CO5	L1
23	Explain the working of a flash type ADC.	8	CO5	L2
24	Explain any three performance parameters of ADC.	6	CO5	L2
25	Explain how short circuit and fold back protection are done using IC723 voltage regulator.	8	CO5	L2
26	Describe High voltage and Low voltage configuration of voltage regulators	8	CO5	L1
27	Explain the working of Weighted resistor type DACs.	8	CO5	L2
28	Explain the operation of R-2R Ladder type DAC	8	CO5	L2
29	Explain how current boosting and current limiting is done using IC723 voltage regulator.	8	CO5	L2
30	Differentiate between series and shunt voltage regulators with the help of block diagrams.	6	CO5	L1
31	Explain the working of IC 723 with the help of functional block diagram.	8	CO5	L2

Prepared By : Ms. Sonu Kunjannamma Varghese

Checked By : Ms. Pearl Antonette Mendez

Course Code & Name: ECT 303 DIGITAL SIGNAL PROCESSING**1. Prescribed Syllabus**

Module	Topic	Hours
1	Basic Elements of a DSP system, Typical DSP applications, Finite-length discrete transforms, Orthogonal transforms – The Discrete Fourier Transform: DFT as a linear transformation (Matrix relations), Relationship of the DFT to other transforms, IDFT, Properties of DFT and examples. Circular convolution, Linear Filtering methods based on the DFT, linear convolution using circular convolution, Filtering of long data sequences, overlap save and overlap add methods, Frequency Analysis of Signals using the DFT (concept only required)	9
2	Efficient Computation of DFT: Fast Fourier Transform Algorithms-Radix-2 Decimation in Time and Decimation in Frequency FFT Algorithms, IDFT computation using Radix-2 FFT Algorithms, Application of FFT Algorithms, Efficient computation of DFT of Two Real Sequences and a 2N-Point Real Sequence	8
3	Design of FIR Filters - Symmetric and Anti-symmetric FIR Filters, Design of linear phase FIR filters using Window methods, (rectangular, Hamming and Hanning) and frequency sampling method, Comparison of design methods for Linear Phase FIR Filters. Design of IIR Digital Filters from Analog Filters (Butterworth), IIR Filter Design by Impulse Invariance, and Bilinear Transformation, Frequency Transformations in the Analog and Digital Domain	12
4	Structures for the realization of Discrete Time Systems - Block diagram and signal flow graph representations of filters, FIR Filter Structures: Linear structures, Direct Form, Cascade Form, IIR Filter Structures: Direct Form, Transposed Form, Cascade Form and Parallel Form, Computational Complexity of Digital filter structures. Multi-rate Digital Signal Processing: Decimation and Interpolation (Time domain and Frequency Domain Interpretation), Anti-aliasing and anti-imaging filter.	11
5	Computer architecture for signal processing: Harvard Architecture, pipelining, MAC, Introduction to TMS320C67xx digital signal processor, Functional Block Diagram. Finite word length effects in DSP systems: Introduction (analysis not required), fixed-point and floating-point DSP arithmetic, ADC quantization noise, Finite word length effects in IIR digital filters: coefficient quantization errors. Finite word length effects in FFT algorithms: Round off errors	9

2. Text Books (T)

- T1. Proakis J. G. and Manolakis D. G., Digital Signal Processing, 4/e, Pearson Education, 2007
- T2. Alan V Oppenheim, Ronald W. Schaffer, Discrete-Time Signal Processing, 3rd Edition, Pearson, 2010
- T3. Mitra S. K., Digital Signal Processing: A Computer Based Approach, 4/e McGraw Hill (India) 2014

3. Reference Books (R)

- R1. Ifeachor E.C. and Jervis B. W., Digital Signal Processing: A Practical Approach, 2/e Pearson Education, 2009.
- R2. Lyons, Richard G., Understanding Digital Signal Processing, 3/e. Pearson Education India, 2004.

- R3. Salivahanan S, Digital Signal Processing, 4e, Mc Graw –Hill Education New Delhi, 2019
 R4. Chassaing, Rulph., DSP applications using C and the TMS320C6x DSK. Vol. 13. John Wiley & Sons, 2003
 R5. Vinay.K.Ingle, John.G.Proakis, Digital Signal Processing: Bookware Companion Series, Thomson, 2004
 R6. Chen, C.T., “Digital Signal Processing: Spectral Computation & Filter Design”, Oxford Univ. Press, 2001
 R7. Monson H Hayes, “Schaums outline: Digital Signal Processing”, McGraw Hill Professional, 1999

4. Course Objectives

- ✓ This course aims to provide an understanding of the principles, algorithms and applications of DSP.

5. Course Pre / Co-requisite

- ✓ ECT 204 Signals and systems

6. Course Outcomes

After completion of the course, student will be able to

CO1: State and prove the fundamental properties and relations relevant to DFT and solve basic problems involving DFT based filtering methods

CO2: Compute DFT and IDFT using DIT and DIF radix-2 FFT algorithms

CO3: Design linear phase FIR filters and IIR filters for a given specification

CO4: Illustrate the various FIR and IIR filter structures for the realization of the given system function.

CO5: Explain the basic multi-rate DSP operations decimation and interpolation in both time and frequency domains using supported mathematical equations

CO6: Explain the architecture of DSP processor (TMS320C67xx) and the finite word length effects

7. Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes

PO/ CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	H	H	M		M						M	H		
CO2	H	H	H		H						M	H		
CO3	H	H	H		H						M	H		
CO4	H	H	M		M						M	H		
CO5	M	M	M		M						M	H		
CO6	M	M	-		-						M	H		

8. Justification for CO-PO-PSO Correlation

CO	PO/PSO	Justification
CO1	PO1	Understanding fundamental properties and relations relevant to DFT and solving basic problems involving DFT based filtering methods will help students in real time signal processing.

	PO2	Understanding Discrete Fourier Transform: DFT as a linear transformation (Matrix relations), will help analyze complex engineering problems.
	PO3	Knowing linear filtering methods based on the DFT- linear convolution using circular convolution, filtering of long data sequences, overlap save and overlap add methods will help solutions for complex engineering problems and design system components or processes.
	PO5	Practicing simulation experiments and understanding DSP processor architecture and features help familiarizing modern engineering and IT tools
	PO11	Learning and practicing mathematical analysis of signals help in engaging in independent and life-long learning in the broadest context of technological change.
	PSO1	Knowledge in implementation of linear filtering and frequency analysis using FFT algorithms will help the students in the analysis of discrete time LTI systems. Hence highly correlated
CO2	PO1	Understanding computation methods for DFT and DTFT help in solving basic problems involving DFT based filtering methods will help students in real time signal processing applications.
	PO2	Understanding Discrete Fourier Transform: DFT as a linear transformation (Matrix relations), will help analyze complex engineering problems.
	PO3	Knowing FFT methods based will help solutions for complex engineering problems involving digital signals and help design system components or processes.
	PO5	Practicing simulation experiments and understanding DSP processor architecture and features help familiarizing modern engineering and IT tools
	PO11	Learning and practicing mathematical analysis of signals help in engaging in independent and life-long learning in the broadest context of technological change.
	PSO1	Knowledge in implementation of linear filtering and frequency analysis using FFT algorithms will help the students in the analysis of discrete time LTI systems. Hence highly correlated
CO3	PO1	Understanding computation methods for DFT and DTFT help in solving basic problems involving DFT based filtering methods will help students in real time signal processing applications.
	PO2	Understanding Discrete Fourier Transform: DFT as a linear transformation (Matrix relations), will help analyze complex engineering problems.
	PO3	Knowing FFT methods based will help solutions for complex engineering problems involving digital signals and help design system components or processes.
	PO5	Practicing simulation experiments and understanding DSP processor architecture and features help familiarizing modern engineering and IT tools
	PO11	Learning and practicing mathematical analysis of signals help in engaging in independent and life-long learning in the broadest context of technological change.
	PSO1	Knowledge in various design methods of FIR and IIR filters will help the students to design, analyse and develop digital systems and hence highly correlated

CO4	PO1	Understanding computation methods for DFT and DTFT help in solving basic problems involving DFT based filtering methods will help students in real time signal processing applications.
	PO2	Understanding Discrete Fourier Transform: DFT as a linear transformation (Matrix relations), will help analyze complex engineering problems.
	PO3	Knowing FFT methods based will help solutions for complex engineering problems involving digital signals and help design system components or processes.
	PO5	Practicing simulation experiments and understanding DSP processor architecture and features help familiarizing modern engineering and IT tools
	PO11	Learning and practicing mathematical analysis of signals help in engaging in independent and life-long learning in the broadest context of technological change.
	PSO1	Knowledge of filter structures will help the students in the design, analysis and development of digital systems and hence a high correlation is given
CO5	PO1	Understanding computation methods for DFT and DTFT help in solving basic problems involving DFT based filtering methods will help students in real time signal processing applications.
	PO2	Understanding Discrete Fourier Transform: DFT as a linear transformation (Matrix relations), will help analyze complex engineering problems.
	PO3	Knowing FFT methods based will help solutions for complex engineering problems involving digital signals and help design system components or processes.
	PO5	Practicing simulation experiments and understanding DSP processor architecture and features help familiarizing modern engineering and IT tools
	PO11	Learning and practicing mathematical analysis of signals help in engaging in independent and life-long learning in the broadest context of technological change.
	PSO1	Knowledge in time and frequency domain representation of multirate signal processing techniques will help the students to design, analyse and develop digital systems. Hence high correlation is given
CO6	PO1	Practicing simulation experiments and understanding DSP processor architecture and features help familiarizing modern engineering and IT tools
	PO5	Practicing simulation experiments and understanding DSP processor architecture and features help familiarizing modern engineering and IT tools
	PO11	Learning architecture of digital signal processors and understanding the errors that may peep into digital systems help in engaging in independent and life-long learning in the broadest context of technological change.
	PSO1	Students could be able to absorb and apply the knowledge about DSP processor in implementation of various electronic systems and hence highly correlated

9. Curricular gaps (if any)

Nil

10. Course Enrichment Activities*

Sl No	Description	Proposed Activities	Relevance to POs and PSOs
1	Simulation	Practicing simulation of various signal processing methods	PO5,PO11,PSO1,PSO2,PSO3
2	Seminar Series	Presentation on advanced DSP topics	PO1,PSO1

11. Internal Assessment mark allocation (as per university curriculum)

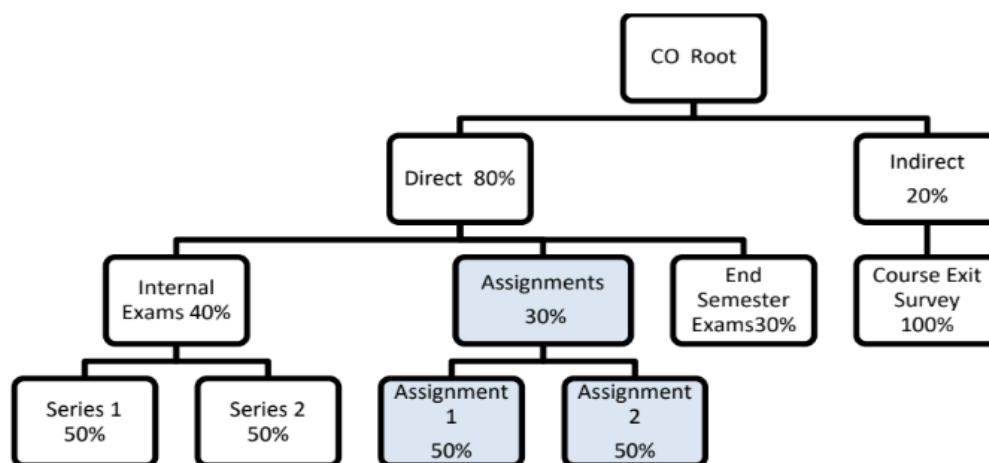
(Provide details as mentioned in syllabus)

Attendance	- 10 marks
Continuous Assessment Test	- 25 marks
Assignment (s)/ Course Project	- 15 marks
<u>Total</u>	<u>- 50 marks</u>

12. Assessment – CO Mapping (Put ‘ x ’ if mapping is present)

	Tools		Weightage #	CO1	CO 2	CO 3	CO 4	CO 5
Direct Assessment Tools**	Internal Exam(s) 40%	Series 1	20%	x	x	x		
		Series 2	20%			x	x	
	Assignment (s)/ Course Project /Quiz etc. 30%	Assignment 1	15%	x	x	x		
		Assignment 2	15%			x	x	x
	End Semester Exam		30%	x	x	x	x	x
Indirect Assessment Tool	Course Exit Survey		100%	x	x	x	x	x

13. Assessment Configuration



14. Course Plan

Hour	Topic	Module	Reference(s)	Teaching Pedagogy
1	Basic Elements of a DSP system, Typical DSP applications, Finite length Discrete transforms, Orthogonal transforms	1	Proakis J. G. and Manolakis D. G., Digital Signal Processing,	Lecture
2	The Discrete Fourier Transform: DFT as a linear transformation (Matrix relations)	1	Proakis J. G. and Manolakis D. G., Digital Signal Processing,	Lecture
3	Relationship of the DFT to other transforms, IDFT	1	Proakis J. G. and Manolakis D. G., Digital Signal Processing,	Lecture
4	Properties of DFT and examples ,Circular convolution	1	Proakis J. G. and Manolakis D. G., Digital Signal Processing,	Lecture
5	Linear Filtering methods based on the DFT-linear convolution using circular convolution, Filtering of long data sequences, overlap save and overlap add methods,	1	Alan V Oppenheim, Ronald W. Schafer ,Discrete-Time Signal Processing, 3rd Edition , Pearson ,2010	Tutorial
6	Frequency Analysis of Signals using the DFT(concept only required)	1	Proakis J. G. and Manolakis D. G., Digital Signal Processing	Lecture
7	Efficient Computation of DFT: Fast Fourier Transform Algorithms	2	Proakis J. G. and Manolakis D. G., Digital Signal Processing	Lecture
8	Radix-2 Decimation in Time and Decimation in Frequency FFT Algorithms	2	Proakis J. G. and Manolakis D. G., Digital Signal Processing	Lecture
9	IDFT computation using Radix-2 FFT Algorithms	2	Proakis J. G. and Manolakis D. G., Digital Signal Processing	Lecture

10	Application of FFT Algorithms -Efficient computation of DFT of Two Real Sequences and a 2N-Point Real Sequence	2	Proakis J. G. and Manolakis D. G., Digital Signal Processing	Lecture
11	Design of FIR Filters- Symmetric and Anti-symmetric FIR Filters, Design of linear phase FIR filters using Window methods, (rectangular, Hamming and Hanning)	3	Proakis J. G. and Manolakis D. G., Digital Signal Processing	Tutorial
12	Design of linear phase FIR filters using frequency sampling Method, Comparison of Design Methods for Linear Phase FIR Filters	3	Proakis J. G. and Manolakis D. G., Digital Signal Processing	Lecture
13	Design of IIR Digital Filters from Analog Filters, (Butterworth), IIR Filter Design by Impulse Invariance	3	Proakis J. G. and Manolakis D. G., Digital Signal Processing	Lecture
14	IIR Filter Design by Bilinear Transformation	3	Proakis J. G. and Manolakis D. G., Digital Signal Processing	Tutorial
15	Frequency Transformations in the Analog and Digital Domain	3	Proakis J. G. and Manolakis D. G., Digital Signal Processing	Lecture
16	Structures for the realization of Discrete Time Systems- Block diagram and signal flow graph representations of filters	4	Alan V Oppenheim, Ronald W. Schafer, Discrete-Time Signal Processing	Lecture
17	FIR Filter Structures: (Linear structures), Direct Form Cascade Form	4	Alan V Oppenheim, Ronald W. Schafer, Discrete-Time Signal Processing	Lecture
18	IIR Filter Structures: Direct Form, Cascade Form and Parallel Form	4	Alan V Oppenheim, Ronald W. Schafer, Discrete-Time Signal Processing	Tutorial
19	Computational Complexity of Digital filter structures	4	Alan V Oppenheim, Ronald W. Schafer, Discrete-Time Signal Processing	Lecture

20	Multi-rate Digital Signal Processing: Decimation and Interpolation (Time domain and Frequency Domain Interpretation), Anti-aliasing and anti-imaging filter	4	Proakis J. G. and Manolakis D. G., Digital Signal Processing	Lecture
21	Computer architecture for signal processing : Harvard Architecture, pipelining, MAC, Introduction to TMS320C67xx digital signal processor, Functional Block Diagram	5	Datasheet of TMS320C67xx	Lecture
22	Finite word length effects in DSP systems: Introduction (analysis not required), fixed-point and floating-point DSP arithmetic, ADC quantization noise,	5	Proakis J. G. and Manolakis D. G., Digital Signal Processing	Tutorial
23	Finite word length effects in IIR digital filters: coefficient quantization errors.	5	Proakis J. G. and Manolakis D. G., Digital Signal Processing	Lecture
24	Finite word length effects in FFT algorithms: Round off errors	5	Proakis J. G. and Manolakis D. G., Digital Signal Processing	Lecture

15. Question Bank

Module 1				
Sl. No.	Question	Marks	CO	BL
1	Derive the relationship of DFT to Z-transform?	3	CO1	L2
2	Find the circular convolution of two sequences $x_1(n)=\{1, 2, -2, 1, 3\}$, $x_2(n)=\{2, -1, 3, 1, 1\}$	3	CO1	L3
3	List any three properties of DFT	3	CO1	L1
4	Find the DFT of the sequence $x(n)=\{1, 1, 0, 0\}$	3	CO1	L3
5	State and prove the time shifting property of DFT	3	CO1	L1
6	Explain how circular convolution of two sequences are performed.	3	CO1	L2
7	Find the IDFT of $Y(k)=\{1, 0, 1, 0\}$	3	CO1	L3
8	Distinguish between linear convolution and circular convolution.	3	CO1	L2

9	Discuss about overlap add method	3	CO1	L2
10	Differentiate between DFT and DTFT	3	CO1	L2
11	Discuss about overlap save method	3	CO1	L2
12	State the differences between overlap add method and overlap save method	5	CO1	L1
13	Explain the frequency analysis of signals using DFT	5	CO1	L2
14	Find 4 point DFT of $x(n) = [1, -2, 3, 2]$.	7	CO1	L3
15	Find 4 point circular convolution of $x(n) = h(n) = [1, 1, 1, 1]$ using DFT	8	CO1	L3
16	Using linear convolution find $y(n)$ where $x(n) = \{1, 2, -1, 2, 3, -2, -3, -1, 1, 1, 2, -1\}$ and $h(n) = \{1, 2\}$. Compare the result by using overlap add and save method	8	CO1	L3
17	Find the IDFT of the sequence $X(k) = \{5, 0, 1-j, 0, 1, 0, 1+j, 0\}$	8	CO1	L3
18	Find the circular convolution of the sequences $x_1(n) = \{1, 2, 2, 1\}$ and $x_2(n) = \{1, 2, 3, 1\}$ using concentric circle method and matrix method	5	CO1	L3
19	Compute the N-point DFT of a. $\delta(n)$ b. $\delta(n-n_0)$ c. $x(n) = a^n$ d. $x(n) = 1$ for n even $= 0$ for n odd	8	CO1	L3
20	Compute the DFT of the sequence $x(n) = (-1)^n$ for $N=4$.	5	CO1	L3
21	How will you perform linear convolution using circular convolution? Find the linear convolution of the given sequences $x(n) = \{2, 9, 7, 4\}$ and $h(n) = \{1, 3, 1, 2\}$ using circular convolution?	8	CO1	L3
22	Explain the following properties of DFT a) Linearity b) Complex conjugate property c) Circular Convolution d) Time Reversal (6) K2	6	CO1	L2
23	The first eight points of 14-point DFT of a real valued sequence are $\{12, -1+j3, 3+j4, 1-j5, -2+j2, 6+j3, -2-j3, 10\}$ i) Determine the remaining points ii) Evaluate $x[0]$ without computing the IDFT of $X(k)$	8	CO1	L3
24	Explain with appropriate diagrams, the overlap-add method for filtering of long data sequences using DFT?	6	CO1	L2

25	Compute 5 point DFT of the sequence $x(n) = \{1,1,1,1,1\}$	6	CO1	L3
26	Using the Overlap Add method, find the output of the filter with filter response $h(n)$ when an input $x(n)=\{1,2,2,3,4,2,2,1,1\}$ is given. Take data block size of length $L= 3$ and $h(n)= \{2,3,4\}$.	8	CO1	L3
27	Let $x(n) = \{1,0,1,0\}$ and $h(n) = \{1,2,2,1\}$. Find 4 point DFTs of these sequences using a single 4 point DFT.	8	CO1	L3
Module 2				
Sl. No.	Question	Marks	CO	BL
28	Calculate the 4- point DFT of $\cos(\pi n)$	3	CO2	L2
29	Find Circular time reversal of $[8, 5, 3, 1]$	3	CO2	L2
30	Explain the importance of FFT	3	CO2	L1
31	Calculate the number of multiplication needed in calculation of DFT using FFT algorithm with 32-point sequence	3	CO2	L3
32	List the applications of FFT algorithm	3	CO2	L1
33	Design a linear phase FIR filter with order $M=15$ and cut-off frequency $\pi n/N) /6$. Use a Hanning Window	7	CO3	L3
34	Design a low pass digital butter-worth filter using bilinear transformation for the given specifications. Passband ripple ≤ 1 dB, Passband edge:4kHz, Stopband Attenuation: ≥ 40 dB, Stopband edge:6kHz, Sampling frequency:24 kHz	7	CO3	L3
35	Mention the limitations of Impulse invariance method of transforming analog filter system function $H(s)$ to digital system function $H(z)$. Also show how these are eliminated in bilinear transformation.	7	CO3	L3
36	Draw the block diagram and signal flow graph representations of the system represented by the following difference equation $y(n) - 0.25y(n-1) = 0.5x(n) + 0.4x(n-1)$	3	CO4	L2

37	Obtain (i) Direct form and (ii) Cascade realizations of a system described by the system function $H(z) = 1 + \frac{5}{2}z^{-1} + 2z^{-2} + 2z^{-3}$	7	CO4	L2
38	Obtain the direct form II and transpose structure of the filter whose transfer function is given below. $H(z) = \frac{0.44z^2 + 0.362z + 0.02}{z^3 + 0.4z^2 + 0.18z - 0.2}$	7	CO4	L2
39	Give the time domain and frequency domain interpretation of decimation and interpolation	3	CO4	L3
40	Explain the various quantization errors occurring in digital signal processing.	3	CO5	L1
41	With a functional block diagram, explain the main architectural features of TMS320C67xx processor	7	CO5	L1

Prepared By : Dr. Bindu C J

Checked By: ,Milna M J

Course Code & Name: ECT 305 ANALOG AND DIGITAL COMMUNICATION

1. Prescribed Syllabus

Module	Topic	Hours
1	Block diagram of a communication system. Need for analog modulation. Amplitude modulation. Equation and spectrum of AM signal. DSB-SC and SSB systems. Block diagram of SSB transmitter and receiver. Frequency and phase modulation. Narrow and wide band FM and their spectra. FM transmitter and receiver.	8
2	Review of random variables – both discrete and continuous. CDF and PDF, statistical averages. (Only definitions, computations and significance) Entropy, differential entropy. Differential entropy of a Gaussian RV. Conditional entropy, mutual information. Stochastic processes, Stationarity. Stochastic processes, Stationarity. Conditions for WSS and SSS. Autocorrelation and power spectral density. LTI systems with WSS as input.	9
3	Source coding theorems I and II (Statements only). Waveform coding. Sampling and Quantization. Pulse code modulation, Transmitter and receiver. Companding. Practical 15 level A and mu-law companders. DPCM transmitter and receiver. Design of linear predictor. Wiener-Hopf equation. Delta modulation. Slope overload.	9
4	Gram-Schmitt procedure. Signal space. Baseband transmission through AWGN channel. Mathematical model of ISI. Nyquist criterion for zero ISI. Signal modeling for ISI, Raised cosine and Square-root raised cosine spectrum, Partial response signalling and duobinary coding. Equalization. Design of zero forcing equalizer. Vector model of AWGN channel. Matched filter and correlation receivers. MAP receiver, Maximum likelihood receiver and probability of error. Capacity of an AWGN channel (Expression only) -- significance in the design of communication schemes.	6
5	Digital modulation schemes. Baseband BPSK system and the signal constellation. BPSK . transmitter and receiver. Base band QPSK system and Signal constellations. Plots of BER Vs SNR with analysis. QPSK transmitter and receiver. Quadrature amplitude modulation and signal constellation	16

2. Text Books (T)

T1 “Communication Systems”, Simon Haykin, Wiley
T2. “Digital Communications: Fundamentals and Applications”, Sklar, Pearson.
T3. “Digital Telephony”, John C. Bellamy, Wiley

3. Reference Books (R)

R1. “Principles of Digital Communication,” R. Gallager, Oxford University Press
R2. “Digital Communication”, John G Proakis, Wiley

4. Course Objectives

To develop analog and digital communication systems.

5. Course Pre / Co-requisite

- ✓ ECT 204 Signals and Systems
- ✓ MAT 204 Probability, Random Process and Numerical Methods.

6. Course Outcomes

After completion of the course, student will be able to

CO1: Analyse the existent analog communication systems

CO2: Apply the concepts of random processes to LTI systems.

CO3: Apply waveform coding techniques in digital transmission.

CO4: Apply GS procedure to develop digital receivers

CO5: Apply equalizer design to counteract ISI.

CO6: Apply digital modulation techniques in signal transmission

7. Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes

PO/ CO	PO 1	PO 2	PO 3	PO 4	PO5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO 3
CO1	H	H					H					H	H		
CO2	H	H	M		H		H						H		
CO3	H	H	M		H	M	H					M	H		H
CO4	H	H	M	H		M	H					M	H	H	H
CO5	H	H	M	H		M	H			M			H	H	
CO6	H	H	M		H	M							H		H

8. Justification for CO-PO-PSO Correlation

CO	PO/PSO	Justification
CO1	PO1	Knowledge in different analog communication systems will enable the students to understand the basic principles and working analog modulation schemes like AM, FM and PM. Hence highly correlated.
	PO2	Understanding the concepts of different analog communication systems will enable the students to analyse parameters like bandwidth, efficiency, modulation index, power, frequency spectrum etc. Hence highly correlated.
	PSO1	Knowledge in the concepts of analog communication systems will enable the students to develop analog communication systems.
CO2	PO1	Knowledge in the concepts of random variables systems will enable the students to develop LTI systems . Hence highly correlated.
	PO2	Understanding the concepts of CDF, PDF and statistical averages of random variables will enable the students to analyse & compute Entropy & density functions of random variables. Hence highly correlated.
	PO3	Analysing the concepts of random variables will enable the students to design the LTI systems using
	PSO1	Knowledge of random variables will enable the students to design electronic communication systems.
CO3	PO1	Understanding waveform coding techniques, students are equipped to apply fundamentals of signal processing and demonstrate their ability to solve intricate engineering problems. Hence highly correlated.

	PO2	Understanding waveform coding techniques, students are equipped to apply fundamentals of signal processing and demonstrate their ability to solve intricate engineering problems. Hence highly correlated.
	PO3	Designing different waveform coding techniques students will be able to use essential skills and knowledge related to communication system design, problem solving, and adaptability.
	PO5	Modelling of waveform coding techniques will enable the students to use modern IT tools like MATLAB and Python.
	PO6	By mastering waveform coding techniques, students are well-equipped to contribute effectively to the field of digital communication.
	PO12	Simulating different waveform coding techniques will enable the students for self directed learning.
	PSO1	Knowledge of waveform coding techniques will enable the students to design electronic communication systems. Hence highly correlated.
	PSO3	Modelling of waveform coding techniques will enable the students to use modern IT tools like MATLAB and Python.
CO4	PO1	Understanding the GS procedure will enable the students to apply fundamentals of mathematics and communication engineering. Hence highly correlated.
	PO2	Understanding the mathematical foundations of GS procedure, students can identify and address issues related to signal quality and reception. Hence highly correlated.
	PO3	Developing digital receivers will enable students dealing with real-world challenges such as noise, interference, and varying signal conditions.
	PO4	Using research-based knowledge and research methods including analysis and interpretation of data, students will synthesise the information for the design of digital receivers.
	PO5	Modelling of digital receivers will enable the students to use modern IT tools like MATLAB and Python .
	PO6	By mastering digital receivers, students are well-equipped to contribute effectively to the field of digital communication.
	PO12	Simulating digital receivers will enable the students for self-directed learning.
	PSO1	Knowledge of GS procedure will enable the students to design electronic communication systems. Hence highly correlated.
	PSO2	Using research-based knowledge and research methods including analysis and interpretation of data, students will synthesise the information for the design of digital receivers. Hence highly correlated.
	PSO3	Modelling of digital receivers will enable the students to use modern IT tools like MATLAB and Python.
CO5	PO1	Understanding of equalizer design will enable the students to apply a deep comprehension of communication theory, signal processing, and mathematics. Hence highly correlated.
	PO2	Analysing different types of equalizers will enable the students to reach substantial solutions to mitigate ISI. Hence highly correlated.
	PO3	Designing of equalizers like zero forcing equalizers will enable the students to counteract ISI.
	PO4	Using research-based knowledge and research methods including analysis and interpretation of data, students will synthesise the information for the design of equalizers.
	PO6	By designing digital equalizers, students are well-equipped to contribute effectively to the field of digital communication.
	PO10	Comprehend and write effective reports based on the NPTEL video based on Channel Equalization and Inter Symbol Interference.

	PO12	Simulating digital equalizers will enable the students for self-directed learning.
	PSO1	Knowledge of equalizers will enable the students to design electronic communication systems. Hence highly correlated.
	PSO2	Using research-based knowledge and research methods including analysis and interpretation of data, students will synthesise the information for the design of equalizers. Hence highly correlated.
CO6	PO1	Understanding of digital modulation techniques will enable the students to demonstrate their understanding of core concepts in electrical and communication engineering. Hence highly correlated.
	PO2	Analysis of digital modulation techniques will enable the students to solve problems related to signal quality, data transmission rates, and bandwidth utilization. Hence highly correlated.
	PO3	Design of digital modulation techniques will enable the students to solve problems related to signal quality, data transmission rates, and bandwidth utilization
	PO5	Modelling of digital modulation schemes will enable the students to use modern IT tools like MATLAB and Python
	PO6	By designing digital modulation schemes, students are well-equipped to contribute effectively to the field of digital communication.
	PO12	Simulating digital modulation schemes like BPSK & QPSK, will enable the students for self-directed learning.
	PSO1	Knowledge in digital modulation schemes will enable the students to design digital communication systems. Hence highly correlated.
	PSO3	Modelling of digital modulation schemes will enable the students to use modern IT tools like MATLAB and Python

9. Curricular gaps (if any)

Nil

10. Course Enrichment Activities

Sl No	Description	Proposed Activities	Relevance to POs and PSOs
1	Channel Equalization and Inter Symbol Interference ISI Model	NPTEL Video- Prof. Aditya Jagannathan, IIT Kanpur	PPO1,PO2,PO4, PO10,PO12,PSO1
2	FM Transmitter and Receiver	Industrial Visit to AIR station	PO1, PO2, PO12
3	Implementation of various applications of communication systems using Python	Simulation workshop	PO1, PO2, PO3, PO5, PO10, PO12, PSO1, PSO3

11. Internal Assessment mark allocation (as per university curriculum)

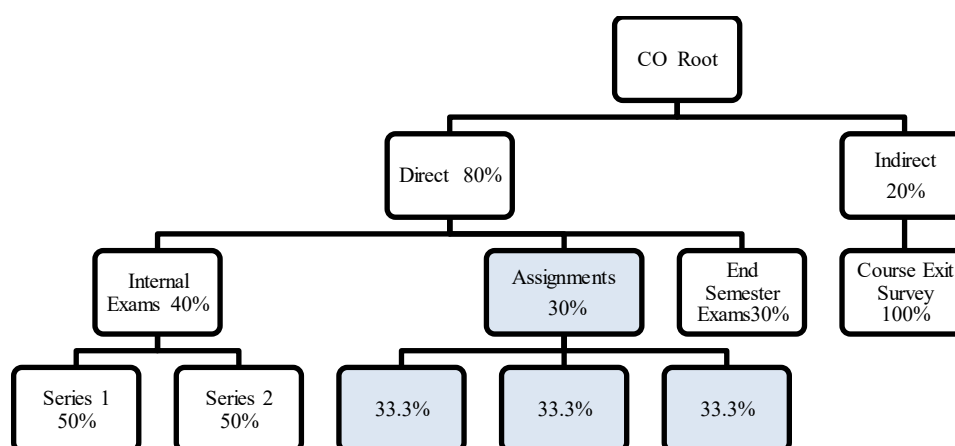
(Provide details as mentioned in syllabus)

Attendance	- 10 marks
Continuous Assessment Test	- 25 marks
Assignment (s)/ Course Project	- 15 marks
<u>Total</u>	<u>- 50 marks</u>

12. Assessment – CO Mapping (Put 'x' if mapping is present)

	Tools		Weightage	CO1	CO2	CO3	CO4	CO5	C06
Direct Assessment Tools**	Internal Exam(s) 40%	Series 1	20%	x	x				
		Series 2	20%			X	x		X
	Assignment (s)/ Course Project /Quiz etc. 30%	Assignment 1	15%	x	x				
		Assignment 2	15%				x	x	
	End Semester Exam		30%	x	x	x	x	x	
Indirect Assessment Tool	Course Exit Survey		100%	x	x	x	x	x	

13. Assessment Configuration



14. Course Plan

Hour	Topic	Module	Reference(s)	Teaching Pedagogy
1	Introduction to the Course	1	T1	Lecture
2	Block diagram of communication system, analog and digital systems	1	T1	Brain Storming
3	Modulation , types, need for modulation	1	T1	Lecture
4	Amplitude modulation	1	T1	Lecture
5	spectrum and index of modulation	1	T1	Lecture
6	Tutorial	1	T1	Tutorial
7	DSB-SC and SSB modulation.	1	T1	Lecture
8	SSB transmitter and receiver	1	T1	Lecture
9	Frequency and phase modulation	1	T1	Lecture
10	Tutorial	1	T1	Tutorial

11	spectrum of FM signal	1	T1	Lecture
12	Review of random variables	2	T1 T2	Lecture
13	CDF and PDF, examples	2	T1 T2	Lecture
14	Tutorial	2	T1 T2	Tutorial
15	Entropy of RV	2	T1 T2	Lecture
16	Differential entropy of Gaussian RV	2	T1 T2	Lecture
17	Expectation, conditional expectation,	2	T1 T2	Lecture
18	Tutorial	2	T1 T2	Tutorial
19	mutual information	2	T1 T2	Lecture
20	Stochastic processes, Stationarity - WSS and SSS	2	T1 T2	Lecture
21	Autocorrelation and power spectral density	2	T1 T2	Lecture
22	Response of LTI systems to WSS	2	T1 T2	Lecture
23	Tutorial	2	T1 T2	Tutorial
24	Source coding theorems I and II	3	T1 T2	Lecture
25	Source coding theorems I and II	3	T1 T2	Lecture
26	PCM	3	T1 T2	Lecture
27	Transmitter and receiver,	3	T1 T2	Lecture
28	companding	3	T2	Lecture
29	Practical A and mu law companders	3	T2	Lecture
30	DPCM	3	T1 T2	Lecture
31	Linear predictor	3	T2	Lecture
32	Wiener Hopf equation	3	T2	Lecture
33	Delta modulator	3	T1 T2	Lecture
34	Need of digital modulation in modern communication.	5	T1 T2	Lecture
35	Baseband QPSK system, signal constellation	5	T1 T2	Lecture
36	Effect of AWGN	5	T2	Lecture
37	probability of error (with derivation). BER-SNR curve	5	T2	Lecture
38	QPSK transmitter and receiver.	5	T2	Lecture
39	QAM system	5	T2	Lecture
40	G-S procedure	4	R2	Lecture
41	G-S procedure	4	R2	Lecture
42	Tutorial	4	R2	Tutorial
43	G-S procedure	4	R2	Lecture
44	ISI, Nyquist criterion,	4	T1 T2	Lecture
45	RS and SRC	4	T2	Lecture

46	PR signalling and duobinary coding	4	T2	Lecture
47	Tutorial	4	T1 T2	Tutorial
48	Equalization	4	T1 T2	Lecture
49	design of zero forcing equalizer	4	T1 T2	Lecture
50	Vector model of AWGN channel	4	T2 R2	Lecture
51	Vector model of AWGN channel	4	T2 R2	Lecture
52	Correlation receiver,	4	T2 R2	Lecture
53	matched filter	4	T2 R2	Lecture
54	MAP receiver,	4	T2 R2	Lecture
55	ML receiver, probability of error	4	T2 R2	Lecture
56	Tutorial	4	T2 R2	Tutorial
57	Channel capacity	4	T2 R2	Lecture
58	capacity of Gaussian channel	4	T2 R2	Lecture
59	significance in design of digital communication schemes	4	T2 R2	Lecture
60	Tutorial	4	T2 R2	Tutorial

15. Question Bank

Module 1				
Sl. No.	Question	Marks	CO	BL
Amplitude Modulation				
1.	Describe the Block diagram of Analog communication system	3	CO1	L1
2.	Describe the Block diagram of Digital communication system	3	CO1	L1
3.	Discuss the need for modulation in communication system.	3	CO1	L1
4.	Define the modulation index for AM.	3	CO1	L1
5.	Derive the mathematical expression for amplitude modulation and draw the frequency spectrum of AM wave. **	10	CO1	L2
6.	Explain the principle of Amplitude Modulation and derive an expression for AM-DSBFC signal. Draw the AM waveform and frequency spectrum and explain the voltage distribution. *	10	CO1	L2
7.	What is SSB in AM? Explain phase shift method of SSB generation.	10	CO1	L2
8.	Give the advantages and disadvantages of SSBSC systems	3	CO1	L2
9.	Compare AM, DSB-SC and SSB-SC modulation schemes with respect to bandwidth and system complexity.	3	CO1	L2
10.	Compare the frequency spectrum , bandwidth and power of SSB-SC systems with DSB-FC and DSB-SC systems	6	CO1	L2

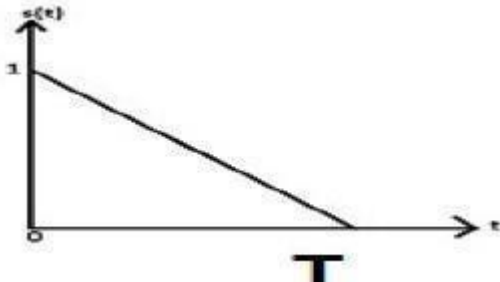
11.	Write the relation between carrier power and side band power of an AM-DSBFC signal.*	3	CO1	L1
12.	Describe the generation of DSBSC Signal.	5	CO1	L1
13.	Explain the generation of SSB signal using phase shift method.*	8	CO1	L2
14.	Draw the frequency spectrum and mention the bandwidth of AM signal.	3	CO1	L1
15.	Draw the frequency spectrum of DSB SC Signal and SSB signal	3	CO1	L1
16.	Explain the SSB Transmitter and receiver with block diagrams.	10	CO1	L2
17.	Derive the modulation index of AM wave in terms of V_{max} and V_{min} . A sinusoidal carrier signal of peak amplitude 5 V and frequency 100 kHz is amplitude modulated by a 5 kHz signal of peak amplitude 3 V. Plot the modulated wave with V_{max} and V_{min} indicated also calculate modulation index	6	CO1	L2
18.	If a 10V carrier is amplitude modulated by two different frequencies with amplitudes 2V and 3V respectively, find the modulation index.	3	CO1	L2
19.	Find the carrier power of an AM broadcast radio transmitter that radiates 20KW for which the modulation index is 0.6.	3	CO1	L2
20.	Calculate the percentage of power saving in DSBSC and SSB AM compared to conventional AM (DSBFC) when all were modulated at a depth of 100% .	3	CO1	L2
21.	To a conventional AM modulator, one input is a 500KHz carrier with an amplitude of 20 V (peak). The other input is a 10KHz modulating signal that is of sufficient amplitude to cause a change in the output wave of $\pm 7.5V$ (peak). Determine Upper and lower side frequencies. Modulation coefficient and percent modulation. Peak amplitude of the modulated carrier and the upper and lower side frequency voltages. Maximum and minimum amplitudes of the envelope. The expression for the modulated wave. Draw the output spectrum. Sketch the output envelope.	14	CO1	L3
22.	An AM wave with carrier 10V and 100 kHz is modulated by modulating signal of amplitude 7V, 5kHz. Write the mathematical equation for the obtained AM wave. Plot the frequency spectrum with accurate scale.	5	CO1	L2
23.	If a sinusoidal amplitude is modulated by the carrier $5\cos 2\pi 300t$ to a depth of 30 %, compute the power in the resultant AM signal.	5	CO1	L2
24.	An AM signal $s(t) = 10(1 + 0.8 \cos(2\pi 103t)) \cos(2\pi 106t)$ is radiated to free space by an antenna having the resistance of 1Ω . Draw the spectrum of $s(t)$. Also calculate the power and bandwidth.	8	CO1	L2
25.	Calculate the percentage power saving when the carrier and one of the sidebands are suppressed in an AM wave with modulation index equal to (a) 1 and (b) 0.40	5	CO1	L2

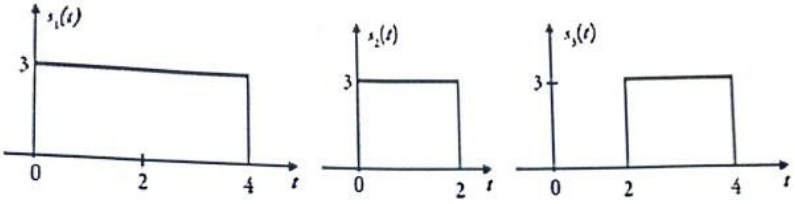
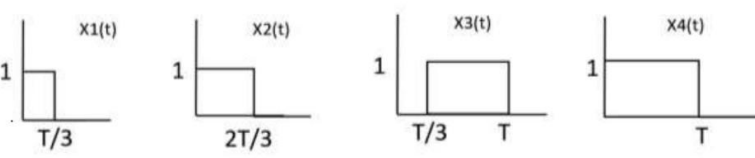
26.	An AM wave is represented by the expression $v(t) = 5(1 + 0.6\cos(6280t)) \sin(157 \times 10^3 t)$ Volts What are the minimum and maximum amplitudes of the AM wave. Determine the frequency components contained in the modulated wave and what is the amplitude of each component Draw the frequency spectrum	7	CO1	L3
Angle Modulation - FM and PM				
27.	Distinguish between narrow band FM and wideband FM.	3	CO1	L2
28.	Compare and contrast frequency and phase modulation*	3	CO1	L2
29.	Compare AM and Angle modulation	3	CO1	L2
30.	With suitable block diagram explain the generation of wideband FM using narrow band FM	3	CO1	L2
31.	Compute the bandwidth of the narrow band FM signal with modulating signal frequency of 1kHz and index of modulation 0.3	3	CO1	L2
32.	The maximum frequency deviation in an FM is 10 KHz and signal frequency is 10 KHz. Find the bandwidth using Carson's rule and modulation index	5	CO1	L2
33.	Explain how FM wave can be generated using PM.	5	CO1	L2
34.	A carrier wave of frequency 100 MHz is frequency modulated by a sinusoidal wave of amplitude 20 volts and frequency 100 kHz. The frequency sensitivity of the modulator is 25kHz per volt. Determine the approximate bandwidth of the FM signal, using Carson's rule. What will happen to bandwidth if modulating signal amplitude and frequency are doubled?	8	CO1	L3
35.	The maximum frequency deviation in an FM is 10 KHz and signal frequency is 10 KHz. Find the bandwidth using Carson's rule and modulation index	5	CO1	L2
36.	Explain how narrow band FM can be generated, derive the expression of narrow band FM signal.	10	CO1	L2
37.	A 105MHz carrier signal is frequency modulated by 7KHz sine wave. The resultant signal has a frequency deviation of 50KHz. Determine the modulation index and bandwidth of FM wave	3	CO1	L2
38.	Draw and explain the block diagram of an FM receiver. What is the purpose of using pre emphasis and de emphasis in FM	7	CO1	L2
39.	The equation of angle modulated wave is $\phi(t) = 10\cos(10^8 t + 3\sin 10^4 t)$ Calculate the carrier and modulating frequencies Calculate the frequency deviation , bandwidth and power dissipated in a 100Ω resistor	8	CO1	L2

40.	An FM wave is represented as $v = 12 \sin(6 \times 108t + 5 \sin 1250t)$. Find its carrier frequency, modulating frequency, modulation index and maximum deviation ($\delta_{\max}$).	5	CO1	L2
Module 2				
Sl. No.	Question	Mark	CO	BL
1.	Define CDF & PDF of a random variable*	3	CO2	L1
2.	A continuous random variable X has probability density function given by $f_X(x) = 3x^2$, $0 \leq x \leq 1$. Find K such that $P(X > K) = 0.05$.	3	CO2	L2
3.	A continuous random variable has a probability density function (PDF) $f_X(x) = 2e^{-2x}$ for $x \geq 0$. Determine the probability that it will take a value between 1 and 3.*	3	CO2	L3
4.	A random variable X has the pdf $f(x)$ given by $F(x) = \begin{cases} Cxe^{-x} & \text{if } x > 0 \\ 0 & \text{if } x < 0 \end{cases}$ Find the value of C and cdf of X	3	CO2	L3
5.	Find entropy of a binary memoryless source emitting two equally probable messages	3	CO2	L2
6.	If X has the probability density $f(X) = K e^{-x}$, $x > 0$ Find K, $P(0.5 \leq X \leq 1)$ and the mean of X	3	CO2	L3
7.	Explain mean, Moment, variance and standard deviation of random variable X	3	CO2	L2
8.	Define stationary process	3	CO2	L1
9.	Explain Entropy of a random variable	3	CO2	L2
10.	Explain Differential entropy. *	3	CO2	L2
11.	Explain conditional Entropy	3	CO2	L2
12.	Describe the concept of mutual information. Write the expressions for the same.	3	CO2	L2
13.	State the properties of an auto correlation function.*	3	CO2	L1
14.	Explain the conditions for stationarity in the strict sense and WSS process*	5	CO2	L2
15.	Derive the expression for differential entropy of a Gaussian random variable X with mean μ and variance σ^2 .	4	CO2	L2
16.	Discuss the properties of power spectral density of a WSS process. Find power spectral density of the WSS random process if its autocorrelation function is given by $R_X(r) = e^{-\alpha r }$ for $-\infty < r < \infty$	10	CO2	L3
17.	Define autocorrelation function of a random process and state its properties. Also show that the autocorrelation function $R_X(r)$ contains a constant component equal to A^2 if a random process	10	CO2	L3

	$X(t)$ contains a dc component equal to A .			
18.	Give the relation between autocorrelation and power spectral density of a WSS.*	3	CO2	L1
19.	State the properties of Power Spectral density.*	4	CO2	L1
20.	Explain the response of LTI systems to WSS	7	CO2	L2
21.	A discrete source emits one of five symbols once every millisecond with probabilities $1/2, 1/4, 1/8, 1/16$ and $1/16$ respectively. Determine the source Entropy	5	CO2	L3
22.	Let X be a discrete RV whose cumulative distribution function is $F(x) = \begin{cases} 0 & \text{for } x < -3 \\ \frac{1}{6} & \text{for } -3 \leq x < 6 \\ 1 & \text{for } x \geq 6 \end{cases}$ Find $P(X \leq 4)$, $P(-5 < X \leq 4)$, $P(X = -3)$, $P(X = 4)$	4	CO2	L3
23.	A continuous random variable X is uniformly distributed in the interval $[0, 8]$. Find the differential entropy $h(X)$	3	CO2	L2
24.	What are the conditions for a stochastic process to be wide sense stationary	3	CO2	L2
25.	Define entropy. A source emits symbols $\{s_1, s_2, s_3, s_4\}$ with probabilities $\{1/2, 1/4, 1/8, 1/8\}$. Find the entropy of the source	5	CO2	L2
26.	Consider a random process $X(t) = \cos(t+A)$ where A is a random variable. that is uniformly distributed over the interval $[0, 2\pi]$. Find whether $X(t)$ is wide sense stationary or not	9	CO2	L3
27.	State and prove any two properties of the autocorrelation function of stationary random process. Explain Wiener - Khinchin's theorem	8	CO2	L2
28.	Let X be a random variable with PDF given by $f_X(x) = \begin{cases} x & 0 < x \leq 1 \\ 2 - x & 1 < x \leq 2 \\ 0 & \text{elsewhere} \end{cases}$ Find $E(X)$, $E(X^2)$ and σ_X^2	8	CO2	L3
17.	A stationary process $X(t)$ has the following values for its autocorrelation functions. $R_X(0) = 1$, $R_X(1) = 0.8$, $R_X(2) = 0.6$ and $R_X(3) = 0.4$. Calculate the coefficients of an optimum linear predictor involving the use of 2 unit delays.	14	CO3	L3
18.	Explain the design of linear predictor and derive Wiener-Hopf equation.**	10	CO3	L2
19.	Explain A-law companding with its characteristics*	5	CO3	L2
20.	Explain μ -law companding with its characteristics*	5	CO3	L2
21.	Explain Delta Modulation with the help of block diagram.*	5	CO3	L2
22.	A Television signal have bandwidth 10.2 MHz is transmitted using binary PCM system. Given that number of quantisation levels is 512. Determine a) Code word length b) Transmission bandwidth and c) final bit rate.	5	CO3	L3
23.	What is the significance of companding in PCM transmission	3	CO3	L2
24.	Interpret the use of pre filtering done before sampling	3	CO3	L2

25.	Describe delta modulation system with neat block diagram, Also illustrate the quantisation error in delta modulation	8	CO3	L2
26.	A delta modulator with a fixed step size of 0.75V, is given a sinusoidal message signal. If the sampling frequency is 30 times the Nyquist rate, determine the maximum permissible amplitude of the message signal if the slope overload is to be avoided	6	CO3	L3
27.	Explain the pulse code modulation transmitter with neat block diagram	6	CO3	L2
28.	What is linear prediction? Derive Wiener Hopf equation from a linear prediction filter	8	CO3	L2
29.	A linear delta modulator is designed to operate on speech signals limited to 3.4 kHz. The sampling rate is 10 times the Nyquist rate of the speech signal. The step size δ is 100 mV. The modulator is tested with a 1kHz test signal. Find the maximum amplitude of this test signal required to avoid slope overload.	5	CO3	L3
30.	Draw the block diagram of transmitter and receiver of a Delta Modulator. Explain each block.	9	CO3	L2
31.	State and explain sampling theorem. A PCM system uses a uniform quantizer followed by an 8 bit encoder. If the bit rate of the system is 108kbps, then what is the maximum bandwidth of the low-pass message signal for which the system operates satisfactorily?	5	CO3	L2
32.	Draw the block diagram of a PCM transmitter and receiver system. Explain each block.	9	CO3	L2
33.	Explain the format of output code in an 8 bit (15 level) μ Law compander with $\mu=255$. In a practical 8-bit (15 level) μ Law compander, output code is 00110001. Find its sign, segment value and quantized level.	5	CO3	L3
34.	Draw the block diagram of DPCM transmitter and receiver. Explain each block.	9	CO3	L2
Module 4				
Sl. No.	Question	Marks	CO	BL
1.	Define the orthogonality property of the signal	3	CO4	L1
2.	Define ISI	3	CO5	L1
3.	Explain Raised cosine filter	3	CO5	L1
4.	Describe about the capacity of AWGN channel	3	CO5	L1

5.	The input to the matched filter is given below.  Determine the impulse response of the matched filter	3	CO5	L1
6.	What is the need of equalisation	3	CO5	L1
7.	State the Nyquist criterion for distortionless baseband transmission in the absence of noise	3	CO5	L1
8.	Define Maximum Likelihood Receiver	3	CO5	L1
9.	Define Maximum A Posteriori estimation.	3	CO5	L1
10.	Define Pulse shaping .	3	CO5	L1
11.	Derive Nyquist criterion for Zero ISI.	7	CO5	L2
12.	Explain Raised cosine and Square-root raised cosine spectrum	6	CO5	L2
13.	Explain Partial response signalling	6	CO5	L2
14.	Explain duobinary encoder with block diagrams	5	CO5	L2
15.	Derive the mathematical model of ISI	7	CO5	L2
16.	Explain the Gram- Schmitt Orthogonalization procedure to find the orthonormal basis functions.	8	CO4	L2
17.	Explain the design of zero forcing equalizer with diagrams and necessary equations.	5	CO5	L2
18.	Design a zero forcing equalizer for the channel that is characterized by the filter taps $\{1, 0.7, 0.3\}$.	6	CO5	L3
19.	The transmission of a signal pulse with a raised cosine spectrum through a channel results in the following (noise-free) sampled output from the demodulator: X_k is $x_{-2} = -0.5$, $x_{-1} = 0.1$, $x_0 = 1$, $x_1 = -0.2$, $x_2 = -0.05$ and 0 for others Determine the tap coefficients of a three tap linear equalizer based on the zero-forcing criterion.*	7	CO5	L3
20.	Explain the block diagram of Correlation receiver	6	CO4	L2
21.	Explain MAP receiver.*	7	CO4	L2
22.	Explain about Maximum Likelihood Receiver & its probability of Error.*	6	CO4	L2
23.	Explain about matched filter. Plot the BER-SNR curve for a matched filter receive	5	CO4	L2
24.	Describe about the capacity of AWGN channel.*	5	CO3	L2
25.	With the help of neat diagram derive the impulse response and frequency response of duobinary encoder.	14	CO4	L2
26.	What is meant by equalisation and why is it needed?	3	CO5	L2

27.	A communication channel of bandwidth 75KHz is required to transmit binary data at a rate of 0.1Mb/s using raised cosine pulses. Determine the roll off factor α	3	CO5	L3
28.	What is raised cosine spectrum? Discuss how does it help to reduce ISI	6	CO5	L3
29.	Derive an expression for the impulse response of a matched filter	8	CO4	L2
30.	Apply Gram Schmidt orthogonalization to obtain orthonormal basis functions for the signals shown below. Express the signals in terms of orthonormal basis functions 	14	CO4	L3
31.	(i) Using the Gram-Schmidt orthogonalization procedure, find orthonormal functions for the set of given signals $x_1(t)$ and $x_2(t)$ given below. Sketch the basis functions. 	14	CO4	L3
32.	What are the practical difficulties encountered in ideal Nyquist channel? How can those be overcome by raised cosine filters.	8	CO5	L2
33.	Compare Maximum Likelihood receiver and MAP receiver.	6	CO4	L2
34.	(i) The signals $X_1(t)$, $X_2(t)$, $X_3(t)$ and $X_4(t)$ are given as shown in Figure. Use the Gram-Schmidt orthogonalization procedure to express these functions in terms of orthonormal basis functions. Sketch the basis functions. 	14	CO4	L3
35.	With the help of necessary mathematical expressions explain intersymbol interference. Explain how it can be rectified using a raised cosine filter.	14	CO5	L2
Module 5				

Sl. No.	Question	Marks	CO	BL
1.	Compare BPSK and QPSK.*	3	CO6	L1
2.	What is Binary Phase Shift Keying?	3	CO6	L1
3.	What is Quadrature Phase Shift Keying?	3	CO6	L1
4.	Draw the signal constellation diagram of BPSK, QPSK	3	CO6	L1
5.	What is the Minimum Nyquist Bandwidth required for BPSK, QPSK.	3	CO6	L1
6.	What are the advantages of QPSK over BPSK?	3	CO6	L1
7.	What is QAM ?	3	CO6	L1
8.	Draw the signal constellation diagram of 8-QAM and 16-QAM.*	3	CO6	L1
9.	Draw the signal constellation diagram of BPSK and explain it briefly.	3	CO6	L2
10.	Explain the basic concept of QAM.	3	CO6	L2
11.	Explain the generation and detection of BPSK system with the help of block diagrams	8	CO6	L2
12.	Differentiate between coherent and non-coherent digital modulation schemes. Give examples for both schemes.	3	CO6	L2
13.	Draw the signal constellation diagram of 16-QAM and explain briefly.	3	CO6	L2
14.	With suitable diagrams explain the operation of QPSK modulator and demodulator.	8	CO6	L2
15.	Derive the probability of error for a BPSK system.	10	CO6	L2
16.	Derive the probability of error for a QPSK system.	14	CO6	L3
17.	Draw the BER-SNR plot for a QPSK and BPSK system.	4	CO6	L2
18.	Derive the probability of error for a QPSK system with Gray coding.	10	CO6	L2
19.	Draw the signal constellation of M-ary QAM for M=16	3	CO6	L1
20.	What are the advantages of QPSK over BPSK	3	CO6	L1
21.	Explain the generation and detection of BPSK signals with the help of block diagrams	8	CO6	L2
22.	Draw and explain the signal constellation diagram for QPSK modulation	6	CO6	L2
23.	Derive the expression for probability of error in QPSK	9	CO6	L2
24.	What is meant by quadrature amplitude modulation? Draw and explain the block diagram of QAM receiver	5	CO6	L2
25.	Draw the block diagram of BPSK generation and detection. Explain it with relevant equations.	10	CO6	L2
26.	Draw the signal constellation diagram of QPSK and explain it briefly.	4	CO6	L2
27.	Draw the BER v/s SNR plot for the BPSK system and explain the graph.	4	CO6	L2
28.	Derive the expression for probability of error in QPSK .	10	CO6	L2

Prepared By : Dr. Rakesh S

Checked By : Tubin T X

1. Prescribed Syllabus

Module	Topic	Hours
1	Introduction: Basic Components of a Control System, Open-Loop Control Systems and Closed-Loop Control Systems, Examples of control system Feedback and its effects: Types of Feedback Control Systems, Linear versus Nonlinear Control Systems, Time-Invariant versus Time-Varying Systems. Mathematical modelling of control systems: Electrical Systems and Mechanical systems. Transfer Function from Block Diagrams and Signal Flow Graphs: impulse response and its relation with transfer function of linear systems. Block diagram representation and reduction methods, Signal flow graph and Mason's gain formula.	10
2	Time Domain Analysis of Control Systems: Introduction- Standard Test signals, Time response specifications. Time response of first and second order systems to unit step input and ramp inputs, time domain specifications. Steady state error and static error coefficients. Frequency domain analysis: Frequency domain specifications, correlation between time and frequency responses.	9
3	Stability of linear control systems: Concept of BIBO stability, absolute stability, Routh Hurwitz Criterion, Effect of P, PI & PID controllers. Root Locus Techniques: Introduction, properties and its construction, Application to system stability studies. Illustration of the effect of addition of a zero and a pole.	9
4	Nyquist stability criterion: Fundamentals and analysis Relative stability: gain margin and phase margin. Stability analysis with Bode plot. Design of Compensators: Need of compensators, design of lag and lead compensators using Bode plots.	9
5	State Variable Analysis of Linear Dynamic Systems: State variables, state equations, state variable representation of electrical and mechanical systems, dynamic equations, merits for higher order differential equations and solution. Transfer function from State Variable Representation, Solutions of the state equations, state transition matrix Concept of controllability and observability and techniques to test them - Kalman's Test.	13

2. Text Books (T)

- T1. Farid Golnaraghi, Benjamin C. Kuo, Automatic Control Systems, 9/e, Wiley India.
 T2. I.J. Nagarath, M.Gopal: Control Systems Engineering (5th-Edition) —New Age International Pub. Co., 2007.
 T3. Ogata K., Discrete-time Control Systems, 2/e, Pearson Education.

3. Reference Books (R)

- R1. I.J. Nagarath, M.Gopal: Scilab Text Companion for Control Systems Engineering (3rd-Edition) —New Age International Pub. Co., 2007.
 R2. Norman S. Nise, Control System Engineering, 5/e, Wiley India.

- R3. M. Gopal, Digital Control and State Variable Method, 4/e, McGraw Hill Education India, 2012.
 R4. Ogata K., Modern Control Engineering, Prentice Hall of India, 4/e, Pearson Education, 2002.
 R5. Richard C Dorf and Robert H. Bishop, Modern Control Systems, 9/e, Pearson Education, 2001.

4. Course Objectives

This course aims to develop the skills for mathematical modelling of various control systems and stability analysis using time domain and frequency domain approaches.

5. Course Pre / Co-requisite

EC202 Signals & Systems

6. Course Outcomes

After the completion of the course the student will be able to:

- CO1. Analyse electromechanical systems by mathematical modelling and derive their transfer functions
 CO2. Determine Transient and Steady State behaviour of systems using standard test signals
 CO3. Determine absolute stability and relative stability of a system
 CO4. Apply frequency domain techniques to assess the system performance and to design a control system with suitable compensation techniques
 CO5. Analyse system Controllability and Observability using state space representation

7. Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes

PO/ CO	PO 1	PO 2	PO 3	PO 4	PO5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H	H	M		M							M	M		
CO2	H	H	M		M							M	M		
CO3	H	H	H		M							M	H		
CO4	H	H	H		M							M	H		
CO5	H	H	H		M							M	H		

8. Justification for CO-PO-PSO

CO	PO/ PSO	Justification
CO1	PO1	Knowledge of differential equations and Laplace transforms helps students to model various systems. Hence highly mapped.
	PO2	Deriving transfer function of electromechanical systems involves analysing the system and therefore developing its mathematical model. Hence highly mapped.
	PO3	Students apply differential equations and Laplace transforms to develop transfer function of the given electromechanical systems. Hence it is mapped with medium correlation.
	PO5	Students obtain the transfer function electromechanical system and develop its model using a simulation software. Hence it is mapped with medium correlation.
	PO12	Students work on a simulation software to develop a model and also to obtain transfer function. Hence it is mapped with medium correlation.

	PSO1	It involves applying knowledge in engineering mathematics to analyse and determine the performance of systems. Hence it is mapped with medium correlation.
CO2	PO1	Knowledge of engineering mathematics helps students to determine transient and steady state behaviour of systems. Hence highly mapped.
	PO2	Deriving the response of a system involves analysing the system. Hence highly mapped.
	PO3	Students apply knowledge of open loop and closed loop systems to develop the response of the given system. Hence it is mapped with medium correlation.
	PO5	Students obtain determine transient and steady state behaviour of systems of using a simulation software. Hence it is mapped with medium correlation.
	PO12	Students work on a simulation software to develop a model and also to obtain transfer function. Hence it is mapped with medium correlation.
	PSO1	It involves applying knowledge in engineering mathematics to determine transient and steady state behaviour of systems.
CO3	PO1	Knowledge of engineering mathematics helps students to determine stability of systems. Hence highly mapped.
	PO2	Determining stability of a system involves analysing the system for given parameters. Hence highly mapped.
	PO3	Students apply methods like R-H criterion, and time domain techniques to analyse and determine stability of a system. Hence it is mapped with medium correlation.
	PO5	Students analyse stability of a system using a simulation software. Hence it is mapped with medium correlation.
	PO12	Students work on a simulation software to plot the response of the system using methods like root locus,. Hence it is mapped with medium correlation.
	PSO1	It involves applying knowledge in engineering mathematics and basic control systems to analyse and determine the stability of systems.
CO4	PO1	Knowledge of differential equations and Laplace transforms helps students to design a control system with suitable compensation techniques. Hence highly mapped.
	PO2	Designing a control system with suitable compensation techniques involves analysis of systems. Hence highly mapped.
	PO3	Students apply analyse the given system parameters and determine the type of compensation suitable for the system and hence design the same. Hence highly mapped.
	PO5	Students obtain the Bode plot of a system using a simulation software. Hence it is mapped with medium correlation.
	PO12	Students work on a simulation software to develop a model and also to obtain transfer function. Hence it is mapped with medium correlation.
	PSO1	It involves applying knowledge in engineering mathematics to analyse and determine the performance of systems.

CO5	PO1	Knowledge of differential equations and Laplace transforms helps students to model various systems. Hence highly mapped.
	PO2	Deriving transfer function of electromechanical systems involves analysing the system and therefore developing its mathematical model. Hence highly mapped.
	PO3	Students apply differential equations and Laplace transforms to develop transfer function of the given electromechanical systems.
	PO5	Students study the controllability and observability of a control system using a simulation software. Hence it is mapped with medium correlation.
	PO12	Students work on a simulation software to develop a model and also to obtain transfer function. Hence it is mapped with medium correlation.
	PSO1	It involves applying knowledge in engineering mathematics to analyse and determine the performance of systems.

9. Curricular gaps (if any):

Nil

10. Course Enrichment Activities* :

Sl. No.	Description	Proposed Activities	Relevance to POs and PSOs
1	Dynamic Error Coefficients and Steady State Error	Session by Prof. Sonu K Varghese	PO1, PO2, PO3, PSO1

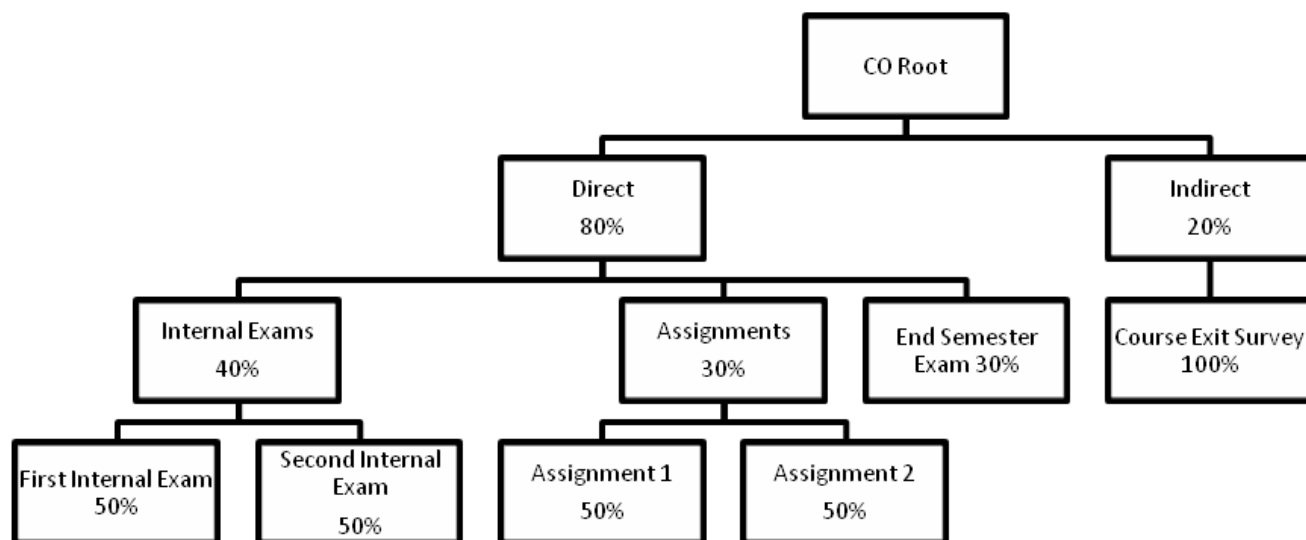
11. Internal Assessment mark allocation (as per university curriculum)

Continuous Assessment Test	- 25 marks
Attendance	- 10 marks
<u>Assignments</u>	<u>- 15 marks</u>
<u>Total</u>	<u>- 50 marks</u>

12. Assessment – CO Mapping (Put ‘ x’ if mapping is present)

Tools			Weightage	CO 1	CO 2	CO 3	CO 4	CO 5
Direct Assessment Tools	Internal Exam(s) - 40%	First Internal	20%	x	x			
		Second Internal	20%			x	x	
	Assignment (s) 30%	Assignment 1	15%	x	x			
		Assignment 2	15%			x	x	x
	End Semester Exam		30%	x	x	x	x	x
Indirect Assessment Tool	Course Exit Survey		100%	x	x	x	x	x

13. Assessment Configuration



14. Course Plan

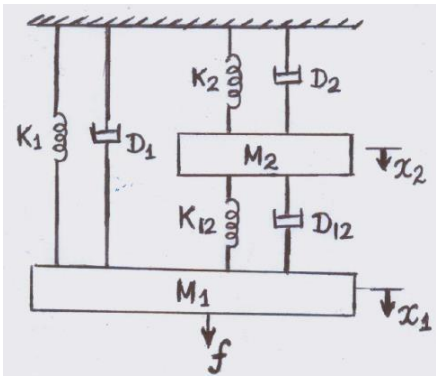
Hour	Topic	Module	Reference	Teaching Pedagogy
1	Basic Components of a Control System, Open-Loop Control Systems and Closed- Loop Control Systems, Examples of control system	1	T1	Lecture
2	Feedback and its effects	1	T1	Lecture
3	Types of Feedback Control Systems, Linear versus Nonlinear Control Systems, Time-Invariant versus Time-Varying Systems	1	T1	Lecture
4	Mathematical modelling of control systems: Mechanical systems	1	T2	Lecture
5	Mathematical modelling of control systems: Mechanical systems	1	T2	Lecture
6	Mathematical modelling of control systems: Mechanical systems	1	T2	Tutorial
7	Mathematical modelling of control systems: Electrical Systems	1	T2	Lecture
8	Impulse response and its relation with transfer function of linear systems. Block diagram representation and reduction methods	1	T2	Lecture

9	Block diagram representation and reduction methods	1	T2	Tutorial
10	Block diagram representation and reduction methods	1	T2	Lecture
11	Signal flow graph and Mason's gain formula	1	T2	Lecture
12	Signal flow graph and Mason's gain formula	1	T2	Remedial
13	Signal flow graph and Mason's gain formula	1	T2	Flipped Classroom
14	Introduction- Standard Test signals	2	T2	Lecture
15	Time response specifications	2	T2	Tutorial
16	Time response of first order systems to unit step input and ramp inputs	2	T2	Lecture
17	Time response of first order systems - Problem	2	T2	Remedial
18	Time response of second order systems to unit step input and ramp inputs	2	T2	Lecture
19	Time domain specifications	2	T2	Lecture
20	Time domain specifications - Problem	2	T2	Tutorial
21	Steady state error	2	T2	Lecture
22	Static error coefficients	2	T2	Lecture
23	Static error coefficients - Problems	2	T2	Remedial
24	Frequency domain specifications	2	T2	Lecture
25	Correlation between time and frequency responses	2	T2	Lecture
26	Stability of linear control systems: concept of BIBO stability, absolute stability	3	T2	Lecture
27	Routh's Hurwitz Criterion	3	T2	Lecture
28	Routh's Hurwitz Criterion	3	T2	Remedial
29	Routh's Hurwitz Criterion	3	T2	Lecture
30	Routh's Hurwitz Criterion	3	T2	Group Discussion
31	Effect of P & PI controllers	3	T2	Lecture
32	Effect of PID controllers	3	T2	Lecture

33	Root Locus : Introduction, properties	3	T2	Lecture
34	Root Locus construction, Application to system stability studies.	3	T2	Remedial
35	Root Locus construction, Application to system stability studies.	3	T2	Lecture
36	Illustration of the effect of addition of a zero and a pole	3	T2	Lecture
37	Root Locus construction, Application to system stability studies.	3	T2	Tutorial
38	Nyquist stability criterion - Fundamentals	4	T2	Lecture
39	Nyquist stability criterion - Analysis	4	T2	Remedial
40	Relative stability: Stability analysis with Bode plot, gain margin and phase margin.	4	T2	Lecture
41	Stability analysis with Bode plot, gain margin and phase margin.	4	T2	Lecture
42	Stability analysis with Bode plot, gain margin and phase margin.	4	T2	Tutorial
43	Stability analysis with Bode plot, gain margin and phase margin.	4	T2	Flipped Classroom
44	Design of Compensators: Need of compensators	4	T2	Lecture
45	Design of lag compensators using Bode plots	4	T2	Remedial
46	Design lead compensators using Bode plots	4	T2	Lecture
47	State variables, state equations	5	T3	Lecture
48	State variables, state equations	5	T3	Tutorial
49	State variables, state equations	5	T3	Lecture
50	State variable representation of electrical Systems	5	T3	Lecture
51	State variable representation of mechanical systems	5	T3	Lecture
52	Dynamic equations, merits for higher order differential equations and solution	5	T3	Lecture

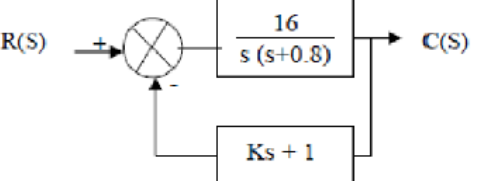
53	Dynamic equations, merits for higher order differential equations and solution	5	T3	Tutorial
54	Transfer function from State Variable Representation, Solutions of the state equations, state transition matrix	5	T3	Lecture
55	Solutions of the state equations, state transition matrix	5	T3	Lecture
56	Concept of controllability and observability and techniques to test them - Kalman's Test	5	T3	Lecture
57	Controllability and observability test - Kalman's Test	5	T3	Lecture
58	Controllability and observability test - Kalman's Test	5	T3	Group Discussion

15. Question Bank

Module1				
Sl. No.	Question	Marks	CO	BL
1.	Compare open loop and closed loop control systems. Give example.	3	CO1	L2
2.	Obtain the impulse response of a series RL high pass filter.	3	CO1	L3
3.	State the properties of a signal flow graph.	3	CO1	L2
4.	Distinguish between open loop and closed loop systems.	3	CO1	L2
5.	Obtain the differential equations governing the mechanical system shown below and draw the force-current electrical analogous circuit. 	7	CO1	L3
6.	Convert the block diagram to signal flow graph and determine the transfer function using Mason's gain formula	8	CO1	L3

7.	Find the transfer function of the given system using block diagram reduction method	8	CO1	L3
8.	Obtain the differential equations governing the mechanical system shown below and draw the <i>force-voltage</i> electrical analogous circuit	7	CO1	L3
9.	Obtain overall transfer function for the given system using Mason's gain formula	7	CO1	L3
10.	Find the transfer function .Also draw the force voltage analogy of the given system	10	CO1	L3
11.	Write the differential equations governing the mechanical systems shown below. Draw the <i>force-voltage</i> and <i>force-current</i> electrical analogous circuits and verify by writing mesh and node equations	12	CO1	L3

Module2

Sl. No.	Question	Marks	CO	BL
1.	A unity feedback system has the following forward path transfer function. $G(s) = \frac{180}{s(s+6)}$ and $r(t) = 4t$. Determine the corresponding static error coefficient and the steady state error.	3	CO2	L3
2.	Compare the features of transient and steady state part of a system response. Give an example for a second order control system with natural frequency of 2 rad/s and damping ratio of 0.5.	3	CO2	L3
3.	i) Determine the type and order of the system ii) Find the minimum value of K for which the steady state error is less than 0.2 for a unit ramp input.	5	CO2	L3
4.	Determine the step, ramp and parabolic error constants for the unity feedback control system.	7	CO2	L3
5.	A positional control system with velocity feedback is shown in fig. What is the response $c(t)$ to the unit step input? Given that $\zeta=0.5$ and also calculate rise time, peak time, Maximum overshoot and settling time. 	7	CO2	L3
6.	Derive expressions for time domain specifications of a second order system.	7	CO2	L2
7.	Derive an expression for time response of a second order under damped system to step input.	7	CO2	L2
8.	A unity feedback system has the following open loop transfer function, where K and T are constants. Determine the factor by which K should be multiplied to reduce the overshoot from 85% to 35%. $G(s) = K/s(1+sT)$	8	CO2	L3
10.	Find the static error coefficients for a system whose $G(s)H(s) = 10/S(1+S)(1+2S)$ and also find steady state error for $r(t) = 1 + t + t^2/2$.	8	CO2	L3
11.	Starting from the generalized transfer function, derive expression for peak time of second order under-damped system subjected to unit step function.	9	CO2	L2
12.	Measurements conducted on a Servomechanism show the system response to be $c(t) = 1 + 0.2e^{-60t} - 1.2e^{-10t}$. when subjected to a unit step. Obtain an expression for closed loop transfer function.	10	CO2	L3
Module3				
Sl. No.	Question	Marks	CO	BL
1.	Explain absolute stability and relative stability of control systems.	3	CO3	L2
2.	Compare PD, PI and PID controllers.	3	CO3	L2

3.	Describe characteristic equation	3	CO3	L2
4.	State Routh stability criterion	3	CO3	L2
5.	Using Routh criterion determine the stability of the system whose characteristics equation is $S^4+8S^3+18S^2+16S+5=0$.	7	CO3	L3
6.	Construct Routh array and determine the stability of the system represented by the characteristics equation $S^7+9S^6+24S^4+24S^3+24S^2+23S+15=0$.	7	CO3	L3
7.	Sketch the root locus for the given open loop transfer function and comment on the system stability. $G(s)H(s) = \frac{K(s+2)}{s(s+1)(s+4)}$	8	CO3	L3
8.	A unity feedback control system has an open loop transfer function $G(S) = K / S (S^2+4S+13)$. Sketch the root locus.	10	CO3	L3

Module4

Sl. No.	Question	Marks	CO	BL
1.	Obtain the DC gain of a unity feedback control system whose overall transfer function is given by $T(s) = \frac{10}{(s+3)(s+5)}$	3	CO4	L3
2.	Starting with the principle of argument, state Nyquist stability criterion.	3	CO4	L2
3.	Draw the s-plane contour used for mapping, for stability analysis, to the plane of open-loop transfer function. $G(s)H(s)= 1/s(s+1)$. Explain the choice of the contour.	3	CO4	L3
4.	Compare lead, lag and lag-lead compensators.	4	CO4	L2
5.	Explain the design procedure of phase lead compensator using Bode plot method.	5	CO4	L2
6.	Draw the Nyquist plot for the system whose open loop transfer function is $G(s)H(s) = \frac{K}{s(s+2)(s+10)}$ Also comment on closed loop stability.	9	CO4	L3
7.	Plot the Bode diagram for the following transfer function and obtain the gain and phase cross over frequencies. $G(S) = 10/ S (1+0.4S) (1+0.1S)$	10	CO4	L3
8.	A unity feedback control system with given $G(s)$, Draw the Bode plot. Find the gain margin and phase margin. Also check for the stability. (Use semi-log sheet) $G(s) = \frac{5(1+2s)}{(1+4s)(1+0.25s)}$	10	CO4	L3
9.	Design a suitable lag compensator for the system with transfer function $G(s)=0.025/s(1+0.5s)(1+0.05s)$ to give velocity error constant of 20 sec and phase margin of 40° .	14	CO4	L3

10.	Design a phase lead compensation for the system shown in figure to satisfy the following specification. i) The phase margin of the system $\geq 45^\circ$ ii) Steady state error for a unit ramp input $\leq 1/5$	14	CO4	L3
11.	Design a unity feedback system with open loop transfer function $G(S) = \frac{100}{(S+1)(S+2)(S+10)}$. Design a PID controller so that the phase margin of the system is 45° at a frequency of 4 rad/sec and the steady state error for unit ramp input is 0.1..	14	CO4	L3
Module5				
Sl. No	Question	Marks	CO	BL
1.	Define state transition matrix. Mention any four properties of it	3	CO5	L2
2.	Define the terms state variable and state space. Mention any four distinct advantages of state space representation.	3	CO5	L2
3.	Give two advantages for using state variable representation of systems.	3	CO5	L2
5.	Obtain the state model of the system whose transfer function is given by $\frac{Y(s)}{U(s)} = \frac{10}{s^3 + 4s^2 + 2s + 1}$	3	CO5	L3
6.	Given the transfer function of a system, determine a state variable representation for the system $\frac{Y(S)}{U(S)} = \frac{1}{(S+2)(S+3)(S+4)}$	4	CO5	L3

Prepared By : Dr. Rakesh S

Checked By : Dr. Saju A

Course Code & Name: MCN 301 DISASTER MANAGEMENT

1. Prescribed Syllabus

Module	Topic	Hours
1	Systems of earth, Lithosphere- composition, rocks, soils; Atmosphere- layers, ozone layer, greenhouse effect, weather, cyclones, atmospheric circulations, Indian Monsoon hydrosphere- Oceans, inland water bodies; biosphere. Definition and meaning of key terms in Disaster Risk Reduction and Management-disaster, hazard, exposure, vulnerability, risk, risk assessment, risk mapping, capacity, resilience, disaster risk reduction, disaster risk management, early warning systems, disaster preparedness, disaster prevention, disaster mitigation, disaster response, damage assessment, crisis counselling, needs assessment.	10
2	Hazard types and hazard mapping; Vulnerability types and their assessment- physical, social, economic and environmental vulnerability. Disaster risk assessment –approaches, procedures	9
3	Disaster risk management -Core elements and phases of Disaster Risk Management Measures for Disaster Risk Reduction – prevention, mitigation, and preparedness. Disaster response- objectives, requirements; response planning; types of responses. Relief, international relief organizations.	9
4	Participatory stakeholder engagement; Disaster communication- importance, methods, barriers, Crisis counselling Capacity Building: Concept – Structural and Non-structural Measures, Capacity Assessment; Strengthening Capacity for Reducing Risk	9
5	Common disaster types in India, Legislations in India on disaster management; National disaster management policy; Institutional arrangements for disaster management in India. The Sendai Framework for Disaster Risk Reduction- targets, priorities for action, guiding principles.	13

2. Text Books (T)

- T1. R. Subramanian, Disaster Management, Vikas Publishing House, 2018
T2. M. M. Sulphey, Disaster Management, PHI Learning, 2016
T3. UNDP, Disaster Risk Management Training Manual, 2016
T4. United Nations Office for Disaster Risk Reduction, Sendai Framework for Disaster Risk

3. Reference Books (R)

- R1. Andrew, S., “Environmental Modeling with GIS and Remote Sensing”, John Willey, 2002
R2. Ariyabandu, M. and Sahni P. “Disaster Risk Reduction in South Asia”, Prentice-Hall (India), 2003.
R3. Bell, F.G., “Geological Hazards: Their assessment, avoidance and mitigation”, E R4. Bossler, J.D., “Manual of Geospatial Science and Technology”, Taylor and Francis, 2001
R5. David Alexander, “Natural Disasters”, Research Press, New Delhi, 1993.

4. Course Objectives

The objective of this course is to introduce the fundamental concepts of hazards and disaster management.

5. Course Pre / Co-requisite

Nil

6. Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes

PO/ CO	PO 1	PO 2	PO 3	PO 4	PO5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO 3
CO1		M				M				M		M			
CO2	M	H	M		M	M	H			H		M			
CO3	M	H	M	M	M	M	H			H		M		M	
CO4	H	H	H		M	M	H					M		M	
CO5	H	H			M	M	H					M		M	
CO6	H					M	H	H				M		M	

7. Justification for CO-PO-PSO

CO	PO/ PSO	Justification
CO1	PO2	Identifying and understanding terminologies and processes in disaster Management help the students to arrive at sustained conclusions on problems.
	PO6	Understanding the processes involved in various disasters and applying various reasoning will enable students to specify the safety and health issues in the respective field of work in the context of a disaster occurred.
	PO10	Communication with engineers and society will help the student to work individually or in a team in the case of a disaster and to take effective measures in disaster prevention, mitigation and preparedness.
	PO12	Lifelong learning and independent decision making help the student to work effectively during a disaster
CO2	PO1	Applying the knowledge of basics of disaster management will help the student to distinguish between the different types of hazards.
	PO2	Understanding the concepts of various disasters will enable students to suggest measures taken to mitigate and contain common episodes of disasters for the safety and health of society.
	PO3	Selecting the processes that meet specified needs with public safety environmental considerations will help the student to prepare vulnerability assessment efficiently.
	PO5	Selecting appropriate techniques in disaster management will help the student to determine the disaster management cycle and assessment
	PO7	Understanding the concept of disaster management will help the student to understand the sustainable solutions in the case of a disaster.
	PO10	Idea about vulnerability and its assessment involved in natural and anthropogenic disasters will enable the students to act proactive in the case of disaster.
	PO12	improving the technological knowledge will help the student to distinguish between different hazard types.

CO3	PO1	Applying the knowledge of basics of disaster management will help the student to apply suitable methodologies for assessing the risk.
	PO2	Understanding the concepts of various disasters will enable students to describe the process of risk assessment
	PO3	Selecting the processes that meet specified needs with public safety ,environmental considerations will help the student to do the risk assessment
	PO4	Students analyse the stability of a system using a simulation software. Hence it is mapped with medium correlation.
	PO5	Research based knowledge and information make the student capable of doing the risk assessment effectively.
	PO6	Potential knowledge and concepts of disaster management learnt will help the students to make effective planning for disaster management for the benefit of safety and health of society.
	PO7	Understanding the impacts of solutions in societal and environmental contexts will help the student to do the risk assessment
	PO10	Knowledge and concepts of disaster management will help the student to work individually or in a team in the case of a disaster
	PO12	Knowledge and concepts of disaster management will enable the students to act proactive in the case of disaster.
	PSO2	Modelling and analyzing the real time problems make the student capable to select suitable methodologies of risk assessment
CO4	PO1	Apply the knowledge in science and engineering will help the student for finding the solution of risk associated with the disaster.
	PO2	Identifying, analyzing and formulating the complex engineering problems will help the student to reach in conclusions and preventive measures to reduce disaster risk
	PO3	Development of solutions will help the student to arrive at conclusions considering the public health and safety. Environmental considerations in the occurrence of a disaster
	PO5	Create , select and apply appropriate techniques will help the student to reduce the risk associated with a disaster
	PO6	Applying reasoning and other engineering techniques will help the student to develop possible measures to reduce disaster risk
	PO7	Understand the impact of disaster will help the student to find solutions in societal and environmental contexts and thereby achieving sustainable development
	PO12	Knowledge and concepts of disaster management will enable the students to explain the core elements and phases in disaster risk management.
CO5	PO1	Applying the knowledge in science and engineering will help the student to identify the nature of disaster and discuss various disaster responses
	PO2	Identifying, analyzing and formulating the complex engineering problems will help the student to select the response actions related to disaster

	PO5	Create , select and apply appropriate techniques will help the student to reduce the risk associated with a disaster.
	PO6	Applying reasoning and other engineering techniques will help the student to identify the factors determining the nature of disaster responses
	PO7	Understanding the impacts of solutions in societal and environmental contexts will help student to effectively d the disaster responses.
	PO12	Knowledge and concepts of disaster management will enable the students to act proactive in the case of disaster
	PSO2	Modelling and analyzing the real time problems make the student capable to determine the nature of disaster responses
CO6	PO1	Applying the knowledge in science and engineering will help the student to know the best practices in disaster management and reducing the risk.
	PO6	Applying reasoning and other engineering techniques will help the student to select best practices of disaster management
	PO7	Understanding the impact of engineering solutions will help the student to take effective measures of disaster management
	PO8	Understanding the professional ethics and responsibilities will help the student to be proactive during a disaster.
	PO12	Understanding the concepts of disaster management will help the student to identify the factors for the best practices in disaster management
	PSO2	Modelling and analyzing the real time problems make the student capable to reduce the risk in national and international levels.

9. Curricular gaps (if any):

Nil

10. Course Enrichment Activities* :

Sl. No.	Description	Proposed Activities **	Relevance to POs and PSOs
1	Poster/Case studies	Study of Socio-economic and environmental impact of massive ship fire of Kerala coast	PO4,PO6,PO7,PO9,PO12

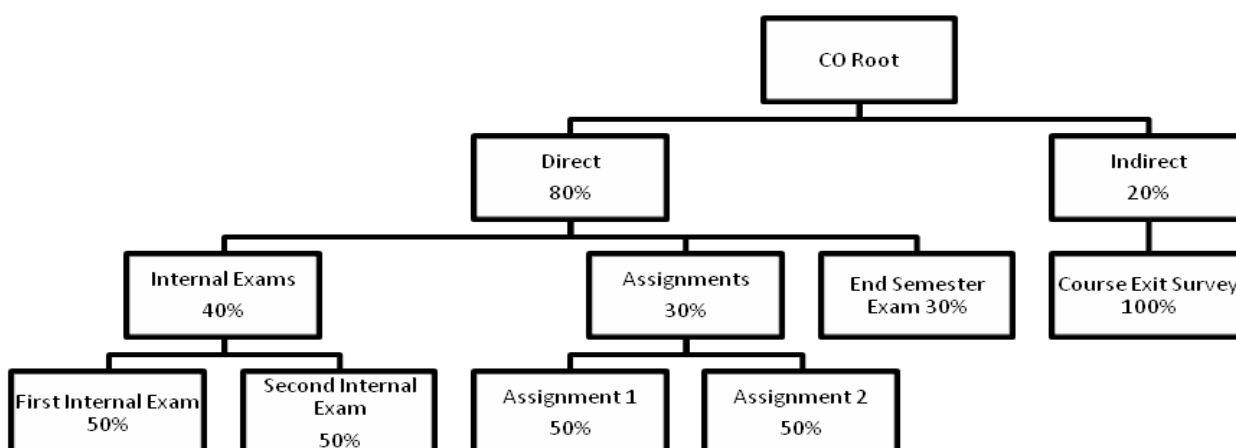
11. Internal Assessment mark allocation (as per university curriculum)

Continuous Assessment Test	- 25 marks
Attendance	- 10 marks
<u>Assignments</u>	<u>- 15 marks</u>
<u>Total</u>	<u>- 50 marks</u>

12. Assessment – CO Mapping (Put 'x' if mapping is present)

Tools			Weightage #	CO 1	CO 2	CO 3	CO 4	CO 5	CO 6
Direct Assessment Tools**	Internal Exam(s) - 40%	First Internal	20%	x	x	x			
		Second Internal	20%				x	x	x
	Assignment (s)/ Course Project/Quiz etc. - 30%	Assignment 1	15%	x	x	x			
		Assignment 2	15%				x	x	x
	End Semester Exam		30%	x	x	x	x	x	x
Indirect Assessment Tool	Course Exit Survey		100%	x	x	x	x	x	x

13. Assessment Configuration



14. Course Plan

Hour	Topic	Module	Reference	Teaching Pedagogy
1	Lithosphere-composition, atmosphere-layers, ozone layer, greenhouse effect	1	T1,T2,T3	Lecture
2	Weather, cyclones, atmospheric circulations	1	T1,T2,T3	Lecture
3	Indian Monsoon, hydrosphere-Oceans, inland water bodies, biosphere	1	T1,T2,T3	Lecture

4	Definition and meaning of key terms in Disaster Risk Reduction and Management- disaster, hazard, exposure, vulnerability, risk, risk assessment	1	T1,T2,T3	Lecture
5	Risk mapping, capacity, resilience, disaster risk reduction	1	T1,T2,T3	Lecture
6	Disaster risk management, early warning systems, disaster preparedness	1	T1,T2,T3	Tutorial
7	Disaster prevention, disaster mitigation, disaster response	1	T1,T2,T3	Lecture
8	Damage assessment, crisis counselling, needs assessment.	1	T1,T2,T3	Lecture
9	Hazard types and hazard mapping;	2	T1,T2,T3	Tutorial
10	Vulnerability types and their assessment- physical, social	2	T1,T2,T3	Lecture
11	Economic and environmental vulnerability	2	T1,T2,T3	Lecture
12	Disaster risk assessment	2	T1,T2,T3	Remedial
13	Disaster risk assessment, Procedure	2	T1,T2,T3	Lecture
14	Disaster risk management -Core elements and phases of Disaster Risk Management	3	T1,T2,T3	Lecture
15	Measures for Disaster Risk Reduction – prevention, mitigation, and preparedness.	3	T1,T2,T3	Tutorial
16	Disaster response- objectives, requirements;	3	T1,T2,T3	Lecture
17	Response planning; types of responses.	3	T1,T2,T3	Remedial
18	Relief; international relief organizations	3	T1,T2,T3	Lecture
19	Disaster communication- importance, methods, barriers;	4	T1,T2,T3	Lecture
20	Crisis counselling	4	T1,T2,T3	Tutorial
21	Capacity Building: Concept – Structural and Non-structural Measures, Capacity Assessment	4	T1,T2,T3	Lecture
22	Strengthening Capacity for Reducing Risk	4	T1,T2,T3	Lecture
23	Common disaster types in India	5	T1,T2,T3	Remedial
24	Legislations in India on disaster management	5	T1,T2,T3	Lecture
25	National disaster management policy	5	T1,T2,T3	Lecture
26	Institutional arrangements for disaster management in India.	5	T1,T2,T3	Lecture

15. Question Bank

Module 1				
Sl. No.	Question	Marks	CO	BL
1	Explain about ozone layer depletion and greenhouse effect.	3	CO1	L2
2	Explain the following terms in the context of disaster management Exposure, Resilience, Disaster risk management, early warning systems, damage assessment, crisis counselling, needs assessment.	14	CO1	L1
3	Explain different atmospheric layers.	3	CO1	L1
4	Explain the two types of cyclones and their formations	14	CO1	L1
5	Define lithosphere	3	CO1	L1
6	Explain the different types of rocks and soils present in lithosphere	14	CO1	L2
7	Explain about different composition of lithosphere.	3	CO1	L1
8	Explain the terms hydrosphere and biosphere	3	CO1	L1
9	Discuss about disaster risk reduction and management steps.	14	CO1	L2
10	Differentiate between disaster and hazard.	3	CO1	L1
11	Differentiate between capacity and resilience	3	CO1	L1
12	Enumerate the different ways to deal with risk	3	CO1	L1
13	With the help of a neat diagram, explain the disaster management cycle	14	CO1	L2
14	Explain the core elements in disaster resilience.	3	CO1	L2
15	Differentiate between crisis and emergency.	3	CO1	L2
16	Explain the mechanism by which stratospheric ozone protects earth from harmful UV rays.	3	CO1	L2
17	Explain the relevance and adverse effects of greenhouse gases.	3	CO1	L2
18	Discuss the two types of monsoon in Indian subcontinent.	3	CO1	L2
19	Categorize the various layers of atmosphere based on their distance from earth and explain the features of each layer with a neat diagram.	8	CO1	L2
20	Define the following terms: a) Disaster b) Hazard c) Risk	6	CO1	L2
21	State and explain crisis counselling. Identify the necessity of crisis counselling.	8	CO1	L2
22	Identify the reasons for the depletion of Ozone layer . Suggest two initiatives which can be implemented at home to prevent this	6	CO1	L2
23	Differentiate between acceptable risk and residual risk.	3	CO1	L2
24	State the composition of lithosphere?	3	CO1	L1
25	Illustrate with diagram the layers of earth's atmosphere.	8	CO1	L1
26	State and explain the classification of rocks.	6	CO1	L1
27	State and explain the features of hydrosphere and biosphere in detail.	8	CO1	L1
28	Explain the terms resilience, recovery and early warning systems with respect to disaster risk management.	6	CO1	L2
29	Define the term "biosphere" and describe the three main	3	CO1	L1

	components that constitute it.			
30	What are disasters? What are their causes?	3	CO1	L1
31	Briefly explain Indian Monsoon and factors affecting Indian Monsoon?	10	CO1	L2
32	Explain greenhouse effect and global warming?	4	CO1	L1
33	Explain the following terms in the context of disaster management (a) Disaster Risk Management (b) Crisis Counselling (c) Exposure (d) Early Warning Systems (e) Damage Assessment (f) Resilience (g) Needs Assessment	14	CO1	L1
34	Describe the role of the ozone layer in the Earth's atmosphere and its significance for life on the planet.	3	CO1	L2
35	Explain the greenhouse effect and its impact on global climate. Provide examples of greenhouse gases.	3	CO1	L2
36	Classify the layers of Earth's atmosphere based on their distance from the surface and explain the distinctive features of each layer.	10	CO1	L1
37	Differentiate between disaster preparedness and disaster response.	4	CO1	L2
38	Differentiate between igneous, sedimentary, and metamorphic rocks. Provide examples of each.	14	CO1	L2
Module 2				
Sl. No.	Question	Marks	CO	BL
1	Explain different categories of hazards with examples.	3	CO2	L1
2	Explain vulnerability and its types	14	CO2	L1
3	Enlist the data required for hazard mapping	3	CO2	L1
4	Discuss the cartographic representation of hazards.	14	CO2	L2
5	Explain hazard mapping using GIS method	3	CO2	L2
6	List the strategies for disaster risk management before, during, and after a disaster	3	CO2	L1
7	Explain the applications of hazard maps.	3	CO2	L2
8	Define participatory hazard mapping and explain its methodology.	14	CO2	L1
9	Explain about the two risk assessment methods.	14	CO3	L1
10	Enumerate the contemporary approaches to risk assessments	3	CO3	L1
11	Enumerate the methods of measuring physical vulnerabilities and socio economic vulnerabilities	14	CO2	L1
12	Explain the different approaches in vulnerability assessment	14	CO2	L2
13	Explain the data needed for vulnerability assessment and their usefulness.	3	CO2	L1
14	State the major data requirements of hazard mapping and the 3 sources for obtaining these data.	3	CO2	L2
15	State the principle of qualitative risk assessment and the method of expressing risk qualitatively.	3	CO3	L2
16	Define hazard mapping. Explain the two approaches of hazard mapping.	8	CO2	L2

17	In Kerala for the past 5 years. the average number of road accidents is 44076 per year and 1 death occurs in every 10 accidents. Considering the population as 3.33 crores, assess the risk of being killed in driving an automobile in terms of societal and individual risk.	6	CO2	L3
18	Explain the four different types of vulnerability. List any four socioeconomic indicators of human capital as livelihood asset.	8	CO2	L2
19	Outline the two major physical vulnerability assessment approaches.	6	CO2	L2
20	Explain physical vulnerability and ecological vulnerability.	3	CO2	L2
21	Define disaster deficit index.	3	CO2	L1
22	Explain the applications of hazard maps.	8	CO2	L2
23	Explain the methods of representing vulnerability.	6	CO2	L1
24	Explain the method of expressing population risk.	5	CO2	L2
25	List the components of risk assessment. Explain the contemporary approaches to risk assessment.	9	CO3	L2
26	Define the term "hazard" and provide examples of natural and human-made hazards.	3	CO2	L1
27	Define vulnerability in the context of disasters.	3	CO2	L1
28	Explain the types of vulnerabilities and approaches to assess them.	10	CO2	L1
29	Explain the application of hazard maps.	4	CO2	L2
30	Describe in detail the approaches and procedures involved in disaster risk assessment.	14	CO3	L2
31	Explain the significance of hazard mapping in disaster risk management.	3	CO2	L2
32	Define Natural Hazards and provide examples.	3	CO2	L1
33	Explain the types of vulnerabilities and approaches to assess them.	10	CO2	L2
34	Outline the two major physical Vulnerability assessment approaches.	4	CO2	L1
35	List the components of risk assessment Explain the contemporary approaches to risk assessment.	10	CO3	L2
36	Explain the application of hazard maps.	4	CO2	L2
Module 3				
Sl. No.	Question	Marks	CO	BL
1	Define disaster risk management.	3	CO4	L1
2	With the help of a block diagram, explain disaster risk management.	3	CO4	L1
3	Define disaster risk reduction	3	CO4	L1
4	Explain the disaster risk reduction measures in detail.	3	CO4	L2

5	Define disaster prevention	3	CO4	L1
6	Define disaster mitigation	3	CO4	L1
7	Define disaster preparedness	3	CO4	L1
8	Explain the objectives of disaster response	3	CO5	L2
9	Explain disaster response	3	CO5	L1
10	Explain the two types of disaster prevention	3	CO4	L1
11	What are the primary objectives of disaster mitigation	3	CO4	L2
12	Explain the two types of disaster mitigation	3	CO4	L1
13	What are the mitigation functions provided by the ecosystem	3	CO4	L3
14	List out the components of a disaster preparedness strategy.	3	CO4	L1
15	Explain the different types of disaster preparedness.	3	CO4	L1
16	What are the factors that determine the nature of disaster response.	3	CO5	L2
17	Explain the requirement for an effective response.	3	CO5	L2
18	Explain the rationale for disaster response.	4	CO5	L2
19	Explain any five disaster response activities in detail.	10	CO5	L1
20	Define relief and explain different relief activities.	3	CO5	L1
21	With the help of a neat diagram explain PCM linked to relief.	3	CO5	L2
22	State the different types of disaster response	3	CO5	L1
23	List six international relief organizations	3	CO5	L1
24	Explain the core elements of disaster risk management.	10	CO4	L2
25	State the requirements for effective disaster response.	4	CO5	L1
26	Define the term 'disaster risk reduction'. Explain the measures for disaster risk reduction.	8	CO4	L1
27	Define 'relief' in the context of disaster management. Identify the principles guiding relief.	6	CO5	L2
28	Explain psychosocial support related with disaster response.	3	CO5	L1
29	List any six public health services required in responding to disasters.	3	CO5	L2
30	State and explain the types of disaster mitigation measures.	4	CO4	L1
31	Identify the factors that determine the nature of disaster response and explain.	10	CO5	L2
32	State and explain the types of disaster preparedness.	6	CO4	L1
33	Identify the standard operating procedures to be followed during a disaster stage and explain.	8	CO5	L1
34	Define the term 'disaster preparedness.	3	CO4	L1
35	Define 'relief' in the context of disaster management.	3	CO5	L1
36	Explain the factors that decide the nature of disaster response.	8	CO5	L2
37	Explain disaster relief and international relief organizations.	6	CO5	L1
38	Explain the core elements of disaster risk management.	7	CO4	L1
39	Explain the different disaster response actions.	7	CO5	L1
40	Discuss the role of international relief organizations in disaster response and recovery.	7	CO5	L2
41	Describe different types of disaster responses.	7	CO5	L2
42	State and explain the types of disaster mitigation measures.	7	CO4	L1

43	Define the term 'disaster risk reduction'.	3	CO4	L1
44	List the strategies for disaster risk management 'before', 'during' and 'after' a disaster	3	CO4	L3
Module 4				
Sl. No.	Question	Marks	CO	BL
1	Define the terms, stakeholder participation and stakeholder engagement.	3	CO5	L1
2	Explain the stakeholder analysis by grid method	3	CO5	L3
3	Explain the stakeholder analysis by salience method	3	CO5	L3
4	Explain the three types of stakeholders.	3	CO5	L1
5	Explain the basic steps of participatory stakeholder engagement.	3	CO5	L1
6	Enlist the potential benefits of increased stakeholder participation.	3	CO5	L2
7	Enlist the impacts of the absence of stakeholder participation.	3	CO5	L2
8	Explain about the different methods for participatory stakeholder engagement.	3	CO5	L2
9	With the help of a neat diagram, explain the levels of stakeholder participation.	3	CO5	L1
10	Briefly explain the importance of communication in disaster risk reduction.	8	CO5	L1
11	What are the steps for an effective communication during a disaster.	6	CO5	L1
12	Enlist the barriers to effective communications.	7	CO5	L1
13	Distinguish between risk communication and crisis communication.	3	CO5	L2
14	List the structural and nonstructural measures in capacity building	3	CO5	L3
15	Describe the effective ways of promoting stakeholder participation in disaster risk reduction. State its benefits.	8	CO5	L3
16	Explain the basic steps in participatory stakeholder engagement.	6	CO5	L2
17	Explain capacity building, relevance of capacity assessment and the different methods of assessing capacity in disaster risk management.	10	CO5	L2
18	State the barriers to effective communication in disaster management.	4	CO5	L1
19	Explain pyramid scheme related with participatory stakeholder engagement.	3	CO5	L1
20	How are stakeholders in disaster management identified?	4	CO5	L1
21	What are the steps to effective disaster communication? What are the barriers to communication?	7	CO5	L2
22	Briefly explain the levels of stakeholder participation in the context of disaster risk reduction?	3	CO5	L2
23	Define the terms counselling and crisis counselling.	3	CO5	L1
24	State and explain the basic principles of participatory rural appraisal tools.	5	CO5	L2

25	Explain the characteristics of effective crisis counsellors. State the advantages of crisis counselling.	9	CO5	L1
26	State and explain the steps for effective communication.	8	CO5	L1
27	Identify the barriers to effective communication.	6	CO5	L1
28	What are the advantages and drawbacks of involving stakeholders in disaster management?	8	CO5	L2
29	Explain capacity building in the context of disaster management.	6	CO5	L2
30	What is the process for identifying stakeholders in disaster management?	5	CO5	L1
31	How can one ensure effective disaster communication by outlining the necessary steps, and what obstacles or barriers to communication should be considered in this context?	9	CO5	L2
32	What distinguishes crisis counselling from regular counselling?	3	CO5	L2
33	Explain the importance of communication in disaster management.	3	CO5	L1
34	Why is crisis counselling important in the aftermath of a disaster, and how does it differ from regular counselling?	3	CO5	L2
35	Define the concept of capacity building in the context of disaster risk reduction.	3	CO5	L2
36	Explain the core elements of disaster risk management.	7	CO5	L1
37	Discuss the role of international relief organizations in disaster response and recovery.	7	CO5	L2
38	Describe different types of disaster responses.	7	CO5	L1
39	State and explain the types of disaster mitigation measures.	7	CO5	L1
Module 5				
Sl. No.	Question	Marks	CO	BL
1	State the legislations in India on disaster management	3	CO6	L1
2	Explain the interrelation of National Disaster Management Policy with other national policies.	3	CO6	L1
3	Explain the common disaster types in India.	10	CO6	L2
4	State the objectives and main elements of national disaster management policy.	4	CO6	L1
5	State the targets, priorities and guiding principles of Sendai Framework for disaster risk reduction.	8	CO6	L1
6	Explain the institutional arrangement for disaster management in India	6	CO6	L1
7	Define man-made disasters and list examples from our country.	3	CO6	L2
8	Explain the role of National Institute of Disaster Management in our country.	3	CO6	L2

9	List the global targets of Sendai framework and explain.	7	CO6	L1
10	Explain the role, composition and responsibilities of National Disaster Management Authority.	7	CO6	L1
11	List the guiding principles of Sendai framework and explain.	10	CO6	L1
12	State the composition and role of National Executive Committee related with the National Policy on Disaster Management.	4	CO6	L1
13	What role do local governments play in implementing disaster management legislation in India?	3	CO6	L1
14	What are Tsunamis? How are they caused?	3	CO6	L3
15	Discuss the priorities for action identified in the Sendai Framework. How can these priorities be tailored to address the specific needs and challenges faced by India?	9	CO6	L3
16	What role do local governments play in implementing disaster management legislation in India.	5	CO6	L2
17	Discuss the key features and objectives of the National Disaster Management Policy in India. How does it guide the country in managing and reducing disaster risks?	7	CO6	L3
18	What are the most common types of disasters faced by India.	7	CO6	L1
19	What are the objectives of the National Disaster Management Policy?	3	CO6	L1
20	State the legislations in India on disaster management.	3	CO6	L1
21	What are the typical types of disasters that frequently occur in India?	10	CO6	L2
22	Explain the institutional arrangement for disaster management in India.	4	CO6	L1
23	Explain the guiding principles target and priorities for action according to the Sendai Framework for disaster risk reduction.	14	CO6	L1
24	Explain the salient features of the National Policy on Disaster Management in India	8	CO6	L2
25	Explain the guiding principles and priorities of action according to the Sendai framework for Disaster Risk Reduction.	8	CO6	L2
26	Explain the earthquake zonation of India	3	CO6	L3

Prepared by: Gregorious Jose C

Checked by: Dr. Ramdas T

1. Prescribed Syllabus

I. Fundamentals of operational amplifiers and basic circuits [Minimum seven experiments are to be done]

1. Familiarization of Operational amplifiers - Inverting and Non inverting amplifiers, frequency response, Adder, Integrator, Comparators.
2. Measurement of Op-Amp parameters.
3. Difference Amplifier and Instrumentation amplifier.
4. Schmitt trigger circuit using Op-Amps.
5. Astable and Monostable multivibrator using Op-Amps.
6. Waveform generators using Op-Amps - Triangular and saw tooth
7. Wien bridge oscillator using Op-Amp - without & with amplitude stabilization.
8. RC Phase shift Oscillator.
9. Active second order filters using Op-Amp (LPF, HPF, BPF and BSF).
10. Notch filters to eliminate the 50Hz power line frequency.
11. Precision rectifiers using Op-Amp.

II. Application circuits of 555 Timer/565 PLL/ Regulator(IC 723) ICs [Minimum three experiments are to be done]

12. Astable and Monostable multivibrator using Timer IC NE555
13. DC power supply using IC 723: Low voltage and high voltage configurations, Short circuit and Fold-back protection.
14. A/D converters- counter ramp and flash type.
15. D/A Converters - R-2R ladder circuit
16. Study of PLL IC: free running frequency lock range capture range

III. Simulation experiments [The experiments shall be conducted using SPICE]

17. Simulation of any three circuits from Experiments 3, 5, 6, 7, 8, 9, 10 and 11 of section I
18. Simulation of Experiments 3 or 4 from section II

2. Text Books (T)

- T1. D. Roy Choudhary, Shail B Jain, "Linear Integrated Circuits,"
T2. M. H. Rashid, "Introduction to Pspice Using Orcad for Circuits and Electronics", Prentice Hall

3. Reference Books (R):

Nil

4. Course Objectives

1. To familiarize students with analog integrated circuits
2. To design and implement application circuits using basic analog integrated circuits
3. To familiarise students with simulation of basic analog integrated circuits

5. Course Pre / Co-requisite

ECL202 Analog Circuits and Simulation Lab

6. Course Outcomes

- CO1. Use data sheets of basic Analog Integrated Circuits and design and implement application circuits using Analog ICs.
- CO2. Design and simulate the application circuits with Analog Integrated Circuits using simulation tools.
- CO3. Function effectively as an individual and in a team to accomplish the given task.

7. Mapping of Course Outcomes with Program Outcomes

PO/ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H	H	H	M					H	H		M	H	M	
CO2	H	H	H	M	H				H	H		M	H	M	H
CO3									H	H					

8. Justification for CO-PO-PSO Correlation

CO	PO/PSO	Justification
CO 1	PO1	Knowledge of mathematics, science & Engineering fundamentals will help the students design and implement application circuits using ICs.
	PO2	Analysing complex engineering problems, students will be able to design and implement application circuits using ICs.
	PO3	Designing solutions for complex engineering problems, students will be able to design IC's that meet the specified needs with appropriate consideration for public health & safety, and cultural, societal & environment considerations.
	PO4	Using research-based knowledge and research methods, students will be able to design and implement application circuits using analog circuits.
	PO9	IC circuits can be designed for different applications by functioning effectively as an individual and a member in diverse teams.
	PO10	Communicating effectively on complex engineering activities with the engineering community, students will be able to design and implement application circuits using analog circuits.
	PO12	Recognizing the need for, and having the preparation & ability to engage in independent & lifelong learning will help students to design and implement IC's for various applications.
	PSO1	Applying contextual knowledge of Electronics and Communication Engineering in design and analysis, students will be able to develop IC circuits for various applications.
	PSO2	Analyzing and synthesizing experimental data, students will be able to develop IC circuits for various applications.
CO 2	PO1	Knowledge of mathematics, science & Engineering fundamentals will help students design application circuits with Analog Integrated Circuits and simulation tools.

	PO2	Analyzing complex engineering problems, students will be able to simulate application circuits with Analog Integrated Circuits.
	PO3	Designing solutions for complex engineering problems, students will be able to simulate application circuits that meet the specified needs with appropriate consideration for public health & safety, and cultural, societal & environment considerations.
	PO4	Using research based knowledge and research methods including design of experiments, analysis and interpretation of data, students will be able to synthesize information to provide valid conclusions about simulated application circuits & tools used for simulation.
	PO5	By creating, selecting & applying appropriate techniques, resources & modern Engineering & IT Tools, including prediction & modelling, students will be able to design & simulate application circuits with Analog Integrated Circuit using simulation tools with an understanding of the limitation.
	PO9	IC circuits can be designed and application circuits for different applications can be simulated by functioning effectively as an individual and a member in diverse teams.
	PO10	Communicating effectively on complex engineering activities with the engineering community, students will be able to design and simulate application circuits using simulation tools.
	PO12	Recognising the need for, and have the preparation & ability to engage in independent & lifelong learning will help students to design and simulate application circuits using suitable simulation tools.
	PSO1	Absorbing and applying contextual knowledge of Electronics and Communication Engineering, students will be able to design and simulate application circuits using suitable simulation tools.
	PSO2	Analysing and synthesizing experimental data, students will be able to design and simulate application circuits using simulation tools.
	PSO 3	Applying modern engineering tools to analyse complex Electronics and Communication engineering problems, students will be able to simulate application specific analog integrated circuits.
CO 3	PO9	Function effectively as an individual and a member in diverse teams , students will be able to design & simulate IC circuits for different applications.
	PO10	Communicating effectively on complex engineering activities with the engineering community and with the society at large, students will be able to work as a team to design IC circuits.

9. Curricular gaps (if any)

Nil

10. Course Enrichment Activities*

Sl No	Description	Proposed Activities	Relevance to POs and PSOs
		Nil	

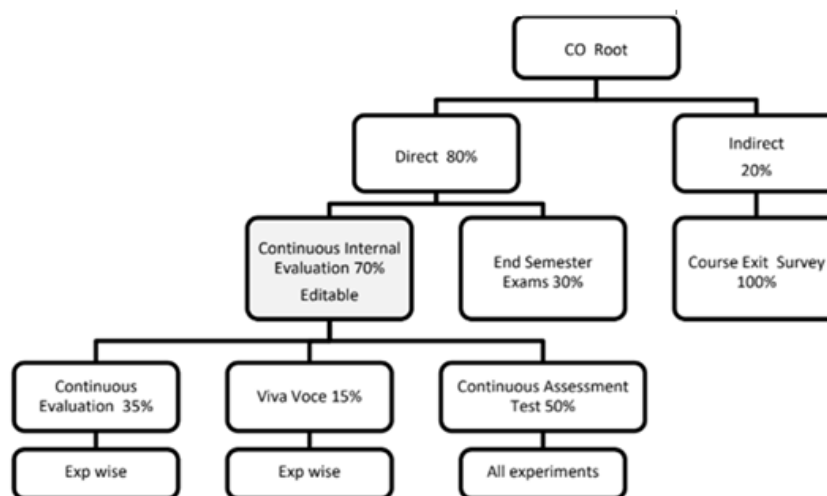
11. Internal Assessment mark allocation (as per university curriculum)

Continuous Internal evaluation	- 75 marks
End Semester Examination	- 75 marks
Total	- 150 marks

12. Assessment – CO Mapping

	Tools	Weightage	CO1	CO2	CO3
Direct Assessment Tools	Continuous Evaluation Experiment wise CO mapping	25%	x	x	x
	Viva – Voce Experiment wise CO mapping	10%	x	x	x
	Continuous Assessment Test	10%	x	x	x
	End Semester Exam – 30%	30%	x	x	x
Indirect Assessment Tool	Course Exit Survey	100%	x	x	x

13. Assessment Configuration



14. Course Plan

Weeks(W)	Experiments	Relevance to COs
1	Familiarization of Operational amplifiers – Inverting and Non inverting amplifiers, frequency response, Adder, Integrator, Comparators.	CO1, CO3
2	RC Phase shift Oscillator.	CO1, CO3
3	Precision rectifiers using Op-Amp.	CO1, CO3
4	Schmitt trigger circuit using Op–Amps.	CO1, CO3
5	Astable and Monostable multivibrator using Op-Amps.	CO1, CO3

6	Waveform generators using Op-Amps – Triangular and saw tooth	CO1, CO3
7	Wien bridge oscillator using Op-Amp – without amplitude stabilization.	CO1, CO3
8	Astable and Monostable multivibrator using Timer IC NE555	CO1, CO3
9	Study of PLL IC: free running frequency lock range capture range	CO1, CO3
10	D/A Converters – R-2R ladder circuit	CO1, CO3
11	Simulation of Experiments using SPICE	CO2
12	Simulation of Experiments using SPICE	CO2
13	Simulation of Experiments using SPICE	CO2
14	Simulation of Experiments using SPICE	CO2
T1. Total No. of Hours	T2. 42	T3.

Prepared By : Ms. Sonu Kunjannamma Varghese

Checked By : Ms. Pearl Antonette Mende

1. Prescribed Syllabus

1. Simulation of Signals: Simulate the various signals using Python
2. Verification of the Properties of DFT:
 - a. Generate and appreciate a DFT matrix.
 - b. Circular Convolution
- c. Parseval's Theorem
2. Familiarization of DSP Hardware
3. Implementation of Linear convolution of two arrays.
4. Implementation of N - point FFT of signal.
5. Computation of the IFFT of the input signal with FFT.
6. Implementation of FIR low pass filter.
7. Implementation of the overlap save block convolution method
8. Implementation of the overlap add block convolution method

2. Text Books (T)

- T1. Vinay K. Ingle, John G. Proakis, "Digital Signal Processing Using MATLAB."
T2. Allen B. Downey, "Think DSP: Digital Signal Processing using Python."
T3. Rulph Chassaing, "DSP Applications Using C and the TMS320C6x DSK(Topics in Digital Signal Processing

3. Reference Books (R):

- R1. Digital signal Processing by Sanjay Sharma
R2. Digital Signal Processing by Ramesh Babu

4. Course Objectives

1. The experiments are designed to make the student demonstrate their abilities towards DSP processor based implementation of DSP systems.
2. The experiments are designed to familiarize various computational tools to do basic operations for signal processing.
3. The experiments are designed to Analyze and implement digital systems using the DFT and the Fast Fourier Transform (FFT).

5. Course Pre / Co-requisite

ECL202 Analog Circuits and Simulation Lab

6. Course Outcomes

- CO1: Simulate digital signals
CO2: Verify the properties of DFT computationally
CO3: Familiarize the DSP hardware and interface with computer.

CO4: Implement LTI systems with linear convolution.

CO5: Implement FFT and IFFT and use it on real time signals.

CO6: Implement FIR low pass filter.

CO7: Implement real time LTI systems with block convolution and FFT

7. Mapping of Course Outcomes with Program Outcomes

PO/ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H	H	M	M	H				H	H		M	H	M	H
CO2	H	H			H				H	H		M	H		H
CO3	H	H	H		H				H	H		M	H		H
CO4	H	H	H	H	H				H	H		M	H	M	H
CO5	H	H	H	M	H				H	H		M	H	M	H
CO6	H	H			H				H	H		M	H		H
CO7	H	H	H	M	H				H	H		M	H	M	H
CO3	H	H	H		H				H	H		M	H		H

8. Justification for CO-PO-PSO Correlation

CO1	PO1	Understanding the elementary concepts of digital signals will help the students to simulate various digital signals. Hence highly correlated.
	PO2	Simulation of digital signals will help the students to perform analysis of various operations on signals. Hence highly correlated.
	PO3	Simulation of digital signals will help the students to design various solutions for different applications. Hence medium correlation.
	PO4	Simulation of digital signals will help the students to interpret the signal data and synthesize it to provide valid conclusions. Hence medium correlation.
	PO5	Simulation of digital signals will help the students to represent and generate various digital signals. Hence highly correlated.
	PO9	Simulation of digital signals will help the students to function effectively as an individual, and a member in groups. Hence highly correlated.
	PO10	Simulation of digital signals will help the students to document their simulation methodologies. Hence highly correlated
	PO12	Understanding signals and it's simulation will help the students to use it for various digital signal processing applications. Hence medium correlation.
	PSO1	Knowledge about various digital signals will help the students in the analysis of discrete time LTI systems. Hence high correlation.
	PSO2	Simulation of digital signals will engage the students in working with real signals to analyze data of various electronic systems. Hence medium correlated. Hence high correlation.
	PSO3	Simulation of digital signals will help the students to hone their abilities to apply engineering tools to a wide array of intricate Electronics and Communication Engineering challenges.

CO2	PO1	Verification of DFT properties will help the students to apply the knowledge of mathematics & Engineering fundamentals. Hence highly correlated.
	PO2	Identifying different properties of DFT will help the students to process the finite duration sequences. Hence highly correlated.
	PO5	Verification of DFT properties will help the students to design systems using modern tools. Hence highly correlated.
	PO9	Verification of DFT properties will help the students to function effectively as an individual, and a member in groups. Hence highly correlated.
	PO10	Verification of DFT properties will help the students to communicate their findings through report. Hence highly correlated.
	PO12	Validation of properties of DFT will help the students to recognize recent trends in signals and systems. Hence medium correlation.
	PSO1	Describing various DFT properties will help the students to acquire knowledge about various discrete time LTI systems. Hence high correlation.
	PSO3	Verification of DFT properties will help the students to use the tools with contemporary practices in signal processing. Hence highly correlated.
	PO1	Familiarization of DSP hardware and interfacing will help the students to perform various real-world applications. Hence highly correlated.
	PO2	Familiarization of DSP hardware and interfacing will help the students to analyse communication systems. Hence highly correlated.
	PO3	Familiarization of DSP hardware and interfacing will help the students to design solutions for a wide variety of applications. Hence highly correlated.
	PO5	Familiarization of DSP hardware and interfacing will help the students to process digital signals for audio applications. Hence highly correlated.
	PO9	Familiarization of DSP hardware and interfacing will help the students to function effectively as an individual, and a member in groups to perform communication and audio processing. Hence highly correlated.
	PO10	Knowledge in DSP hardware will help the students to communicate effectively on complex engineering activities with the engineering community. Hence highly correlated.
	PO12	Attaining knowledge in DSP hardware will help the students in real- time signal processing. Hence medium correlation.
	PSO1	Interfacing DSP hardware with computers will enable the students to contribute effectively to design and develop various electronic systems. Hence highly correlated.
	PSO3	Knowledge in DSP hardware will help the students to analyse complex Electronics and Communication engineering problem. Hence highly correlated.
	PO1	Implementing convolution in LTI system will help the students to apply their knowledge in digital signal processing. Hence highly correlated.
	PO2	Implementing convolution in LTI system will help the students to analyse complex engineering problems. Hence highly correlated.
	PO3	Implementing LTI systems with linear convolution, will help the students to design solutions for complex engineering problems. Hence high correlation.
	PO4	Implementing LTI systems with linear convolution, will help the students to analyse, interpret the information about signal processing. Hence high correlation.
	PO5	Implementing LTI systems with linear convolution, will help the students to study various characteristics of signals and LTI systems. Hence highly correlated.
	PO9	Implementing LTI systems with linear convolution, will help the students to function effectively as an individual, and a member in diverse teams. Hence highly correlated.
	PO10	Implementing LTI systems with linear convolution, will help the students to develop the ability to communicate their ideas, processes, and results clearly. Hence highly correlated.

PO12	Implementing LTI systems with linear convolution, will help the students to express the relation between input and output of an LTI system. Hence medium correlation.
PSO1	Implementing LTI systems with linear convolution will enable the students to apply their understanding of signal processing to solve real-world problems in electronic systems. Hence high correlation.
PSO2	Implementing LTI systems with linear convolution, will develop the ability to analyze data and validate designs for LTI systems and also for various engineering contexts where experimentation and analysis are central. Hence medium correlation.
PSO3	Knowledge in LTI systems will help the students to perform convolution using modern engineering tools. Hence high correlation.
PO1	Implementation of FFT and IFFT and use it on real time signals will help the students to understand the procedure for developing algorithms for efficient computation of DFT and its practical applications. Hence highly correlated.
PO2	Implementation of FFT and IFFT and use it on real time signals will help the students to use efficient computation algorithms in linear filtering and spectrum analysis for digital signal processing applications. Hence highly correlated.
PO3	Understanding the computation methods of FFT and IFFT will help the students to design solutions for complex engineering problems. Hence high correlation.
PO4	Implementation of FFT and IFFT and use it on real time signals will help the students to understand the domain conversion of different signals. Hence medium correlation.
PO5	Implementation of FFT and IFFT and use it on real time signals will help the students to predict and model complex engineering activities. Hence highly correlated.
PO9	Implementation of FFT and IFFT will help the students to involve in real- time signal analysis leading to the development of both individual problem- solving skills and teamwork abilities. Hence highly correlated
PO10	Implementation of FFT and IFFT will help the students share insights, collaborate on projects, and contribute effectively to interdisciplinary teams. Hence highly correlated.
PO12	Implementation of FFT and IFFT and use it on real time signals will help the students to understand the need of the signal that is to be processed in the spectral, or frequency domain. Hence medium correlation.
PSO1	Implementation of FFT and IFFT on real-time signals, will help students in utilizing foundational knowledge in electronic systems design and analysis, aligning with the program's emphasis on absorbing and applying contextual knowledge. Hence high correlation.
PSO2	Implementation of FFT and IFFT on real-time signals, will enable students to develop skill set that encompasses both practical implementation and analytical validation for understanding system behavior, analyzing data, and ensuring the successful application of complex algorithms. Hence medium correlation.
PSO3	Implementation of FFT and IFFT and use it on real time signals will help the students to analyse complex Electronics and Communication engineering problems. Hence high correlation.
PO1	Implementing FIR low pass filter will help the students to understand mathematical modelling of analog and digital filters. Hence highly correlated.
PO2	Implementing FIR low pass filter will help the students to identify the design parameters and this will help the students to design FIR filter. Hence highly correlated.
PO5	Implementing FIR low pass filter will help the students to select appropriate techniques and modern engineering and IT tools to predict and model complex engineering activities. Hence highly correlated.
PO9	Implementing FIR low pass filters help the students to work collaboratively on projects that involve filter design, implementation, and optimization can be done individually or as part

	of a team project. Hence high correlation.
PO10	Implementing FIR low pass filters help the students to perform problem- solving skills and the ability to adapt filter designs to specific communication scenarios. Hence high correlation.
PO12	Implementing FIR low pass filter using window and frequency sampling method will help the students to design systems for signal processing applications. Hence medium correlation.
PSO1	Implementing FIR low pass filter will help students in utilizing foundational knowledge for designing and developing electronic systems, which aligns with the program's emphasis on absorbing and applying contextual knowledge. Hence highly correlated.
PSO3	Implementing FIR low pass filter will help the students to choose modern engineering tools in digital signal processing. Hence high correlation.
PO1	Implementing real time LTI systems with block convolution and FFT will help the students to relate the input signal and the impulse response of the system to produce the output signal from the system. Hence highly correlated.
PO2	Implementing real time LTI systems with block convolution and FFT will help the students to analyse different signals. Hence highly correlated.
PO3	Implementing real time LTI systems with block convolution and FFT will help the students to design solutions for complex engineering problems. Hence high correlation.
PO4	Implementing real time LTI systems with block convolution and FFT will help the students to use research based knowledge in processing different signals. Hence medium correlated.
PO5	Implementing real time LTI systems with block convolution and FFT will help the students to apply appropriate techniques and modern engineering and IT tools to predict and model complex engineering activities. Hence highly correlated.
PO9	Implementing real time LTI systems with block convolution and FFT will help the students to function effectively as an individual, and a member in diverse teams for performing. Hence highly correlated.
PO10	Implementing real time LTI systems with block convolution and FFT will help the students to analyse output of an LTI system with input sequence and impulse response. Hence highly correlated.
PO12	Implementing real-time LTI systems will enable the students to engage in self-directed learning, and to keep up with evolving technologies throughout their careers. Hence medium correlation.
PSO1	Implementing real time LTI systems with block convolution and FFT will help the students to analyse output of an LTI system with input sequence and impulse response. Hence highly correlated.
PSO2	Implementing real time LTI systems with block convolution and FFT helps students in utilizing data analysis and validation methods to ensure electronic systems' accuracy and effectiveness. Hence medium correlation.
PSO3	Implementing real time LTI systems with block convolution and FFT will help the students to choose and apply modern engineering tools to analyse complex engineering problems. Hence high correlation.

9. Curricular gaps (if any)

Nil

10. Course Enrichment Activities*

Sl No	Description	Proposed Activities	Relevance to POs and PSOs
		Nil	

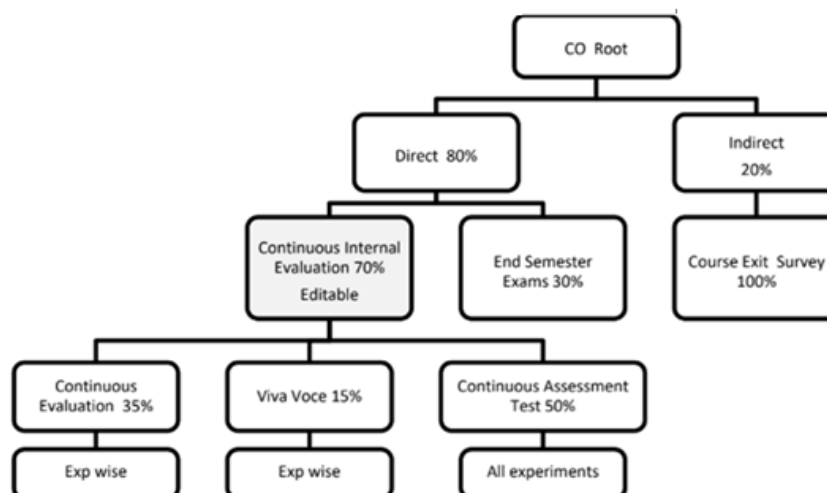
11. Internal Assessment mark allocation (as per university curriculum)

Continuous Internal evaluation	- 75 marks
End Semester Examination	- 75 marks
Total	- 150 marks

12. Assessment – CO Mapping

	Tools	Weightage	CO1	CO2	CO3
Direct Assessment Tools	Continuous Evaluation Experiment wise CO mapping	25%	x	x	x
	Viva – Voce Experiment wise CO mapping	10%	x	x	x
	Continuous Assessment Test	10%	x	x	x
	End Semester Exam – 30%	30%	x	x	x
Indirect Assessment Tool	Course Exit Survey	100%	x	x	x

13. Assessment Configuration



14. Course Plan

Weeks(W)	Experiments	Relevance to COs
1	Simulation of Signals	CO1

2	Verification of the Properties of DFT	CO2
3	Familiarization of DSP Hardware	CO3
4	Linear convolution	CO4
5	FFT of signals	CO5
6	IFFT with FFT	CO5
7	FIR low pass filter	CO6
8	Overlap Save Block Convolution	CO7
9	Overlap Add Block Convolution	CO7
Total No. of Hours	27 hours	

Prepared By : Dr. Saju A

Checked By : Milna M J

Semester: 6

SLOT	COURSE NO.	COURSES	L-T-P	HOURS	CREDIT
A	ECT302	ELECTROMAGNETICS	3-1-0	4	4
B	ECT304	VLSI CIRCUIT DESIGN	3-1-0	4	4
C	ECT306	INFORMATION THEORY AND CODING	3-1-0	4	4
D	ECT352	EMBEDDED SYSTEM	2-1-0	3	3
D	ECT362	INTRODUCTION TO MEMS	2-1-0	3	3
E	HUT310	MANAGEMENT FOR ENGINEERS	3-0-0	3	3
F	ECT308	COMPREHENSIVE COURSE WORK	1-0-0	1	1
S	ECL332	COMMUNICATION LAB	0-0-3	3	2
T	ECD334	MINIPROJECT	0-0-3	3	2

1. Prescribed Syllabus

Module	Topic	Hours
1	Introduction to Electromagnetic Theory. Review of vector calculus- curl, divergence gradient. Rectangular, cylindrical and spherical coordinate systems. Expression of curl divergence and Laplacian in cartesian, cylindrical and spherical coordinate system. Electric field and magnetic field, Review of Coulomb's law, Gauss law and Amperes current law. Poisson and Laplace equations, Determination of E and V using Laplace equation.	10
2	Derivation of capacitance and inductance of two wire transmission line and coaxial cable. Energy stored in Electric and Magnetic field. Displacement current density, continuity equation. Magnetic vector potential. Relation between scalar potential and vector potential. Maxwell's equation from fundamental laws. Boundary condition of electric field and magnetic field from Maxwells equations. Solution of wave equation.	10
3	Propagation of plane EM wave in perfect dielectric, lossy medium, good conductor, media attenuation, phase velocity, group velocity, skin depth. Reflection and refraction of plane electromagnetic waves at boundaries for normal & oblique incidence (parallel and perpendicular polarization), Snell's law of refraction, Brewster angle.	8
4	Power density of EM wave, Poynting vector theorem. Polarization of electromagnetic wave linear, circular and elliptical polarisation. Uniform lossless transmission line - line parameters. Transmission line equations, Voltage and Current distribution of a line terminated with load. Reflection coefficient and VSWR. Derivation of input impedance of transmission line.	7
5	Transmission line as circuit elements (L and C). Development of Smith chart - calculation of line impedance and VSWR using smith chart. The hollow rectangular wave guide –modes of propagation of wave-dominant mode, group velocity and phase velocity -derivation and simple problems only	8

2. Text Books (T)

T1. John D. Kraus, Electromagnetics, 5/e, TMH, 2010.

T2. Mathew N O Sadiku, Elements of Electromagnetics, Oxford University Press, 6/e, 2014.

T3. William, H. Hayt, and John A. Buck. Engineering Electromagnetics. McGraw-Hill, 8/e McGraw-Hill, 2014.

3. Reference Books (R)

R1. Edminister, "Schaum's Outline of Electromagnetics", 4/e, McGraw-Hill, 2014.

R2. Jordan and Balmain, Electromagnetic waves and Radiating Systems, PHI, 2/e, 2013

4. Course Objectives

To impart knowledge on the basic concepts of electric and magnetic fields and its applications.

5. Course Pre / Co-requisite

MAT102 Vector Calculus

6. Course Outcomes

- CO1. To summarize the basic mathematical concepts related to electromagnetic vector fields.
 CO2. Analyse Maxwell's equation in different forms and apply them to diverse engineering
 CO3. problems.
 CO4. To analyse electromagnetic wave propagation and wave polarization
 CO5. To analyse the characteristics of transmission lines and solve the transmission line problems using
 Smith chart.
 CO6. To analyse and evaluate the propagation of EM waves in Wave guides.

7. Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes

PO/ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H	H	M										H		
CO2	H	H	M	M								M	H	M	
CO3	H	H	H	M								M	H	M	
CO4	H	H	H	M	M							M	H	M	M
CO5	H	H	H	M								H	H	M	

8. Justification for CO-PO-PSO Correlation

CO	PO	Justification
CO1	PO1	Knowledge of vector calculus and engineering fundamentals will help students to understand fundamentals of electric and magnetic fields, and to solve problems.
	PO2	The analysis of static electric and magnetic fields will enable students use differential equations to reach substantiated conclusions.
	PO3	By understanding concepts related to electromagnetic vector fields students will be able to design solutions to problems in electrostatics and magnetostatics
	PSO1	By applying the knowledge in basic static electric and magnetic fields, students will be able to develop systems based on electromagnetics.
CO2	PO1	Knowledge of Maxwell's equation in different forms enable students to use differential and integral calculus to solve diverse problems.
	PO2	The analysis of Maxwell's equation helps the students to use vector calculus, differential equations and use the basic Gauss laws and Faradays law.
	PO3	By understanding Maxwell's equation in different form, students will be able to design solutions to problems related to static and time varying fields.
	PO4	By referring the journal papers and collecting data, students will be able to interpret the information related to Maxwell's equation and its applications and provide valid conclusions.

	PO12	By applying Maxwells equations as a mathematical model for electric, optical, and radio technologies, students will recognize the need for persistent learning.
	PSO1	Applying the knowledge of Maxwell's equations and its diverse applications will help students in developing systems based on electronic communication.
	PSO2	Analysis of Maxwell's equation in different forms helps students in analysis of system related to communication system and validate the design.
CO3	PO1	The knowledge of electromagnetic wave propagation in different media will enable students to apply the fundamental laws like Gauss's law.
	PO2	Understanding the electromagnetic wave propagation helps the students to analyse the reflection and refraction of waves at boundaries.
	PO3	The analysis of electromagnetic wave propagation and wave polarization will help students to design systems related to electromagnetic communication thereby developing solutions to cater to specific needs.
	PO4	By conducting investigation by referring papers and collecting data on wave propagation in different media, students will be able to interpret data related to perfect dielectric, lossy medium and conductor.
	PO12	By understanding the vast applications of propagation of electromagnetic waves and polarization by referring recent papers, students will recognize the need for persistent learning and updating recent trends.
	PSO1	Applying the knowledge of electromagnetic wave propagation through different media will help students in developing systems based on electromagnetic communication.
	PSO2	Analysing and evaluating the data related propagation of EM waves will help the students to validate the design of the systems related to electromagnetic communication.
CO4	PO1	Knowledge of transmission line parameters and the use of smith chart will help students to use basic graphical and analytical method to solve problems related impedance matching etc.
	PO2	Analysis of transmission lines using graphical and analytical methods, the students will use partial differential equations and solution of algebraic equations to find the parameters of transmission line.
	PO3	Analysing the characteristics of transmission lines using Smith chart will enable the students to design a transmission line that meet specified needs.
	PO4	By conducting investigation by referring papers and collecting data, students will be able to evaluate the characteristics of transmission lines.
	PO5	Using online smith chart tools, students will be able to design matching networks, impedance calculation etc
	PO12	With the knowledge of graphical measuring tool which is used to solve problems related to RF transmission lines, for impedance matching etc, students will recognize the need for persistent learning and updating recent trends.
	PSO1	Applying the knowledge of smith charts and the characteristics of transmission lines, students will be able to develop systems related to electromagnetic communication.
	PSO2	Evaluating the data related to transmission line parameters using Smith chart will help students to analyse transmission line problems and validate the design.
	PSO3	Using modern online Smith chart tools, students will be able to analyse the characteristics of transmission lines for solution of problems related to impedance matching, VSWR etc.
CO5	PO1	With the knowledge of EM wave propagation in waveguides, students will apply differential equations and algebraic expressions in the solution of problems.
	PO2	For analysing and evaluating modes of propagation in waveguides, students will use the solution of partial differential equations to calculate group velocity, phase velocity etc..
	PO3	Analysing the characteristics of waveguides will enable the students to find solutions to problems related to different modes of propagation.

	PO4	By referring papers and interpretation of data, students will be able to evaluate the electromagnetic wave propagation in waveguides.
	PO12	By analysing the propagation of electromagnetic waves and understanding vast range of practical everyday applications that includes diverse uses as communication by cell phone, radio broadcasting, microwaves etc will instil students to constantly update the recent trends.
	PSO1	Knowledge of propagation of electromagnetic waves in waveguides helps students in developing electromagnetic communication system.
	PSO2	Evaluating the data related to propagation of EM waves in waveguides helps students to analyse the characteristics of waveguides to validate the design.

9. Curricular gaps (if any)

Nil

10. Course Enrichment Activities*

Sl No	Description	Proposed Activities **	Relevance to POs and PSOs
1	Electromagnetic theory concepts using Animation and Simulation	Seminar	PO2, PSO1

11. Internal Assessment mark allocation (as per university curriculum)

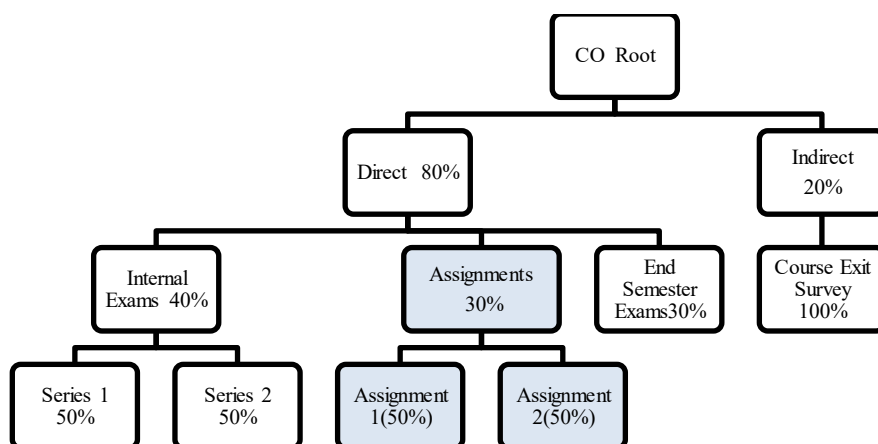
(Provide details as mentioned in syllabus)

Continuous Assessment Test	- 40 marks
Assignment (s)/ Course Project	- 10 marks
Total	- 50 marks

12. Assessment – CO Mapping (Put ‘x’ if mapping is present)

	Tools		Weight age	CO 1	CO 2	CO 3	CO 4	CO 5
Direct Assessment Tools**	Internal Exam(s) 40%	Series 1	20%	x	x	x		
		Series 2	20%			x	x	x
	Assignment (s)/ Course Project /30%	Assignment 1			x			
		Assignment 2						x
	End Semester Exam		30%	x	x	x	x	x
Indirect Assessment Tool	Course Exit Survey		100%	x	x	x	x	x

13. Assessment Configuration



14. Course Plan

Hour	Topic	Module	Reference(s)	Teaching Pedagogy
1	Introduction to Electromagnetic Theory.	1	T2,T3	PPT
2	Review of vector calculus- curl	1	T2,T3	PPT
3	divergence radient.	1	T2,T3	Tutorial
4	Rectangular, cylindrical and spherical coordinate systems.	1	T2,T3	PPT
5	Expression of curl divergence and Laplacian in cartesian, cylindrical and spherical coordinate system	1	T2,T3	PPT
6	Expression of curl divergence and Laplacian in cartesian, cylindrical and spherical coordinate system.	1	T2,T3	PPT
7	Electric field and magnetic field, Review of Coulomb's law,	1	T2,T3	PPT
8	Gauss law and Amperes current law.	1	T1,T3	PPT
9	Poisson and Laplace equations	1	T1	PPT
10	Determination of E and V using Laplace equation.	1	T1	PPT
11	Derivation of capacitance of two wire transmission line and coaxial cable.	2	T1	Tutorial

12	Derivation of inductance of two wire transmission line and coaxial cable.	2	T1	PPT
13	Energy stored in Electric and Magnetic field.	2	T1	PPT
14	Displacement current density, continuity equation.	2	T1	PPT
15	Magnetic vector potential.	2	T1	PPT
16	Relation between scalar potential and vector potential.	2	T1	PPT
17	Maxwell's equation from fundamental laws.	2	T1	PPT
18	Maxwell's equation from fundamental lawS(contd)	2	T1	PPT
19	Boundary condition of electric field and magnetic field from Maxwell's equations.	2	T1	Tutorial
20	Solution of wave equation	2	T1	PPT
21	Propagation of plane EM wave in perfect dielectric lossy medium, good conductor	3	T1,T2	PPT
22	Propagation of plane EM wave in perfect dielectric lossy medium, good conductor(contd)	3	T1,T2	PPT
23	Attenuation, phase velocity, group velocity,skin depth.	3	T1,T2	PPT
24	Attenuation, phase velocity, group velocity,skin depth(contd)	3	T1,T2	PPT
25	Reflection and refraction of plane electromagnetic waves at boundaries for normal & oblique incidence	3	T1,T2	PPT
26	Reflection and refraction of plane electromagnetic waves at boundaries for normal & oblique incidence(contd)	3	T1,T2	PPT
27	Snell's law of refraction, Brewster angle	3	T1,T2	Tutorial

28	Snell's law of refraction, Brewster angle(contd)	3	T1,T2	PPT
29	Power density of EM wave	4	T1,T2	PPT
30	Poynting vector theorem.	4	T1,T2	PPT
31	Polarization of electromagnetic wave- linear	4	T1,T2	PPT
32	Circular and elliptical polarisation.	4	T1,T2	PPT
33	Uniform lossless transmission line - line parameters	4	T1,T2	PPT
34	Transmission line equations	4	T1,T2	PPT
35	Transmission line Equations(contd)	4	T1,T2	Tutorial
36	Transmission line as circuit elements (L and C).	5	T1,T2	PPT
37	Development of Smith chart	5	T1,T2	PPT
38	Calculation of line impedance and VSWR using smith chart.	5	T1,T2	PPT
39	Calculation of line impedance and VSWR using smith chart.	5	T1,T2	PPT
40	The hollow rectangular wave guide – modes of propagation of wave-	5	T1,T2	PPT
41	Dominant mode, group velocity and phase velocity	5	T1,T2	Tutorial
42	Dominant mode, group velocity and phase velocity(contd)	5	T1,T2	PPT
43	Derivation and simple problems only	5	T1,T2	PPT

15. Question Bank

Module 1				
Sl. No.	Question	Marks	CO	BL

1.	Write expression for differential length in cylindrical and spherical co-ordinates.	3	CO1	L1
2.	Express the value of differential volume in rectangular and cylindrical Co-ordinate systems	3	CO1	L1
3.	Define gradient of scalar field	3	CO1	L1
4.	List the properties of gradient	3	CO1	L1
5.	Find the divergence of $F = x y \mathbf{a}_x + y x \mathbf{a}_y + z x \mathbf{a}_z$	3	CO1	L2
6.	For a vector field A, show explicitly that $\Delta \cdot \Delta \times A = 0$: that is the divergence of the curl of any vector field is zero	3	CO1	L2
7.	Show that the vector $H = yz \mathbf{a}_x + zx \mathbf{a}_y + xy \mathbf{a}_z$ is both irrotational and solenoidal.	3	CO1	L3
8.	State and explain coulomb's law	3	CO1	L2
9.	State and explain Gauss's law	3	CO1	L2
10.	Define electric field intensity or electric field	3	CO1	L1
11.	Define electric flux and flux density	3	CO1	L1
12.	Write the Poisson's and Laplace equation	3	CO1	L1
13.	Define electric potential	3	CO1	L1
14.	Explain Amperes Current law.	3	CO2	L2
15.	Explain the relation between Electric flux density and field intensity	3	CO2	L2
16.	Find the divergence and curl of the following vector fields $\mathbf{P} = x^2 y z \mathbf{a}_x + x z \mathbf{a}_z$ $\mathbf{b. Q} = \rho \sin \Phi \mathbf{a}_\rho + \rho^2 z \mathbf{a}_\Phi + z \cos \Phi \mathbf{a}_z$	8	CO1	L3
17.	Transform a vector $\mathbf{A} = y \mathbf{a}_x - x \mathbf{a}_y + z \mathbf{a}_z$ in to Cylindrical coordinates.	6	CO1	L3
18.	Given point P(-2,6,3) and vector $\mathbf{A} = y \mathbf{a}_x + (x+z) \mathbf{a}_y$. Evaluate A at P in the Cartesian, cylindrical and spherical systems	8	CO1	L3
19.	Two point charges $-4 \mu\text{C}$ and $5 \mu\text{C}$ are located at (2,-1,3) and (0,4,-2) respectively. Find the potential at (1,0,1), assuming zero potential	6	CO1	L3
	at infinity			
20.	Point charges 5 nC and -2 nC are located at (2,0, 4) and (-3,0, 5), respectively. Determine the force on a 1nC point charge located at (1,			

	-3, 7). Find the electric field E at (1, - 3 , 7).	8	CO1	L3
21.	Eight identical charges, Q each are placed on the corners of a cube of side 'a'. Find the resultant force on a charge.	6	CO1	L3
22.	An infinite line charge charged uniformly with a line charge density of 20 n C/m is located along z-axis. Find E at (6, 8, 3) m.	6	CO1	L3
23.	Three concentrated charges of 0.25 μ C are located at the vertices of an equilateral triangle of 10 cm side. Find the magnitude and direction of the force on one charge due to other two charges.	7	CO1	L3
Module 2				
Sl. No.		Marks	CO	BL
1	Explain conduction , convection and displacement current density	3	CO2	L2
2	List all Maxwell's equations in integral form	3	CO2	L2
3	List all Maxwell's equations in differential form	3	CO2	L2
4	Define magnetic scalar potential	3	CO2	L1
5	Define magnetic vector potential	3	CO2	L1
6	Write the relation between magnetic flux density and field intensity	3	CO2	L2
7	Write down the equation for general, Integral and point form of Ampere's law	3	CO2	L2
8	Write down the magnetic boundary conditions.	3	CO2	L2
9	Explain the term inductance	3	CO2	L2
10	Define Capacitance	3	CO2	L2
11	Derive Continuity Equation	5	CO2	L2
12	Derive the expressions for Energy stored in Electric Field	5	CO2	L2
13	Derive the expression for the energy stored in magnetic field	5	CO2	L2
14	State and explain Maxwell's equation in Integral and differential form	5	CO2	L2
15	State and prove boundary conditions for E and H in accordance with Maxwell's equations.	10	CO2	L2
16	Determine the inductance of a Two- wire transmission line	5	CO2	L2
17	Determine the capacitance of a Two- wire transmission line	5	CO2	L2
18	Derive an expressions for inductance of coaxial cable.	6	CO2	L2
19	Derive an expressions for capacitance of coaxial cable.	5	CO2	L2

20	A parallel plate capacitor with plate area of 5 cm ² plate separation of 3 mm has a voltage $50 \sin 103 t$ applied to its plates. Calculate the displacement current assuming $\xi = 2 \xi_0$	5	CO2	L3
21	Derive the boundary conditions for electric field at the interface of two dielectrics.	6	CO2	L2
Module 3				
Sl. No.	Question	Marks	CO	BL
1	Define propagation constant, attenuation constant and phase constant.	3	CO3	L1
2	Explain the wave velocity and its relationship with phase constant.	3	CO3	L2
3	Explain the intrinsic impedance of the medium	3	CO3	L2
4	Define Skin depth .	3	CO3	L1
5	Explain skin effect and skin resistance	3	CO3	L2
6	Find the skin depth, δ at a frequency of 1.6 MHz in aluminium, where $\sigma = 38.2 \text{ mS/m}$ and $\epsilon_r \approx 1$.	3	CO3	L2
7	Define loss tangent and write the expression for it.	3	CO3	L1
8	Calculate the depth of penetration of copper when EM wave is incident normally. Given that frequency of the wave is 30 MHz, $\mu_r = 1$ and $\sigma = 5.8 \times 10^7 \text{ mho/m}$	3	CO3	L2
9	Define standing wave ratio and write its relationship with reflection coefficient.	3	CO3	L1
10	Explain Snell's law of refraction.	3	CO3	L2
11	Explain Brewster angle	3	CO3	L2
12	Starting from Maxwell's equations, derive the wave equation for lossy dielectric medium	7	CO3	L2
13	For a plane wave propagating in a lossy dielectric, derive the expression for propagation constant	7	CO3	L2
14	A plane wave in a nonmagnetic medium has $E = 50 \sin(108t + 2z) \hat{a}_y \text{ V/m}$. Find a) Direction of propagation b) γ , f and ϵ_r c) H	7	CO3	L3
15	A uniform plane wave propagating in medium has $E = 2 e^{-\alpha z} \sin(108t - \beta z) \hat{a}_y \text{ V/m}$. If the medium is characterised by $\epsilon_r = 1$, $\mu_r = 20$ and $\sigma = 3 \text{ S/m}$. Find α , β and H	7	CO3	L3
16	Derive the expression for reflection and transmission coefficient of a plane wave incident normally on the interface of two different media.	7	CO3	L2
17	A plane wave propagating through a medium with $\epsilon_r = 8$ $\mu_r = 2$ has $E = 0.5 e^{-z/3} \sin(108t - \beta z) \hat{a}_x \text{ V/m}$. Determine β The loss tangent Intrinsic impedance Wave velocity	5	CO3	L2

	H field			
18	Derive the expression for reflection coefficient for a wave of parallel polarization, travelling from one medium to another at oblique incidence.	7	CO3	L2
19	Derive Brewster angle. A parallel-polarized plane wave is incident from air onto a dielectric medium with $\epsilon_r = 9$ at the Brewster angle. What is the refraction angle?	9	CO3	L3
20	Derive the expression for reflection coefficient for a wave of perpendicular polarization, travelling from one medium to another at oblique incidence	9	CO3	L2
21	Show that Brewster angle does not exist for a non magnetic medium for perpendicular polarization	9	CO3	L2
Module 4				
Sl. No.	Question	Marks	CO	BL
1	State Poynting theorem	3	CO3	L1
2	Explain the Power density vector of EM Wave with equations.	3	CO3	L2
3	Define Poynting vector	3	CO3	L1
4	Explain the wave polarisation of EM wave.	3	CO3	L2
5	Draw the equivalent circuit of a two wire transmission line.	3	CO4	L1
6	Define characteristic impedance of transmission line	3	CO4	L1
7	Differentiate lossless line and distortionless line	3	CO4	L2
8	A lossless line has a characteristic impedance of 70Ω and phase constant 3 rad/m . Calculate the capacitance per meter of the line.	3	CO4	L3
9	Define Voltage and current reflection coefficient	3	CO4	L1
10	Define VSWR	3	CO4	L1
11	Derive an expression for net outward power flow associated with an electromagnetic wave, from a surface.	7	CO3	L2
12	State Poynting theorem. Derive the equation of complex vector.	7	CO3	L2
13	Derive the expression for propagation constant of transmission line.	8	CO4	L2
14	Derive the transmission line equations and characteristic impedance of transmission line.	9	CO4	L2
15	A distortionless transmission line $Z_0 = 60 \Omega$, $\alpha = 20 \text{ mNp/m}$, $\mu = 0.6c$, where c is the speed of light in vacuum. Find R & L	6	CO4	L3
16	A telephone line has $R = 30 \Omega/\text{km}$, $L = 100 \text{ mH/km}$, $G = 0$, and $C = 20 \mu\text{F/km}$. At $f = 1 \text{ KHz}$, Obtain: i) Characteristic impedance ii) propagation constant iii) phase velocity	5	CO4	L3
17	Derive the expression of input impedance due to a transmission	8	CO4	L2

	line terminated by load. Also find the expression for SWR			
18	A transmission line of length 0.2λ and characteristic impedance 100Ω is terminated with a load impedance of $50+200j$. Find input impedance, reflection coefficient at load end, reflection coefficient at the input end and VSWR.	8	CO4	L3
Module 5				
Sl. No.	Question	Marks	CO	BL
1.	Brief on the r- circles and X circles in smith chart.	3	CO 4	L1
2.	Define waveguide	3	CO 5	L1
3.	Obtain the cut off frequency for propagation in a rectangular wave guide.	3	CO 5	L2
4.	Define cut off wavelength of wave guide	3	CO 5	L1
5.	Define cut off frequency of wave guide	3	CO 5	L1
6.	Explain Dominant mode.	3	CO 5	L2
7.	Define phase velocity and group velocity	3	CO 5	L1
8.	Explain TE ₁₀ mode of propagation	3	CO 5	L2
9.	What are the applications of smith chart?	3	CO 4	L1
10.	The cross section of a rectangular wave guide is 20 cm x 5 cm. Find 3 lowest order mode frequencies	3	CO 5	L2
11.	What is the relationship between group velocity and phase velocity?	3	CO 5	L1
12.	Calculate the cutoff wavelength for the TM ₁₁ mode in a standard rectangular waveguide if $a = 4.5$ cm.	3	CO 5	L2
13.	Derive the expression for r-circles and x-circles in Smith chart	8	CO4	L2
14.	A $100 + j150 \Omega$ load is connected to a 75Ω lossless line. Using Smith Chart, find: Γ_s The load admittance Y_L Z_{in} at 0.4λ from the load	10	CO4	L3
15.	Explain the propagation of electromagnetic wave in a rectangular waveguide	8	CO 5	L2
16.	Derive the expression for Electric and magnetic field intensities for TM mode of propagation of rectangular waveguide	10	CO 5	L2
17.	Explain waveguides and its different modes of wave propagation.	8	CO 5	L2
18.	Determine ,assuming TE ₁₀ mode of propagation ,the cut-off frequency, cut-off wavelength, guide wavelength ,phase constant, phase velocity, group velocity and wave impedance in the case of a hollow rectangular metallic waveguide of dimensions 6cm and 3 cm ,respectively, when the applied signal frequency is 5GHz	8	CO 5	L3
19.	A rectangular wave guide has a dimension of 3cm x 5cm , and is operating at a frequency of 10 GHz . Calculate the cutoff wavelength, cutoff frequency , guide wavelength , phase velocity and group velocity . and the wave impedance for TE ₁₀ mode.	8	CO 5	L3
	Explain Group velocity and Phase velocity. When a wave of 6GHz			

20.	propagates in parallel conducting plates separated by 3cm, find the VP and Vgof the wave for dominant wave	6	CO 5	L3
21.	A $50 + j200 \Omega$ load is connected to a 100Ω lossless transmission line . Using smith chart , find Reflection coefficient at load VSWR Load admittance	10	CO 4	L3
	Input impedance at 0.2λ from the load Reflection coefficient at 0.2λ from the load			
22.	Derive the expressions for TE mode in a rectangular wave guide	8	CO 5	L2
23.	The longitudinal electric field for TM11 mode is given by $E_z = \sin 5x \sin 8y e^{-j\beta z} V/m$ Find the cut off frequency of the mode	8	CO 5	L3

Prepared by: Ms.Milna M J

Checked By : Ms.Ambily Joseph

Course Code & Name: ECT304 VLSI CIRCUIT DESIGN**1. Prescribed Syllabus**

Module	Topic	Hours
1	VLSI Design Methodologies. Introduction: Moore's law. ASIC design, Full custom ASICs, Standard cell based ASICs, Gate array based ASICs, SoCs, FPGA devices, ASIC and FPGA Design flows, Top-Down and Bottom-Up design methodologies. Logical and Physical design. Speed power and area considerations in VLSI design	11
2	Static CMOS Logic Design MOSFET Logic Design - NMOS Inverter (Static analysis only), basic logic gates, CMOS logic, Static and transient analysis of CMOS inverter, Switching power dissipation and delays. Realization of logic functions with static CMOS logic, Pass transistor logic, and transmission gate logic	9
3	Dynamic logic Design and Storage Cells Dynamic Logic Design-Pre charge-Evaluate logic, Domino Logic, NP domino logic. Read Only Memory-4x4 MOS ROM Cell Arrays(OR,NOR,NAND) Random Access Memory –SRAM-Six transistor CMOS SRAM cell, DRAM –Three transistor and One transistor Dynamic Memory Cell.	7
4	Arithmetic circuits Adders: Static adder, Carry-Bypass adder, Linear Carry-Select adder, Square-root carry-select adder. Multipliers: Array multiplier.	3
5	Fabrication techniques and MOSFET physical Design Material Preparation Purification and Crystal growth (CZ process), wafer preparation Thermal Oxidation- Growth mechanisms, Dry and Wet oxidation. Diffusion and ion implantation techniques. Epitaxy : molecular beam epitaxy. Lithography- Photo lithographic sequence, Electron Beam Lithography, Etching and metal deposition techniques. MOSFET Fabrication techniques Twin-Tub fabrication sequence, Fabrication process flow. Layout Design and Design rules, Stick Diagram and Design rules-micron rules and Lambda rules. (definitions only).layout of CMOS Inverter, two input NAND and NOR gates.	15

2. Text Books (T)

- T1. Sung –Mo Kang & Yusuf Leblebici, CMOS Digital Integrated Circuits- Analysis & Design, McGraw-Hill, Third Ed., 2003
T2. S.M. SZE, VLSI Technology, 2/e, Indian Edition, McGraw-Hill,2003
T3. Wayne Wolf, Modern VLSI design, Third Edition, Pearson Education,2002

3. Reference Books (R)

- R1. Michael John Sebastian Smith, Application Specific Integrated Circuits, Pearson Education,2001.
R2. Neil H.E. Weste, Kamran Eshraghian, Principles of CMOS VLSI Design- A Systems Perspective, Second Edition. Pearson Publication, 2005.
R3. Jan M. Rabaey, Digital Integrated Circuits- A Design Perspective, Prentice Hall, Second Edition, 2005.
R4. Razavi - Design of Analog CMOS Integrated Circuits, 1e, McGraw Hill Education India Education, New Delhi, 2003.

4. Course Objectives

To impart the knowledge of VLSI design methodologies and Digital VLSI circuit design.

5. Course Pre / Co-requisite

- ECT201 Solid State Devices
- ECT202 – Analog Circuits
- ECT203 Logic Circuit Design

6. Course Outcomes

After the completion of the course the student will be able to:

CO1 Explain the various methodologies in ASIC and FPGA design.

CO2 Design VLSI Logic circuits with various MOSFET logic families.

CO3 Compare different types of memory elements.

CO4 Design and analyse data path elements such as Adders and multipliers.

CO5 Explain MOSFET fabrication techniques and layout design rules.

7. Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes

PO/ CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H		H						H	H		M	H		
CO2	H	M	H	M								M	H	M	
CO3	H	M	H									M	H		
CO4	H	M	H	M								M	H	M	
CO5	H	M	M							M		M	H		

8. Justification for CO-PO-PSO Correlation

CO	PO/PSO	Justification
CO1	PO1	Knowledge of science & fundamentals of VLSI will enable the students to for understand various methodologies in ASIC and FPGA Design.
	PO2	Knowledge of various methodologies in ASIC and FPGA design will help the students to analyse complex engineering problems related to VLSI.
	PO12	Understanding the various methodologies in ASIC and FPGA circuits will enable students to engage in life-long learning in the broadest context of technological knowledge.
	PSO1	Absorbing and applying various methodologies in ASIC and FPGA circuits, students will be able to design various ASIC and FPGA circuits.
CO2	PO1	Understanding the fundamentals of various VLSI logic circuits, students will be able to design VLSI Logic circuits with various MOSFET logic families.
	PO2	Knowledge of various VLSI logic circuits will enable the students to analyse complex engineering problems related to the design of VLSI logic circuits with various MOSFET logic families and arrive at substantiated conclusions.
	PO3	Knowledge of various VLSI logic circuits will enable the students to design system components of VLSI Logic circuits with various MOSFET logic families that meet specific needs with appropriate consideration for societal and environmental considerations.
	PO12	Understanding the basics of VLSI logic circuits will enable students to design VLSI logic circuits for future applications.

	PSO1	Applying contextual knowledge of VLSI logic circuits, students will be able to design VLSI circuits with various MOSFET logic families.
CO3	PO1	Knowledge of different types of memory elements will enable them solve problems related to the working of storage cells.
	PO2	Understanding different types of memory elements, students will be able to identify and analyse complex engineering problems related to storage cells.
	PO3	Applying the knowledge in different types of memory elements, students will be able to design different storage cells that meet specific needs with appropriate consideration for societal and environmental considerations.
	PO12	Understanding different types of memory elements will enable students to design logic cells for future applications.
	PSO1	Absorbing and applying contextual knowledge of different types of memory elements, students will be able to design dynamic logic cells.
CO4	PO1	Knowledge of fundamentals of data path elements will help students to for analyse and design Adders and multiplier circuits.
	PO2	Understanding the basics of data path elements will enable students to analyse complex engineering problems in the design and analysis of data path elements such as Adders and multipliers.
	PO3	Designing and analysing data path elements, students will be able to design Adders and multiplier circuits that meet specific needs with appropriate consideration for societal and environmental considerations.
	PO12	Knowledge of data path elements such as Adders and multipliers & will help students to design circuits using these elements for future applications.
	PSO1	Absorbing and applying contextual knowledge of different types of data path elements, students will be able to design adder and multiplier circuits for various applications.
CO5	PO1	Knowledge of MOSFET fabrication techniques and layout design rules will enable students to analyse MOSFET circuits and draw layout diagrams for the same.
	PO2	Understanding the basics of MOSFET fabrication will help the students to analyse complex engineering problems related to MOSFET circuits.
	PO3	Knowledge of MOSFET fabrication techniques and layout design rules will help students to design MOSFET circuits that meet specific needs with appropriate consideration for societal and environmental considerations.
	PO10	Knowledge of MOSFET fabrication techniques and layout design rules will enable students to communicate on complex engineering activities.
	PO12	Knowledge of MOSFET fabrication techniques and layout design rules will help the students to design MOSFET circuits for various applications in the future.
	PSO1	Absorbing and applying contextual knowledge of MOSFET device fabrication and setting layout design rules, students will be able to design MOSFET devices for various applications.

9. Curricular gaps (if any)

Nil

10. Course Enrichment Activities*

Sl No	Description	Proposed Activities	Relevance to POs and PSOs
1	Webinar on Design of Logic circuits	Webinar / Talk	The design of ASIC, FPGA & other VLSI circuits could be used for the solution of complex engineering problems.

11. Internal Assessment mark allocation (as per university curriculum)

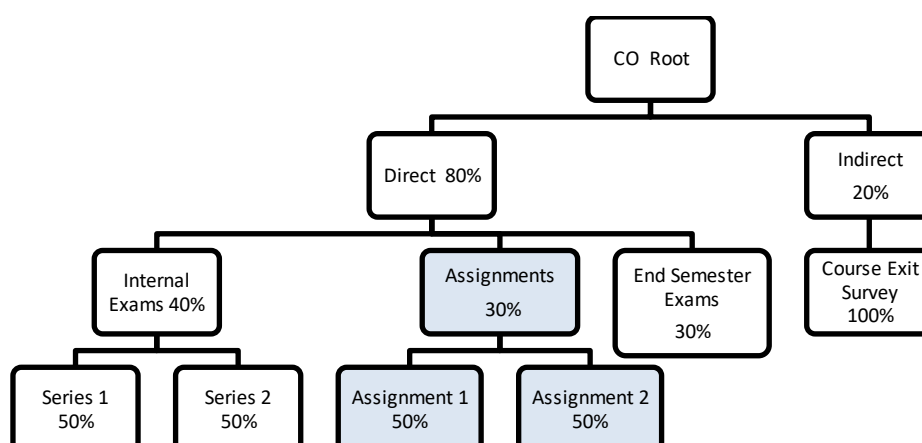
(Provide details as mentioned in syllabus)

Attendance	- 10 marks
Continuous Assessment Test	- 25 marks
<u>Assignment (s)</u>	- 15 marks
Total	- 50 marks

12. Assessment – CO Mapping (Put 'x' if mapping is present)

	Tools	Weightage#	CO1	CO2	CO3	CO4	CO5
Direct Assessment Tools**	Internal Exam(s) 40%	Series 1	20%	x	x		
		Series 2	20%			x	x
	Assignment (s)/ Course Project /Quiz etc. 30%	Assignment 1		x	x		
		Assignment 2				x	x
	End Semester Exam		30%	x	x	x	x
Indirect Assessment Tool	Course Exit Survey		100%	x	x	x	x

13. Assessment Configuration



14. Course Plan

Hour	Topic	Module	Reference(s)	Teaching Pedagogy
1	Introduction: Moore's law .ASIC design, Full custom ASICs	1	R1	L
2	Standard cell based ASICs	1	R1	L
3	Gate array based ASICs	1	R1	L
4	SoCs	1	R1	L
5	FPGA devices	1	R1	L
6	ASIC Design flow	1	R1	L
7	FPGA Design flow	1	R1	L
8	Top-Down and Bottom-Up design methodologies.	1	R1	L
9	Logical design	1	R1	L
10	Physical design.	1	R1	L
11	Speed power and area considerations in VLSI design	1	R1	L
12	Static CMOS Logic Design	2	R4	L
13	MOSFET Logic Design - NMOS Inverter (Static analysis only)	2	R4	L
14	Basic logic gates	2	R4	L
15	CMOS logic	2	R4	L
16	Static and transient analysis of CMOS inverter	2	R4	L
17	Switching power dissipation and delays.	2	R4	L
18	Realization of logic functions with static CMOS logic	2	R4	T
19	Pass transistor logic	2	R4	T
20	Transmission gate logic	2	R4	T
21	Dynamic Logic Design-Pre charge- Evaluate logic	3	R4	T
22	Domino Logic, NP domino logic.	3	R4	L
23	Read Only Memory-4x4 MOS ROM Cell Arrays(OR)	3	R4	T
24	Read Only Memory-4x4 MOS ROM Cell Arrays(NOR,NAND)	3	R4	T
25	Random Access Memory –SRAM-Six transistor CMOS SRAM cell	3	R4	L

26	DRAM –Three transistor Dynamic Memory Cell.	3	R4	L
27	DRAM –One transistor Dynamic Memory Cell.	3	R4	L
28	Arithmetic circuits Adders: Static adder, Carry-Bypass adder	4	R3	L
29	Linear Carry- Select adder, Square- root carry- select adder.	4	R3	L
30	Multipliers: Array multiplier.	4	R3	L
31	Material Preparation	5	T2	L
32	Purification and Crystal growth (CZ process)	5	T2	L
33	Wafer preparation	5	T2	L
34	Thermal Oxidation- Growth mechanisms	5	T2	L
35	Dry and Wet oxidation.	5	T2	L
36	Diffusion and ion implantation techniques.	5	T2	L
37	Epitaxy : molecular beam epitaxy.	5	T2	L
38	Lithography- Photo lithographic sequence, Electron Beam Lithography,	5	T2	L
39	Etching and metal deposition techniques.	5	T2	L
40	MOSFET Fabrication techniques Twin- Tub fabrication sequence,	5	T2	L
41	Fabrication process flow.	5	T2	L
42	Layout Design and Design rules, Stick Diagram	5	T2	T
43	Design rules-micron rules and Lambda rules. (definitions only).	5	T2	T
44	Layout of CMOS Inverter,	5	T2	T
45	Two input NAND and NOR gates.	5	T2	T

15. Question Bank

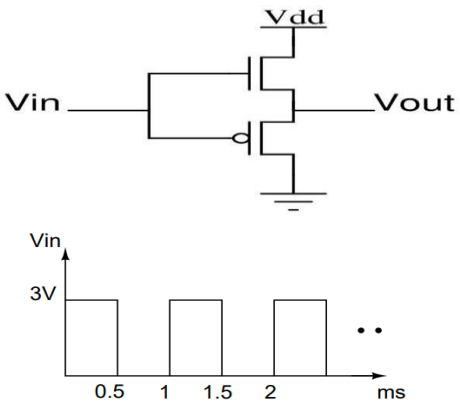
Sl No	Question	Marks	CO	BL
Module 1				
1	Describe FPGA. What are its applications? With block diagram explain its internal architecture.	8	CO1	L2
2	Brief on ASIC design flow.	6	CO1	L1
3	Discuss in detail about Top down & bottom up approaches for ASIC Design.	8	CO1	L1
4	Enumerate the advantages of SOC.	6	CO1	L1

5	Differentiate between PROM, PAL & PLA.	6	CO1	L2
6	List the advantages & disadvantages of Full custom ASICs.	6	CO1	L1
7	Differentiate between full custom & semi-custom ASICs.	6	CO1	L1
8	Describe in detail about Standard cell-based ASICs.	8	CO1	L2
9	Describe in detail about Gate array-based ASICs.	8	CO1	L2
10	Discuss in detail about System On chips.	8	CO1	L2
11	Enumerate the differences between FPGAs & ASICs.	6	CO1	L1
12	Compare the working of different types of PLDs.	8	CO1	L2
13	Explain working of PLA.	8	CO1	L1
14	Explain the main steps of VLSI Physical Design.	8	CO1	L1
15	Explain FPGA Design flow.	8	CO1	L1
16	Explain fabrication & packaging of VLSI circuits.	6	CO1	L1
17	Explain speed, power and area considerations in VLSI Design.	8	CO1	L1
18	Brief on Logical, Physical & Circuital design of VLSI circuits.	8	CO1	L1
19	Enumerate different types of FPGAs	3	CO1	L1
20	State Moore's Law in VLSI Design.	3	CO1	L1
21	Explain the classification of ASICs with a neat diagram.	3	CO1	L2
22	Differentiate between full custom & semi custom ASICs.	3	CO1	L1
23	Explain standard cell based ASICs.	3	CO1	L2
24	List the differences between top-down approach & bottom-up approach in ASIC design.	3	CO1	L1
25	List the differences between ASICs & FPGAs.	3	CO1	L1
26	Describe the advantages of Soc Technology.	3	CO1	L1
27	Draw the architecture of FPGA & explain.	3	CO1	L1
28	List the advantages of VLSI Technology	3	CO1	L1
29	Explain Gate array based ASICs.	3	CO1	L2
30	Draw the flowchart of ASIC Design flow.	3	CO1	L1
31	List different types of Programmable logic devices.	3	CO1	L1
32	Draw the general structure of PLDs. How are they different from each other?	3	CO1	L1

33	Draw the flow chart of FPGA Design flow.	3	CO1	L1
34	List the typical components of SoC.	3	CO1	L1
35	Differentiate between top-down & bottom up design architectures.	3	CO1	L1
36	Differentiate between logical and physical design in VLSI.	3	CO1	L1
37	What is gate array-based ASIC? Explain the different types of Gate Array based ASICs. (May 2024)	8	CO1	L2
38	Illustrate the various steps involved in VLSI physical design. Explain how physical design impacts circuit performance, area and power? (May 2024)	8	CO1	L2
39	Comment on the performance features of FPGA based design. (December 2024)	3	CO1	L2
40	Explain in detail ASIC Design flow. (December 2024)	8	CO1	L2
41	Differentiate between Channelled and channel less gate array. (December 2024)	6	CO1	L4
Module 2				

1	Implement the function $f = [AB + C(DE+F)]'$ using static CMOS logic. (May 2019)	5	CO2	L3
2	Realise a The Function $f = AB'C + AC(DE+A'B)$ using standard CMOS logic. (April 2018)	5	CO2	L3
3	Implement the function $f = [AB(D+E) + C(DE+F)]'$ using static CMOS logic.	5	CO2	L3
4	Implement the function $f = [ABC+CDE+ABF]$ using static CMOS logic.	5	CO2	L3
5	Implement the function $f = [(A+B)(C+D)(E'+F'')]$ using static CMOS logic.	5	CO2	L3
6	Implement the function $u = A'B + AB'$ and $v = AB + A'B'$ using complementary pass transistor logic. (May 2019)	5	CO2	L3
7	What is meant by pass transistor logic? What are the differences in transmission characteristics of N MOS and P MOS transistors? (April 2018)	5	CO2	L1
8	Draw the circuit diagram of an Ex-OR gate in pass transistor logic. (April 2018)	5	CO2	L2
9	Draw the circuit diagram of an Ex-NOR gate in pass transistor logic.	5	CO2	L2
10	Draw the circuit diagram of an AND & NAND gate in pass transistor logic.	5	CO2	L2
11	Draw the circuit diagram of an OR & NOR gate in pass transistor logic.	5	CO2	L2
12	Draw the circuit diagram of an OR & NOR gate in TG	5	CO2	L2
13	Explain the structure and working of a transmission gate. Implement 4×1 multiplexer using transmission gates. (May 2019)	10	CO2	L3
14	Design the logic gates using transmission gates	10	CO2	L3

15	Implement 8:1 MUX using Pass transistor logic & transmission gate logic.	9	CO2	L3
16	Explain static analysis of CMOS inverters	5	CO2	L2
17	Explain dynamic analysis of CMOS inverters	5	CO2	L2
18	Explain pass transistor logic.	3	CO2	L1
19	Explain transmission gate logic.	3	CO2	L1
20	Explain the working of a CMOS inverter.	3	CO2	L1
21	Explain the working of NMOS inverters.	3	CO2	L1
22	Explain switching power dissipation.	3	CO2	L1
23	List the advantages of CMOS circuits	3	CO2	L1
24	Describe the two main types of power dissipation happening in CMOS.	3	CO2	L2
25	Draw the switching characteristics of CMOS inverters and write the equation for propagation delay.	3	CO2	L2
26	Explain pre charge & evaluate phases in dynamic logic circuits.	4	CO2	L2
27	With relevant waveforms, define propagation delay times in a CMOS circuit. (May 2024)	3	CO2	L1
28	Plot the Voltage transfer characteristics of a static CMOS inverter and label the details. Derive the equation for the switching threshold. (May 2024)	7	CO2	L2
29	Realize the following logic functions $Y = \overline{A+B(C+D)}$ using static CMOS 4 to 1 MUX using transmission gate logic (May 2024)	7	CO2	L2
30	Design a 3-input XOR gate using a) Pass transistor logic b) Transmission gate logic (May 2024)	8	CO2	L3
31	Why PMOS transistor can pass only strong ones and NMOS can pass strong zeros? Explain (May 2024)	6	CO2	L2
32	Comment and compare two NMOS inverters with enhancement type and depletion type NMOS load operated in saturation region. (December 2024)	6	CO2	L2
33	Implement two input XOR and XNOR in static CMOS logic and pass transistor logic. (December 2024)	8	CO2	L3
34	Derive the expression for V_{IH} & V_{IL} for a static CMOS inverter (December 2024)	10	CO2	L3
35	Comparison between switch implemented using transmission logic and pass transistor logic. (December 2024)	4	CO2	L3
36	Draw the DC characteristics of CMOS inverter and mark the regions of operation of NMOS and PMOS transistors as input is varied from 0 to V_{dd} . (December 2024)	3	CO2	L1
37	Show the output waveform, V_{out} for the following input pattern. Given $V_{dd} = 3V$, $V_{tn} = V_{tp} = 1V$. Assume zero rise and fall delay.	3	CO2	L3

	 (December 2024)			
Module 3				
1	Explain Evaluate logic.	3	CO3	L1
2	Explain Domino logic.	3	CO3	L1
3	Explain NP domino logic.	3	CO3	L1
4	Differentiate between RAM & ROM.	3	CO3	L1
5	Differentiate between SRAM & DRAM.	3	CO3	L1
6	Explain the read and write operation of a six transistor CMOS SRAM cell. (May 2019)	10	CO3	L2
7	Design a 4-bit × 4-bit NOR-based ROM array and explain its working. (May 2019)	10	CO3	L3
8	Explain the read and write operation of a three-transistor DRAM cell. (May 2019)	10	CO3	L2
9	Draw the circuit diagram and explain the principle of operation of a CMOS based static RAM cell. Explain the read and write operations. What are the constraints on the sizes of transistors? (April 2018)	10	CO3	L2
10	Draw the circuit diagram and explain the principle of operation of a one transistor dynamic RAM cell. Explain the read, write and refresh operations. (April 2018)	10	CO3	L2
11	Design a 4-bit × 4-bit OR-based ROM array and explain its working.	10	CO3	L3
12	Design a 4-bit × 4-bit NAND-based ROM array and explain its working.	10	CO3	L3
13	Implement AB+CD in domino logic. (December 2024)	3	CO3	L3
14	Compare DRAM and SRAM cells. (December 2024)	3	CO3	L2
15	Draw and explain NORA logic. How will you connect NORA logic to a NMOS domino logic ? (December 2024)	7	CO3	L2
16	Comment the working of 3 transistors (3-T) DRAM. (December 2024)	7	CO3	L2

17	Comment on charge sharing issue in domino logic. Explain any method to reduce it. (December 2024)	8	CO3	L2
18	Implement a 4 * 4 NOR based ROM to store the following data 1100,1010,1001 and 0110. (December 2024)	6	CO3	L3
19	What is Dynamic CMOS logic ? Compare static and dynamic CMOS logic. Design a 2-input NAND gate in dynamic logic and static CMOS logic. (May 2024)	8	CO3	L3
20	Explain the limitation of dynamic CMOS logic for multistage applications. How it can be eliminated with the help of np Domino logic? (May 2024)	6	CO3	L2
21	Draw the circuit and explain the read and write operation of a 6T SRAM cell. (May 2024)	7	CO3	L2
22	Design a 4x4 NOR ROM to store the data 1010, 0100, 1101 and 0011. Explain the data read operation. (May 2024)	7	CO3	L3
23	Design a 3-input AND gate in domino logic. (May 2024)	3	CO3	L3
24	Differentiate between SRAM and DRAM. (May 2024)	3	CO3	L2
Module 4				
1	Explain the working a 16-bit carry-by pass adder and write down the expression for worst-case delay. (May 2019)	10	CO4	L2
2	Explain 4×4 bit-array multiplier with block diagram. (May 2019)	10	CO4	L3
3	With block diagram illustrate the principle of operation of a square root carry select adder. Estimate the delay of an n bit adder (April 2018)	10	CO4	L2
4	Draw circuit diagram of a full adder with not more than 28 transistors in standard CMOS logic. (April 2018)	10	CO4	L2
5	With diagram illustrate the principle of operation of an array multiplier. Show the critical path. Estimate the delay of the multiplier. (April 2018)	10	CO4	L2
6	Explain the working principle of linear carry select Adder	10	CO4	L2
7	Explain 3×3 bit-array multiplier with block diagram.	10	CO4	L3
8	Compare carry bypass adder & carry select adder (Sept 2020)	6	CO4	L1
9	With block diagrams, illustrate the behavior of linear carry select adder & square root carry select adder (Dec 2019)	10	CO4	L2
10	Show the conversion of a ripple carry adder into a carry bypass adder. Draw the block diagram of a 16 bit carry bypass adder and show the worst case delay path (Dec 2019)	10	CO4	L2
11	Draw the circuit diagram of a full adder with not more than 28 transistors in standard CMOS logic (April 2018)	10	CO4	L1
12	Draw the block diagram of a carry bypass adder.	3	CO4	L1
13	Draw the truth table of full adder.	3	CO4	L1
14	Give equations for generate, delete & propagate signals.	3	CO4	L1
15	Explain the advantage of square root carry select adders over linear carry select adders.	3	CO4	L2
16	Draw the propagation delay curve denoting delay of different types of adders	3	CO4	L1

17	Give equations for the propagation delay of carry bypass adder & linear carry select adder.	3	CO4	L1
18	Explain partial product generation in bit array multipliers.	3	CO4	L1
19	Explain the mechanism of carry bypassing in improving critical path delay in adder design. (December 2024)	4	CO4	L2
20	Implement transistor structure of sum and carry of a full adder in static CMOS structure. (December 2024)	6	CO4	L2
21	Express sum and carry output of a full adder in terms of propagate and generate signal. (December 2024)	3	CO4	L1
22	Give the value for critical path delay for 16 bit carry bypass adder and 4* 4 array multiplier. Assume $t_{sum} = t_{mux} = t_{carry} = 10ns$ and $t_{setup} = t_{and} = 5ns$. (December 2024)	3	CO4	L3
23	Derive the Propagate, Generate and Delete signals for a full adder circuit. (May 2024)	3	CO4	L2
24	Compare the delay performance of ripple carry, linear carry select and square root carry select adders. (May 2024)	3	CO4	L1
25	With the help of a block diagram, explain the operation of a 16-bit linear carry select adder. Identify the critical path and estimate the critical path delay. (May 2024)	8	CO4	L2
26	Explain the logic of square root carry select adder. Why is it called so? Write the equation for its critical path delay. (May 2024)	6	CO4	L2
27	Show the implementation of a 4x4 array multiplier and illustrate the principle of operation. Show the critical path and estimate the delay of the multiplier. (May 2024)	7	CO4	L2
28	With block diagram, explain the working of a 16-bit carry bypass adder. Identify the critical path and estimate the critical path delay. (May 2024)	7	CO4	L2
Module 5				

1	List the main components of CZ process.	3	CO5	L1
2	List the factors that affect the diffusion of impurities in a semiconductor.	3	CO5	L1
3	List the differences between wet & dry oxidation processes.	3	CO5	L1
4	Draw the process diagram of Vapour phase epitaxy.	3	CO5	L1
5	Explain the process of interstitial diffusion.	3	CO5	L2
6	Explain how electronic grade silicon is developed.	3	CO5	L2
7	Explain the principle of Floating zone process	3	CO5	L1
8	State Fick's First law of diffusion.	3	CO5	L1
9	List the advantages of ion implantation process.	3	CO5	L1
10	Explain the basic elements of an MBE system	3	CO5	L1
11	Give the advantages & disadvantages of MBE	3	CO5	L1
12	Explain the characteristics of positive & negative resists.	3	CO5	L1
13	Differentiate between wet etching & plasma etching	3	CO5	L1

14	Explain why Aluminium is used for metallization.	3	CO5	L1
15	How electronic grade silicon is prepared from raw SiO ₂ ? (May 2019)	5	CO5	L1
16	Phosphorous is implanted in a p-type silicon sample with a uniform doping concentration of 5×10^{16} atoms per cm ³ . If the beam current density is 2.5 μ A per cm ² and the implantation time is 8 minutes, calculate the implantation dose and peak impurity concentration. Assume $\Delta R_p = 0.3 \mu$ m (May 2019)	5	CO5	L2
17	Illustrate with diagram the principle of crystal growth by Czochralski method (April 2018)	10	CO5	L1
18	A SiO ₂ layer is grown by wet oxidation at 1000°C for 40 minutes followed by dry oxidation for 1 hour at 1200°C. Determine the thickness of the oxide layer formed. For wet oxidation at 1000°C, $B=0.29$, $B/A=1.27$ and for dry oxidation at 1200°C, $B=0.045$, $B/A=1.120$, $\tau=0.027$ (April 2018)	5	CO5	L3
20	A silicon crystal is to be grown by Czochralski process and is to contain 5×10^{15} boron atoms/cm ³ . Given the segregation constant k_0 for Boron in silicon is 0.8. Atomic weight of boron equals 10.81g/mole, density of silicon 2.22g/cm ³ and Avogadro number is 6.023×10^{23} atoms/mole. (a) Determine the initial concentration of Boron in the melt to produce the required doping density. (b) If the initial amount of silicon in the crucible is 20kg, how many grams of Boron should be added to obtain the same doping? (April 2018)	5	CO5	L3
21	With schematic diagram and chemical reactions involved, illustrate wet and dry oxidation processes. (April 2018)	5	CO5	L2
22	Determine the ratio of Silicon consumed to the thickness of grown SiO ₂ layer over silicon wafer. If SiO ₂ layer of 0.2 μ m is to be grown, what would be the thickness of used up Silicon. Molecular weight of SiO ₂ = 60.08g. mole, density of SiO ₂ =2.2g/cm ³ , atomic weight of Si=20.09 and density of Si= 2.33g/cm ³ (April 2018)	5	CO5	L3
23	Illustrate with diagram the principle of crystal growth by Flat Zone method	8	CO5	L1
24	Illustrate the dry and wet oxidation technique used in IC fabrication with schematic diagram (May 2019)	10	CO5	L2
25	What is the difference between diffusion and ion implantation with different impurity? Explain Annealing	10	CO5	L2
26	Comment on Wet and Dry oxidation. (December 2024)	3	CO5	L2
27	Draw the stick diagram of two input CMOS NAND gate (December 2024)	3	CO5	L1

28	Describe in detail the manufacturing steps of single crystal Silicon from Quartzite(sand). (December 2024)	10	CO5	L2
29	Describe the λ rule to be followed in connecting wires. (December 2024)	4	CO5	L2
30	With neat diagram explain molecular beam epitaxy. (December 2024)	8	CO5	L2
31	Draw the circuit diagram and layout of static CMOS inverter (December 2024)	6	CO5	L1
32	What are the differences between λ rule and micron rule? (May 2024)	3	CO5	L2
33	Differentiate between wet and dry oxidation in VLSI fabrication process (May 2024)	3	CO5	L2
34	Explain the Czochralski technique for silicon crystal growth with the help of neat diagram. (May 2024)	7	CO5	L2
35	What is photolithography? With neat diagram illustrate the steps involved in photolithography process. (May 2024)	7	CO5	L1
36	Explain Twin- well CMOS IC fabrication process with neat diagram. (May 2024)	8	CO5	L2
37	Draw the stick diagram and layout of a two-input CMOS NOR gate. (May 2024)	6	CO5	L1

Prepared By : Dr. Ann Varghese

Checked By : Ms. Ambily Joseph

Course Code & Name: ECT306 INFORMATION THEORY AND CODING

1. Prescribed Syllabus

Module	Topic	Hours
1	Entropy, Sources and Source Coding Entropy, Properties of Entropy, Joint and Conditional Entropy, Mutual Information, Properties of Mutual Information. Discrete memoryless sources, Source code, Average length of source code, Bounds on average length, uniquely decodable and prefix-free source codes. Kraft Inequality (with proof), Huffman code. Shannon's source coding theorem (both achievability and converse) and operational meaning of entropy	10
2	Channels and Channel Coding Discrete memoryless channels. Capacity of discrete memoryless channels. Binary symmetric channels (BSC), Binary Erasure channels (BEC). Capacity of BSC and BEC. Channel code. Rate of channel code. Shannon's channel coding theorem (both achievability and converse without proof) and operational meaning of channel capacity. Modelling of Additive White Gaussian channels. Continuous-input channels with average power constraint. Differential entropy. Differential Entropy of Gaussian random variable. Relation between differential entropy and entropy. Shannon-Hartley theorem (with proof – mathematical subtleties regarding power constraint may be overlooked). Inferences from Shannon Hartley theorem – spectral efficiency versus SNR per bit, power-limited and bandwidth-limited regions, Shannon limit, Ultimate Shannon limit.	11
3	Introduction to Linear Block Codes Overview of Groups, Rings, Finite Fields, Construction of Finite Fields from Polynomial rings, Vector spaces. Block codes and parameters. Error detecting and correcting capability. Linear block codes. Two simple examples -- Repetition code and single parity-check code. Generator and parity-check matrix. Systematic form. Maximum likelihood decoding of linear block codes. Bounded distance decoding. Syndrome. Standard array decoding.	15
4	A Few Important Classes of Algebraic codes Cyclic codes. Polynomial and matrix description. Interrelation between polynomial and matrix view points. Systematic encoding. Decoding of cyclic codes. (Only description, no decoding algorithms) Hamming Codes, BCH codes, Reed-Solomon Codes	7
5	Convolutional and LDPC Codes Convolutional Codes. State diagram. Trellis diagram. Maximum likelihood decoding. Viterbi algorithm. Low-density parity check (LDPC) codes. Tanner graph representation. Message-passing decoding for transmission over binary erasure channel.	5

2. Text Books (T)

T1. Elements of Information Theory, Joy A Thomas, Thomas M Cover, Wiley-Interscience.

- T2. Information Theory, Inference and Learning Algorithms, David JC McKay, Cambridge University Press
 T3. Principles of digital communication, RG Gallager, Cambridge University Press
 T4. Digital Communication Systems, Simon Haykin, Wiley

3. Reference Books ®

- R1. Introduction to Coding Theory, Ron M Roth, Cambridge University Press
 R2. Shu Lin & Daniel J. Costello. Jr., Error Control Coding : Fundamentals and Applications, 2nd Edition
 R3. Modern Coding Theory, Rüdiger Urbanke and TJ Richardson, Cambridge University Press.
 R4. Information Theory and Coding, J.S. Chitode, Technical Publications..

4. Course Objectives

This course aims

- To lay down the foundation of information theory introducing both source coding and channel coding.
- To expose students to algebraic and probabilistic error-control codes that are used for reliable transmission.

5. Course Pre / Co-requisite

1. MAT 201 Linear Algebra and Calculus,
2. MAT 204 Probability, Random Process and Numerical Methods,
3. ECT 204 Signals and Systems.

6. Course Outcomes

After the completion of the course the student will be able to

- CO 1: Explain measures of information – entropy, conditional entropy, mutual information
 CO 2: Apply Shannon’s source coding theorem for data compression.
 CO 3: Apply the concept of channel capacity to characterize limits of error-free transmission.
 CO 4: Apply linear block codes for error detection and correction
 CO 5: Apply algebraic codes with reduced structural complexity for error correction
 CO 6: Understand encoding and decoding of convolutional and LDPC codes

7. Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes

PO/ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H	H											H		
CO2	H	H	M	H	H							M	H	H	H
CO3	H	H	M	H	H	M						M	H	H	H
CO4	H	H	M			M							H		
CO5	H	H	M			M							H		
CO6	H	H	M		H	M			H	H		M	H		H

8. Justification for CO-PO-PSO Correlation

CO	PO/PSO	Justification
CO1	PO1	Knowledge in mathematics and engineering will enable the student to measure and describe information – entropy, conditional entropy, mutual information
	PO2	Analysing a given data using statistical Methods will enable students to describe information– entropy, conditional entropy, mutual information
	PSO1	Knowledge in information theory will enable students to design and develop efficient and reliable digital communication systems
CO2	PO1	Knowledge in mathematics and engineering will enable students to explain Shannon’s source coding theorem and Channel coding theorem for efficient data compression and reliable transmission
	PO2	By applying specific constraints, the student will be able to analyse channel parameters for channel capacity calculations
	PO3	Designing solutions for complex engineering problems and designing system components will enable students to meet the specified needs with appropriate consideration for the public health and safety using data compression
	PO4	Research-based knowledge and research methods including design of experiments of Shannon’s source coding theorem will enable students to analyse and interpret data to design and develop efficient and reliable communication systems
	PO5	Applying appropriate techniques including prediction and modelling to complex engineering activities will enable student to perform data compression
	PO12	Applying Shannon’s source coding theorem for data compression will enable students to engage in independent technological change
	PSO1	Knowledge in source coding for data compression will enable students to design and develop efficient and reliable communication systems
	PSO2	Analysing and synthesizing the experimental data from the electronic systems will enable students to perform data compression
	PSO3	Choosing and applying modern engineering tools for Shannon’s source coding theorem will enable students to analyse complex Electronics and Communication engineering problems
CO3	PO1	Knowledge in mathematics and engineering will enable students to explain the concept of channel capacity for characterize limits of error-free transmission
	PO2	Identifying complex engineering problems using first principles of mathematics will enable students to explain the Galois field and the related properties and operations
	PO3	Designing solutions for complex engineering problems with appropriate consideration for error-free transmission will enable students to apply the concept of channel capacity
	PO4	Research-based knowledge and research methods including design of experiments will enable students to analyse and interpret data for error-free transmission
	PO5	Applying different channel coding techniques for error detection and correction schemes will enable students to characterize limits of error-free transmission

	PO6	Applying linear block codes for error detection and correction will enable students to characterize limits of error-free transmission
	PO12	Recognizing the need for, and have the preparation and ability to engage in independent and life-long learning will enable students to apply the concepts of channel capacity for error-free transmission
	PSO1	Absorbing and applying channel capacity concepts will enable students to design and develop efficient communication systems
	PSO2	Concept of channel capacity will enable students to analyse and synthesize the experimental data from electronic system in the
	PSO3	Concept of channel capacity will enable students to choose and apply modern engineering tools to analyse complex Electronics and Communication engineering problems
CO4	PO1	Knowledge in mathematics and engineering will enable students to explain the concept of polynomial and matrix description for error detection and correction
	PO2	Identifying complex engineering problems using first principles of mathematics will enable students to explain the concept of linear block codes for error detection and correction
	PO3	Designing solutions for complex engineering problems with appropriate consideration will enable students to do error detection and correction
	PO6	Contextual knowledge for error detection and correction will enable students to apply reasoning in linear block codes
	PSO1	Applying contextual knowledge of Electronics and Communication Engineering will enable students to do error detection and correction in linear block codes
CO5	PO1	Knowledge in mathematics and engineering in algebraic codes with reduced structural complexity will enable students to do error correction
	PO2	Identifying complex engineering problems using first principles of mathematics will enable students to explain algebraic codes
	PO3	Appropriate consideration in decoding of cyclic codes will enable students to design solutions for complex engineering problems by apply algebraic codes with reduced structural complexity
	PO6	Applying reasoning informed by the contextual knowledge for error correction will enable students to apply algebraic codes with reduced structural complexity for error correction
	PSO1	Absorb and apply algebraic codes will enable students to design and develop efficient communication systems
CO6	PO1	Knowledge in mathematics and engineering will enable students in encoding and decoding of convolutional and LDPC codes
	PO2	Complex engineering problems using first principles of mathematics will enable students to explain convolution codes
	PO3	Design solutions for complex engineering problems with appropriate consideration will enable students to understand encoding and decoding of convolutional and LDPC codes
	PO5	Applying appropriate techniques for Trellis diagram and Tanner graph representation will enable students to encoding and decoding of convolutional and LDPC codes
	PO6	Applying reasoning informed by the contextual knowledge for maximum likelihood decoding will enable students to encoding and decoding of convolutional and LDPC codes

	PO9	Understand encoding and decoding of convolutional and LDPC codes for representing tanner graphs will enable students to function as a team in multidisciplinary settings
	PO10	Understand encoding and decoding of convolutional and LDPC codes for representing tanner graphs, will enable students to communicate effectively on complex engineering activities and write effective reports
	PO12	Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in applying encoding and decoding of convolutional and LDPC codes
	PSO1	Absorbing and applying convolutional and LDPC codes will enable students to to design and develop efficient communication systems
	PSO3	Choosing and applying modern engineering tools to analyse complex Electronics and Communication engineering problems will enable students to represent tanner graph

9. Curricular gaps (if any)

NIL

10. Course Enrichment Activities

Sl No	Description	Proposed Activities	Relevance to POs and PSOs
1.	Source and Channel Coding.	Simulation Assignments	PO5, PO12

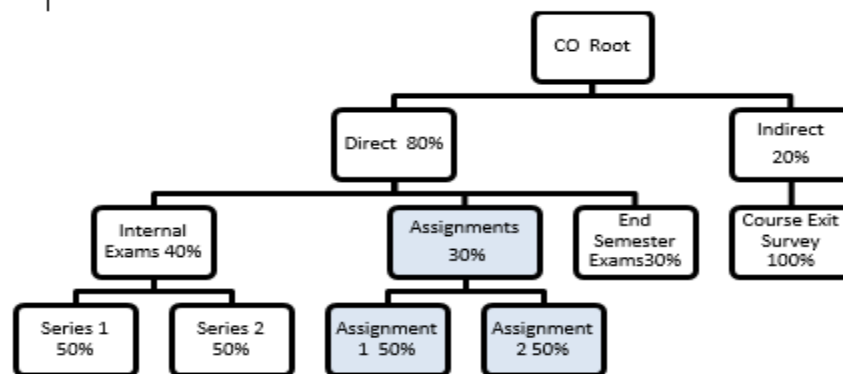
11. Internal Assessment mark allocation (as per university curriculum)

Attendance	- 10 marks
Continuous Assessment Test	- 25 marks
<u>Assignment (s)/ Course Project</u>	<u>- 15 marks</u>
<u>Total</u>	<u>- 50 marks</u>

12. Assessment – CO Mapping

	Tools		Weightage	CO1	CO2	CO3	CO4	CO5
Direct Assessment Tools**	Internal Exam(s)40%	Series 1	20%	x	x	x		
		Series 2	20%				x	x
	Assignment (s)/30%	A1	15%	x	x	x		
		A2	15%				x	x
	End Semester Exam		30%					
Indirect Assessment Tool	Course Exit Survey		100%	x	x	x	x	x

13. Assessment Configuration



14. Course Plan

Hour	Topic	Module	Reference(s)	Teaching Pedagogy
1	Introduction to the Course	1	T1T2R1	Lecture
2	Review of probability - Measure of Information - unit - properties	1	T1T2R1	Tutorial
3	Entropy, Properties of Entropy	1	T1T2R1	Lecture
4	Joint and Conditional Entropy,	1	T1T2R1	Lecture
5	Relations among Entropies, Mutual Information,	1	T1T2R1	Lecture
6	Properties of Mutual Information.	1	T1T2R1	Lecture
7	Tutorial	1	Tutorial	Tutorial
8	Discrete memoryless sources, Entropy of a binary DMS	1	T1T2R1	Lecture
9	Source code, Average length of source code, Bounds on average length	1	T1T2R1	Lecture
10	Uniquely decodable and prefix-free source codes.	1	T1T2R1	Lecture
11	Kraft Inequality (with proof),	1	T1T2R1	Lecture
12	Huffman code.	1	T1T2R1	Lecture
13	Shannon's source coding theorem (both achievability and converse) and operational meaning of entropy.	1	T1T2R1	Lecture
14	Capacity of discrete memoryless channels.	2	T1T3T4	Lecture
15	Binary symmetric channels (BSC), Capacity of BSC	2	T1T3T4	Lecture
16	Tutorial	2	Tutorial	Tutorial
17	Binary Erasure channels (BEC). Capacity of BEC.	2	T1T3T4	Lecture
18	Channel code. Rate of channel code.	2	T1T3T4	Lecture
19	Shannon's channel coding theorem (both achievability and converse without proof) and operational meaning of channel capacity.	2	T1T4R4	Lecture

20	Modelling of Additive White Gaussian channels. Continuous-input channels with average power constraint.	2	T1T4R4	Lecture
21	Tutorial	2	Tutorial	Tutorial
22	Differential entropy. Relation between differential entropy and entropy.	2	T4R4	Lecture
23	Differential Entropy of Gaussian random variable	2	T4R4	Lecture
24	Tutorial	2	Tutorial	Tutorial
25	Shannon-Hartley theorem (with proof mathematical regarding power constraint may be overlooked).	2	T4R4	Lecture
26	Inferences from Shannon Hartley theorem spectral efficiency versus SNR per bit, power-limited and bandwidth-limited regions,	2	T4R4	Lecture
27	Shannon limit, Ultimate Shannon limit.	2	T4R4	Lecture
28	Overview of Groups	3	T4R2R4	Lecture
29	Tutorial	3	Tutorial	Tutorial
30	Rings,	3	T4R2R4	Lecture
31	Finite Fields,	3	T4R2R4	Lecture
32	Construction of Finite Fields from Polynomial rings,	3	T4R2R4	Lecture
33	Vector spaces.	3	T4R2R4	Lecture
34	Tutorial	3	Tutorial	Tutorial
35	Block codes and parameters. Error detecting and correcting capability.	3	T4R2R4	Lecture
36	Repetition code and single parity-check code.	3	T4R2R4	Lecture
37	Linear block codes -- Generator and parity-check matrix. Systematic form	3	T4R2R4	Lecture
38	Maximum likelihood decoding of linear block codes.	3	T4R2R4	Lecture
39	Tutorial	3	Tutorial	Tutorial
40	Bounded distance decoding. Syndrome.	3	T4R2R4	Lecture
41	Standard Array decoding	3	T4R2R4	Lecture
42	Cyclic codes.	4	T4R2R4	Lecture
43	Polynomial and matrix description. Interrelation between polynomial and matrix view point.	T4R2R4	4	Lecture
44	Tutorial	Tutorial	4	Tutorial
45	Systematic encoding.	T4R2R4	4	Lecture
46	Decoding of cyclic codes.	T4R2R4	4	Lecture
47	Hamming Codes,	T4R2R4	4	Lecture
48	BCH codes,	T4R2R4	4	Lecture
49	Reed-Solomon Codes.	T4R2R4	4	Lecture
50	Convolutional Codes.	T4R2R4	5	Lecture
51	Tutorial	Tutorial	5	Lecture
52	State diagram.	T4R2R4	5	Lecture

53	Trellis diagram.	T4R2R4	5	Lecture
54	Maximum likelihood decoding- Viterbi algorithm.	T4R2R4	5	Lecture
55	Maximum likelihood decoding- Viterbi algorithm.	T4R2R4	5	Lecture
56	Tutorial	Tutorial	5	Tutorial
57	Low-density parity check (LDPC) codes.	T4R2R4	5	Lecture
58	Tanner graph representation.	T4R2R4	5	Lecture
59	Message-passing decoding for transmission over binary erasure channel.	T4R2R4	5	Lecture

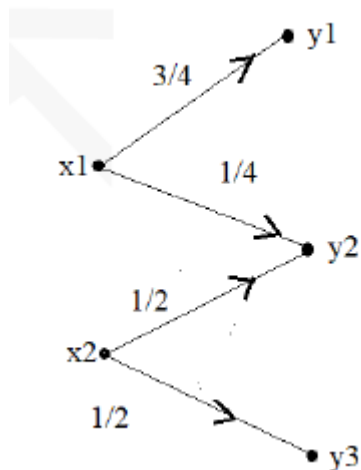
15. Question Bank

Sl. No.	Question	Marks	CO	BL
Module 1				
1.	Define conditional entropy.	3	CO1	L1
2.	Define Entropy and list its properties	3	CO1	L1
3.	Define a. Entropy b. Information rate	3	CO1	L1
4.	Define mutual information. Mention the properties of mutual information	3	CO1	L1
5.	Define the term entropy of a discrete memory-less source. Calculate the entropy of a DMS with two symbols with respective probabilities $\{1/2, 1/2\}$.	3	CO1	L2
6.	Consider a source $S = \{S_1, S_2, S_3\}$ with $P = \{1/2, 1/4, 1/4\}$. Find self-information of each message and comment on results	3	CO1	L1
7.	A discrete source emits one of six symbols once every millisecond. The source probabilities are $\frac{1}{2}, \frac{1}{4}, \frac{1}{8}, \frac{1}{6}, \frac{1}{32}$ and $\frac{1}{32}$. Find the Information rate.	3	CO1	L2
8.	Calculate the information rate of a telegraphy system which uses a dash and dot as symbols. Assume that the dash is twice as long as dot and half as probable. The data last for 0.2 milliseconds and the same interval exists for the pause between the symbols.	3	CO1	L2
9.	A given source alphabet consists of 300 words, of which 15 occur with probability 0.06 each and the remaining words occur with probability 0.00035 each. If 1000 words are transmitted each second, what is the average rate of information transmission?	3	CO1	L2
10.	An analog signal is bandlimited to B Hz, sampled at the Nyquist rate, and the samples are quantized into 4 levels. The quantization levels are assumed independent and occur with probabilities $P_1 = P_4 = 3/8$ and $P_2 = P_3 = 1/8$. Find the information rate of the source assuming $B = 100\text{Hz}$.	3	CO1	L2

11.	A source transmits two independent messages with probabilities p and $(1-p)$ respectively. Prove that the entropy is maximum when both the messages are equally likely and plot the graph for Entropy H .	3	CO1	L2
12.	Show that the entropy is maximum when all the messages are equally likely. Also derive the expression for maximum entropy	3	CO1	L2
13.	Prove that $H(X,Y)=H(X) + H(Y/X)$	3	CO1	L2
14.	For any discrete memoryless source $S= \{s_1, s_2, s_3, \dots s_q\}$, prove that $0 \leq H(S) \leq \log_2 q$, where $H(S)$ is the entropy of the source.	3	CO1	L1
15.	The joint probability matrix of a communication system is given below. Find $H(X)$, $H(Y)$, $H(X,Y)$, $H(X/Y)$ and $H(Y/X)$. $P(XY) = \begin{bmatrix} 0.1 & 0.05 & 0.05 \\ 0.2 & 0.15 & 0.1 \\ 0.1 & 0.2 & 0.05 \end{bmatrix}$ Also verify the relation between joint, conditional and marginal entropies?	14	CO1	L3
16.	The joint probability of a pair of random variables is given below. Determine $H(X)$, $H(Y)$, $H(X,Y)$, $H(X/Y)$, $H(Y/X)$ and $I(X,Y)$. Verify the relation between joint, conditional and marginal entropies? $P(X,Y) = \begin{bmatrix} 1/3 & 1/3 \\ 0 & 1/3 \end{bmatrix}$	14	CO1	L3
17.	Determine the mutual information between two discrete memoryless sources X and Y with conditional probability matrix given by $P(Y/X) = \begin{bmatrix} 0.5 & 0.5 & 0 \\ 0.5 & 0 & 0.5 \\ 0 & 0.5 & 0.5 \end{bmatrix}$ Verify the formula $H(X,Y)= H(X) + H(Y/X)$. Given $p(x_1)=0.6$, $p(x_2)=0.3$ & $p(x_3)=0.1$.	14	CO1	L3
18.	Differentiate between source coding and channel coding	3	CO2	L1
19.	Explain prefix property and discuss the test for instantaneous property with an example.	3	CO2	L1
20.	Explain uniquely decodable and prefix free property of source code	3	CO2	L1
21.	State Shannon's source coding theorem.	3	CO2	L1

22.	Find Huffman code for the source with symbol probabilities $\{1/2, 1/3, 1/6\}$.	3	CO2	L3																														
23.	Given the messages X1, X2, X3, X4, X5 and X6 with respective probabilities of 0.4, 0.2, 0.2, 0.1, 0.07 and 0.03. Construct a binary code by applying Huffman encoding procedure. Also determine its efficiency and redundancy	7	CO2	L3																														
24.	A DMS has 6 codes with probabilities as $p(x_1)=0.25$, $p(x_2)=0.3$, $p(x_3)=0.12$, $p(x_4)=0.2$, $p(x_5)=0.08$ and $p(x_6)=0.05$. Obtain the Huffman codes and find the code efficiency and redundancy.	7	CO2	L3																														
25.	The five symbols S1, S2, S3, S4 and S5 of a source have probabilities 0.4, 0.2, 0.2, 0.1 and 0.1 respectively. Obtain the codewords using Huffman algorithm	7	CO2	L3																														
26.	A Discrete memoryless system has 6 codes with probabilities $1/3$, $1/4$, $1/8$, $1/8$, $1/12$, and $1/12$. Obtain the Huffman codes and find the code efficiency and redundancy	7	CO2	L3																														
27.	Consider a DMS with source probabilities $\{0.35, 0.25, 0.2, 0.15, 0.05\}$ i. Determine the binary Huffman code for this source ii. Determine the ternary Huffman code for this source using symbols A, B and C. iii. Determine the average code word length and compare.	10	CO2	L3																														
28.	A transmitter has an alphabet consisting of five letters $\{x_1, x_2, x_3, x_4, x_5\}$ and the receiver has an alphabet of four letters $\{y_1, y_2, y_3, y_4\}$. The joint probabilities of the systems are shown as <table> <tr> <td></td><td>y_1</td><td>y_2</td><td>y_3</td><td>y_4</td></tr> <tr> <td>x_1</td><td>0.25</td><td>0</td><td>0</td><td>0</td></tr> <tr> <td>x_2</td><td>0.1</td><td>0.3</td><td>0</td><td>0</td></tr> <tr> <td>x_3</td><td>0</td><td>0.05</td><td>0.1</td><td>0</td></tr> <tr> <td>x_4</td><td>0</td><td>0</td><td>0.05</td><td>0.1</td></tr> <tr> <td>x_5</td><td>0</td><td>0</td><td>0.05</td><td>0</td></tr> </table> Find Mutual information.		y_1	y_2	y_3	y_4	x_1	0.25	0	0	0	x_2	0.1	0.3	0	0	x_3	0	0.05	0.1	0	x_4	0	0	0.05	0.1	x_5	0	0	0.05	0	10	CO2	L3
	y_1	y_2	y_3	y_4																														
x_1	0.25	0	0	0																														
x_2	0.1	0.3	0	0																														
x_3	0	0.05	0.1	0																														
x_4	0	0	0.05	0.1																														
x_5	0	0	0.05	0																														
Module 2																																		
1.	State Shannon's channel coding theorem. What is its significance in digital communication system?	3	CO3	L1																														
2.	What is differential entropy? Give the expression for the entropy of a continuous signals	3	CO3	L1																														
3.	What is meant by the differential entropy? Derive an expression for the same	3	CO3	L1																														
4.	Derive the expression for differential entropy for a Gaussian Random Variable	6	CO3	L2																														
5.	State Shannon's second theorem on channel capacity. Give the Positive and Negative statements.	3	CO3	L1																														

6.	Illustrate channel diagram for a Discrete memoryless channel with an example	3	CO3	L2
7.	A message source produces two independent symbols A and B with probabilities $P(A)=0.4$ and $P(B)=0.6$ and transmitted through a BSC. Calculate the Information transmission rate of the system if the symbols are received in average with 4 in every 100 symbols in error.	7	CO3	L3
8.	Calculate the capacity of a Gaussian channel with a bandwidth of 1MHz and S/N ratio of 30dB.	3	CO3	L2
9.	Explain Binary Erasure Channel and derive its channel capacity.	6	CO3	L2
10.	Explain Binary Symmetric Channel and derive its channel capacity.			
11.	Derive the capacity of a Binary Symmetric Channel.	6	CO3	L2
12.	For the Channel matrix given below, find $H(X)$, $H(Y)$ and $H(X,Y)$. Assume all input symbols are equally likely. $P(Y/X) = \begin{bmatrix} \frac{1}{6} & 0 & \frac{2}{3} & \frac{1}{6} \\ 0 & \frac{1}{2} & \frac{1}{2} & 0 \\ 0 & 0 & \frac{2}{3} & \frac{1}{3} \\ \frac{1}{4} & \frac{1}{4} & 0 & \frac{1}{2} \end{bmatrix}$	8	CO3	L3
13.	Given an AWGN channel with 5 K Hz bandwidth and the noise power spectral density $\eta/2 = 10^{-9}$ W/Hz. The signal power required at the receiver is 0.2 mW. Calculate the capacity of this channel.	3	CO3	L2
14.	A Gaussian channel has 10MHz bandwidth. If (S/N) ratio is 100, calculate the channel capacity and the maximum information rate	3	CO3	L2
15.	Derive the expression for channel capacity of a Gaussian channel with AWGN when bandwidth becomes infinite.	6	CO3	L2
16.	Derive the expression for channel capacity of a Gaussian channel with AWGN	6	CO3	L2
17.	Find the mutual information of a channel with the channel diagram given below, if $P(x_1) = P(x_2) = \frac{1}{2}$.	8	CO3	L3



Module 3

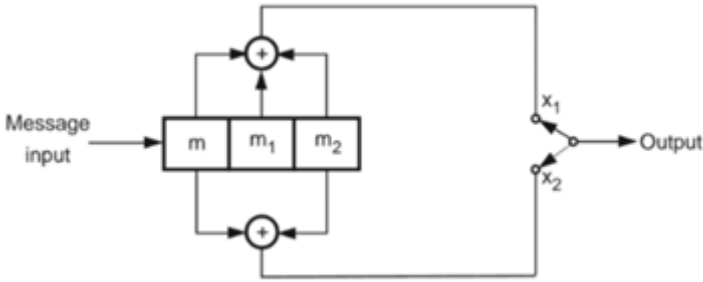
1.	Differentiate i. Systematic and nonsystematic codes ii. Linear and non-linear codes	3	CO4	L2
2.	For a (7,4) linear block code, the Parity Check matrix $H = \begin{bmatrix} 1 & 1 & 1 & 0 & 1 & 0 & 0 \\ 0 & 1 & 1 & 1 & 0 & 1 & 0 \\ 1 & 1 & 0 & 1 & 0 & 0 & 1 \end{bmatrix}$ Obtain the Generator matrix	3	CO4	L2
3.	Define Hamming weight, Hamming distance, $d_{\min}$ of a linear block code.	3	CO4	L1
4.	If C is a valid code word generated by an (n, k) linear block code with parity check matrix 'H', prove that the product of C and the transpose of 'H' is 0.	3	CO4	L2
5.	Distinguish between block codes and convolutional codes.	3	CO4	L2
6.	Explain how the generator matrix is obtained for a linear block code.	3	CO4	L2
7.	A (6, 3) linear block code has a generator matrix given by $G = \begin{bmatrix} 1 & 0 & 0 & 0 & 1 & 1 \\ 0 & 1 & 0 & 1 & 0 & 1 \\ 0 & 0 & 1 & 1 & 1 & 0 \end{bmatrix}$ Find all the code vectors.	3	CO4	L3
8.	Explain the error detection and error correction capability of a linear block code.	3	CO4	L2
9.	List the properties to be satisfied by a linear block code?	3	CO4	L1
10.	Define ring and field. Discuss its properties.	3	CO4	L2
11.	For a systematic linear block code, the three parity check bits, c_4 , c_5 and c_6 are given by:	7	CO4	L3

	$c_4 = d_1 \oplus d_2 \oplus d_3$ $c_5 = d_1 \oplus d_2$ $c_6 = d_1 \oplus d_3$ i. Construct the Generator matrix ii. Decode the received code word 101100.			
12.	Write notes on i. Rings ii. Finite fields.	7	CO4	L2
13.	The Parity check matrix of a (7,4) linear block code is given as $H = \begin{bmatrix} 1 & 0 & 1 & 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 1 & 0 & 1 & 0 \\ 0 & 1 & 1 & 1 & 0 & 0 & 1 \end{bmatrix}$ Construct the code words and show that this is a Hamming code.	7	CO4	L3
14.	For a systematic (6,3) linear block code, the parity matrix P is given by, $P = \begin{bmatrix} 1 & 0 & 1 \\ 0 & 1 & 1 \\ 1 & 1 & 0 \end{bmatrix}$ Find all possible code vectors and draw the encoder circuit.	7	CO4	L3
15.	Draw the general syndrome calculation circuit for (n, k) linear block code and explain its operation.	7	CO4	L2
16.	Consider a (7,4) linear block code whose parity matrix is given by $P = \begin{bmatrix} 1 & 0 & 0 & 0 & 1 & 1 & 0 \\ 0 & 1 & 0 & 0 & 0 & 1 & 1 \\ 0 & 0 & 1 & 0 & 1 & 1 & 1 \\ 0 & 0 & 0 & 1 & 1 & 0 & 1 \end{bmatrix}$ i) Find all code vectors. ii) Draw the encoder circuit.	7	CO4	L3
17.	Consider a (7,4) linear block code whose parity matrix is given by $P = \begin{bmatrix} 1 & 0 & 0 & 0 & 1 & 1 & 0 \\ 0 & 1 & 0 & 0 & 0 & 1 & 1 \\ 0 & 0 & 1 & 0 & 1 & 1 & 1 \\ 0 & 0 & 0 & 1 & 1 & 0 & 1 \end{bmatrix}$ i) Find all code vectors. ii) Draw the encoder circuit.	7	CO4	L3

18.	Draw the complete decoding circuit for the (7,4) linear block code where the syndrome bits are $S=[s_1 \ s_2 \ s_3]$ $=[(r_1+r_2+r_3+r_5), (r_1+r_2+r_4+r_6), (r_1+r_3+r_4+r_7)]$.	7	CO4	L3
19.	Construct the encoding circuit of a systematic (6,3) LBC with the parity matrix given by $P = \begin{bmatrix} 1 & 0 & 1 \\ 0 & 1 & 1 \\ 1 & 1 & 0 \end{bmatrix}$ Also find all possible code vectors.	7	CO4	L3
20.	Explain the error detection and correction capabilities of linear block code.	7	CO4	L2
21.	Explain the procedure to prepare the standard array of LBC. Also construct the standard array of (4,2) LBC whose parity matrix is given by, $P = \begin{bmatrix} 1 & 1 \\ 1 & 0 \end{bmatrix}$	7	CO4	L3
22.	For a systematic (7,4) linear block code, the parity matrix P is given by, $P = \begin{bmatrix} 1 & 1 & 1 \\ 1 & 1 & 0 \\ 1 & 0 & 1 \\ 0 & 1 & 1 \end{bmatrix}$ A single error has occurred in the received vectors [0111110] and [1011100]. Detect and correct the error? Also draw the syndrome calculation circuit?	7	CO4	L3
23.	The parity check list of an (8,4) linear block code is given by $C_5 = d_1 + d_2 + d_4$ $C_6 = d_1 + d_2 + d_3$ $C_7 = d_1 + d_3 + d_4$ $C_8 = d_2 + d_3 + d_4$ a. Find the generator and parity check matrix. b. Find the minimum weight. c. Calculate the error correction and detection capability. d. Implement the encoder circuit.	14	CO4	L3
24.	The parity matrix for a (7,4) linear block code is given by $P = \begin{bmatrix} 1 & 0 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 0 \\ 0 & 1 & 0 \end{bmatrix}$ a. Find all code vectors. b. Find Parity check matrix.	14	CO4	L3

	c. Implement a decoder circuit of the code			
Module 4				
1.	The generator polynomial of a (15,7) Cyclic code is, $G(p) = p^8 + p^7 + p^6 + p^4 + 1$ Find the code vector in Systematic form for the message vector 1101100	3	CO5	L3
2.	Explain the various parameters of RS codes?	3	CO5	L2
3.	Explain Hamming code.	3	CO5	L2
4.	What is BCH code?	3	CO5	L2
5.	List any three properties of cyclic code.	3	CO5	L1
6.	Find the systematic cyclic code for the data D= [1001] where the generator polynomial for the (7,4) single error correcting cyclic code is $1+x+x^3$	3	CO5	L3
7.	The generator polynomial of a (7, 4) Cyclic code is $G(p) = p^3 + p + 1$. Find the code vectors in systematic form for the message vector 0101.	3	CO5	L3
8.	Explain the BCH codes.	3	CO5	L2
9.	Discuss the properties of Hamming codes.	3	CO5	L3
10.	Explain decoding of cyclic codes.	3	CO5	L2
11.	The generator polynomial of a (7,4) Cyclic code is . $G(p) = p^3 + p + 1$. Find the code vectors corresponding to the message vectors 1011 and 1101 in Non-Systematic form.	7	CO5	L3
12.	Draw the encoder circuit for a (7,4) Cyclic code with and $G(p) = p^3 + p + 1$. obtain the codeword for the message sequence 1001.	7	CO5	L3
13.	Obtain the generator matrix of a (7,4) Cyclic code for the generator polynomial $G(p) = p^3 + p^2 + 1$ in Non-systematic form and using that find the codeword for the message vector 1100 and 1111.	7	CO5	L3
14.	For a (7,4) Cyclic code, the received vector Y is 1110101 and the generator polynomial is p^3+p+1 . Draw the syndrome calculation circuit and correct the single error in the received vector.	7	CO5	L3
15.	The generator polynomial of a (15,7) cyclic code is $g(x)=1+x^4+x^6+x^7+x^8$. Find the codeword in systematic form for the message (0101010) using encoder circuit listing the states of registers in each step of code computation. Verify the answer by direct hand calculation.	14	CO5	L3
16.	The generator polynomial of a (15,7) Cyclic code is, $G(p) = p^8 + p^7 + p^6 + p^4 + 1$ Find the code vector in Systematic form for the message vector 1101100	3	CO5	L3
17.	Draw the general encoding circuit for (n,k) cyclic code and explain its operation.	7	CO5	L2

18.	Find the generator and parity check matrices of (7,4) cyclic code where $x^n+1 = x^7+1 = (1+x+x^3)(1+x+x^2+x^4)$.	7	CO5	L3
19.	For a (7,4) cyclic code, the received vector $Z(x)$ is 0100101 and the generator polynomial is $g(x)=1+x+x^3$. Draw the syndrome calculation circuit and correct the single error in the received vector.	14	CO5	L3
20.	The generator polynomial of a (7, 4) Cyclic code is $G(p) = p^3 + p + 1$. Find the code vectors corresponding to the message vectors 1011 and 1101 in Non-systematic form	10	CO5	L3
21.	Draw syndrome circuit for a (7, 4) cyclic code generated by $g(x) = 1 + x + x^2$. If the received codeword r is [0010110], what is the syndrome of r ? Explain the circuit with a table showing the contents of syndrome register.	10	CO5	L3
Module 5				
1.	Give notes on tanner graph representation with an example.	3	CO6	L2
2.	Explain the concept of Tanner graph in LDPC Code?	3	CO6	L2
3.	Draw the encoder circuit of a (2, 1, 3) convolutional encoder, if the generator sequences are $g^{(1)}=(1\ 0\ 0\ 1)$ and $g^{(2)} = (1\ 1\ 0\ 1)$ respectively.	3	CO6	L3
4.	What are convolutional codes? How is it different from block codes?	3	CO6	L2
5.	For a (2,1,2) convolutional encoder with impulse response $g^{(1)}=[111]$ and $g^{(2)}=[101]$, find the output sequence for the message $D=1\ 0\ 0\ 1\ 1$ by time domain approach.	3	CO6	L2
6.	Explain trellis diagram.	3	CO6	L2
7.	Draw the encoder circuit of a (2, 1, 3) convolutional encoder, with sequences are [1 0 0 1] and [1 1 1 1] as impulse responses.	3	CO6	L3
8.	Explain LDPC Codes.	3	CO6	L2
9.	Explain the Message-passing decoding scheme for LDPC codes.	7	CO6	L2
10.	For a Convolutional encoder, the generator sequences are given as, $g^{(1)} = (1,1,0)$ and $g^{(2)} = (1,0,1)$. Obtain the a. Code Tree for the message sequence 1011 b. State diagram	7	CO6	L3
11.	For a Convolutional encoder, the generator sequences are given as, $g^{(1)} = (1,0,1)$ and $g^{(2)} = (0,1,1)$. a. Draw the encoder circuit. b. Output sequence for a message sequence 1011 using Time domain approach.	14	CO6	L3
12.	For a (2,1,3) convolutional encoder, the generator sequences are given as, $g^{(1)} = (1011)$ and $g^{(2)} = (1111)$. i) Draw the encoder circuit and obtain the state diagram. ii) Find the output sequence for a message sequence 1101 using Time domain approach.	14	CO6	L3

13.	For the convolutional encoder shown in figure , decode the sequence ,Y= 11 01 11 00 01 10 using Viterbi algorithm. 	7	CO6	L3
14.	Consider a (3,1,2) convolutional code with $g^{(1)}=(1\ 1\ 0)$, $g^{(2)}=(1\ 0\ 1)$ and $g^{(3)}=(1\ 1\ 1)$. i) Draw the encoder block diagram. ii) Find the generator matrix. iii) Find the code vector corresponding to the information sequence (1 1 1 0 1) using time domain and transfer domain approach.	14	CO6	L3
15.	Explain Viterbi algorithm for decoding of convolutional code with example with the help of figure.	14	CO6	L2
16.	For a Convolutional encoder, the generator sequences are given as, $g^{(1)} = (1,1,0)$ and $g^{(2)} = (1,0,1)$. Obtain the state diagram and encode the message sequence (1011). Also verify the output sequence using the Transform domain approach.	14	CO6	L3
17.	For a (2,1,2) convolutional encoder with generator sequences $g^{(1)} = (1,1,1)$ and $g^{(2)} = (1,0,1)$. Draw the Trellis diagram and perform Viterbi decoding on this trellis for the received sequence {01, 10, 10, 11, 01, 01, 11} and obtain the estimate of the transmitted sequence.	14	CO6	L3
18.	Draw the trellis diagram of (2,1,3) convolutional encoder with impulse response $g^{(1)}=(1011)$ and $g^{(2)}=(1101)$. Also decode the sequence, Y = 110111000110 using the Viterbi algorithm.	14	CO6	L3

Prepared By: Ms. Anu Antony

Checked By : Ms. Ambily Joseph,

Course Code & Name: ECT362 INTRODUCTION TO MEMS

1. Prescribed Syllabus

Module	Topic	Hours
1	MEMS and Microsystems: Applications – multidisciplinary nature of MEMS – principles and examples of Micro sensors and micro actuators – micro accelerometer –comb drives - Micro grippers – micro motors, micro valves, micro pumps, Shape Memory Alloys. Actuation and Sensing techniques: Thermal sensors and actuators, Electrostatic sensors and actuators, Piezoelectric sensors and actuators, magnetic actuators	8
2	Review of Mechanical concepts: Stress, Strain, Modulus of Elasticity, yield strength, ultimate strength – General stress strain relations – compliance matrix. Overview of commonly used mechanical structures in MEMS - Beams, Cantilevers, Plates, Diaphragms – Typical applications Flexural beams: Types of Beams, longitudinal strain under pure bending – Deflection of beams – Spring constant of cantilever – Intrinsic stresses	6
3	Scaling laws in miniaturization - scaling in geometry, scaling in rigid body dynamics, Trimmer force scaling vector, scaling in electrostatic and electromagnetic forces, scaling in electricity and fluidic dynamics, scaling in heat conducting and heat convection. Materials for MEMS – Silicon – Silicon compounds – Silicon Nitride, Silicon Dioxide, Silicon carbide, Poly Silicon, GaAs , Silicon Piezo resistors. Polymers in MEMS – SU-8, PMMA, PDMS, Langmuir – Blodgett Films.	10
4	Micro System fabrication – Photolithography – Ion implantation- Diffusion – Oxidation – Chemical vapour deposition – Etching Overview of Micro manufacturing – Bulk micro manufacturing, Surface micro machining, LIGA process –Microstereo lithography	8
5	Micro system Packaging: general considerations in packaging design – Levels of Micro system packaging. Bonding techniques for MEMS: Surface bonding, Anodic bonding, Silicon - on - Insulator, wire bonding, Sealing – Assembly of micro systems. Overview of MEMS areas : RF MEMS, BioMEMS, MOEMS, NEMS	6

2. Text Books (T)

T1. Chang Liu, Foundations of MEMS, Pearson 2012

T2. Tai-Ran Hsu, MEMS and Microsystems Design and Manufacture, TMH, 2002

3. Reference Books (R)

- R1. Chang C Y and Sze S. M., VLSI Technology, McGraw-Hill, New York, 2000
 R2. Julian W Gardner, Microsensors: Principles and Applications, John Wiley & Sons, 1994
 R3. Mark Madou, Fundamentals of Micro fabrication, CRC Press, New York, 1997
 R4. Stephen D. Senturia, Microsystem design, Springer (India), 2006.
 R5. Thomas B. Jones, Electromechanics and MEMS, Cambridge University Press, 2001
 R6. Gregory T.A. Kovacs, Micromachined Transducers Sourcebook, McGraw Hill, 1998

4. Course Objectives

This course aims

- To understand the operation of major classes of MEMS devices/systems
- To study the essential mechanical concepts of MEMS
- To know about the various materials used for MEMS
- To grasp the fundamentals of standard micro fabrication techniques and processes
- To create interest for further study in this area

5. Course Pre / Co-requisite

1. EST130-Basics of Electrical and Electronics Engineering
2. EST 100-Engineering Mechanics

6. Course Outcomes

After the completion of the course the student will be able to

CO1 Describe the working principles of micro sensors and actuators

CO2 Identify commonly used mechanical structures in MEMS

CO3 Explain the application of scaling laws in the design of micro systems

CO4 Identify the typical materials used for fabrication of micro systems

CO5 Explain the principles of standard micro fabrication techniques

CO6 Describe the challenges in the design and fabrication of Micro systems

7. Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes

PO/ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
CO1	H	H											H		
CO2	H	H											H		
CO3	H	H											H		
CO4	H	H	M										H		
CO5	H	H											H		
CO6	H	H										M	H		

8. Justification for CO-PO-PSO Correlation

CO	PO/P SO	Justification

CO1	PO1	Student will be able to apply the basic knowledge of engineering fundamentals to understand the working principles of micro sensors and actuators
	PO2	Understanding the working principles of micro sensors and actuators enable students to analyze MEMS system effectively
	PSO1	Knowledge on the working of microsensors and microactuators will enable students to develop MEMS components in future
CO2	PO1	Student will be able to apply the basic knowledge of engineering fundamentals to understand the mechanical concepts and identify commonly used mechanical structures in MEMS
	PO2	Student will be able to apply the principles of mathematics and engineering science to analyze the longitudinal strain under pure bending
	PSO1	Understanding the commonly used mechanical structures in MEMS will enable the students to apply the knowledge in the design of MEMS structures.
CO3	PO1	Student will be able to apply the basic knowledge of engineering fundamentals in understanding the use of scaling laws in MEMS
	PO2	Student will be able to use the principles of scaling laws to analyze the effect of miniaturization in MEMS
	PSO1	Knowledge on the scaling laws will enable the students to understand the effect of miniaturization in the design of MEMS components.
CO4	PO1	Understanding the fundamental concepts in chemistry will enable the students to identify the production process of typical materials used for fabrication of Microsystems.
	PO2	Understanding the properties of typical MEMS materials will enable the students to analyze their suitability for fabrication of Microsystems
	PO3	Knowledge of typical MEMS materials used for fabrication enables the students to suggest a material solution for fabrication
	PSO1	Understanding the typical MEMS materials used for fabrication will enable the students to apply the material knowledge for the development of a MEMS device.
CO5	PO1	Knowledge in science enable the students to explain the processes taking place in the standard micro fabrication techniques
	PO2	Student will be able to use the principles of science to analyze the suitability of different micro fabrication techniques for MEMS
	PSO1	Understanding the principles of standard micro fabrication techniques will enable the students to develop MEMS devices in future
CO6	PO1	Student will be able to apply the basic knowledge of engineering fundamentals to describe the challenges in the design and fabrication
	PO2	Understanding the engineering fundamentals will enable students to analyze the challenges in the design and fabrication
	PO12	Exploring the specialized areas of MEMS will enable the students to seek more knowledge and deepen their understanding through self directed continuous learning practice
	PSO1	Knowledge of RF MEMS will enable the students to design a RF MEMS device.

9. Curricular gaps (if any)

NIL

10. Course Enrichment Activities

Sl No	Description	Proposed Activities	Relevance to POs and PSOs
1.	RF MEMS	Session by Dr. Neenu Joseph	PO1, PO2, PO12, PSO1

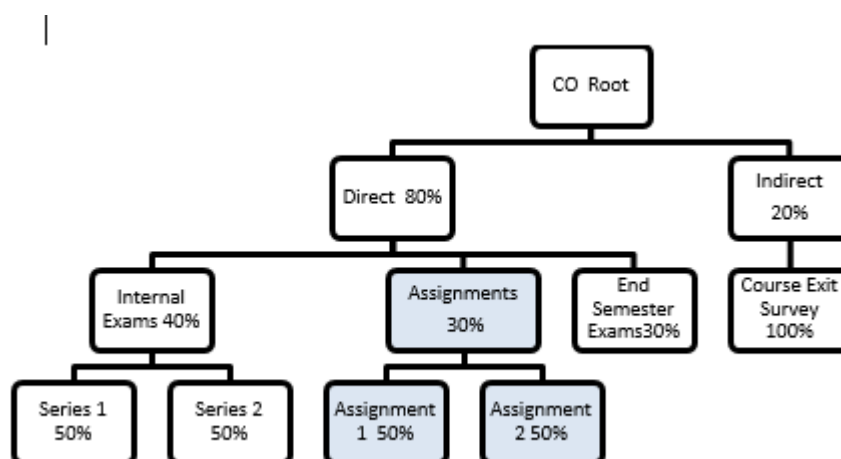
11. Internal Assessment mark allocation (as per university curriculum)

Attendance	- 10 marks
Continuous Assessment Test	- 25 marks
<u>Assignment (s)/ Course Project</u>	<u>- 15 marks</u>
<u>Total</u>	<u>- 50 marks</u>

12. Assessment – CO Mapping

	Tools		Weightage	CO1	CO2	CO3	CO4	CO5	CO6
Direct Assessment Tools**	Internal Exam(s)40%	Series 1	20%	x	x				
		Series 2	20%			x	x	x	
	Assignment (s)/30%	A1	15%	x	x	x			
		A2	15%				x	x	x
	End Semester Exam		30%	x	x	x	x	x	x
Indirect Assessment Tool	Course Exit Survey		100%	x	x	x	x	x	x

13. Assessment Configuration



14. Course Plan

Hour	Topic	Module	Reference(s)	Teaching Pedagogy
1	Introduction to MEMS & Microsystems	1	T1,T2	Lecture
2	Applications – multidisciplinary nature of MEMS – principles and examples of Micro sensors and micro actuators	1	T1,T2	Lecture

3	Thermal Sensors : Thermocouple Thermal Actuator : Thermal Bimorph	1	T1,T2	Lecture
4	Thermistor	1	T1,T2	Tutorial
5	Thermal Actuation : Microvalve, Shape Memory Alloys	1	T1,T2	Lecture
6	Electrostatic Sensor:microaccelerometer Electrostatic Actuator : Microgripper	1	T1,T2	Lecture
7	Electrostatic Actuation : Micromotor, Micropump	1	T1,T2	Lecture
8	Piezoelectric Sensor : Piezoelectric Accelerometer, Piezoelectric Actuation	1	T1,T2	Lecture
9	magnetic actuators	1	T1,T2	Lecture
10	Review of Mechanical concepts: Stress, Strain, Modulus of Elasticity, yield strength, ultimate strength	2	T1,T2	Lecture
11	General stress strain relations – compliance matrix	2	T1,T2	Lecture
12	Overview of commonly used mechanical structures in MEMS - Beams, Cantilevers, Plates, Diaphragms – Typical applications	2	T1,T2	Lecture
13	Flexural beams: Types of Beams	2	T1,T2	Lecture
14	longitudinal strain under pure bending	2	T1,T2	Lecture
15	Deflection of beams, Intrinsic stresses	2	T1,T2	Lecture
16	Spring constant of cantilever	2	T1,T2	Tutorial
17	Scaling laws in miniaturization - scaling in geometry, scaling in rigid body dynamics	3	T1,T2	Lecture
18	Trimmer force scaling vector	3	T1,T2	Lecture
19	scaling in electrostatic and electromagnetic forces	3	T1,T2	Lecture
20	scaling in electricity and fluidic dynamics	3	T1,T2	Lecture
21	scaling in heat conducting and heat convection	3	T1,T2	Tutorial
22	Materials for MEMS – Silicon – Silicon compounds- Silicon Nitride	3	T1,T2	Lecture
23	Silicon Dioxide, Silicon carbide	3	T1,T2	Lecture
24	Poly Silicon, GaAs , Silicon Piezo resistors	3	T1,T2	Lecture
25	Polymers in MEMS – SU-8, PMMA	3	T1,T2	Lecture
26	PDMS, Langmuir – Blodgett Film	3	T1,T2	Lecture
27	LB Process	3	T1,T2	Tutorial
28	Micro System fabrication, Photolithography	4	T1,T2	Lecture
29	Ion implantation	4	T1,T2	Lecture
30	Diffusion, Oxidation	4	T1,T2	Lecture
31	Chemical vapour deposition, Etching	4	T1,T2	Lecture

32	Overview of Micro manufacturing – Bulk micro manufacturing	4	T1,T2	Lecture
33	Surface micro machining	4	T1,T2	Lecture
34	LIGA process	4	T1,T2	Tutorial
35	Microstereo lithography	4	T1,T2	Lecture
36	Fabrication of a square tube using LIGA process	4	T1,T2	Tutorial
37	Micro system Packaging: general considerations in packaging	5	T1,T2	Lecture
38	Levels of Micro system packaging	5	T1,T2	Lecture
39	Bonding techniques for MEMS : Surface bonding , Anodic bonding	5	T1,T2	Tutorial
40	Silicon - on - Insulator , wire bonding	5	T1,T2	Lecture
41	Sealing – Assembly of micro systems	5	T1,T2	Lecture
42	Overview of MEMS areas : RF MEMS, BioMEMS, MOEMS, NEMS	5	T1,T2	Tutorial

15. Question Bank

Module 1				
Sl. No.	Question	Marks	CO	BL
1	Explain the basic block diagram of Micro sensors & Actuators with neat sketches	3	CO1	L2
2	Explain the working principle of micro inertia sensor	3	CO1	L2
3	With necessary block diagram explain principle of micro sensors.	3	CO1	L2
4	List three applications of MEMS systems.	3	CO1	L1
5	With a neat diagram, explain the basic block diagram of a microelectromechanical system.	3	CO1	L2
6	Explain the working of shape memory alloys.	3	CO1	L2
7	Write short notes on the multidisciplinary nature of microsystem design and manufacturing.	3	CO1	L1
8	Differentiate the operating principle of thermal sensors and actuators. State any two applications	6	CO1	L2

9	Explain the operating principle of piezoelectric sensors and actuators with relevant sketches	8	CO1	L2
10	Describe the operating principle of Linear Micro motors with neat diagrams	6	CO1	L2
11	Explain the principle of operation of MEMS based electrostatic sensors and actuators.	8	CO1	L2
12	With necessary diagrams explain the working of linear micro motors and rotary micro motors.	8	CO1	L2
13	Draw and explain the working of a micro valve.	6	CO1	L2
14	Describe the working principle of micro accelerometer with neat schematic diagrams. Give two applications.	8	CO1	L2
15	Explain the operating principle of thermal bimorphs with neat sketches.	6	CO1	L2
16	Explain the operating principle of the cantilever beam accelerometer with a neat sketch.	8	CO1	L2
17	Explain the operating principle of the microgripper with relevant sketches	6	CO1	L2
18	With relevant sketches and equations, explain the operation of a capacitive accelerometer.	8	CO1	L2
19	Explain the operation of the actuator using piezoelectric crystals with relevant sketches.	6	CO1	L2
Module 2				
20	Define normal stress and strain, how it is different from shear stress and strain	3	CO2	L1
21	Describe the different boundary conditions that are encountered in MEMS systems	3	CO2	L2
22	Define normal stress, normal strain and modulus of elasticity.	3	CO2	L1
23	Calculate the spring constant of the given mechanical structure in the direction of force F applied.	3	CO2	L2

24	List any three strategies for minimizing undesirable intrinsic bending.	3	CO2	L1
25	List any three mechanical structures used in MEMS. Explain any one structure by emphasizing its application.	3	CO2	L2
26	Identify the relation between tensile stress and strain in terms of compliance matrix	6	CO2	L2
27	Discriminate how plates and diaphragms can be used for the design of MEMS with examples	8	CO2	L2
28	Determine the moment of inertia for a beam under longitudinal strain and also find Flexural formula	8	CO2	L2
29	State the reasons of intrinsic stress in thin film materials under room temperature and zero loading conditions. Describe anyone method for stress compensation.	6	CO2	L2
30	Explain with neat sketches the type of mechanical beams and boundary conditions associated with supports.	6	CO2	L2
31	In terms of the compliance matrix, Identify the relation between tensile stress and strain	8	CO2	L2
32	With the aid of relevant sketches, derive the spring constant of the cantilever.	8	CO2	L2
Module 3				
33	Obtain the relationship with linear dimension l under scaling for the following electrical parameters. a) Electrical resistance R b) Resistive power loss P .	3	CO3	L2
34	Give one application each of PDMS and PMMA in MEMS fabrication.	3	CO4	L1
35	Explain the significance of surface to volume ratio.	3	CO3	L2
36	Derive equations for acceleration a , time t , and power density P/V based on the Trimmer force scaling vector.	8	CO3	L2
37	State three relevant properties of Silicon Carbide and Silicon Nitride for use in microsystems.	6	CO4	L2

38	With reference to scaling, derive the expressions for electrostatic forces and electromagnetic forces. Prove that electromagnetic actuation is least preferred over electrostatic actuation for scaling.	9	CO3	L3
39	What are the reasons for using Si most widely as a MEMS material?	5	CO4	L1
40	Explain the features and manufacturing methods of any two silicon compounds.	6	CO4	L2
41	Explain the processes involved in the fabrication of the SU-8 films.	5	CO4	L2
42	Explain Trimmer Force Scaling Vector. Use scaling laws to estimate the changes in acceleration, time to actuate a MEMS component if its weight is reduced by a factor of 10.	8	CO3	L2
43	Explain Langmuir-Blodgett process with relevant figures	6	CO4	L2
Module 4				
44	Differentiate dry oxidation and wet oxidation method.	3	CO5	L2
45	Explain stiction with an example.	3	CO5	L2
46	List the advantages of Surface micromachining over Bulk micromanufacturing.	3	CO5	L1
47	Define etch stop. State the different methods used to stop etching.	3	CO5	L1
48	Describe chemical etching and plasma etching	8	CO5	L2
49	Describe steps of fabrication of a square tube using LIGA process.	6	CO5	L2
50	With neat sketches and equations, explain chemical vapor deposition involved microsystem fabrication.	8	CO5	L2
51	With neat diagrams explain how a cantilever beam is fabricated using surface micromachining.	6	CO5	L2
52	With neat sketches, explain diffusion and ion implantation involved in micro system fabrication.	8	CO5	L2
53	With neat sketches, explain any two problems associated with surface micromachining.	6	CO5	L2
54	With neat sketches, explain bulk micro manufacturing.	6	CO5	L2
55	Explain the LIGA process associated with MEMS fabrication.	8	CO5	L2
56	Explain the steps involved in photolithography with neat sketches.	8	CO5	L2

57	Give any six relevant points of comparison between bulk and surface micromachining	6	CO5	L2
Module 5				
58	Describe any one sealing method used in assembly of microsystems.	3	CO6	L2
59	Mention the general considerations to be taken in the microsystem packaging design.	3	CO6	L1
60	Why the microsystem packaging is critical?	3	CO6	L1
61	Give any 3 features of NEMS.	3	CO6	L1
62	Describe anodic bonding.	3	CO6	L2
63	Explain the following process techniques with figures a) Silicon-on-Insulator b) Wire bonding	8	CO6	L2
64	Explain the various applications of RF MEMS.	6	CO6	L2
65	Explain the following bonding techniques a) Anodic bonding b) Silicon fusion bonding	8	CO6	L2
66	Write short notes on a) Bio-MEMS b) NEMS	6	CO6	L1
67	With neat sketches, explain sealing in micro pressure sensors, microvalves, and micropumps.	10	CO6	L2
68	Describe different levels of microsystem packaging.	6	CO6	L2

Prepared By: Dr Rakesh S

Checked By : Dr. Ann Varghese

Course Code & Name: ECT308 Comprehensive Course Work

1. Prescribed Syllabus

Five core courses credited from Semesters 3, 4 and 5 are chosen for the detailed study in this course work.

- Analog Circuits
- Logic Circuit Design
- Linear Integrated
- Circuits Digital Signal processing
- Analog and Digital communication

2. Text Books (T)

Text books prescribed in the course syllabus

3. Reference Books (R)

Reference books prescribed in the course syllabus

4. Course Objectives

The objective of this Course work is to ensure the comprehensive knowledge of each student in the most fundamental Program core courses in the curriculum.

5. Course Pre / Co-requisite

Full Syllabus of all five selected courses

- ✓ ECT202 Analog Circuits
- ✓ ECT203 Logic Circuit Design
- ✓ ECT301 Linear Integrated Circuits
- ✓ ECT303 Digital Signal processing
- ✓ ECT305 Analog and Digital communication

6. Course Outcomes

- CO1. Apply the knowledge of circuit theorems and solid state physics to solve the problems in electronic Circuits
- CO2. Design a logic circuit for a specific application

- CO3. Design linear IC circuits for linear and non-linear circuit applications. CO4: Explain basic signal processing operations and Filter designs
- CO4. Explain existent analog and digital communication systems

7. Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes

PO/ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H	H										M	H		
CO2	H	H										M	H		
CO3	H	H										M	H		
CO4	H	H										M	H		
CO5	H	H										M	H		

8. Justification for CO-PO-PSO Correlation

CO	PO/Justification Statement
CO1	PO1: Understanding of circuit theorems and solid state physics will enable the students to apply their knowledge in electronics fundamentals. Hence highly correlated.
	PO2: Analysing different electronic circuits will enable the students to use first principles of mathematics, and engineering sciences. Hence highly correlated
	PO12: The knowledge in circuit theorems and solid state physics will enable the students to solve complex circuits. Hence moderately correlated.
	PSO 1: Absorbing knowledge in circuit theorems and solid state physics will enable the students to solve complex circuits. Hence highly correlated.
CO2	PO1: Understanding of different logic design principles will enable the students to apply their knowledge in electronics fundamentals. Hence highly correlated.
	PO2: Analysing different logic circuits will enable the students to use first principles of mathematics, and engineering sciences. Hence highly correlated
	PO12: The knowledge in logic circuits will enable the students to solve complex circuits. Hence moderately correlated.
	PSO 1: Absorbing knowledge in logic circuits will enable the students to solve complex circuits. Hence highly correlated.
CO3	PO1: Understanding of different linear IC circuits will enable the students to apply their knowledge in electronics fundamentals. Hence highly correlated.
	PO2: Analysing different linear IC circuits will enable the students to use first principles of mathematics, and engineering sciences. Hence highly correlated
	PO12: The knowledge in linear IC circuits will enable the students to solve complex circuits. Hence moderately correlated.
	PSO 1: Absorbing knowledge in linear IC circuits will enable the students to solve complex circuits. Hence highly correlated.
	PO1: Understanding of signal processing operations and Filter designs will enable the students to apply their knowledge in electronics fundamentals. Hence highly correlated.

CO4	PO2: Analysing signal processing operations and Filter designs will enable the students to use first principles of mathematics, and engineering sciences. Hence highly correlated
	PO12: The knowledge in signal processing operations and Filter designs will enable the students to solve complex circuits .Hence moderately correlated.
	PSO 1: Absorbing knowledge in signal processing operations and Filter designs will enable the students to solve complex circuits .Hence highly correlated.
CO5	PO1: Understanding of different logic design principles will enable the students to apply their knowledge in electronics fundamentals. Hence highly correlated.
	PO2: Analysing different logic circuits will enable the students to use first principles of mathematics, and engineering sciences. Hence highly correlated
	PO12: The knowledge in logic circuits will enable the students to solve complex circuits .Hence moderately correlated.
	PSO 1: Absorbing knowledge in logic circuits will enable the students to solve complex circuits .Hence highly correlated.

9. Curricular gaps (if any)

Nil

10. Course Enrichment Activities*

Sl No	Description	Proposed Activities **	Relevance to POs and PSOs
	Nil		

11. Internal Assessment mark allocation (as per university curriculum)

End Semester Examination - 50 marks

Total - 50 mark

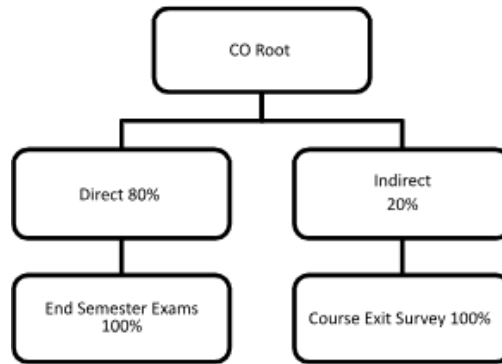
End Semester Examination Pattern:

Objective Questions with multiple choice (Four). Question paper include Fifty Questions of One mark each covering the five identified courses

12. Assessment – CO Mapping (Put 'x' if mapping is present)

	Tools	Weightage	CO1	CO2	CO3	CO4	CO5
Direct Assessment Tools	End Semester Exam – 100%	100%	x	x	x	x	x
Indirect Assessment Tool	Course Exit Survey	100%	x	x	x	x	x

13. Assessment Configuration



14. Course Plan

Hour	Topic	Module	Reference(s)	Teaching Pedagogy
1	Analog Circuits	1	R1, R2	Flipped Classroom
2	Mock Test on Module 1 and Module 2	1	R1, R2	Mock Test
3	Mock Test on Module 3, Module 4 and Module 5	1	R1, R2	Mock Test
4	Feedback and Remedial	1	R1, R2	Group Discussion
5	Logic Circuit design	2	R3	Flipped Classroom
6	Mock Test on Module 1, Module 2 and Module 3	2	R3	Mock Test
7	Mock Test on Module 4 and Module 5	2	R3	Mock Test
8	Feedback and Remedial	2	R3	Group Discussion
9	Linear IC	3	R2	Flipped Classroom
10	Mock Test on Module 1 and Module 2	3	R2	Mock Test
11	Mock Test on Module 3, Module 4 and Module 5	3	R2	Mock Test
12	Feedback and Remedial	3	R2	Group Discussion
13	Digital Signal Processing	4	R4	Flipped Classroom
14	Mock Test on Module 1, Module 2 and Module 3	4	R4	Mock Test
15	Mock Test on Module 4 and Module 5	4	R4	Mock Test
16	Feedback and Remedial	4	R4	Group Discussion
17	Analog and Digital Communication	5	R5, R6	Flipped Classroom
18	Mock Test on Module 1, Module 2	5	R5, R6	Mock Test

	and Module 3			
19	Mock Test on Module 4 and Module 5	5	R5, R6	Mock Test
20	Feedback and Remedial	5	R5, R6	Group Discussion

Prepared By : Sonu K Varghese

Checked by : Arun V

Course Code & Name: ECL332 COMMUNICATION LAB

1. Prescribed Syllabus

Part A

Any two experiments are mandatory. The students shall design and setup simple prototype circuits with the help of available ICs. They can observe Waveforms produced by these circuits for standard ideal inputs.

1. FM generation and demodulation using PLL
2. Generation and Detection of PCM signals
3. Generation and Detection of Delta modulated signals
4. Generation and Detection of BPSK
5. Generation and Detection of 16-QPSK

Part B

All experiments are mandatory. The students shall write scripts to simulate components of communication systems. They shall plot various graphs that help to appreciate and compare performance.

1. Performance of Waveform Coding Using PCM

1. Generate a sinusoidal waveform with a DC offset so that it takes only positive amplitude value.
2. Sample and quantize the signal using an uniform quantizer with number of representation levels L. Vary L. Represent each value using decimal to binary encoder.
3. Compute the signal-to-noise ratio in dB.
4. Plot the SNR versus number of bits per symbol. Observe that the SNR increases linearly.

2. Pulse Shaping and Matched Filtering

1. Generate a string of message bits.
2. Use root raised cosine pulse $p(t)$ as the shaping pulse, and generate the corresponding baseband signal with a fixed bit duration T_b . You may use roll-off factor as $\alpha = 0.4$.
3. Simulate transmission of baseband signal via an AWGN channel
4. Apply matched filter with frequency response $P_r(f) = P^*(f)$ to the received signal.
5. Sample the signal at mT_b and compare it against the message sequence.

3. Eye Diagram

1. Generate a string of message bits.
2. Use raised cosine pulse $p(t)$ as the shaping pulse, and generate the corresponding baseband signal with a fixed bit duration T_b . You may use roll-off factor as $\alpha = 0.4$.
3. Use various roll off factors and plot the eye diagram in each case for the received signal. Make a comparison study among them.

4. Error Performance of BPSK

1. Generate a string of message bits.
2. Encode using BPSK with energy per bit E_b and represent it using points in a signal-space.
3. Simulate transmission of the BPSK modulated signal via an AWGN channel with variance $N_0/2$.
4. Detect using an ML decoder and plot the probability of error as a function of SNR per bit E_b/N_0 .

5. Error Performance of QPSK

1. Generate a string of message bits.
2. Encode using QPSK with energy per symbol E_s and represent it using points in a signal-space.
3. Simulate transmission of the QPSK modulated signal via an AWGN channel with variance $N_0/2$ in both I-channel and Q-channel.
4. Detect using an ML decoder and plot the probability of error as a function of SNR per bit E_b/N_0 where $E_s = 2E_b$.

Part C

Any two experiments are mandatory. The students shall emulate communication systems with the help of software-defined-radio hardware and necessary control software. Use available blocks in GNU Radio to implement all the signal. These experiments will help students to appreciate better how theoretical concepts are translated into practice.

1. Familiarization with Software Defined Radio (Hardware and Control Software)

1. Familiarize with an SDR hardware for reception and transmission of RF signal.
2. Familiarize how it can be interfaced with computer.
3. Familiarize with GNU Radio (or similar software's like Simulink/ Lab- View) that can be used to process the signals received through the SDR hardware.
4. Familiarize available blocks in GNU Radio. Study how signals can be generated and spectrum (or power spectral density) of signals can be analyzed. Study how filtering can be performed.

2. FM Reception

1. Receive digitized FM signal (for the clearest channel in the lab) using the SDR board.
2. Set up an LPF and FM receiver using GNU Radio.
3. Use appropriate sink in GNU Radio to display the spectrum of signal.
4. Resample the voice to make it suitable for playing on computer speaker.

3. FM Transmission

1. Use a wave file source.
2. Set up an FM transmitter using GNU Radio.
3. Resample the voice source and transmit using the SDR.

2. Text Books (T)

T1. WH Tranter, KS Shanmugan, TS Rappaport, KL Kosbar, "Principles of Communication Systems Simulation with Wireless Applications", Prentice Hall.

T2. Mathuranathan Viswanathan, "Digital Modulations using Python" T3. Tomasi, Electronic Communications System, Pearson, 5/e, 2011

T3. Carl Laufer, "The Hobbyist's Guide to the RTL-SDR: Really Cheap Software Defined Radio"

3. Reference Books (R)

R1. Neel Pandeya, "Implementation of a Simple FM Receiver in GNU Radio," <https://kb.ettus.com/>

R2. Michael Ossmann, "Software Defined Radio with HackRF," YouTube Tutorial

4. Course Objectives

To provide experience on design, testing and analysis of few electronic circuits used in communication engineering.

5. Course Pre / Co-requisite

- ✓ ECT 305 Analog and Digital Communication
- ✓ ECT 303 Digital Signal Processing

6. Course Outcomes

_At the end of this course the students will be able to

CO1: Setup simple prototype circuits for waveform coding and digital modulation techniques working in a team.

CO2: Simulate the error performance of a digital communication system using standard binary and M -ary modulation schemes.

CO3: Develop hands-on skills to emulate a communication system with software-designed-radio working in a team

7. Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes

PO/ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
CO1	H	H	H	M					H	M		M	H	H	
CO2	H	H	H	M	H					M		M	H	H	H
CO3	H	H	H	H	H				H	M		M	H	H	H

8. Justification for CO-PO-PSO Correlation

Students will be able to

CO	PO	Justification Statement
CO1	PO1	Set up prototype circuits for waveform coding and digital communication will enable the students to apply their knowledge in basic in circuits and communication engineering. Hence highly correlated .
	PO2	Analysing the output waveforms of waveform coding and digital communication techniques will enable the students to use first principles of mathematics, and engineering sciences. Hence highly correlated
	PO3	Designing of prototype circuits for waveform coding and digital communication, will enable the students to solve complex engineering problems with appropriate consideration of safety and environmental considerations. Hence highly correlated.
	PO4	Designing Circuits and experimental data , will enable the students to moderately interpret the valid results and find the conclusions. Hence moderately correlated .

	PO9	Design and set up the circuits functioning them effectively as an individual , and a member in a team to execute the work.
	PO10	Comprehend and write effective reports & document the design and results.
	PO12	The knowledge in waveform coding and digital communication techniques enable the students to design more complex circuits used in communication systems. Hence moderately correlated.
	PSO1	Absorbing the knowledge in waveform coding and digital communication circuits will enable the students to design different communication systems. Hence highly correlated.
	PSO2	Analysing the experimental data will enable the students to validate the design of digital communication circuits. Hence highly correlated.
CO2	PO1	:Knowledge in error performance of a digital communication system will enable the students to apply the concepts of binary and M -ary modulation schemes. Hence highly correlated.
	. PO2	Analysis of the impact of different modulation techniques on the system's error performance, such as bit error rate, signal-to-noise ratio will enable to gain hands-on experience . Hence highly correlated
	PO3	Simulating the error performance of digital communication systems using standard binary and M-ary modulation schemes is crucial for students to understand the trade-offs between different modulation techniques and for designing efficient and reliable communication systems. Hence highly correlated.
	PO4	Simulating the modulation schemes will enable the students to moderately interpret the valid results and find the conclusions. Hence moderately correlated
	PO5	Simulating a communication system, students will have the opportunity to practice and develop their skills on software tool in communication.
	PO9	Simulating different error performance of digital communication systems students will be able to function effectively as an individual and to execute the work
	PO10	From the results and inference student will be able to comprehend & write effective reports & document the design and results.
	PO12	Simulating the error performance of M-ary modulation schemes, students will understand how these schemes work and how they can be optimized for different applications.
	PSO1	Knowledge and skills gained in this course, will enable students to analyze the effects of different parameters, such as channel noise, signal-to-noise ratio (SNR), and channel capacity, on the performance of the system.
	PSO2	Analysing the experimental data will enable the students to validate the design of digital communication circuits. Hence highly correlated.

	PSO3	Simulating a communication system, students will have the opportunity to practice and develop their skills on software tool in communication.
CO3	PO1	Emulating a communication system with software-designed-radio, will enable the students to apply their knowledge of communication theory to a real-world scenario, developing their hands-on technical skills in the process. Hence highly correlated.
	PO2	Emulating a communication system with software-designed-radio, students will have the opportunity to apply their theoretical knowledge to real-world problems and gain practical experience in design, implementation, and testing of communication systems. Hence highly correlated.
	PO3	Emulating a communication system with software-designed-radio, students will gain a deeper understanding of the intricacies involved in designing and implementing a communication system. Hence highly correlated.
	PO4	Emulating a communication system will enable the students to moderately interpret the valid results and find the conclusions. Hence moderately correlated
	PO5:	Hands on skill on software-designed-radio will enable the students to practice the use of relevant software tools, hardware components, and communication systems.
	PO9	By working in a team to develop a communication system with software-designed-radio, students will learn to collaborate and communicate effectively with others.
	PO10	From the results and inference student will be able to comprehend & write effective reports & document the design and results.
	PO12:	Absorbing the knowledge in emulating communication system with software-designed-radio will enable the students to used in communication systems.
	PSO1	Absorbing the knowledge in emulating communication system with software-designed-radio will enable the students to understand the practical applications of software-designed-radio. Hence highly correlated.
	PSO2	Emulating a communication system will enable the students to moderately interpret the valid results and find the conclusions. Hence moderately correlated
	PSO3	Hands-on skill on software-designed-radio will enable the students to practice the use of relevant software tools, hardware components, and communication systems. Hence highly correlated.

9. Curricular gaps (if any)

Nil

10. Course Enrichment Activities*

Sl No	Description	Proposed Activities	Relevance to POs and PSOs
1	WORKSHOP on Software defined Radio by Mr. Tubin T X	Workshop	PO1, PO2, PO3, PO4, PO5, PSO1, PSO2, PSO3

11. Course Plan / Schedule of experiments

List of Experiments.

Weeks(W)	Experiments	Relevance to COs
	PART A	
1	Generation and Detection of BPSK	CO1
2	FM generation and demodulation using PLL	CO1
	PART B	
3	Performance of Waveform Coding Using PCM	CO2
4	Error Performance of BPSK	CO2
5	Error Performance of QPSK	CO2
6	Pulse Shaping and Filtering	CO2
7	Eye Diagram	CO2
	PART C	
8	Familiarization with Software Defined Radio (Hardware and Control Software)	CO3
9	FM Reception	CO3
Total No. of Hours		27

12. Assessment Pattern (as per curriculum)

Continuous Internal evaluation	- 75 marks
End Semester Examination	- 75 marks
Total	-150 marks

13. Evaluation criteria (as per syllabus)

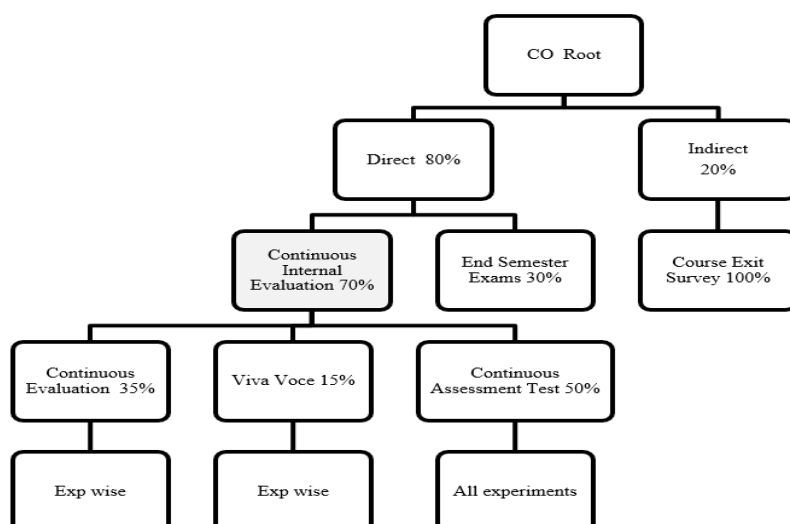
Sl. No.	Nature of Evaluation	Evaluation Pattern	Topics of Evaluation	Duration	Weightage Of marks
1	Continuous Internal evaluation (75 marks)				
a	Attendance	15 marks	NA	NA	10%

b	Continuous Evaluation & Viva-voce	30marks	Each experiment	NA	20%
c	Continuous Assessment Test	Design & Procedure – 10 marks performance & output– 10marks, viva – 10 marks, Total – 30 marks	All Experiments	3hrs	20%
2	End Semester Examination (75 marks)				
a.	End semester Examination	Preliminary work- 15 marks, implementation – 10marks, performance, Output – 25 marks viva –20 marks Record-5 marks. Total 75 marks	All Experiments	3hrs	50%

14. Assessment – CO Mapping (Put ‘ x’ if mapping is present)

	Tools**	Weightage#	CO1	CO2	CO3
Direct Assessment Tools	Continuous Evaluation Experiment wise CO mapping	25%	x	x	x
	Viva – Voce Experiment wise CO mapping	10%	x	x	x
	Continuous Assessment Test	35%	x	x	x
	End Semester Exam – 30%	30%	x	x	x
Indirect Assessment Tool	Course Exit Survey	100%	x	x	x

15. Assessment Configuration



Prepared by : Tubin T X

Checked by : Milna M J

Course Code & Name: ECL332 COMMUNICATION LAB

1. Prescribed Syllabus

In this course, each group consisting of three/four members is expected to design and develop a moderately complex electronic system with practical applications, this should be a working model. The basic concept of product design may be taken into consideration.

Students should identify a topic of interest in consultation with Faculty/Advisor. Review the literature and gather information pertaining to the chosen topic. State the objectives and develop a methodology to achieve the objectives. Carryout the design/fabrication or develop codes/programs to achieve the objectives. Demonstrate the novelty of the project through the results and outputs. The progress of the mini project is evaluated based on a minimum of two reviews.

The review committee may be constituted by the Head of the Department. A project report is required at the end of the semester. The product has to be demonstrated for its full design specifications. Innovative design concepts, reliability considerations, aesthetics/ergonomic aspects taken care of in the project shall be given due weight.

2. Text Books (T)

-

3. Reference Books (R)

R1. Minimum 5 SCI Indexed journals

Web Source References:

W1. <http://www.sciencedirect.com>

W2. <https://www.springer.com/in>

W3. <https://www.ieee.org/>

4. Objectives

- To apply engineering knowledge in practical problem solving.
- To foster innovation in design of products, processes or systems.
- To develop creative thinking in finding viable solutions to engineering problems

5. Course Pre / Co-requisite

- Basic and advanced engineering current knowledge
- Undergraduate level Electronics and Communication Engineering subjects

6. Course Outcomes

Upon completion of the course the students will be able to

CO1: Be able to practice acquired knowledge within the selected area of technology for project development.

CO2: Identify, discuss and justify the technical aspects and design aspects of the project with a systematic approach.

CO3: Reproduce, improve and refine technical aspects for engineering projects.

CO4: Work as a team in development of technical projects.

CO5: Communicate and report effectively project related activities and findings.

7. Mapping of Course Outcomes with Program Outcomes

PO/ CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	H	H	H	H	H	H						H	H		H
CO2	H	H	H	H		H					H	H	H	H	
CO3	H	H	H	H	H	H			H	H	H	H	H		H
CO4								H		H	H	H	H		
CO5								H	H	H		H	H		

8. Justification for CO-PO-PSO Correlation

CO	PO/ PSO	Corre lation	Justification
CO1	PO1	H	They could apply knowledge in mathematics and engineering for innovative thinking the development of components, products, processes or technologies in Electronics and Communication Engineering.
	PO2	H	They could analyze a problem to identify innovative solution, formulate scope of work, review research literature for the development of components, products, processes or technologies using first principles of mathematics and Electronics and Communication Engineering
	PO3	H	They could think innovatively to design solutions for complex engineering problems and design system components or processes that meet the specified needs

	PO4	H	They could use research based knowledge to design an innovative solution that require consideration of constraints such as cost, power requirement, durability, product life, etc
	PO5	H	They could select and apply appropriate techniques and modern design and analysis IT tools in design, analysis and evaluation of complex problems
	PO6	H	They could think innovatively by applying reasoning using contextual knowledge to Develop components, products, processes or technologies in Electronics and Communication Engineering to benefit the society
	PO12	H	They could recognize the need for innovative thinking to engage in independent and lifelong learning
	PSO1	H	They could think innovatively on the development of components, products, processes or technologies in electronics and communication engineering.
	PSO3	H	They could choose and apply modern engineering and IT tools to analyse complex Electronics and Communication engineering problems.
CO2	PO1	H	They could apply knowledge in mathematics and engineering to use modern design and analysis tools in design, analysis and evaluation of complex problems.
	PO2	H	They could analyze and evaluate complex problems using modern design and analysis tools.
	PO3	H	They could use modern design and analysis tools to design solutions for complex problems.
	PO4	H	They could use modern design and analysis tools to design experiments, analyse and interpret data to provide solution for complex problems
	PO6	H	They could think innovatively by applying reasoning using contextual knowledge to Develop components, products, processes or technologies in Electronics and Communication Engineering to benefit the society
	PO11	H	They could demonstrate skills in scheduling and budget estimation for the effective utilisation of resources for the development of most feasible and cost effective fulfilment of the project work
	PO12	H	They could use knowledge in modern engineering and IT tools to engage in independent and lifelong learning through projects and researches
	PSO1	H	They could use knowledge in modern engineering and IT tools in the design, analysis and development of various electronic systems
	PSO2	H	They could use modern engineering and IT to analyze and synthesize the experimental data from electronic system to validate the design.
CO3	PO1	H	They could apply knowledge in mathematics and engineering to communicate effectively with written, oral, and visual means.
	PO2	H	They could analyze a problem to communicate effectively using various means
	PO3	H	They could use various tools like algorithm, flowcharts , to communicate the solutions developed for complex problems
	PO4	H	They could use various research methodologies to analyze and communicate possible solutions for complex problems
	PO5	H	They could use modern engineering and IT tools for prediction and modelling of complex engineering activities for effectively communicating with the engineering community
	PO6	H	They could think innovatively by applying reasoning using contextual knowledge to Develop components, products, processes or technologies in Electronics and Communication Engineering to benefit the society
	PO9	H	They could acquire skills to serve as effective team member to plan and complete the project.
	PO10	H	They could are able to communicate effectively , make effective presentations, and give and receive clear instructions by serving as a member / leader in a project team
	PO11	H	They could demonstrate skills in scheduling and budget estimation for the effective utilisation of resources for the development of most feasible and cost effective fulfilment of the project work
	PO12	H	They could use skills acquired by serving as an effective team member to plan and complete the project/task within a specified budget and time to manage projects in

			Professional life.
	PSO1	H	They could absorb and apply contextual knowledge of Electronics and Communication Engineering to communicate effectively the design, analysis, and development of various electronic systems.
	PSO3	H	They could think innovatively on the development of components, products, processes or technologies in electronics and communication engineering.
CO4	PO8	H	They could develop skills to write effective reports avoiding plagiarism and also to divide the quantum of work equally among team members by applying ethical principles
	PO10	H	They could able to communicate effectively , make effective presentations, and give and receive clear instructions by serving as a member / leader in a project team
	PO12	H	They could gain the ability to communicate effectively with written, oral, and visual means in professional life.
	PSO1	H	They could absorb and apply contextual knowledge of Electronics and Communication Engineering to communicate effectively the design, analysis, and development of various electronic systems.
	PSO2	H	They could analyze and synthesize the experimental data from electronic system to effectively communicate the design validations
	PSO3	H	They could choose and apply modern engineering tools to analyse and communicate the solutions to complex Electronics and Communication engineering problems
CO5	PO8	H	They could develop skills to write effective reports avoiding plagiarism and also to divide the quantum of work equally among team members by applying ethical principles
	PO9	H	They could develop skills as a member / leader in a project team to communicate effectively, make effective presentations, and give and receive clear instructions.
	PO10	H	They could able to communicate effectively and make effective presentations by serving as a member in a project team
	PO12	H	They could gain the ability to communicate effectively with written and oral presentations in professional life.
	PSO1	H	They could absorb and apply contextual knowledge of Electronics and Communication Engineering to communicate effectively the design, analysis, and development of various systems in the area of electronics and communication

9. Curricular gaps (if any)

Nil

10. Course Enrichment Activities*

Sl No	Description	Proposed Activities **	Relevance to POs and PSOs
1	workshop	Python	PO8, PO9, PO10, PO12

11. Course Plan / Schedule of experiments

- In depth study of the topic assigned in the light of the preliminary report prepared in the seventh semester
- Review and finalization of the approach to the problem relating to the assigned topic.
- Preparing a detailed action plan for conducting the investigation, including team work.
- Detailed Analysis/Modelling/Simulation/Design/Problem Solving/Experiment as needed.
- Final development of product/process, testing, results, conclusions and future directions.
- Preparing a paper for Conference presentation/Publication in Journals, if possible.
- Preparing a report in the standard format for being evaluated by the dept. assessment board.

Review 1	Progress Assessment 1	- Review and finalization of approach to Problem identified - Detailed action plan	4 th Week
Review 2	Progress Assessment 2	Progress Review on final product / testing / results / conclusions Working Demo Preparation of paper for conference presentation / publication in journals	8 th Week
Review 3	Final Project Report	Report in standard format being evaluated by department assessment board Preparing a paper for Conference presentation/Publication in Journals, if possible	10 th Week
Review 4	Project Presentation and Viva Voce	Final Project Presentation and Viva Voce by assessment board including external expert	10 th week

12. Assessment Pattern (as per curriculum)

- (i) Two progress assessments - 26.65% by the faculty supervisor(s) - 40 marks
(ii) Final project report - 6.65% - 10 marks
(iii) Evaluation by Guide - 10% - 15 marks
(iv) Attendance - 6.65% - 10 marks
(v) Project presentation and viva voce - 50% by the assessment board - 75 marks

Total -150 marks

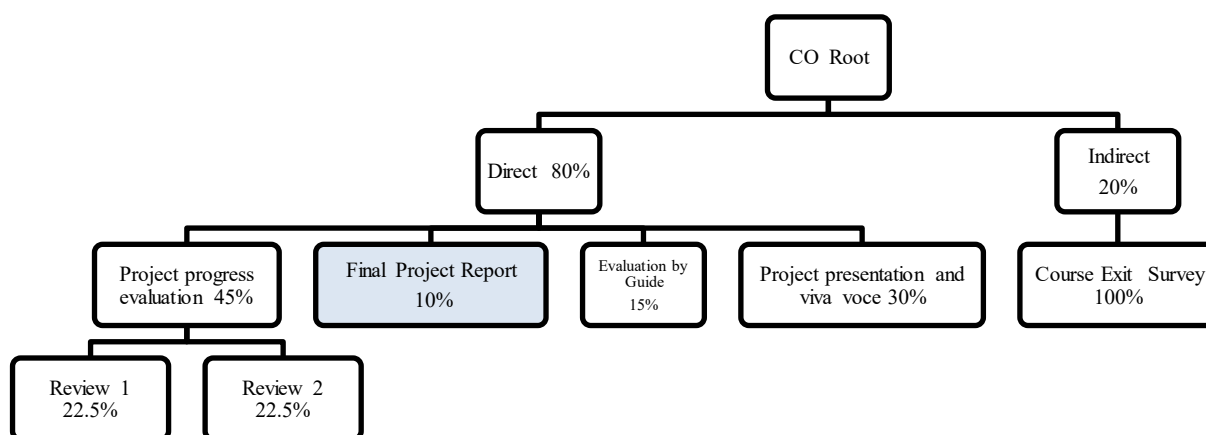
13. Evaluation criteria(as per syllabus)

Sl. No.	Nature of Evaluation	Evaluation Pattern	Topics of Evaluation	Duration	Weightage of marks
1.	Evaluation – Total Marks - 100 marks				
a.	Project progress evaluation	Review 1			13.33%
		Review 2			13.33%
b.	Final Project Report				6.65%
c.	Evaluation by Guide				10%
d.	Attendance				6.65%
e.	Project presentation and viva voce				50%

14. Assessment – CO Mapping (Put ‘ x ’ if mapping is present)

	Tools		Weightage [#]	CO1	CO2	CO3	CO4	CO5
Direct Assessment Tools**	Project progress evaluation	Review 1	26.65%	x	x	x	x	x
		Review 2		X	x	x	x	x
	Final Project Report		6.65%	X	x	x	x	x
	Evaluation by Guide		16.65%	x	x	x	x	x
	Project presentation and viva voce		50%	X	x	x	x	x
Indirect Assessment Tool	Course Exit Survey		100%	X	x	x	x	x

15. Assessment Configuration



Prepared By : Ms. Ambily Joseph

Checked By : Dr. Ramadas T

Semester: 7

CONTENTS

SLOT	COURSE NO.	COURSES	L-T-P	HOURS	CREDIT
A	ECT 401	MICROWAVE AND ANTENNAS	2-1-0	3	3
B	ECT413	OPTICAL FIBRE COMMUNICATION	2-1-0	3	3
B	ECT463	MACHINE LEARNING	2-1-0	3	3
C	CST	COMPUTER GRAPHICS	2-1-0	3	3
D	MCN401	INDUSTRIAL SAFETY ENGINEERING	2-1-0	3	---
S	ECL 411	ELECTROMAGNETICS LAB	0-0-3	3	2
T	ECQ 413	SEMINAR	0-0-3	3	2
U	ECD 415	PROJECT PHASE I	0-0-6	6	2

Course Code & Name: ECT401 Microwave and Antennas

1. Prescribed Syllabus

Module	Topic	Hours
1	Basic antenna parameters: gain, directivity, beam width and effective aperture calculations, effective height, wave polarization, radiation resistance, radiation efficiency, antenna field zones. Duality and Principles of reciprocity, Helmholtz theorem (derivation required), Field, directivity and radiation resistance of a short dipole and half wave dipole (far field derivation).	8
2	Broad band antenna: Principle of Log periodic antenna array and design, Helical antenna: types and design. Design of Microstrip Rectangular Patch antennas and feeding methods. Principles of Horn, Parabolic dish antenna (expression for E, H and Gain without derivation), Mobile phone antenna – Inverted F antenna	7
3	Arrays of point sources, field of two isotropic point sources, principle of pattern multiplication, linear arrays of 'n' isotropic point sources. Array factor, Grating lobes. Design of Broadside, End fire and Dolph Chebyshev arrays. Concept of Phase array.	8
4	Microwaves: Introduction, advantages, Cavity Resonators- Derivation of resonance frequency of rectangular cavity. Single cavity klystron- Reflex Klystron Oscillators: Derivation of Power output, efficiency and admittance. Magnetron oscillators: Cylindrical magnetron, Cyclotron angular frequency, Power output and efficiency. Travelling Wave Tube: Slow wave structures, Helix TWT, Amplification process, Derivation of convection current, axial electric field, wave modes and gain.	6
5	Microwave Hybrid circuits: Scattering parameters, Waveguide Tees- Magic tees, Hybrid rings. Formulation of S-matrix. Directional couplers: Two hole directional couplers, S-matrix. Circulators and Isolators. Phase Shifter. Microwave Semiconductor Devices: Amplifiers using MESFET. Principle of Gunn diodes: Different modes, Principle of operation Gunn Diode Oscillators.	6

2. Text Books (T)

- T1. Balanis, Antenna Theory and Design, 3/e, Wiley Publications.
- T2. John D. Krauss, Antennas for all Applications, 3/e, TMH.
- T3. K D Prasad, Antenna and Wave Propagation, Satyaprakash Publications
- T4. Samuel Y. Liao, Microwave Devices and Circuits, 3/e, Pearson Education, 2003.
- T5. Robert E. Collin, Foundation of Microwave Engineering, 2/e, Wiley India, 2012.

3. Reference Books (R)

- R1. Collin R.E, Antennas & Radio Wave Propagation, McGraw Hill. 1985.
- R2. Jordan E.C. & K. G. Balmain, Electromagnetic Waves & Radiating Systems, 2/e, PHI.
- R3. Raju G.S.N., Antenna and Wave Propagation, Pearson, 2013.
- R4. Sisir K. Das & Annapurna Das, Antenna and Wave Propagation, McGraw Hill, 2012
- R5. Thomas A. Milligan, Modern Antenna Design, IEEE PRESS, 2/e, Wiley Inter science.
- R6. Das, Microwave Engineering, 3/e, McGraw Hill Education India Education, 2014
- R7. David M. Pozar, Microwave Engineering, 4/e, Wiley India, 2012.

4. Course Objectives

This course aims to impart knowledge on the basic parameters of antenna, design and working of various broad band antennas, arrays and its radiation patterns. It also introduces various microwave sources, their principle of operation and study of various microwave hybrid circuits and microwave semiconductor devices.

5. Course Pre / Co-requisite

ECT 302 Electromagnetics

6. Course Outcomes

At the end of the course, student will be able to

After the completion of the course the student will be able to

CO1: Understand the basic concept of antennas and its parameters.

CO2: Analyse the far field pattern of short dipole and Half wave dipole antenna.

CO3: Design of various broad band antennas, arrays and its radiation patterns.

CO4: Illustrate the principle of operation of cavity resonators and various microwave sources.

CO5: Explain various microwave hybrid circuits and microwave semiconductor devices.

7. Mapping of Course Outcomes with Program Outcomes and Program Specific Outcome

PO/ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H	H											H		
CO2	H	H	H	M	H							M	H	M	H
CO3	H	H	H		H							M	H		H
CO4	H	H	M									M	H		
CO5	H	H	M	M								M	H	M	

8. Justification for CO-PO-PSO Correlation

CO	PO	Justification Statement
CO1	PO1	Knowledge in basic concepts of antennas and its parameters will help the students to understand the properties of antenna, signal radiation and its directivity.
	PO2	Understanding the parameters of antennas will help students to analyse the antenna field zones.
	PSO1	Knowledge in antennas and its parameter helps students to design analyse and develop signal transmission system
CO2	PO1	Understanding transmission characteristics and losses in optical fibers will enable the students to apply theoretical knowledge to assess different parameters, evaluate trade-offs, and propose solutions to ensure reliable data transmission. Hence highly correlated.

	PO1	Knowledge of antenna parameters help students to understand the far field pattern of short and half wave dipole
	PO2	Analysis of Helmholtz equation and far field pattern of short and half wave dipole helps students to understand Field, directivity and radiation resistance of a short dipole and half wave dipole..
	PO3	The knowledge of short and halfwave field expressions helps students to design practical hypothetical dipole antennas for a required frequency.
	PO4	Students will be able to use the knowledge of short and halfwave dipole antenna analysis to provide valid conclusions by synthesizing the data available.
	PO5	Analysis of far field patters helps students to develop and simulate design of dipole antenna.
	PO12	Understanding far filed pattern analysis helps students to learn advancements in dipole antenna technology.
	PSO1	Knowledge in far field pattern helps students to design analyse and develop dipole antenna for a signal transmission system
	PSO2	Analysing and synthesizing experimental data from antenna system, students will be able to design dipole antenna.
	PSO3	Applying acquired knowledge, students will be able to design dipole antennas for various applications for the improved communication.
CO3	PO1	Knowledge in broad band antennas helps students to understand the various types of broadband antennas and its electric and magnetic field expression.
	PO2	Understanding the types of broadband antennas helps students to analyse its radiation pattern and field expressions
	PO3	Students will be able to design solutions for complex engineering problems using the knowledge of design of various broad band antennas, arrays and its radiation patterns
	PO5	Knowledge of various broadband antenna helps students to simulate the design of antenna arrays, helical antenna, parabolic antenna etc.
	PO12	Design of various broad band antennas, arrays and its radiation patterns help students to understand the advancements of broadband antennas
	PSO1	Knowledge in types broadband antennas help students to design analyse and develop signal transmission system according to their application.
	PSO3	Applying acquired knowledge, students will be able to design broadband antenna for better communication
CO4	PO1	Understanding the basics principle of operation of cavity resonators help the students to gain knowledge in fundamentals of microwave sources.

	PO2	Knowledge in cavity resonators help the students to analyse the output power and efficiency of microwave sources
	PO3	Students will be able to design solutions for complex engineering problems using the knowledge of operation of cavity resonators and various microwave sources.
	PO12	Knowledge in cavity resonators help the students learn radar systems.
	PSO1	Knowledge in cavity resonators help students to design microwave sources for electronic applications.
	PSO3	Applying acquired knowledge, students will be able to design applications of microwave frequencies.
CO5	PO1	Understanding the concept of WDM, FSO, and LiFi, will enable the students to apply knowledge of optics, light propagation, and the basic principles of signal multiplexing. Hence highly correlated.
	PO1	Understanding the operation of microwave hybrid circuits helps students to gain knowledge in scattering parameter.
	PO2	Knowledge in scattering parameter helps students to analyse the hybrid circuits and knowledge in microwave semiconductor devices helps students to analyse its VI characteristics
	PO3	Students will be able to design solutions for complex engineering problems using the knowledge of working of hybrid circuits and microwave semiconductor devices
	PO4	Students will be able to use the knowledge of analysis of properties of hybrid circuits and analysis of characteristics of microwave semiconductor to provide valid conclusions by synthesizing the data available
	PO12	Knowledge in microwave semiconductor devices helps students to learn the evolution of microwave sources from tubes to the advancements in semiconductor technology
	PSO1	Understanding the fundamentals of microwave semiconductor devices helps students to design compact microwave devices.
	PSO2	Analysing and synthesizing experimental data from microwave circuits, students will be able to design microwave systems

9. Curricular gaps (if any)

Nil

10. Course Enrichment Activities*

Sl No	Description	Proposed Activities	Relevance to POs and PSOs
1	Talk by an Academic expert	Webinar	PO1,PO2
2.	Broad cast antenna system	Industrial Visit	PO1, PO12, PSO1

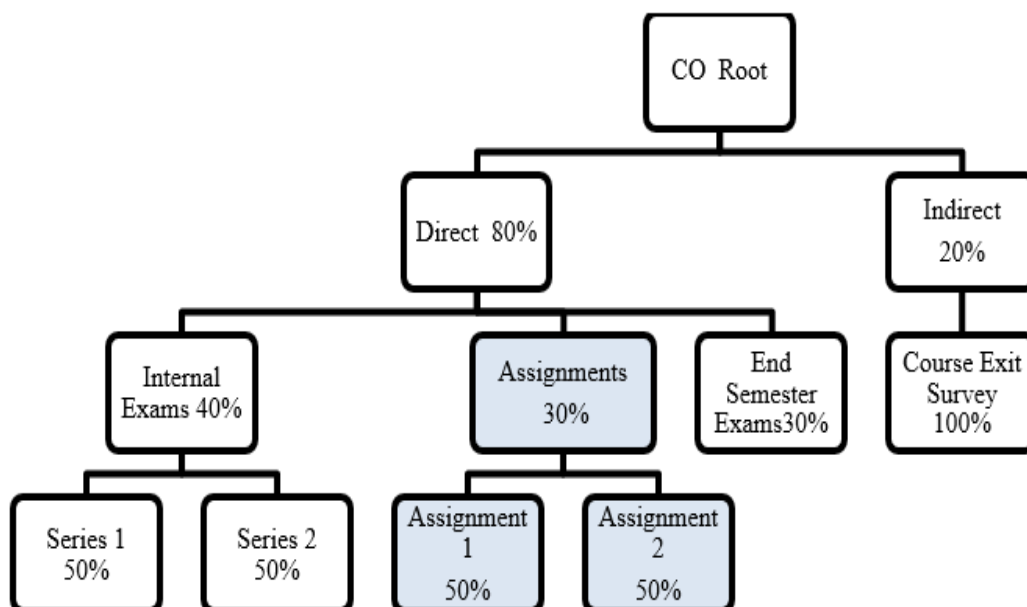
3. Internal Assessment mark allocation (as per university curriculum)
(Provide details as mentioned in syllabus)

Attendance	- 10 marks
Continuous Assessment Test	- 25 marks
Assignment (s)/ Course Project	- 15 marks
<u>Total</u>	<u>- 50 marks</u>

10. Assessment – CO Mapping (Put‘ x’ if mapping is present)

	Tools		Weightage	CO1	CO2	CO3	CO4	CO5
Direct Assessment Tools**	Internal Exam(s) 40%	Series 1	20%	x	x			
		Series 2	20%			x	x	
	Assignment (s)/ 30%	Assignment1	15%	x	x			
		Assignment2	15%				x	x
	End Semester Exam		30%	x	x	x	x	x
Indirect Assessment Tool	Course Exit Survey		100%	x	x	x	x	x

11. Assessment Configuration



12. Course Plan

Hour	Topic Name	Module	Reference	Teaching Pedagogy
1	Basic antenna parameters: gain, directivity, beam width and effective aperture calculations	1	T2, T3	Lecture
2	Effective height, wave polarization, radiation resistance, radiation efficiency, antenna field zones	1	T2, T3	Lecture
3	Duality and Principles of reciprocity, Helmholtz theorem	1	T2, T3	Lecture
4	Field, directivity and radiation resistance of a short dipole	1	T2, T3	Lecture
5	Field, directivity and radiation resistance of a short dipole	1	T2, T3	Lecture
6	Field, directivity and radiation resistance of a short dipole	1	T2, T3	Tutorial
7	Field, directivity and radiation resistance of a half wave dipole	1	T2, T3	Lecture
8	Principle of Log periodic antenna array and design	2	T1, T3	Lecture
9	Helical antenna: types and design	2	T1, T3	Lecture
10	Design of Microstrip Rectangular Patch antennas	2	T1, T3	Lecture
11	Feeding Methods	2	T1, T3	Lecture
12	Principles of Horn, Parabolic dish antenna	2	T1, T3	Lecture
13	Mobile phone antenna – Inverted F antenna	2	T1, T3	Tutorial
14	Arrays of point sources	3	T1, T3	Lecture
15	field of two isotropic point sources, principle of pattern multiplication	3	T1, T3	Lecture
16	linear arrays of 'n' isotropic point sources	3	T1, T3	Lecture
17	Array factor, Grating lobes	3	T1, T3	Lecture
18	Design of Broadside Array	3	T1, T3	Tutorial
19	Design of End fire Array	3	T1, T3	Lecture
20	Design of Dolph Chebyshev arrays	3	T1, T3	Lecture
21	Concept of Phase array	3	T1, T3	Lecture
22	Microwaves: Introduction, advantages, Cavity Resonators- Derivation of resonance frequency of rectangular cavity	4	T4, T5	Tutorial

23	Single cavity klystron- Reflex Klystron Oscillators	4	T4, T5	Lecture
24	Derivation of Power output, efficiency and admittance	4	T4, T5	Lecture
25	Magnetron oscillators: Cylindrical magnetron	4	T4, T5	Lecture
26	Cyclotron angular frequency, Power output and efficiency	4	T4, T5	Lecture
27	Travelling Wave Tube: Slow wave structures	4	T4, T5	Lecture
28	Helix TWT, Amplification process	4	T4, T5	Lecture
29	Derivation of convection current, axial electric field, wave modes and gain.	4	T4, T5	Tutorial
30	Scattering parameters, Waveguide Tees- Magic tees, Hybrid rings. Formulation of S-matrix.	5	T4, T5	Lecture
31	Directional couplers: Two hole directional couplers, S-matrix	5	T4, T5	Lecture
32	Circulators and Isolators. Phase Shifter	5	T4, T5	Lecture
33	Microwave Semiconductor Devices: Amplifiers using MESFET	5	T4, T5	Lecture
34	Principle of Gunn diodes: Different modes, Principle of operation	5	T4, T5	Lecture
35	Gunn diode Oscillators	5	T4, T5	Lecture

13. Question Bank

Module 1				
Sl. No.	Question	Marks	CO	BL
1.	Differentiate between Gain and Directivity of an antenna.	3	CO1	L1
2.	Derive expression for effective aperture of an antenna.	3	CO1	L2
3.	(i) Obtain the radiation resistance of a thin dipole antenna of length $\lambda/15$. (ii) Find HPBW of an antenna which has a field given by: $E(\theta) = \cos^2 \theta$, for $0 \leq \theta < 90^\circ$	3	CO1	L2
4.	Define isotropic radiator and derive the expression for its electric field strength.	3	CO1	L2
5.	Derive an expression for Radiation efficiency of an antenna.	3	CO1	L2
6.	Define the term Antenna efficiency	3	CO1	L1
7.	Explain the term Half Power Beam width (HPBW) of an antenna	3	CO1	L2

8.	Explain the terms i) Antenna temperature ii) Antenna efficiency iii) Beam efficiency iv) Radiation pattern v) Antenna Polarization	3	CO1	L2
9.	Show that the directivity of a half wave dipole is 4	3	CO1	L2
10.	With the help of a neat figure explain about the antenna field zones.	6	CO1	L2
11.	Derive expressions for the Radiation Resistance and Directivity of a short dipole antenna	8	CO2	L3
12.	State and prove Reciprocity Theorem	7	CO2	L2
13.	Derive Helmholtz Equation in terms of Vector Magnetic Potential.	7	CO2	L2
14.	Define the terms (i) Retarded potential (ii) Antenna field zones	7	CO2	L2
15.	Derive expressions for the Radiation Resistance and Directivity of a half wave dipole antenna	8	CO2	L3
16.	(i) Compute the radiation resistance, power radiated and efficiency of an antenna having total resistance of 50Ω and effective height of 69.96m and a current of 50A (rms) at 0.480MHz. (ii) Calculate the effective aperture of a short dipole antenna operating at 100kHz	7	CO2	L3
17.	An antenna has a loss resistance 25 ohms, power gain of 30 and directivity of 42. Calculate its radiation resistance.	5	CO1	L3
Module 2				
1.	Why Log Periodic antenna is called as Frequency Independent antenna, explain?	3	CO3	L2
2.	Briefly explain about Inverted F antenna.	3	CO3	L2
3.	Explain the principle of operation of a Horn Antenna.	3	CO3	L2
4.	Explain the working of an Inverted – F antenna.	3	CO3	L2
5.	Describe the transmission line model of microstrip patch antennas?	3	CO3	L2
6.	Draw geometrical construction of helical antenna with its applications?	3	CO3	L1
7.	List and distinguish between different types of array antennas.	3	CO2	L2
8.	Distinguish between different types of horn antennas with its design?	3	CO3	L2
9.	Derive expression for array factor of N isotropic sources for end-fire array and also the expression for major lobe, minor lobes and Nulls of the array	14	CO3	L2
10.	Explain Chebyshev array and write down the expression for array factor.	7	CO3	L2
11.	Design a Broadside Array and plot its radiation pattern	7	CO3	L2
12.	Explain the axial mode and normal mode of operation of a helical antenna.	6	CO3	L2
13.	Design a rectangular patch antenna using a substrate with a dielectric constant of 10.5, $h = 0.126$ cm so as to resonate at 1.65 Ghz .	8	CO3	L3

14.	Explain the steps involved in the design of a Log	7	CO3	L2
15.	With the help of neat sketches explain the working principle of parabolic dish antenna. What are the typical feed antennas used with Dish antennas?	7	CO3	L2
Module 3				
1.	Explain the principle of Pattern Multiplication.	3	CO3	L2
2.	Explain the concept of phased array	3	CO3	L2
3.	Explain (i) Pattern Multiplication (ii) Grating lobes	3	CO3	L2
4.	Derive expression for array factor of N isotropic sources for end-fire array and also the expression for major lobe, minor lobes and Nulls of the array	14	CO3	L2
5.	Show that for an array of two isotropic point sources with identical amplitude and phase, have a broadside radiation pattern	14	CO2	L3
6.	Explain the difference between broadside array and end fire array	4	CO3	L2
7.	Design a 7 element Dolph-Chebyshev array with a spacing of $d = \lambda/2$. The pattern is to be optimum with a side lobe of 22 db	10	CO3	L3
8.	Derive the relation for normalized electrical field in the case of 'n' isotropic array sources $E_n = (AF) n$.	4	CO3	L2
9.	Explain the working of a horn antenna. Write down the expression for gain, HPBW and BWFN.	4	CO3	L2
Module 3				
1.	Describe intra and inter modal dispersion with neat diagrams.	14	CO2	L ₂
2.	Write short note on elastic- tube splicing method in the optical fibre with a neat sketch?	6	CO2	L2
3.	Explain various mechanical misalignment losses in fibre joints with neat figure?	6	CO2	L2
4.	An optical fiber has an attenuation coefficient of 0.5dB/km at 1310nm. Find the optical power at 25km if 500μW of optical power is launched into the fiber.	5	CO2	L2
5.	Discuss various nonlinear scattering process such as stimulated Raman scattering and stimulated Brillouin scattering in the optical fibre communication?	8	CO2	L2
6.	Discuss the importance of intramodal dispersion and material dispersion effect in the optical fibre communication?	6	CO2	L2
7.	Given an optical fiber of 50 μm diameter, core index of 1.5, and cladding index 1.49 for operation at $\lambda = 1.31 \mu\text{m}$, What would be the pulse spread due to modal dispersion over a distance of 10 km?	6	CO2	L3
8.	Describe the various types of fiber connectors and couplers.	6	CO2	L2
9.	Describe various fiber splicing techniques with their diagrams.	10	CO2	L2
10.	Explain fiber alignment and joint losses.	8	CO2	L2
Module 3				

Sl. No.		Marks	CO	BL
1.	Differentiate between Spontaneous and Stimulated emission	3	CO3	L1
2.	Differentiate the optical sources LED and Laser	3	CO3	L2
3.	Describe amplifier spontaneous emission noise	3	CO3	L2
4.	Draw different LED characteristics	3	CO3	L1
5.	Discuss the laser diode structures and radiation patterns	3	CO3	L2
6.	Distinguish direct and indirect band- gap materials	3	CO3	L2
7.	Define responsivity & quantum efficiency of a photodetector	3	CO3	L1
8.	Describe the quantum limit of detection.	3	CO3	L2
9.	A photodiode is constructed of GaAs, which has band gap energy of 1.43 eV at 300 K. Determine the cut off wavelength.	3	CO3	L2
10.	Explain the modulation of Laser diodes & Laser characteristics.	5	CO2	L2
11.	Explain the operation of double heterojunction injection laser with neat sketches.	8	CO3	L2
12.	Explain the structure and working of surface emitting LED & Edge emitting LED	8	CO2	L2
13.	Explain the structure of distributed feedback Laser.	6	CO3	L2
14.	Consider a silicon avalanche photodiode has a quantum efficiency of 70 percent at a wavelength of 950nm. Suppose $0.5\mu\text{W}$ of optical power produces a multiplied photocurrent of $15\mu\text{A}$. Find (a) the primary photocurrent? (b) the multiplication factor?	5	CO2	L3
15.	Discuss the principle of operation of APD with neat circuit diagram. Also discuss the requirements of photo detector.	8	CO3	L2
16.	Discuss the principle of operation of PIN with neat circuit diagram.	8	CO3	L2
17.	Discuss the fundamentals of receiver operations with neat block diagram	6	CO3	L2
18.	Explain different types of noise & noise performance parameters in photodetectors	7	CO3	L2
19.	A PN photodiode has a quantum efficiency of 65% for photons of energy $1.52 \times 10^{-19} \text{ J}$. Calculate (a) wavelength at which the diode is operating and b) the optical power required to achieve photocurrent of $3 \mu\text{A}$, when the wavelength of incident photon is that of calculated in part (a). ($h=6.626 \times 10^{-34}$, $e=1.6 \times 10^{-19}$)	5	CO3	L3
20.	Compare APD & PIN diode.	5	CO3	L2

21.	Explain optical receiver equivalent circuit & front end receiver amplifier configurations..	6	CO3	L2
22.	A given APD has a quantum efficiency of 65 % at a wavelength of 900nm. If 0.5 μ w of optical power produces a multiplied photocurrent of 10 μ A. Find the multiplication factor M?	6	CO3	L2
23.	Discuss gain guided and index guided type laser diode structures with neat sketches	7	CO3	L2

Prepared By : Gregarious Jose C

Checked By : Milna M J

1. Prescribed Syllabus

Module	Topic	Hours
1	Optical fiber Communications: The general system, Advantages of optical fiber communication, Optical fiber waveguides: Ray theory transmission, Modes in planar guide, Phase and group velocity Fibres: Types and refractive index profiles, Step index fibers, Graded index fibers, Single mode fibers, Cutoff wavelength, Mode field diameter, effective refractive index. Fibre materials, photonic crystal fibre, index guiding PCF, photonic band-gap fibres, fibre cables.	8
2	Transmission characteristics of optical fiber: Attenuation, Material absorption losses, Linear scattering losses, Nonlinear scattering losses, Fiber bend loss, Dispersion, Chromatic dispersion, Intermodal dispersion: Multimode step index fiber. Optical Fiber Connectors: Fiber alignment and joint loss, Fiber splices, Fiber connectors, Fiber couplers.	7
3	Optical sources: LEDs and LDs, structures, characteristics, modulators using LEDs and LDs. coupling with fibres, noise in Laser diodes, Amplified Spontaneous Emission noise, effects of Laser diode noise in fibre communications Optical detectors: Types and characteristics, structure and working of PIN and AP, noise in etectors, comparison of performance. Optical receivers, Ideal photo receiver and quantum limit of detection.	8
4	Optical Amplifiers: basic concept, applications, types, doped fibre amplifiers, EDFA, basic theory, structure and working, Semiconductor laser amplifier, Raman amplifiers, TDFA, amplifier configurations, performance comparison.	6
5	The WDM concept, WDM standards, WDM components, couplers, splitters, Add/Drop multiplexers, gratings, tunable filters. Introduction to free space optics, LiFi technology and VLC. Optical Time Domain Reflectometer (OTDR) – fault detection length and refractive index measurements.	6

2. Text Books (T)

T1. Gerd Keiser, Optical Fiber Communications, 5/e, McGraw Hill, 2013.

T2. Mishra and Ugale, Fibre optic Communication, Wiley, 2013.

3. Reference Books (R)

R1. “John M Senior- Optical communications, 3/e, Pearson, 2009.

R2. “Keiser, Optical Communication Essentials (SIE), 1/e McGraw Hill Education New Delhi, 2008

4. Course Objectives

To introduce the concepts of light transmission through optical fibers and introduce the working of optical components.

5. Course Pre / Co-requisite

Basic concepts of Solid State Devices

6. Course Outcomes

At the end of the course, student will be able to

CO 1 : Analyse the working and classification of optical fibers in terms of propagation modes.

CO 2 : Solve problems of transmission characteristics and losses in optical fiber

CO 3 : Analyse and Explain the constructional features and the characteristics of optical sources and detectors.

CO 4 : Differentiate the operations of optical amplifiers.

CO 5 : Summarize the concept of WDM, FSO and LiFi

7. Mapping of Course Outcomes with Program Outcomes and Program Specific Outcome

PO/ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H	H	M									M	H		
CO2	H	H	M									M	H		
CO3	H	H	M									M	H		
CO4	H	H	M									M	H		
CO5	H	H										M	H		

8. Justification for CO-PO-PSO Correlation

CO	PO	Justification Statement
CO1	PO1	Understanding the working and the propagation modes of optical fibers involves grasping concepts from electromagnetics, wave theory, and transmission theory. Hence highly correlated.
	PO2	Knowledge in the propagation modes of optical fibers will enable the students to contribute effectively to the analysis, and optimization of communication systems. Hence highly correlated.
	PO3	Analysing optical fiber propagation modes in fibers will enable the students to gain insights into how these fibers transmit data through light signals, choose the appropriate fiber type for specific applications and solve real-world issues in communication systems
	PO12	Understanding the working and classification of optical fibers will enable students to cultivate skills such as continuous learning, critical thinking, adaptability, self-directed learning, interdisciplinary exploration, and reflective practice.
	PSO1	Knowledge in the propagation modes of optical fibers equipping students with the specialized knowledge required to excel in advanced communication systems and technologies. Hence highly correlated.
CO2	PO1	Understanding transmission characteristics and losses in optical fibers will enable the students to apply theoretical knowledge to assess different parameters, evaluate

		trade-offs, and propose solutions to ensure reliable data transmission. Hence highly correlated.
	PO2	Analysing transmission characteristics and losses in optical fibers will enable the students to apply the core principles of their discipline to practical problems. Hence highly correlated.
	PO3	Solving the problems related to optical fiber transmission and losses, will enable the students to analyze the impact of different factors on signal quality, attenuation, dispersion, and other characteristics, showcasing their analytical thinking abilities.
	PO12	Knowledge in transmission characteristics and losses in optical fibers, will enable the students to demonstrate their proficiency in applying specialized knowledge to real-world challenges.
	PSO1	Knowledge in transmission characteristics and losses in optical fibers, equipping students with the specialized knowledge required to excel in advanced communication systems and technologies. Hence highly correlated.
CO3	PO1	Understanding the constructional features and characteristics of optical sources and detectors is fundamental to various fields within science and engineering, such as optics, photonics, telecommunications. Hence highly correlated.
	PO2-	Analyzing and explaining these features and characteristics, will enable the students to identify the right source or detector for specific applications, trouble shoot issues, and optimize system performance. Hence highly correlated.
	PO3-	Designing optical systems , students gain insights into how these components interact with other elements in a system, helping them make informed design decisions.
	PO12	Exploring related online resources, students develop the capacity to proactively seek out information and deepen their understanding an integral aspect of lifelong learning.
	PSO1	Understanding the constructional features and characteristics of optical sources and detectors ,equips the students with specialized skills and knowledge in optical engineering, advanced analytical abilities. Hence highly correlated.
CO4	PO1-	Understanding the operations of optical amplifiers is fundamental to comprehending the broader field of optical engineering. Hence highly correlated.
	PO2	Knowledge of optical amplifiers enables students to optimize amplifier performance, select appropriate amplifier types for different scenarios, and mitigate signal degradation issues. Hence highly correlated.
	PO3	Designing optical amplifiers involves tackling intricate challenges related to signal-to-noise ratios, gain optimization, and nonlinear effects.
	PO12	Exploring related online resources, students develop the capacity to proactively seek out information and deepen their understanding an integral aspect of lifelong learning.

	PSO1	Knowledge in the principles of optical amplifiers, will enable the students to develop advanced optical communication systems. Hence highly correlated.
CO5	PO1	Understanding the concept of WDM, FSO, and LiFi, will enable the students to apply knowledge of optics, light propagation, and the basic principles of signal multiplexing. Hence highly correlated.
	PO2	Summarizing the concepts WDM, FSO, and LiFi requires students to synthesize knowledge from different fields. Hence highly correlated.
	PO12	Exploring related online resources, students develop the capacity to proactively seek out information and deepen their understanding an integral aspect of lifelong learning.
	PSO1	Knowledge in the concepts WDM, FSO, and LiFi, will enable the students to design, implement, and adapt advanced communication systems. Hence highly correlated.

9. Curricular gaps (if any)

Nil

10. Course Enrichment Activities*

Sl No	Description	Proposed Activities	Relevance to POs and PSOs
1	NPTEL -Fiber Optic Communication technology	NPTEL videos- Prof. Deepa Venkitesh, IIT Madras	PO1,PO2,PO3, PO12,PSO1

11. Internal Assessment mark allocation (as per university curriculum)

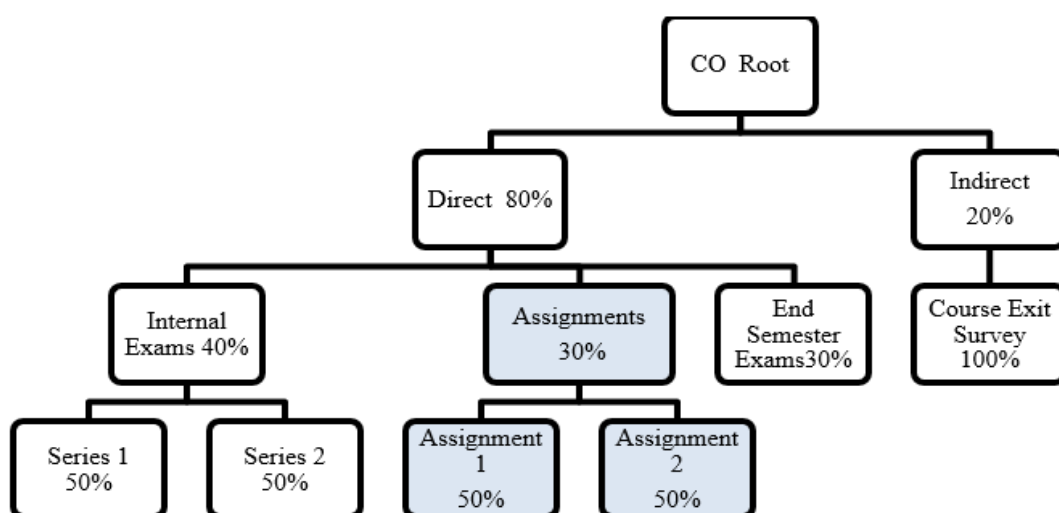
Attendance	- 10 marks
Continuous Assessment Test	- 25 marks
Assignment (s)/ Course Project-	15 marks
<u>Total</u>	<u>- 50 marks</u>

12. Assessment – CO Mapping (Put ‘ x’ if mapping is present)

	Tools		Weightage	CO1	CO2	CO3	CO4	CO5
Direct Assessment Tools**	Internal Exam(s) 40%	Series 1	20%	x	x			
		Series 2	20%			x	x	x
	Assignment (s)/ 30%	Assignment 1	15%	x	x			
		Assignment 2	15%			x		x

	End Semester Exam	30%	x	x	x	x	x
Indirect Assessment Tool	Course Exit Survey	100%	x	x	x	x	x

13. Assessment Configuration



14. Course Plan

Hour	Topic Name	Module	Reference	Teaching Pedagogy
1	The general system, Advantages of optical fiber communication	1	T1, T2	Lecture
2	Optical fiber waveguides: Ray theory transmission	1	T1, T2	Lecture
3	Modes in planar guide, Phase and group velocity	1	T1, T2	Lecture
4	Fibres: Types and refractive index profiles	1	T1, T2	Lecture
5	Step index fibers, Graded index fibers, Single mode fibers	1	T1, T2	Lecture
6	Cutoff wavelength, Mode field diameter, effective refractive index	1	T1, T2	Tutorial
7	Fibre materials, fibre cables	1	T1, T2	Lecture
8	photonic crystal fibre, index guiding PCF, photonic band-gap fibres	1	T1, T2	Lecture
9	Attenuation, Material absorption losses	2	T1, T2	Lecture
10	Linear scattering losses	2	T1, T2	Lecture
11	Nonlinear scattering losses, Fiber bend loss	2	T1, T2	Lecture

12	Dispersion, Chromatic dispersion	2	T1, T2	Lecture
13	Intermodal dispersion: Multimode step index fiber	2	T1, T2	Tutorial
14	Optical Fiber Connectors: Fiber alignment and joint loss	2	T1, T2	Lecture
15	Fiber splices, Fiber connectors, Fiber couplers	2	T1, T2	Lecture
16	LEDs and LDs, structures, characteristics	3	T1, T2	Lecture
17	modulators using LEDs and LDs	3	T1, T2	Lecture
18	coupling with fibres, noise in Laser diodes	3	T1, T2	Tutorial
19	Amplified Spontaneous Emission noise, effects of Laser diode noise in fibre communications	3	T1, T2	Lecture
20	Optical detectors: Types and characteristics	3	T1, T2	Lecture
21	structure and working of PIN and AP	3	T1, T2	Lecture
22	noise in detectors, comparison of performance	3	T1, T2	Tutorial
23	Optical receivers, Ideal photo receiver and quantum limit of detection	3	T1, T2	Lecture
24	basic concept, applications, types	4	T1, T2	Lecture
25	doped fibre amplifiers	4	T1, T2	Lecture
26	EDFA, basic theory, structure and working	4	T1, T2	Lecture
27	Semiconductor laser amplifier	4	T1, T2	Lecture
28	Raman amplifiers, TDFA	4	T1, T2	Lecture
29	amplifier configurations, performance comparison	4	T1, T2	Tutorial
30	WDM standards, WDM components	5	T1, T2	Lecture
31	couplers, splitters, Add/ Drop multiplexers	5	T1, T2	Lecture
32	gratings, tunable filters	5	T1, T2	Lecture
33	Introduction to free space optics, LiFi technology and VLC	5	T1, T2	Lecture
34	Optical Time Domain Reflectometer (OTDR)	5	T1, T2	Lecture
35	fault detection length and refractive index measurements.	5	T1, T2	Lecture

15. Question Bank

Module 1				
Sl. No.	Question	Marks	CO	BL
1.	List the advantages of optical fiber communication	3	CO1	L1

2.	Draw the elements of an optical fiber Communication system.	3	CO1	L1
3.	Describe the single mode step Index fiber with neat sketch.	3	CO1	L2
4.	Brief on the necessity of cladding for an optical fiber?	3	CO1	L1
5.	Define critical angle and also derive the expression for critical angle.	3	CO1	L2
6.	Define Photonic Crystal Fibers.	3	CO1	L1
7.	Briefly explain the importance of mode field diameter in optical fibre communication with a neat diagram?	3	CO1	L2
8.	Consider multimode fiber that has a core refractive index of 1.488 and core cladding index difference of 2.0%. Evaluate numerical aperture, critical angle and acceptance angle.	3	CO1	L3
9.	Consider a multimode silica fibre that has a core refractive index $n_1=1.47$ and a cladding refractive index $n_2=1.45$. Find (a) the acceptance angle in air? (b) the numerical aperture ?	3	CO1	L3
10.	Consider a multimode step index optical fibre that has a core radius of $30\mu\text{m}$, a core index of 1.49 and an index difference $\Delta = 0.02$. What are the number of modes in the fibre at wavelength 1310 and 1550nm?	3	CO1	L3
11.	Compare step index & graded index fiber.	3	CO1	L2
12.	A step index fiber has a normalized frequency $V = 26.6$ at 1300 nm Wavelength. If the core radius is $25\mu\text{m}$, find the numerical aperture	3	CO1	L2
13.	Label a neat block diagram and explain the fundamental blocks of optical fiber communication	8	CO1	L2
14.	Explain the structure of step index & graded index fibers with its Refractive index profiles.	10	CO1	L2
15.	Derive the Expression for Acceptance angle and Numerical aperture.	7	CO1	L2
16.	Describe about different types of fiber cables.	6	CO1	L2
17.	What are fiber modes? Explain mode theory for optical fibers in detail.	10	CO1	L2
18.	Describe about different types of fiber materials	6	CO1	L2
19.	Briefly explain the relation of the cut off wavelength and V number of step index single mode and multi-mode fibre.?	5	CO1	L2
20.	Discuss the modes in step- index fibers.	8	CO1	L2
21.	For a step index fiber $n_1=1.465$, $n_2=1.46$, normalised frequency is 2.4. Calculate the core radius and Numerical aperture at $0.8\mu\text{m}$	6	CO1	L2

22.	A graded index fiber with parabolic refractive index has $n_1=1.48$ and $n_2=1.46$ if core radius is $20\mu\text{m}$. Find the number of modes at 1300nm and 1550nm ?	5	CO1	L2
23.	Explain the significance of phase velocity and group velocity for the light propagating through the optical fiber cables?	6	CO1	L2
24.	Explain the features of any three fibre materials which are used for manufacturing optical fibre cable?	10	CO1	L2
25.	Explain different types of photonic crystal fibers with neat diagrams.	10	CO1	L2
26.	Explain the Numerical Aperture of an optical fiber with neat diagram. Calculate the fractional index change for a given optical fiber if the refractive indices of the core and cladding are 1.563 and 1.498 respectively. Also, calculate (i) numerical aperture (ii) angle of acceptance in air.	6	CO1	L3
27.	A light wave is travelling in a semiconductor medium (GaAs) of refractive index 3.6 . It is incident on a different semiconductor medium (AlGaAs) of refractive index 3.4 & angle of incidence is 80° . Calculate numerical aperture & acceptance angle. Will it result in total internal reflection? Comment on the result.	6	CO1	L3
Module 2				
1.	Inspect the three different mechanisms which cause absorption.	3	CO2	L1
2.	State the causes of dispersion	3	CO2	L1
3.	Mention the three types of fiber couplers	3	CO2	L1
4.	State the drawbacks of fusion splicing?	3	CO2	L1
5.	Describe the causes of Attenuation.	3	CO2	L2
6.	Explain absorption losses in fiber.	3	CO2	L2
7.	Distinguish between intrinsic & extrinsic Absorption.	3	CO2	L2
8.	Discuss your understanding on chromatic dispersion in optical fibre cable?	3	CO2	L2
9.	How do you measure attenuation in optical fiber? Substantiate with necessary equations?	3	CO2	L2
10.	Write a short note on extrinsic absorption effect on the optical fibre cable?	3	CO2	L2
11.	What is meant by group velocity dispersion?	3	CO2	L2
12.	How does the scattering loss occur?	3	CO2	L2
13.	Describe the various attenuation losses incurred by light signal while transmitting through a fiber.	14	CO2	L2
14.	Explain macro bending and micro bending losses with a neat diagram.	6	CO2	L2

15.	Define linear scattering. Explain about Rayleigh & Mie scattering.	8	CO2	L2
16.	Explain different types of intramodal dispersion and derive the expression for pulse spread and dispersion factor for each case.	8	CO2	L2
17.	Explain different types of bending losses in optical fibers?	6	CO2	L2
18.	Describe intra and inter modal dispersion with neat diagrams.	14	CO2	L2
19.	Write short note on elastic- tube splicing method in the optical fibre with a neat sketch?	6	CO2	L2
20.	Explain various mechanical misalignment losses in fibre joints with neat figure?	6	CO2	L2
21.	An optical fiber has an attenuation coefficient of 0.5dB/km at 1310nm. Find the optical power at 25km if 500 μ W of optical power is launched into the fiber.	5	CO2	L2
22.	Discuss various nonlinear scattering process such as stimulated Raman scattering and stimulated Brillouin scattering in the optical fibre communication?	8	CO2	L2
23.	Discuss the importance of intramodal dispersion and material dispersion effect in the optical fibre communication?	6	CO2	L2
24.	Given an optical fiber of 50 μ m diameter, core index of 1.5, and cladding index 1.49 for operation at $\lambda = 1.31 \mu$ m, What would be the pulse spread due to modal dispersion over a distance of 10 km?	6	CO2	L3
25.	Describe the various types of fiber connectors and couplers.	6	CO2	L2
26.	Describe various fiber splicing techniques with their diagrams.	10	CO2	L2
27.	Explain fiber alignment and joint losses.	8	CO2	L2
Module 3				
Sl. No.		Marks	CO	BL
1.	Differentiate between Spontaneous and Stimulated emission	3	CO3	L1
2.	Differentiate the optical sources LED and Laser	3	CO3	L2
3.	Describe amplifier spontaneous emission noise	3	CO3	L2
4.	Draw different LED characteristics	3	CO3	L1
5.	Discuss the laser diode structures and radiation patterns	3	CO3	L2
6.	Distinguish direct and indirect band- gap materials	3	CO3	L2
7.	Define responsivity & quantum efficiency of a photodetector	3	CO3	L1
8.	Describe the quantum limit of detection.	3	CO3	L2
9.	A photodiode is constructed of GaAs, which has band gap energy of 1.43 eV at 300 K. Determine the cut off wavelength.	3	CO3	L2
10.	Explain the modulation of Laser diodes & Laser characteristics.	5	CO2	L2
11.	Explain the operation of double heterojunction injection laser with neat sketches.	8	CO3	L2

12.	Explain the structure and working of surface emitting LED & Edge emitting LED	8	CO2	L2
13.	Explain the structure of distributed feedback Laser.	6	CO3	L2
14.	Consider a silicon avalanche photodiode has a quantum efficiency of 70 percent at a wavelength of 950nm. Suppose 0.5 μ W of optical power produces a multiplied photocurrent of 15 μ A. Find (a) the primary photocurrent? (b) the multiplication factor?	5	CO2	L3
15.	Discuss the principle of operation of APD with neat circuit diagram. Also discuss the requirements of photo detector.	8	CO3	L2
16.	Discuss the principle of operation of PIN with neat circuit diagram.	8	CO3	L2
17.	Discuss the fundamentals of receiver operations with neat block diagram	6	CO3	L2
18.	Explain different types of noise & noise performance parameters in photodetectors	7	CO3	L2
19.	A PN photodiode has a quantum efficiency of 65% for photons of energy 1.52×10^{-19} J. Calculate (a) wavelength at which the diode is operating and b) the optical power required to achieve photocurrent of 3 μ A, when the wavelength of incident photon is that of calculated in part (a). ($h=6.626 \times 10^{-34}$, $e=1.6 \times 10^{-19}$)	5	CO3	L3
20.	Compare APD & PIN diode.	5	CO3	L2
21.	Explain optical receiver equivalent circuit & front end receiver amplifier configurations..	6	CO3	L2
22.	A given APD has a quantum efficiency of 65 % at a wavelength of 900nm. If 0.5 μ w of optical power produces a multiplied photocurrent of 10 μ A. Find the multiplication factor M?	6	CO3	L2
23.	Discuss gain guided and index guided type laser diode structures with neat sketches	7	CO3	L2

Prepared By : Tubin T X

Checked By : Milna M J

1. Prescribed Syllabus

Module	Topic	Hours
1	Basics of machine learning, supervised and unsupervised learning, examples, features, feature vector, training set, target vector, test set, feature extraction, over-fitting, curse of dimensionality. Review of probability theory, Gaussian distribution, decision theory	7
2	Regression: linear regression, error functions in regression, multivariate regression, regression applications, bias and variance. Classification: Bayes' decision theory, discriminant functions and decision surfaces, Bayesian classification for normal distributions, classification applications.	8
3	Linear discriminant based algorithm: perceptron, gradient descent method, perceptron algorithm, support vector machines, separable classes, non-separable classes, multiclass case.	6
4	Unsupervised learning: Clustering, examples, criterion functions for clustering, proximity measures, algorithms for clustering. Ensemble methods: boosting, bagging. Basics of decision trees, random forest, examples.	7
5	Dimensionality reduction: principal component analysis, Fischer's discriminant analysis. Evaluation and model Selection: ROC curves, evaluation measures, validation set, bias variance trade-off. Confusion matrix, recall, precision, accuracy.	7

2. Text Books (T)

- T1. Bishop, C. M. "Pattern Recognition and Machine Learning" Springer, New York, 2006.
T2. Theodoridis, S. and Koutroumbas, K. "Pattern Recognition". Academic Press, San Diego, 2003.

3. Reference Books (R)

- R1. Hastie, T., Tibshirani, R. and Friedman, J. "The Elements of Statistical Learning". Springer. 2001.
R2. Duda, R.O., Hart, P.E., and Stork, D.G. "Pattern Classification". Wiley, New York, 2001.

4. Course Objectives

This course aims to impart the fundamentals of machine learning techniques.

5. Course Pre / Co-requisite

- MAT 101 Linear Algebra and Calculus
- MAT 204 Probability, Random Process, and Numerical Methods

6. Course Outcomes

At the end of the course students will be able to :

- CO1. Understand the basics of machine learning and different types.
CO2. Differentiate regression and classification, apply Bayes' decision theory in classification
CO3. Apply linear algebra and statistical methods in discriminant based algorithms

- CO4. Understand the basics of unsupervised learning and non-metric methods and to apply unsupervised learning techniques to find natural groupings and patterns in data.
- CO5. Understand ensemble methods, dimensionality reduction, evaluation, model selection and to apply dimensionality reduction techniques

7. Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes

PO/ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO 12	PSO 1	PSO 2	PSO 3
CO1	H														
CO2	H	H	H	H	H							M			H
CO3	H	H	H	H	H							M			H
CO4	H	H	H	H	H							M			H
CO5	H			H	H							M			H

8. Justification for CO-PO-PSO Correlation

CO	PO/PSO	Justification
CO1	PO1	Understanding the basics of machine learning and different types will help the students to apply knowledge in machine learning concepts to solve problems. Hence highly correlated.
CO2	PO1	Understanding regression and classification techniques will help the students to apply knowledge in regression and classification methods to solve machine learning problems. Hence highly correlated.
	PO2	Ability to differentiate regression and classification techniques and knowledge in machine learning will help the students to analyse machine learning problems. Hence highly correlated.
	PO3	Knowledge in regression and classification techniques will help the students to select design solutions for machine learning problems. Hence highly correlated.
	PO4	Knowledge in machine learning and ability to differentiate regression and classification techniques will help the students to synthesize information about the problem from the raw data, to use appropriate techniques to analyse data and to reach conclusions in ML problems. Hence highly correlated.
	PO5	Ability to differentiate regression and classification techniques and knowledge in machine learning will help the students to use appropriate tools to solve machine learning problems. Hence highly correlated.
	PO12	Knowledge in the basics of machine learning and different types will help the students to understand the changing trends and techniques in machine learning
	PSO3	Ability to differentiate regression and classification techniques and knowledge in machine learning will help the students to choose and apply appropriate modern tools to analyse ML problems. Hence highly correlated.

CO3	PO1	Knowledge in linear algebra and statistical methods will help the students to apply discriminant-based algorithms to solve machine learning problems. Hence highly correlated.
	PO2	Ability to apply linear algebra and statistical tools will help the students to analyse machine learning problems and apply discriminant-based algorithms. Hence highly correlated.
	PO3	Ability to apply linear algebra and statistical methods in discriminant-based algorithms will help the students to select design solutions for machine learning problems. Hence highly correlated.
	PO4	Knowledge in linear algebra and statistical methods in discriminant based algorithms will help the students to synthesize information about the problem from the raw data, to use appropriate techniques to analyse data and to reach conclusions in ML problems. Hence highly correlated.
	PO5	Ability to apply linear algebra and statistical methods in discriminant-based algorithms will help the students to use appropriate tools to solve machine learning problems. Hence highly correlated. Hence highly correlated.
	PO12	Knowledge in perceptron algorithm and support vector machine will help the students to understand the changing trends and techniques in the field
	PSO3	Ability to apply linear algebra and statistical methods in discriminant-based algorithms will help the students to choose and apply appropriate modern tools to analyse ML problems. Hence highly correlated.
CO4	PO1	Understanding the basics of unsupervised learning and non-metric methods will help the students to apply knowledge in machine learning concepts to solve problems to find natural groupings and patterns in data. Hence highly correlated.
	PO2	Ability to apply unsupervised learning will help the students to analyse natural groupings and patterns in data using clustering algorithms. Hence highly correlated.
	PO3	Ability to apply clustering algorithms will help the students to select design solutions for unsupervised machine learning problems. Hence highly correlated.
	PO4	Knowledge in unsupervised learning algorithms will help the students to apply appropriate algorithms to synthesize information from the raw data, to analyse data and to reach conclusions problems. Hence highly correlated.
	PO5	Ability to implement unsupervised learning algorithms will help the students to use appropriate tools to solve machine learning problems. Hence highly correlated. Hence highly correlated.
	PO12	Knowledge in unsupervised learning algorithms will help the students to understand the changing trends and techniques in the clustering applications of unlabelled data sets
	PSO3	Ability to implement unsupervised learning algorithms will help the to choose and apply appropriate modern tools to analyse ML problems. Hence highly correlated.

CO5	PO1	Understanding ensemble methods and dimensionality reduction will help the students to solve machine learning problems. Hence highly correlated.
	PO4	Knowledge in ensemble methods, dimensionality reduction, evaluation and model selection will help the students to synthesize information about the problem from the raw data, to use appropriate techniques to analyse data and to reach conclusions in ML problems. Hence highly correlated.
	PO5	Knowledge in ensemble methods and dimensionality reduction will help the students to use appropriate tools to solve machine learning problems. Hence highly correlated.
	PO12	Knowledge in ensemble methods, dimensionality reduction, evaluation and model selection will help the students to analyse the models for accuracy and precision
	PSO3	Knowledge in ensemble methods and dimensionality reduction will help the students to choose and apply appropriate modern tools to analyse ML problems. Hence highly correlated.

9. Curricular gaps (if any)

NIL

10. Course Enrichment Activities

SI No	Description	Proposed Activities	Relevance to POs and PSOs
1	Practical Demonstration	Workshop using Python on ML applications	PO4PO5PO12 PSO3
2	Webinar	Webinar on applications of ML	PO10 PO12

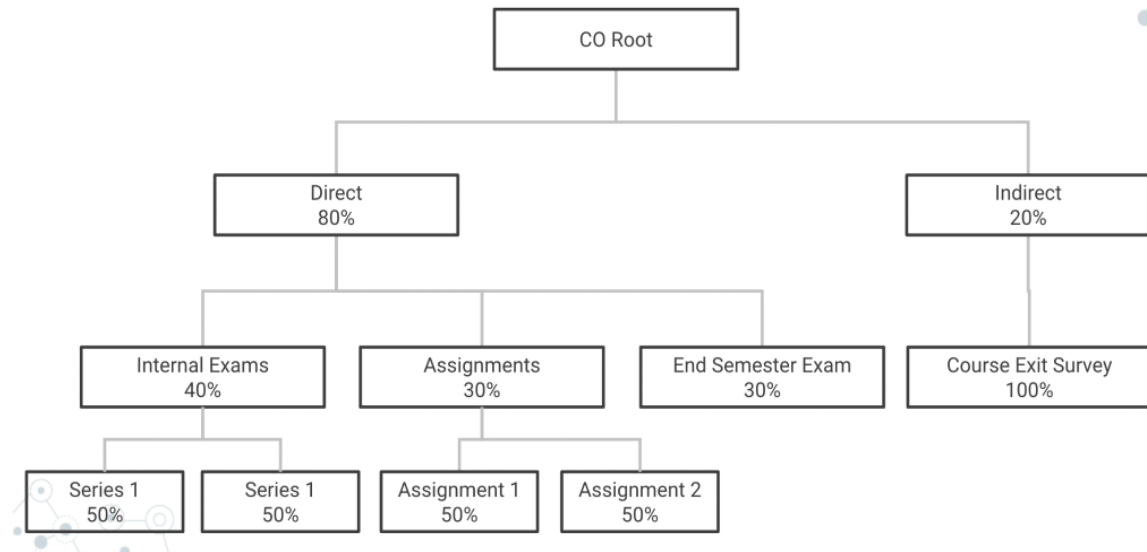
11. Internal Assessment mark allocation (as per university curriculum)

Attendance	- 10 marks
Continuous Assessment Test	- 25 marks
<u>Assignment(s)/ Quiz/Course Project</u>	<u>- 15 marks</u>
<u>Total</u>	<u>- 50 marks</u>

12. Assessment – CO Mapping

	Tools		Weightage	CO1	CO2	CO3	CO4	CO5
Direct Assessment Tools**	Internal Exam(s)40%	Series 1	20%	x	x	x		
		Series 2	20%			x	x	x
	Assignment (s)/30%	A1	15%		x	x		
		A2	15%				x	x
	End Semester Exam		30%	x	x	x	x	x
Indirect Assessment Tool	Course Exit Survey		100%	x	x	x	x	x

13. Assessment Configuration



14. Course Plan

Hour	Topic	Module	Reference(s)	Teaching Pedagogy
1	Basics of machine learning, supervised and unsupervised learning	1	T2	L
2	Examples	1	T2	T
3	Features: Feature vector	1	T2	L
4	Training set, target vector, test set	1	T2	L
5	Feature extraction, over-fitting, curse of dimensionality	1	T1	L
6	Review of probability theory, Gaussian distribution	1	T1, R1	L
7	Decision theory.	1	T1	L
8	Regression: linear regression	2	T1	L
9	Error functions in regression	2	T1	L
10	Multivariate regression, regression applications	2	T1	L
11	Bias and variance.	2	T1	L
12	Classification: Bayes' decision theory,	2	T1	L
13	Discriminant functions and decision surfaces	2	T1	L
14	Bayesian classification for normal distributions	2	T1	T
15	Classification applications	2	T1	L
16	Linear discriminant-based algorithm: perceptron	3	T2	L
17	Gradient descent method	3	T2	L
18	Perceptron algorithm	3	T2	T
19	Support vector machines	3	T2	L
20	SVM for separable classes and non- separable classes	3	T2	L
21	Multiclass case	3	T2	L

22	Unsupervised learning: Clustering, examples	4	T2	L
23	Criterion functions for clustering	4	T2	L
24	Proximity measures	4	T2	L
25	Algorithms for clustering	4	T2	T
26	Ensemble methods: boosting, bagging.	4	R2	L
27	Basics of decision trees	4	R1	L
28	Random forest, examples.	4	R1	L
29	Dimensionality reduction	5	R1	L
30	Principal component analysis	5	R1	T
31	Fischer's discriminant analysis	5	R2	L
32	Evaluation and model selection	5	T2	L
33	ROC curves, evaluation measures	5	T2	L
34	Validation set, bias-variance trade-off.	5	T2	L
35	Confusion matrix, recall, precision, accuracy	5	T2	L

16. Question Bank

Sl. No.	Question	Marks	CO	BL
MODULE 1				
1	Explain the different methods of learning in machine learning	6	CO1	L2
2	Compare Supervised and Unsupervised learning with example	6	CO1	L2
3	Explain two types of Supervised Learning methods.	6	CO1	L2
4	Differentiate the 2 types of Supervised Learning methods.	6	CO1	L2
5	Explain Classification problem with examples	6	CO1	L2
6	Differentiate between binary and multi class classification using an example	6	CO1	L2
7	Explain regression problem with example	6	CO1	L2
8	Explain overfitting of data with an example.	6	CO1	L2
9	Differentiate overfitting and underfitting of data with examples.	6	CO1	L2
10	Differentiate supervised and unsupervised learning using examples.	6	CO1	L2
11	Explain the terms features, training set, target vector, and test set using example	6	CO1	L2
12	Explain the curse of dimensionality in machine learning?	6	CO1	L2
13	Explain a multivariate Gaussian distribution along with its parameters	6	CO1	L2
MODULE 2				
1.	Which are the different error functions used in regression	6	CO2	L2
2.	Calculate the Mean Squared Error (MSE), Root Mean Square Error (RMSE) and Mean Absolute Error (MAE) of the predicted outputs (-1, 2, 2.5, 3.5, 5.5) and the actual outputs for a given set of data is (1, 2, 3, 4, 5)	3	CO2	L2
3.	State Bayes decision theory	3	CO2	L2
4.	Write the Naive Bayes Classification Algorithm.	6	CO2	L2
5.	Differentiate regression and classification using examples	6	CO2	L2
6.	Explain what is the decision surface in a classification problem?	6	CO2	L2
7.	Illustrate the idea of discriminant of a classification problem using an example	6	CO2	L2
8.	Given an instance X of a feature vector and a class label c_k , explain how Bayes theorem is used to compute the probability $P(c_k X)$.	6	CO2	L2

9.	Use naive Bayes algorithm to determine whether a red domestic SUV car is a stolen car or not using the following data: <table><tr><th>Example no.</th><th>Colour</th><th>Type</th><th>Origin</th><th>Whether stolen</th></tr><tr><td>1</td><td>red</td><td>sports</td><td>domestic</td><td>yes</td></tr><tr><td>2</td><td>red</td><td>sports</td><td>domestic</td><td>no</td></tr><tr><td>3</td><td>red</td><td>sports</td><td>domestic</td><td>yes</td></tr><tr><td>4</td><td>yellow</td><td>sports</td><td>domestic</td><td>no</td></tr><tr><td>5</td><td>yellow</td><td>sports</td><td>imported</td><td>yes</td></tr><tr><td>6</td><td>yellow</td><td>SUV</td><td>imported</td><td>no</td></tr><tr><td>7</td><td>yellow</td><td>SUV</td><td>imported</td><td>yes</td></tr><tr><td>8</td><td>yellow</td><td>SUV</td><td>domestic</td><td>no</td></tr><tr><td>9</td><td>red</td><td>SUV</td><td>imported</td><td>no</td></tr><tr><td>10</td><td>red</td><td>sports</td><td>imported</td><td>yes</td></tr></table>	Example no.	Colour	Type	Origin	Whether stolen	1	red	sports	domestic	yes	2	red	sports	domestic	no	3	red	sports	domestic	yes	4	yellow	sports	domestic	no	5	yellow	sports	imported	yes	6	yellow	SUV	imported	no	7	yellow	SUV	imported	yes	8	yellow	SUV	domestic	no	9	red	SUV	imported	no	10	red	sports	imported	yes	8	CO2	L3
Example no.	Colour	Type	Origin	Whether stolen																																																							
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8	yellow	SUV	domestic	no																																																							
9	red	SUV	imported	no																																																							
10	red	sports	imported	yes																																																							
10.	Based on the following data determine the gender of a person having height 6 ft., weight 130 lbs. and foot size 8 in <table><tr><th>person</th><th>height (feet)</th><th>weight (lbs)</th><th>foot size (inches)</th></tr><tr><td>male</td><td>6.00</td><td>180</td><td>10</td></tr><tr><td>male</td><td>6.00</td><td>180</td><td>10</td></tr><tr><td>male</td><td>5.50</td><td>170</td><td>8</td></tr><tr><td>male</td><td>6.00</td><td>170</td><td>10</td></tr><tr><td>female</td><td>5.00</td><td>130</td><td>8</td></tr><tr><td>female</td><td>5.50</td><td>150</td><td>6</td></tr><tr><td>female</td><td>5.00</td><td>130</td><td>6</td></tr><tr><td>female</td><td>6.00</td><td>150</td><td>8</td></tr></table>	person	height (feet)	weight (lbs)	foot size (inches)	male	6.00	180	10	male	6.00	180	10	male	5.50	170	8	male	6.00	170	10	female	5.00	130	8	female	5.50	150	6	female	5.00	130	6	female	6.00	150	8	8	CO2	L3																			
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female	5.50	150	6																																																								
female	5.00	130	6																																																								
female	6.00	150	8																																																								
11.	Explain linear regression with an example.	6	CO2	L2																																																							
12.	Explain the ordinary least squares method for regression.	6	CO2	L2																																																							
13.	In the table below, the x_i row shows scores in an aptitude test. Similarly, the y_i row shows statistics grades. If a student made an 80 on the aptitude test, what grade would we expect her to make in statistics? <table><tr><th>Student i</th><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th></tr><tr><td>x_i</td><td>95</td><td>85</td><td>80</td><td>70</td><td>60</td></tr><tr><td>y_i</td><td>85</td><td>95</td><td>70</td><td>65</td><td>70</td></tr></table>	Student i	1	2	3	4	5	x_i	95	85	80	70	60	y_i	85	95	70	65	70	8	CO2	L3																																					
Student i	1	2	3	4	5																																																						
x_i	95	85	80	70	60																																																						
y_i	85	95	70	65	70																																																						
14.	Determine the regression equation by finding the regression slope coefficient and the intercept value using the following data. <table><tr><td>x</td><td>55</td><td>60</td><td>65</td><td>70</td><td>80</td></tr><tr><td>y</td><td>52</td><td>54</td><td>56</td><td>58</td><td>62</td></tr></table>	x	55	60	65	70	80	y	52	54	56	58	62	8	CO2	L3																																											
x	55	60	65	70	80																																																						
y	52	54	56	58	62																																																						
15.	Explain bias and variance for regression	6	CO2	L2																																																							
16.	Obtain a linear regression for the data in assuming that y is the independent variable. <table><tr><td>x</td><td>1.0</td><td>2.0</td><td>3.0</td><td>4.0</td><td>5.0</td></tr><tr><td>y</td><td>1.00</td><td>2.00</td><td>1.30</td><td>3.75</td><td>2.25</td></tr></table>	x	1.0	2.0	3.0	4.0	5.0	y	1.00	2.00	1.30	3.75	2.25	8	CO2	L3																																											
x	1.0	2.0	3.0	4.0	5.0																																																						
y	1.00	2.00	1.30	3.75	2.25																																																						
17.	Fit a multiple linear regression model to the following data: <table><tr><td>x_1</td><td>1</td><td>1</td><td>2</td><td>0</td></tr><tr><td>x_2</td><td>1</td><td>2</td><td>2</td><td>1</td></tr><tr><td>y</td><td>3.25</td><td>6.5</td><td>3.5</td><td>5.0</td></tr></table>	x_1	1	1	2	0	x_2	1	2	2	1	y	3.25	6.5	3.5	5.0	8	CO2	L3																																								
x_1	1	1	2	0																																																							
x_2	1	2	2	1																																																							
y	3.25	6.5	3.5	5.0																																																							
18.	Use the following data to construct a regression model for the auto insurance premium as a function of driving experience.	8	CO2	L3																																																							

	<table><tr><td colspan="2">Driving experience (in years)</td><td>5</td><td>2</td><td>12</td><td>9</td><td>15</td><td>6</td><td>25</td><td>16</td></tr><tr><td colspan="2">Monthly auto insurance premium (\$)</td><td>64</td><td>87</td><td>50</td><td>71</td><td>44</td><td>56</td><td>42</td><td>60</td></tr></table>	Driving experience (in years)		5	2	12	9	15	6	25	16	Monthly auto insurance premium (\$)		64	87	50	71	44	56	42	60			
Driving experience (in years)		5	2	12	9	15	6	25	16															
Monthly auto insurance premium (\$)		64	87	50	71	44	56	42	60															
19.	Obtain the decision surface for an equi-probable two class system, where the probability density functions of 1-dimensional feature vectors in both classes are normally distributed.	6	CO2	L2																				
20.	Show that the Bayesian classifier is optimal with respect to minimizing the classification error probability.	6	CO2	L2																				
MODULE 3																								
1	Define Activation function and list any 2 examples	4	CO3	L2																				
2	Describe any four types of activation functions used in Artificial Neural Networks.	4	CO3	L2																				
3	Define a perceptron and draw the schematic representation of a perceptron	4	CO3	L2																				
4	Why does a single perceptron cannot simulate simple XOR function ? Explain how this limitation is overcome?	4	CO3	L3																				
5	What is an activation function in an artificial neuron? Give some examples	4	CO3	L2																				
6	Explain about perceptron algorithm.	6	CO3	L2																				
7	Define activation function. Explain about any four activation functions in detail.	8	CO3	L2																				
8	Explain the gradient descent method	6	CO3	L2																				
9	Define a linearly separable dataset? Give an example. Give an example for a dataset which is not linearly separable	3	CO3	L2																				
10	Define a hyperplane in an n-dimensional space. What are the hyperplanes in 2-dimensional and 3-dimensional spaces?	3	CO3	L2																				
11	Find the distance of the point (1,-2, 3) from the hyperplane $3x_1 - 4x_2 + 12x_3 - 1 = 0$.	3	CO3	L3																				
12	Demonstrate an algorithm to find the SVM classifier and describe the mathematical formulation of the SVM problem.	8	CO3	L2																				
13	Describe the significance of soft margin hyperplane and explain how they are computed.	4	CO3	L2																				
14	What is the significance of optimal separating hyperplanes in SVM?	4	CO3	L2																				
15	State the mathematical formulation of the SVM problem. Give an outline of the method for solving the problem	6	CO3	L2																				
16	Obtain the cost function for optimization in SVM for separable classes	6	CO3	L2																				
17	Explain Kernel Trick in the context of support vector machine. List any two kernel function used in SVM.	4	CO3	L2																				
18	What is the purpose of Kernel functions used in Support Vector Machines?	6	CO3	L2																				
19	How the SVM's can be used to obtain classifiers when there are more than two class labels.	4	CO3	L2																				
20	How SVM is used in separable classes? Apply SVM algorithm to model an SVM classifier for the following data. <table><tr><td>Number</td><td>x₁</td><td>x₂</td><td>class</td></tr><tr><td>1</td><td>2</td><td>1</td><td>+1</td></tr><tr><td>2</td><td>4</td><td>3</td><td>-1</td></tr></table>	Number	x ₁	x ₂	class	1	2	1	+1	2	4	3	-1	14	CO3	L3								
Number	x ₁	x ₂	class																					
1	2	1	+1																					
2	4	3	-1																					
MODULE 4																								
1	Illustrate the algorithm for K-means clustering of unsupervised learning. Write the disadvantages and applications of K-means clustering.	6	CO4	L2																				
2	Using an example illustrate the different steps in KMeans clustering algorithm.	6	CO4	L2																				
3	Use K means clustering algorithm to divide the following data into two clusters	14	CO4	L3																				

	<table><tr><td>x1</td><td>1</td><td>2</td><td>2</td><td>3</td><td>4</td><td>5</td></tr><tr><td>x2</td><td>1</td><td>1</td><td>2</td><td>3</td><td>3</td><td>5</td></tr></table>	x1	1	2	2	3	4	5	x2	1	1	2	3	3	5																									
x1	1	2	2	3	4	5																																		
x2	1	1	2	3	3	5																																		
4	Find the three clusters after one epoch for the following eight examples using the k-means algorithm and Euclidean distance A1=(2,10), A2=(2,5), A3=(8,4), A4=(5,8), A5=(7,5), A6=(6,4), A7=(1,2), A8=(4,9). Suppose that the initial seeds (centers of each cluster) are A1, A4 and A7.	14	CO4	L3																																				
5	Apply K Means clustering to cluster the following data into two groups. Assume cluster centroids are C1=2 and C2=4. The distance function used is Euclidean distance. {2, 4, 10, 12, 3, 20, 30, 11, 25}	14	CO4	L3																																				
6	List proximity measures or dissimilarity measures used in clustering	3	CO4	L2																																				
7	Explain the methods to find the distance between various groups of data points	3	CO4	L2																																				
8	Write any four commonly used equations for measures of distance between data points of numeric data in Hierarchical Clustering.	4	CO4	L2																																				
9	Calculate the dissimilarity between two data points x1(2,3,4) and x2(4,3,5) using(a) Euclidian distance (b) Manhattan Distance	4	CO4	L3																																				
10	Consider two data points in two-dimensional A (5,8) and B (8,9). Calculate (a) Manhattan distance (b) Squared Euclidian distance between A & B	4	CO4	L3																																				
11	Write the algorithm for agglomerative hierarchical clustering	6	CO4	L2																																				
12	Write the algorithm for DIANA (Divisive ANALysis) of hierarchical clustering technique.	6	CO4	L2																																				
13	Compare Agglomerative and divisive clustering methods	6	CO4	L2																																				
14	Construct the dendrogram using Complete Linkage Method for the given data points. <table><tr><td></td><td>a</td><td>b</td><td>c</td><td>d</td><td>e</td></tr><tr><td>a</td><td>0</td><td></td><td></td><td></td><td></td></tr><tr><td>b</td><td>8</td><td>0</td><td></td><td></td><td></td></tr><tr><td>c</td><td>2</td><td>6</td><td>0</td><td></td><td></td></tr><tr><td>d</td><td>5</td><td>4</td><td>8</td><td>0</td><td></td></tr><tr><td>e</td><td>10</td><td>9</td><td>1</td><td>7</td><td>0</td></tr></table>		a	b	c	d	e	a	0					b	8	0				c	2	6	0			d	5	4	8	0		e	10	9	1	7	0	6	CO4	L3
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a	0																																							
b	8	0																																						
c	2	6	0																																					
d	5	4	8	0																																				
e	10	9	1	7	0																																			
15	Given the following distance matrix, construct the dendrogram using single linkage, complete linkage and average linkage clustering algorithm <table><tr><td>Item</td><td>A</td><td>B</td><td>C</td><td>D</td><td>E</td></tr><tr><td>A</td><td>0</td><td>1</td><td>2</td><td>2</td><td>3</td></tr><tr><td>B</td><td>1</td><td>0</td><td>2</td><td>4</td><td>3</td></tr><tr><td>C</td><td>2</td><td>2</td><td>0</td><td>1</td><td>5</td></tr><tr><td>D</td><td>2</td><td>4</td><td>1</td><td>0</td><td>3</td></tr><tr><td>E</td><td>3</td><td>3</td><td>5</td><td>3</td><td>0</td></tr></table>	Item	A	B	C	D	E	A	0	1	2	2	3	B	1	0	2	4	3	C	2	2	0	1	5	D	2	4	1	0	3	E	3	3	5	3	0	6	CO4	L3
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C	2	2	0	1	5																																			
D	2	4	1	0	3																																			
E	3	3	5	3	0																																			
16	Show the final result of hierarchical clustering with single link by drawing a dendrogram.	8	CO4	L3																																				

	<table><tr><th></th><th>A</th><th>B</th><th>C</th><th>D</th><th>E</th><th>F</th></tr><tr><th>A</th><td>0</td><td></td><td></td><td></td><td></td><td></td></tr><tr><th>B</th><td>0.12</td><td>0</td><td></td><td></td><td></td><td></td></tr><tr><th>C</th><td>0.51</td><td>0.25</td><td>0</td><td></td><td></td><td></td></tr><tr><th>D</th><td>0.84</td><td>0.16</td><td>0.14</td><td>0</td><td></td><td></td></tr><tr><th>E</th><td>0.28</td><td>0.77</td><td>0.70</td><td>0.45</td><td>0</td><td></td></tr><tr><th>F</th><td>0.34</td><td>0.61</td><td>0.93</td><td>0.20</td><td>0.67</td><td>0</td></tr></table>		A	B	C	D	E	F	A	0						B	0.12	0					C	0.51	0.25	0				D	0.84	0.16	0.14	0			E	0.28	0.77	0.70	0.45	0		F	0.34	0.61	0.93	0.20	0.67	0			
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F	0.34	0.61	0.93	0.20	0.67	0																																															
17	Describe any two techniques used for Ensemble Learning	6	CO5	L2																																																	
18	What is ensemble learning? Give an example.	4	CO5	L2																																																	
19	Explain the bagging and boosting methods used in learning algorithms.	6	CO5	L2																																																	
20	Describe about the concept of decision tree with an example.	6	CO5	L2																																																	
21	Describe decision trees with examples.	6	CO5	L2																																																	
22	Explain the issues involved in decision tree learning.	6	CO5	L2																																																	
23	Calculate the Gini index of the given number of class label with bird=2, fish=2and reptile=1.	3	CO5	L2																																																	
24	Explain in detail about the random forest algorithm to improve classifier accuracy.	6	CO5	L2																																																	
MODULE 5																																																					
1	Discuss about the significance of dimensionality reduction.	4	CO5	L2																																																	
2	Discuss about principal component analysis.	6	CO5	L2																																																	
3	Explain the procedure for performing a Principal Component Analysis (PCA) on a given data set.	6	CO5	L2																																																	
4	Briefly Explain the procedure for the computation of the principal components of a given data..	6	CO5	L2																																																	
5	Is principal component analysis a supervised learning problem? Why? Describe how principal component analysis is carried out to reduce dimensionality of data sets.	6	CO5	L2																																																	
6	Define true positive and false negative.	4	CO5	L2																																																	
7	Discuss about confusion matrix, precision and recall.	4	CO5	L2																																																	
8	Express the confusion matrix table for two class datasets.	4	CO5	L2																																																	
9	Suppose a computer program for recognizing dogs in photographs identifies eight dogs in a picture containing 12 dogs and some cats. Of the eight dogs identified, five actually are dogs while the rest are cats. Compute the precision and recall of the computer program.	4	CO5	L3																																																	
10	Consider a Machine Learning Model which can detect and hence filter out all the spams. Let’s take a sample set of 1000 emails. Out of 1000, 100 are spam and rest 900 are relevant emails. Our Machine Learning Model predicts 30 as spam and 970 as relevant. Compute precision and recall of the model. Also draw the confusion matrix.	4	CO5	L3																																																	
11	Explain the Receiver Operating Characteristics (ROC) Space in machine learning.	4	CO5	L2																																																	
12	Differentiate between cross validation and bootstrapping.	6	CO5	L2																																																	
13	Explain Bootstrapping method for evaluating accuracy of a classifier.	4	CO5	L2																																																	
14	Describe the ROC curve with a neat diagram.	6	CO5	L2																																																	

Prepared By : Ms. Anu Antony,

Checked By : Dr. Saju A

Course Code & Name: CST435 Computer Graphics

1. Prescribed Syllabus

Module	Topic	Hours
1	Basics of Computer graphics: Basics of Computer Graphics and its applications. Video Display devices- Refresh Cathode Ray Tubes (CRT), Random Scan Displays and systems, Raster scan displays and systems, Color CRT displays, Flat panel display and its categories.	9
2	Line drawing, Circle drawing and Filled Area Primitives: Line drawing algorithms- DDA, Bresenham's algorithm. Circle drawing algorithms- Midpoint Circle generation algorithm, Bresenham's algorithm. Filled Area Primitives- Scan line polygon filling, Boundary filling and flood filling.	12
3	Geometric transformations: Two dimensional transformations-Translation, Rotation, Scaling, Reflection and Shearing, Composite transformations, Matrix representations and homogeneous coordinates. Basic 3D transformations.	11
4	Clipping: Window to viewport transformation. Cohen Sutherland and Midpoint subdivision line clipping algorithms, Sutherland Hodgeman and Weiler Atherton Polygon clipping algorithms.	10
5	Three-dimensional graphics: Three-dimensional viewing pipeline. Projections- Parallel and Perspective projections. Visible surface detection algorithms- Back face detection, Depth buffer algorithm, Scan line algorithm, A buffer algorithm	10

2. Text Books (T)

- T1. Zhigang Xiang and Roy Plastock, Computer Graphics (Schaum's outline Series), McGraw Hill, 2019
T2. Donald Hearn and M. Pauline Baker, Computer Graphics, PHI, 2e, 1996

3. Reference Books (R)

- R1. William M. Newman and Robert F. Sproull, Principles of Interactive Computer Graphics. McGraw Hill, 2001
R2. David F. Rogers , Procedural Elements for Computer Graphics, Tata McGraw Hill,2001.
R3. Donald Hearn, M. Pauline Baker and Warren Carithers, Computer Graphics with OpenGL, PHI, 4e, 2013

4. Course Objectives

Nil

5. Course Pre / Co-requisite

A sound knowledge of Mathematics and concepts of any programming language.

6. Course Outcomes

Students will be able to

- CO1 : Describe the working principles of graphics devices
 CO2 : Illustrate line drawing, circle drawing and polygon filling algorithms
 CO3 : Demonstrate geometric representations and transformations on 2D & 3D objects
 CO4 : Demonstrate the working of line and polygon clipping algorithms
 CO5 : Summarize visible surface detection methods and illustrate projection algorithms.

7. Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes

PO/ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H	M										M			
CO2	H	M	M	M	M							M			
CO3	H	M	M	M	M							M			
CO4	H	M	M	M	M							M			
CO5	H	M										M			

8. Justification for CO-PO-PSO Correlation

CO	PO	Justification Statement
CO1	PO1	Understanding the working principles of different graphic devices enable the students to compare different graphic devices and use this knowledge to solve engineering problems.
	PO2	Students will be able to analyse the pros and cons of different graphic devices and use this knowledge to solve engineering problems.
	PO12	Students will be able to identify technological advancements in graphical devices for continuing professional development in the area of computer graphics.
CO2	PO1	Students will be able to apply various line drawing, circle drawing and polygon filling algorithms to solve engineering problems.
	PO2	Students will be able to analyse different line drawing, circle drawing and polygon filling algorithm to identify the best algorithm for solving engineering problem.
	PO3	By applying various line drawing, circle drawing and polygon filling algorithm students will be able to design and develop graphic system of less complexity.
	PO4	The knowledge in various line drawing, circle drawing and polygon filling algorithm enable the student to conduct investigation on real life problems and provide valid conclusion.
	PO5	Use of appropriate line drawing and circle drawing algorithms to scan convert line and circle helps to substantially select and apply modern engineering tools
	PO12	Students will be able to engage in lifelong learning in the field of computer graphics by understanding the basis of line drawing, circle drawing and polygon filling algorithm.

CO3	PO1	Students will be able to apply different transformation techniques to solve engineering problems.
	PO2	Students will be able to analyse different transformations for developing animation project of less complexity.
	PO3	Students will be able to develop animation project by applying transformation techniques.
	PO4	The knowledge in transformation techniques enable the student to conduct investigation on real life problems and provide valid conclusion.
	PO5	Use of appropriate transformation techniques to change object orientation helps to substantially select and apply modern engineering tools
	PO12	Able to acquire more knowledge in the advanced field of transformation techniques results in lifelong learning
CO4	PO1	Understanding the concepts of clipping enable the students to perform clipping operation as a part of developing graphic applications.
	PO2	Students can analyze various clipping techniques and can understand the concept of clipping on different type of objects.
	PO3	Students will be able to apply the process of clipping to graphics applications
	PO4	The knowledge in different clipping algorithms enable the student to conduct investigation on real life problems and provide valid conclusion.
	PO5	Use of appropriate clipping algorithms to find out the clipped area helps to substantially select and apply modern engineering tools
	PO12	Able to acquire more knowledge in the advanced field of transformation techniques results in lifelong learning
CO5	PO1	Students will be able to understand the basic concepts in visible surface detection techniques.
	PO2	Students can analyze various surface detection techniques and able to understand the concept of eliminating hidden surface
	PO12	Students will be able to identify various surface detection techniques for continuing professional development in the area of computer graphics.

9. Curricular gaps (if any)

Nil

10. Course Enrichment Activities*

Sl No	Description	Proposed Activities	Relevance to POs and PSOs
1	Concepts of computer vision	Webinar	PO1

11. Internal Assessment mark allocation (as per university curriculum)

(Provide details as mentioned in syllabus)

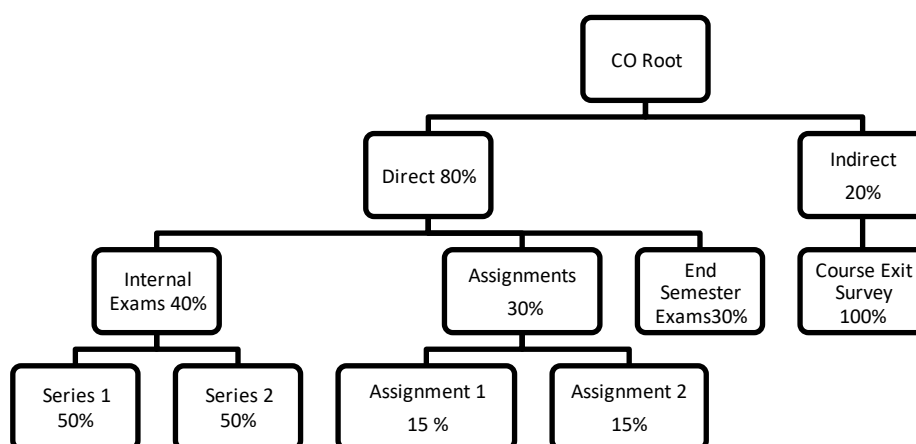
Continuous Assessment Test	- 40 marks
Assignment(s)/ Course Project	- 10 marks
Total	- 50 marks

12. Assessment – CO Mapping (Put 'x' if mapping is present)

	Tools	Weightage [#]	CO1	CO2	CO3	CO4	CO5
	Series 1	20%	x	x			

Direct Assessment Tools	Internal Exam(s) 40%	Series 2	20%					x
	Assignments	Assignment 1	15%		x			
		Assignment 2	15%			x	x	
	End Semester Exam		30%	x	x	x	x	x
Indirect Assessment Tool	Course Exit Survey		100%	x	x	x	x	x

13. Assessment Configuration



14. Course plan

Hour	Topic	Module	Reference	Teaching Pedagogy
Module 1				
1	Basics of Computer Graphics and applications	1	T1, T2	Lecture
2	Refresh Cathode Ray Tubes	1	T1, T2	Lecture
3	Random Scan Displays and systems	1	T1, T2	Tutorial
4	Raster scan displays and systems	1	T1, T2	Lecture
5	Color CRT displays	1	T1, T2	Lecture
6	Flat panel display	1	T1, T2	Lecture
7	Flat panel display and its categories	1	T1, T2	Lecture
8	Flat panel display and its categories	1	T1, T2	Remedial
9	Problems	1	T1, T2	Tutorial
Module 2				
10	DDA Line drawing Algorithm	2	T1, T2	Lecture
11	example	2	T1, T2	Lecture
12	Bresenham's line drawing algorithm	2	T1, T2	Lecture
13	example	2	T1, T2	Tutorial
14	Midpoint Circle generation algorithm	2	T1, T2	Lecture
15	Bresenham's Circle generation algorithm	2	T1, T2	Lecture

16	Illustration of line drawing and circle drawing algorithms	2	T1, T2	tutorial
17	Scan line polygon filling	2	T1, T2	Lecture
18	example	2	T1, T2	Lecture
19	Boundary filling	2	T1, T2	Lecture
20	flood filling	2	T1, T2	Lecture
21	Filling area	2	T1, T2	Remedial
Module 3				
22	Basic 2D transformations-Translation	3	T1, T2	Lecture
23	Rotation	3	T1, T2	Lecture
24	Basic 2D transformations- Scaling	3	T1, T2	Lecture
25	Reflection and Shearing	3	T1, T2	Lecture
26	Illustration of 2D Transformations	3	T1, T2	Tutorial
27	Composite transformations	3	T1, T2	Lecture
28	Matrix representations and homogeneous coordinates	3	T1, T2	Lecture
29	Matrix representations	3	T1, T2	Lecture
30	Basic 3D transformations	3	T1, T2	Lecture
31	Illustration of basic 3D transformations	3	T1, T2	Remedial
32	Illustration of basic 3D transformations	3	T1, T2	Tutorial
Module 4				
33	Window to viewport transformation	4	T1, T2	Lecture
34	Cohen Sutherland Line clipping algorithm	4	T1, T2	Lecture
35	Cohen Sutherland Line clipping algorithm	4	T1, T2	Remedial
36	Midpoint subdivision Line clipping algorithm	4	T1, T2	Lecture
37	Midpoint subdivision Line clipping algorithm	4	T1, T2	Tutorial
38	Sutherland Hodgeman Polygon clipping algorithm	4	T1, T2	Lecture
39	Sutherland Hodgeman Polygon clipping algorithm	4	T1, T2	Lecture
40	Weiler Atherton Polygon clipping algorithm	4	T1, T2	Lecture
41	Weiler Atherton Polygon clipping algorithm	4	T1, T2	Lecture
42	Practice problems on Clipping algorithms	4	T1, T2	Tutorial
Module 5				
43	Three-dimensional viewing pipeline, Projections- Parallel projections	5	T1, T2	Lecture
44	Projections- Perspective projections	5	T1, T2	Lecture
45	Projections- Perspective projections	5	T1, T2	Tutorial
46	Visible surface detection algorithms- Back face detection.	5	T1, T2	Lecture
47	Visible surface detection algorithms- Back face detection.	5	T1, T2	Remedial
48	Depth buffer algorithm	5	T1, T2	Lecture
49	Depth buffer algorithm	5	T1, T2	Tutorial
50	Scan line visible surface detection algorithm	5	T1, T2	Lecture
51	Scan line visible surface detection algorithm	5	T1, T2	Remedial
52	A buffer algorithm	5	T1, T2	Lecture

15. Question Bank

MODULE 1

1. Distinguish between raster scan display and random scan display.
2. What do you understand about the aspect ratio and resolution of a display screen in a raster scan display?
3. Explain the working of a random scan display system with a suitable diagram.
4. Explain the working of a beam penetration CRT.
5. Explain the working of direct view storage tubes (DVST).
6. Consider a raster system with a resolution of 2560×2048 . Determine the frame buffer size (in bytes) needed for the system to store 12-bits per pixel. How much storage is required if 24-bits per pixel are to be stored?
7. Explain the working of a delta-delta shadow mask CRT.
8. What is the use of computer graphics? List out and explain any 5 applications of computer graphics.
9. Draw and explain the architecture of simple raster graphics systems.
10. Define the following terms.
 - a. Persistence.
 - b. Resolution.
 - c. Aspect ratio.
 - d. Frame buffer.
11. Describe in detail the basic video controller refresh operation used in interactive raster graphics systems.
12. Explain the working of the cathode ray tube in detail.
13. What is the role of a display controller in a raster scan display system? Explain.
14. Explain the functioning of a random scan display system.
15. With a neat diagram describe the working of a cathode ray display device.
16. With a suitable figure, describe the shadow masking techniques in CRT.
17. Describe simple random scan display system and draw its architecture.

MODULE-2

1. Using the midpoint circle drawing algorithm find out the first quadrant point of a circle from $x=0$ to $x=y$ where $r=10$. Also draw the complete circle using the same.
2. Using both DDA and Bresenham's line drawing algorithm, plot the line with endpoints (20,15) and (34,20).
3. How 8-way symmetric points if (x,y) is a point on the circle with centre at origin.
4. Write the DDA line drawing algorithm.
5. Rasterize the line segment from pixel coordinate (1,1) to (8,5) using Bresenham's line drawing algorithm.
6. Write the midpoint circle drawing algorithm.
7. Use midpoint circle drawing algorithm to plot a circle whose radius = 20 units and center is (50,30).
8. What are the advantages and disadvantages of the DDA algorithm?
9. Describe the DDA line drawing algorithm. Use the algorithm to find the coordinate along the line joining the pixel positions (5,12) and (15,20).
10. Explain DDA line drawing algorithm with examples.

11. Explain the midpoint circle drawing algorithm. Find the pixel locations approximately the first octant of a circle having centre (10,13) and radius of 5 units using this algorithm.
12. Write the boundary fill algorithm for filling a polygon using eight connected approach.

MODULE 3

1. Given a triangle A(20,10) B(80,20) C(50,70). Find the co-ordinates of vertices after each of the following transformations.
 - a. Reflection about the line $x=y$.
 - b. Rotation of the triangle ABC about vertex A in clockwise direction for an angle 90 degree.
2. What do you mean by homogeneous coordinate system? What is its significance?
3. Derive the Initial decision parameter of midpoint circle drawing algorithm.
4. Perform the following transformations on a point (6,4).
 - a. Translate by $t_x=-2$ and $t_y=4$.
 - b. Then, scale by $s_x=2$ and $s_y=1$.
 - c. And rotate by 90 degree in a clockwise direction. Determine the final coordinates of the transformed point.
5. Prove that the multiplication of 2D transformation matrices for two successive rotations is commutative.
6. Represent all transformations equations as matrix multiplication.
7. How can you get the mirror image of an object.
8. Prove that two successive translations are additive.
9. Perform 45 degree rotation of a triangle A(0,0) B(1,1) C(5,3) about the origin and about the fixed point (-1,-1)
10. Explain shearing and formulate transformations matrix for conditions. Perform shearing for the given unit square A(0,0) B(1,0) C(1,1) D(0,1) relative to the reference line $Y_{ref}=-2$ and $sh_x=1/2$.
11. Clip the given line A(1,3) B(4,1) and against a window P(2,2)
12. Write short notes on 2D rotation transformation.
13. What are the homogeneous coordinates? Explain their relevance in simplifying the geometric transformations of graphical objects.
14. Describe the relevance and various methods of inside-outside test used in polygon filling.
15. Magnify the triangle ABC with A(0, 0), B(1, 1) and C(5, 2) to twice its size while keeping C(5, 2) fixed.
16. Show that the composition of two successive rotations are additive i.e. $R(\theta_1). R(\theta_2) = R(\theta_1 + \theta_2)$.
17. Generate the points between the end points of a line viz. (2,2) and (9,6) by using Bresenham's line drawing algorithm.
18. Scan convert the line segment with end points (30,20) and (15,10) using DDA line drawing algorithm.
19. Prove that the multiplication of 3D transformations matrices for each of the following sequences of operations is commutative.
20. Any two successive translations.
21. Any two successive scaling operations.
22. Any two successive rotations about any one of the coordinate axes.

MODULE 4

1. Define window to viewport transformations.
2. Which are the steps involved in window to viewport coordinate transformation in 2D?
3. Draw the schematic of the general 2D transformations pipeline from modeling coordinate to final

- device coordinate.
4. Describe the techniques that can be used to provide text clipping in a graphics package.
 5. Given a clipping window $A(-20,-20), B(40,-20), C(40,30)$ and $D(-20,30)$ using Cohen Sutherland line clipping algorithm, find the visible portion of the line segment joining the points $P(-30,20)$ and $Q(60,-10)$.
 6. Derive an equation for window to viewport transformation by specifying the sequence of basic transformations involved.
 7. Describe the following terms
 - a. Window
 - b. Viewport
 - c. World coordinate
 - d. coordinate
 8. Define the terms window, viewport and windowing transformations in the context of 2D viewing with suitable diagrams.
 9. Explain the concepts of point clipping in 2D.
 10. Explain the Cohen Sutherland line clipping algorithm with suitable examples.
 11. Brief on 2D viewing transformations pipeline.
 12. Why are line clipping algorithms not used for clipping polygons? Explain Sutherland Hodgeman polygon clipping algorithm with an example.

MODULE 5

1. Describe in detail the depth buffer visible surface detection technique. Derive the equation to find the depth values for a surface position (x, y) .
2. What are the advantages of z-buffer algorithm? Also discuss what is its major drawback.
3. Explain scan line algorithm is used for visible surface detection.
4. Define the terms
 - (i) Centre of projection
 - (ii) Principal vanishing point.
5. Differentiate between oblique and orthogonal projection. Differentiate between oblique and orthogonal projection.
6. What is meant by vanishing point in the context of a perspective projection.
7. Distinguish between object space methods and image space methods for visible surface detection.
8. Define the following terms
 - a) Centre of projection
 - b) Vanishing point
 - c) Isometric projection
 - d) Oblique projection
9. Explain how visible surfaces can be detected using depth buffer algorithm.
10. Define parallel projection. Describe orthographic and oblique parallel projection.
11. Illustrate the scan line method used in visible surface detection.
12. Differentiate between parallel and perspective projections?
13. Describe vanishing point in projection?
14. Differentiate between orthographic and perspective projection.
15. What are the main features of the depth buffer algorithm in visible surface detection?
16. Describe the steps involved in the three-dimensional viewing pipeline, from object space to screen space.
17. Explain the depth buffer algorithm for hidden surface removal in 3D graphics. Illustrate with an example of rendering overlapping objects.

18. What is the scan-line algorithm for visible surface detection? Explain its process and provide an example involving three overlapping polygons.
19. Using the A-buffer algorithm, explain how transparency is handled in visible surface detection

Prepared By : Krishna CJ

Checked By : Teenu Jose

Course Code & Name: MCN401 INDUSTRIAL SAFETY ENGINEERING

1. Prescribed Syllabus

Module	Topic	Hours
1	Need for safety. Safety and productivity. Definitions: Accident, Injury, Unsafe act, Unsafe Condition, Dangerous Occurrence, Reportable accidents. Theories of accident causation. Safety organization- objectives, types, functions, Role of management, supervisors, workmen, unions, government and voluntary agencies in safety. Safety policy. Safety Officer-responsibilities, authority. Safety committee-need, types, advantages.	5
2	Personal protection in the work environment, Types of PPEs, Personal protective equipment- respiratory and non-respiratory equipment. Standards related to PPEs. Monitoring Safety Performance: Frequency rate, severity rate, incidence rate, activity rate. Housekeeping: Responsibility of management and employees. Advantages of good housekeeping. 5 s of housekeeping. Work permit system- objectives, hot work and cold work permits. Typical industrial models and methodology. Entry into confined spaces.	7
3	Introduction to construction industry and safety issues in construction Safety in various construction operations – Excavation and filling – Under-water works – Under-pinning & Shoring – Ladders & Scaffolds – Tunneling – Blasting – Demolition – Confined space – Temporary Structures. Familiarization with relevant Indian Standards and the National Building Code provisions on construction safety. Relevance of ergonomics in construction safety. Ergonomics Hazards - Musculoskeletal Disorders and Cumulative Trauma Disorders.	7
4	Machinery safeguard-Point-of-Operation, Principle of machine guarding -types of guards and devices. Safety in turning, and grinding. Welding and Cutting-Safety Precautions of Gas, welding and Arc Welding. Material Handling-Classification-safety consideration- manual and mechanical handling. Handling assessments and techniques- lifting, carrying, pulling, pushing, palletizing and stocking. Material Handling equipment-operation & maintenance. Maintenance of common elements-wire rope, chains slings, hooks, clamps. Hearing Conservation Program in Production industries.	8
5	Hazard and risk, Types of hazards –Classification of Fire, Types of Fire extinguishers, fire explosion and toxic gas release, Structure of hazard identification and risk assessment. Identification of hazards: Inventory analysis, Fire and explosion hazard rating of process plants - The Dow Fire and Explosion Hazard Index, Preliminary hazard analysis, Hazard and Operability study (HAZOP)) – methodology, criticality analysis, corrective action and follow-up. Control of Chemical Hazards, Hazardous properties of chemicals, Material Safety Data Sheets (MSDS).	8

2. Text Books (T)

T1. R.K Jain (2000) Industrial Safety, Health and Environment management systems, Khanna Publications.

3. Reference Books (R)

- R1. Paul S V (2000), Safety management System and Documentation training Programme handbook, CBS Publication
- R2. Krishnan, N.V. (1997). *Safety management in Industry*. Jaico Publishing House, New Delhi.
- R3. John V. Grimaldi and Rollin H. Simonds. (1989) *Safety management*. All India Traveller Book Seller, Delhi.
- R4. Ronald P. Blake. (1973). *Industrial safety*. Prentice Hall, New Delhi.
- R5. Alan Waring. (1996). *Safety management system*. Chapman & Hall, England.
- R6. Vaid, K.N., (1988). Construction safety management. National Institute of Construction Management and Research, Mumbai.
- R7. AIChE/CCPS. (1992). *Guidelines for Hazard Evaluation Procedures*. (second edition). Centre for Chemical Process Safety, American Institute of Chemical Engineers, New York

4. Course Objectives

The general objective of this course is to give knowledge of various safety management principles, various safety systems, various machine guarding devices, hazard identification techniques, energy sources, systems & applications and the need in the present context. Students will be able to compare different hazard identification tools and choose the most appropriate based on the nature of the industry. It aims to equip students in working with projects and to take up research work in connected areas

5. Course Pre / Co-requisite

Nil

6. Course Outcomes

After completion of the course, students will be able to

- CO1. Describe the theories of accident causation and preventive measures of Industrial accidents.
- CO2. Explain about personal protective equipment, its selection, safety performance & indicators and importance of housekeeping.
- CO3. Explain different issues in construction industries
- CO4. Describe various hazards associated with different machines and mechanical material handling.
- CO5. Utilise different hazard identification tools in different industries with the knowledge of different types of chemical hazards.

7. Mapping of Course Outcomes with Program Outcomes and Program Specific outcomes

PO/ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	M	M				M	M	M				H			
CO2	M	M	M		M	M	M	M				H	H		
CO3	M	M	M		M	M	M	M	M	M		M	H		
CO4	M	M	M		M	M	M	M	M	M		M	H		
CO5	M	M	M	M	M	M	M	M	M	M		M	H		

8. Justification for CO-PO-PSO Correlation

CO	PO/PSO	Justification
CO1	PO1	Having knowledge in engineering fundamentals helps the students in understanding the theories of accident causation and thereby helps to prevent industrial accidents
	PO2	Understanding the theories of accident makes the students to analyze the causes of such accidents and helps to prevent industrial accidents.
	PO6	As an engineer, by understanding the causes of an accident helps a student in preventing such mistakes in near future and thereby increasing the social commitment of an engineer.
	PO7	By understanding the environmental impacts of an industrial accident helps the students in preventing such accidents and create a safe and sustainable environment.
	PO8	Understanding the theories of accidents helps the students in applying ethical methods of safety practices thereby preventing accidents in industry.
	PO12	By recalling the theories of accident causation will help the students in gaining lifelong knowledge of the causes of accidents and forge them to take safe decisions thereby preventing of an industrial accident.
CO2	PO1	Understanding the significance of personal protection will help students to solve the problem of increased accident rates in industries.
	PO2	Analyzing the relation between safety performance in an industry and usage of personal protective equipment can help to reach substantiated conclusions regarding safety
	PO3	Design solutions for safety related problems in industries with appropriate consideration for the public health and safety, societal, and environmental considerations
	PO5	Select and use appropriate personal protection equipment based on the working environment.
	PO6	Understanding the concepts of safety performance will enable students to suggest measures taken to mitigate and contain accidents in industries for the safety and health of society.
	PO7	Understanding the impact of industrial personal protection in societal and environmental contexts for sustainable development.
	PO8	By understanding the importance of personal protection and safety performance, students will be able to apply ethical principles and commit to professional ethics and responsibilities.
	PO12	Life-long learning about the selection of different personal protective equipment based on the work environment will enable the students to ensure the safety of those involved.
	PO1	Knowledge of different issues in construction industries will help students to solve problems related to the same

CO3	PO2	By understanding major issues in construction industries, students will be able to analyze the issues and reach substantiated conclusions.
	PO3	Design of suitable solutions to different issues in construction industries by identifying the causes of major safety issues in construction industry.
	PO5	Students will be able to select and apply appropriate techniques to solve different issues in construction industry.
	PO6	Knowledge of different issues in construction industries enable the students to assess societal, health, safety, legal issues related to construction industry
	PO7	By learning issues in construction industries, the students will able to understand the impact of the engineering solutions in societal and environmental contexts, and the need for sustainable development
	PO8	Students will be able to commit to professional ethics and responsibilities while dealing with various issues related to construction industries
	PO9	Having in sight on different issues related to construction industry, students can effectively work as an individual, and as a member or leader in diverse team
	PO10	Knowledge of issues in construction industry will enable the students to communicate effectively with the engineering community and with the society in large on construction activities and enable them to give and receive clear instructions
	PO12	Knowledge of issues in construction industry help the students to engage in lifelong learning which gives in the broadest context of technological change in the industry.
	PSO1	High correlation is that it helps the student in understanding various safety issues in construction and makes him in operating safety equipment to solve problems in construction industry
CO4	PO1	Knowledge of various principles in machine guarding help students to solve issues related to mechanical material handling.
	PO2	By understanding various issues in mechanical material handling, students will be able to analyze the machine related hazards and should be able to reach substantiated conclusions.
	PO3	The students will be able to design suitable solutions to issues related to mechanical material handling by identifying the causes of various hazards in machines.
	PO5	Students will be able to apply various mechanical material handling techniques to handle hazard related to the machines in construction industry.
	PO6	Knowledge of different issues in mechanical material handling enable the students to assess societal, health, safety, legal issues related to construction industry.
	PO7	By understanding the issues of mechanical material handling in construction industries, the students will able to understand the impact of the engineering solutions in societal and environmental contexts, and the need for sustainable development

	PO8	Understanding various principles in machine guarding, the students will be able to apply ethical principles and commit to professional ethics and responsibilities.
	PO9	Understanding various principles in machine guarding and issues related to mechanical material handling, the students will be able to work as an individual or as a member/leader in a team.
	PO10	Knowledge of issues related to mechanical material handling in construction industry will enable the students to communicate effectively with the engineering community and with the society in large on construction activities and enable them give and receive clear instructions.
	PO12	Knowledge of various principles in machine guarding and material handling help the students to engage in lifelong learning which gives in the broadest context of technological change in the industry.
	PSO1	By understanding various issues in various mechanical machines helps to solve safety hazard in machines in a sustainable way.
CO5	PO1	Knowledge of different hazard identification tools and chemical hazards in different industries will help students to apply in complex engineering problems related to industries.
	PO2	Concepts of different hazard identification tools and chemical hazards will help the students to analyze and formulate different engineering problems from different dimensions.
	PO4	Students will use the risk assessment, inventory analysis, HAZOP, MSDS to analyze, interpret data, and synthesis of information to provide valid conclusions.
	PO5	By understanding hazard identification tools and chemical hazards, students will be able to apply appropriate techniques to handle industrial hazards.
	PO6	In sight on types of hazard identification tools and chemical hazards will enable the students to assess societal health, and safety issues to Professional engineering practice
	PO7	By learning hazard identification and analysis, students will understand. The impact of the engineering solutions in societal and environmental contexts, and the need for sustainable development.
	PO8	Understanding the types of hazards, risks, HAZOP, corrective action, control, etc. will help students to apply ethical principles to engineering practice.
	PO9	By utilizing different hazard identification tools and understanding Different aspects of chemical hazards, the students will be able to function better as an individual or as a member/leader in a team.
	PO10	Knowledge of hazard identification and analysis tools will enable the students to communicate effectively with the engineering community on complex engineering activities and enable them give and receive clear instructions.
	PO12	Learning, understanding and application of hazard identification and analysis tools will help to engage in lifelong learning which in the broadest context of technological change.

	PSO1	Understanding cause of chemical hazard will helps to solve the hazard issue in a sustainable way

9. Curricular gaps (if any)

Can include electrical hazards in syllabus

10. Course Enrichment Activities*

Sl No	Description	Proposed Activities	Relevance to POs and PSOs
1	Expert talk on “Importance of Industrial safety”	Expert talk	PO1, PO6, PO7, PO12
2	Fire and safety training and awareness program	Workshop	PO1, PO8, PO9, PO12

11. Internal Assessment mark allocation (as per university curriculum)

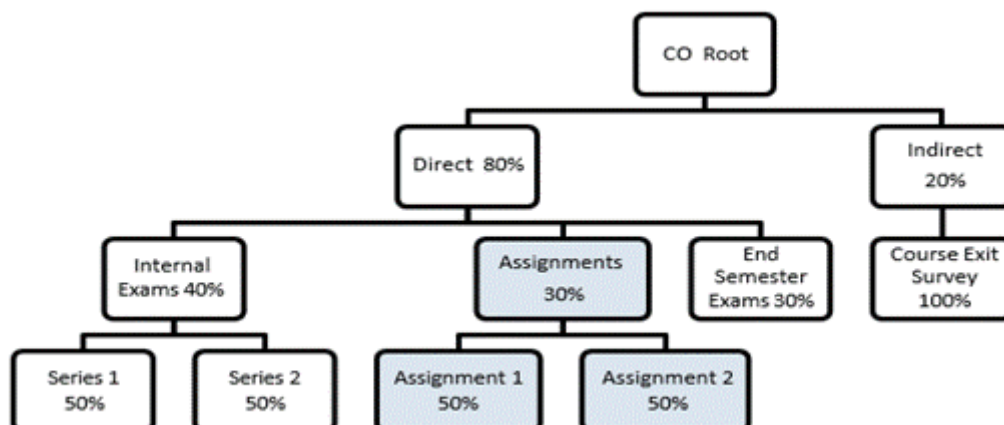
(Provide details as mentioned in syllabus)

Attendance	- 10 marks
Continuous Assessment Test	- 25 marks
<u>Assignment (s)/ Course Project</u>	<u>- 15 marks</u>
<u>Total</u>	<u>- 50 marks</u>

12. Assessment – CO Mapping (Put ‘ x ’ if mapping is present)

	Tools		Weightage [#]	CO1	CO2	CO3	CO4	CO5
Direct Assessment Tools	Internal Exam(s) 40%	Series 1	20%	x	x	x		
		Series 2	20%			x	x	x
	Assignment (s)/ 30%	Assignment 1	15%	x	x	x		
		Assignment 2	15%				x	x
	End Semester Exam		30%	x	x	x	x	x
Indirect Assessment Tool	Course Exit Survey		100%	x	x	x	x	x

13. Assessment Configuration



14. Course Plan

Hour	Topic	Module	Reference(s)	Teaching Pedagogy
1	Need for safety. Safety and productivity. Definitions: Accident, Injury, Unsafe act, Unsafe Condition, Dangerous Occurrence. Reportable accidents	1	R1	Lecture
2	Theories of accident causation. Safety organization	1	R1	Lecture
3	Role of management, supervisors, workmen, unions, government and voluntary agencies in safety	1	R1	Lecture
4	Importance of Industrial safety	1	R1	Tutorial
5	Safety Officer-responsibilities, authority.	1	R2	Lecture
6	Safety committee-need, types, advantages	1	R2	Lecture
7	Types of PPEs, respiratory and non-respiratory equipment.	2	R2	Lecture
8	Standards related to PPEs	2	R2	Lecture
9	Monitoring Safety Performance: Frequency rate, severity rate	2	R1	Lecture
10	Monitoring Safety Performance: incidence rate, activity rate	2	R2	Lecture
11	Monitoring Safety Performance	2	R2	Tutorial

12	Housekeeping: Responsibility of management and employees. Advantages of good housekeeping. 5 s of housekeeping.	2	R2	Lecture
13	Work permit system- objectives, hot work and cold work permits.	2	R5	Lecture
14	Typical industrial models and methodology. Entry into confined spaces	2	R5	Lecture
15	Excavation and filling – Under-water works – Under- pinning & Shoring	3	R5	Lecture
16	Ladders & Scaffolds – Tunnelling	3	R5	Lecture
17	Blasting –Demolition – Confined space	3	R5	Lecture
18	Familiarization with relevant Indian Standards and the National Building Code provisions on construction safety.	3	R5	Lecture
19	Relevance of ergonomics in construction safety	3	R5	Lecture
20	Ergonomics Hazards	3	R8	Lecture
21	Musculoskeletal Disorders and Cumulative Trauma Disorders.	3	R5	Lecture
22	Point-of-Operation, Principle of machine guarding -	3	R5	Lecture
23	Types of guards and devices.	3	R5	Tutorial
24	Types of guards and devices.	4	R5	Lecture
25	Safety in Power Presses, primary & secondary operations - shearing -bending - rolling – drawing	4	R5	Lecture
26	Safety in turning, boring, milling, planing and grinding.	4	R5	Lecture
27	Safety Precautions of Gas welding and Arc Welding	4	R5	Tutorial
28	Welding and Cutting-Safety Precautions of Gas welding and Arc Welding	4	R5	Lecture
29	Cutting and Finishing.	4	R5	Lecture
30	Material Handling-Classification-safety consideration- manual and mechanical handling. Handling assessments and techniques- lifting, carrying, pulling, pushing, palletizing and stocking.	4	R5	Lecture

31	Material Handling equipment-operation & maintenance. Maintenance of common elements- wire rope, chains slings, hooks, clamps	4	R5	Lecture
32	Hazard and risk, Types of hazards – Classification of fire	4	R7	Lecture
33	Hazard and risk, Types of hazards – Classification of fire	4	R7	Tutorial
34	Types of Fire extinguishers fire, explosion and toxic gas release.	5	R7	Lecture
35	Fire and safety training and awareness program	5	R7	Tutorial
36	Inventory analysis, Fire and explosion hazard rating of process plants	5	R7	Lecture
37	The Dow Fire and Explosion Hazard Index.	5	R7	Lecture
38	Preliminary hazard analysis, Hazard and Operability study (HAZOP)	5	R7	Lecture
39	Chemical hazard- Classifications, Control of Chemical Hazards	5	R7	Lecture
40	Hazardous properties of chemicals	5	R7	Tutorial
41	Hazardous properties of chemicals	5	R7	Lecture
42	Material Safety Data Sheets (MSDS	5	R7	Lecture

15. Question Bank

Module 1				
Sl. No	Question	Marks	CO	BL
1	Define Industrial Safety, Accident and Injury.	3	CO1	L1
2	Describe the personal factors that lead to accidents	3	CO1	L1
3	Describe the objectives of industrial safety.	3	CO1	L1
4	Define terms: Accident, Reportable accident, Dangerous occurrence.	4	CO1	L1
5	Explain any 3 unsafe acts while are responsible for accidents in industries	3	CO1	L1
6	List any important six responsibilities of worker/workmen towards the safety measures in an organization.	3	CO1	L1
7	Write the importance of safety in organisations	3	CO1	L1
8	List out the objectives of Industrial Safety	4	CO1	L1
9	List the various accident causation theories and explain any one in details.	14	CO1	L1
10	Define an industrial accident. Write a note on economic aspects of accidents.	7	CO1	L1
11	Explain objectives and functions of Safety organization	8	CO1	L1

12	With suitable schematics, describe the different types of safety organization.	6	CO1	L2
13	Differentiate Unsafe act and Unsafe conditions with suitable Examples	3	CO1	L2
14	Discuss the significance of a safety committee in improving the safety performance of an industry	3	CO1	L2
15	How can you describe safety policy	3	CO1	L2
16	Discuss the significance of safety policy in reducing the accidents.	4	CO1	L2
17	Explain Domino Theory of accident causation	7	CO1	L2
18	Explain the responsibilities of safety officer in the implementation of safety in industries.	8	CO1	L2
19	Explain the personal factors that lead to accidents	6	CO1	L2
20	Explain environmental causes of accidents. What are the corrective actions to eliminate them?	10	CO1	L2
21	“Safety is the need of this century”. Do you agree with this. If so explain	10	CO1	L2
22	Discuss the need of Safety committee- types, and advantages.	14	CO1	L2
23	Discuss the Role of management, supervisors, workmen, unions, government and voluntary agencies in safety.	14	CO1	L2
24	Discuss on authorities and roles of a safety officer?	10	CO1	L2
25	Discuss various Theories of accident causation	14	CO1	L2
26	Safety and productivity are the two sides of a coin’. Are you agreeing with this statement? Explain with your arguments.	10	CO1	L3
27	List the various accident causation theories and explain any two in detail with relevant schematics.	14	CO1	L2
MODULE 2				
1	Define (i) Frequency rate, (ii) severity rate, (iii) incidence rate	3	CO2	L1
2	List the advantages of good housekeeping	3	CO2	L1
3	What is PPE? Give examples	3	CO2	L1
4	List the different types of personal protective equipment	3	CO2	L1
5	What is respiratory protective equipment (RPE)? Explain the features of any one type of RPE.	3	CO2	L1
6	How does frequency rate and incidence rate support safety analysis?	3	CO2	L1
7	How can workers' safety be ensured during underpinning work?	3	CO2	L1
8	What do you mean by confined space? Give examples.	4	CO2	L1
9	How do you monitor the safety performance in industries	3	CO2	L2
10	List the steps to be followed in confined space entry to protect the life of a worker?	4	CO2	L1
11	Briefly explain the standards related to PPE?	6	CO2	L1
12	Describe the responsibility of management and employees in housekeeping?	3	CO2	L1
13	Define (i) Activity rate, (ii) incidence rate	3	CO2	L1

14	Explain the 5 s of housekeeping.	10	CO2	L2
15	Explain the benefits of good housekeeping? Also, explain the five 'S' (5 S) concept in housekeeping.	9	CO2	L2
16	Classify the personal protective equipment. List the suitability of at least fifteen types of PPEs.	10	CO2	L2
17	How will you calculate the frequency rate? Explain with an example.	4	CO2	L2
18	How will you compare the safety performance of two industries? Explain with suitable example.	10	CO2	L2
19	Discuss the significance of work permit system in accident prevention.	4	CO2	L2
20	Give the different types of work permit ? Highlight its suitability.	4	CO2	L2
21	Explain the equipment that can be used for protecting the workers from breathing poisonous gases.	3	CO2	L2
22	Explain the protective equipment that can be used in a noisy environment.	3	CO2	L2
232	Explain any one protective equipment that could be selected during welding work.	3	CO2	L2
24	Explain the equipment that can be used for protecting the workers from falling objects.	3	CO2	L2
25	Explain any 3 equipment that can be used for protection of finger, hand and arm.	3	CO2	L2
26	Using the following data calculate the frequency rate of accident in an industrial plant. Number of workers=500 Number of disabling injuries per year= 5. Average number of hours worked by worker per year=2000.	3	CO2	L3
27	Using the following data to calculate the severity rate of accident in an industrial plant where only one accident occurred during the year, the type of injury being cutting of the tip of a finger. No:of workers=2000. No: of days lost in a year due to accidents=100 Average no: of hours worked by worker per year=2000.	3	CO2	L3
MODULE 3				
1	List the various safety features of ladders.	3	CO3	L1
2	List any important six safety practices used with ladders in construction sites.	3	CO3	L1
3	List the various safety features of scaffolds.	3	CO3	L1
4	Identify any six safety requirements in shoring.	3	CO3	L1
5	Identify any six hazards in underwater works.	3	CO3	L1
6	List any four precautions in Scaffolding.	4	CO3	L1

7	Describe any four safety precautions in the use of a ladder.	4	CO3	L2
8	How safety of the workers can be ensured during a demolition operations.	3	CO3	L2
9	How safety of the workers can be ensured during excavation and filling	3	CO3	L2
10	Explain any important four safety practices in excavation works.	3	CO3	L2
11	Discuss the safety requirement for a confined space entry	3	CO3	L2
12	How safety of the workers can be ensured during tunnelling	3	CO3	L2
13	Discuss the safety requirement for Under-pinning & Shoring	3	CO3	L2
14	Explain Musculoskeletal Disorders and Cumulative Trauma Disorders in detail	7	CO3	L2
15	Explain the Relevance of ergonomics in construction safety	7	CO3	L2
16	Discuss the important types of ergonomic hazards associated with industries.	7	CO3	L2
17	Identify the various hazards during the different stages of building construction.	7	CO3	L2
18	Discuss the safety and fire protection facilities required for a high rise building as per National building code.	14	CO3	L2
19	'Kuthiran' is Kerala's first-ever tunnel for road transport and South India's longest six-lane road tunnel. Illustrate the various safety precautions followed during blasting and tunnelling operations.	10	CO3	L3
20	"Musculoskeletal Disorder (MSD) and Cumulative Trauma Disorder (CTD) are major occupational diseases." Justify the statement with two examples each.	10	CO3	L3
21	"Ergonomics is related to the design of workplaces, products and systems to best fit those who use them". Justify this statement for the construction industry.	10	CO3	L3
22	Illustrate the construction of a multistorey building and apply your knowledge to solve various safety issues. (Hint: Hazards and safety precautions in Excavation & scaffolding)	10	CO3	L3
MODULE 4				
Sl. No.	Question	Marks	CO	BL
1	Define type of Safeguards used in construction industry.	3	CO4	L1
2	Define point of operation devices used for safeguard of machinery	3	CO4	L1
3	Define Slings used for Material handling in industry.	3	CO4	L1
4	Define palletizing and stocking technique in material handling	3	CO4	L1

5	List any three types of machine guards.	3	CO4	L1
6	List any three objectives of material handling	3	CO4	L1
7	Explain the advantage of Chain sling over a wire rope	3	CO4	L2
8	Mention any four potential hazards associated with wire rope used for material handling.	3	CO4	L2
9	Explain the classification of Material Handling	3	CO4	L2
10	Explain Safety Precautions followed in Gas welding	3	CO4	L2
11	Explain Safety precautions followed in Arc Welding	3	CO4	L2
12	Discuss the safety issues of Gas welding operations.	3	CO4	L2
13	Explain the hazards associated with manual material handling?	3	CO4	L2
14	Discuss the key elements of a hearing conservation program.	3	CO4	L2
15	What are the various objectives of Maintenance	3	CO4	L2
16	Explain the various principles used in machine guarding.	9	CO4	L2
17	Explain the issues in mechanical material handling.	9	CO4	L2
18	Explain the various types of machine guarding devices used in industries. Discuss the suitability of each machine guarding devices.	9	CO4	L2
19	With suitable sketches briefly explain seven defects of wire ropes.	9	CO4	L2
20	Explain Hearing Conservation Program in Production industries.	9	CO4	L2
21	Explain various Material Handling equipment, its operation & maintenance.	14	CO4	L2
22	Explain various material handling assessments and techniques used in industry.	14	CO4	L2
23	Describe three major factors affecting the selection of material handling equipment and explain any four types of material handling systems.	14	CO4	L2
24	Explain various classifications and safety considerations in Machine handling	14	CO4	L2
25	Explain the principles of machine guarding and types of guards and devices used for machine safety.	14	CO4	L2
26	Explain Safety Precautions followed in Gas welding and Arc Welding	14	CO4	L2
27	Suppose you are a section supervisor in a Mechanical industry with many machining operations. Predict the safety precautions in grinding operation.	3	CO4	L3
28	Suppose you are a section supervisor in a Mechanical industry with many machining operations. Predict the safety precautions in turning operation.	3	CO4	L3
MODULE 5				

Sl. No.	Question	Marks	CO	BL
1	List the types of Fire extinguishers.	3	CO5	L1
2	MSDS is mandatory for chemical products. Give reasons	3	CO5	L1
3	What is meant by MSDS	3	CO5	L1
4	Name the company who developed the F& EI (Fire & explosion Index)	3	CO5	L1
5	How do you identify chemical hazards.	3	CO5	L1
6	List the hazardous properties of chemicals.	3	CO5	L1
7	Enumerate the industries which uses HAZOP analysis	3	CO5	L1
8	Define(i)Hazard (ii) Risk	3	CO5	L1
9	Differentiate Hazard and Risk.	3	CO5	L3
10	What do you mean by Hazard and Risk	3	CO5	L1
11	Describe any three types of Hazards.	3	CO5	L2
12	Classify Chemical hazards.	3	CO5	L3
13	Explain the hierarchy of control of chemical hazards.	3	CO5	L2
14	Classify different types of Fire.	3	CO5	L3
15	Why material safety data sheet is mandatory for chemical products?	3	CO5	L2
16	Explain ABC analysis of inventory control.	6	CO5	L2
17	Describe the Dow Fire and Explosion Hazard Index.	7	CO5	L2
18	Explain the structure of hazard identification and risk assessment.	7	CO5	L2
19	Describe the Selection of different types of fire extinguishers accordance to type of fire.	10	CO5	L2
20	Explain chemical risk assessment steps in industries.	10	CO5	L2
21	Describe corrective action and follow-up in HAZOP analysis.	10	CO5	L2
22	What is Hazard and Operability Analysis? How do you conduct a HAZOP analysis?	14	CO5	L2
23	Discuss about different types of chemical hazards.	14	CO5	L2
24	Illustrate the Fire and explosion hazard rating of process plants	10	CO5	L3
25	Show with a case study example, the Control of Chemical Hazards in industries.	10	CO5	L3

Prepared By: Dr. Saju A

Checked By: Ms. Renu Mary George

1. Prescribed Syllabus

Each student shall search in the literature including peer reviewed journals, conference, books, project reports etc., and identify an appropriate paper/thesis/report in her/his area of interest, in consultation with her/his seminar guide.

2. Text Books (T)

Nil

3. Reference Books (R)

R1. Minimum 3 SCI Indexed journals

4. Web Sources (W)

W1. <https://ieeexplore.ieee.org/>

W2. <https://www.springer.com/in>

W3. <http://www.sciencedirect.com>

W4. <https://www.researchgate.net>

6. Course Objectives

1. To do literature survey in a selected area of study.
2. To understand an academic document from the literature and to give a presentation about it.
3. To prepare a technical report.

7. Course Pre / Co-requisite

Nil

5. Course Outcomes

Upon completion of the course the students will be able to

- CO1. Identify academic documents from the literature which are related to her/his areas of interest.
- CO2. Read and apprehend an academic document from the literature which is related to her/his areas of interest.
- CO3. Prepare a presentation about an academic document.
- CO4. Give a presentation about an academic document.
- CO5. Prepare a technical report.

28. Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes

PO/ CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	M	M	L	L		M					H	H		
CO2	H	H	M	H		M					H	H		
CO3	H	M			H		L		M		H	H		
CO4	H				M		L		H		H	H		
CO5	H	H	H	H	M	M	M		H		H	H		

29. Justification for CO-PO-PSO Correlation

CO	PO/PSO	JUSTIFICATION
CO1	PO1	Knowledge on science, mathematics and engineering fundamentals will enable students to conduct literature survey.
	PO2	Students will be able to identify research problems reaching substantiated conclusions using fundamental principles in science and engineering.
	PO3	Students will be able to review academic documents during literature survey and can identify solutions to various complex engineering problems
	PO4	Use of research-based knowledge and research methods will enable students to conduct investigation in specified topics.
	PO6	Students will be able to review literatures by understanding the impact of professional engineering solutions in societal and environmental contexts.
	PO11	Students will be able to develop skills to review various literatures that will provide foundation for lifelong learning.
	PSO1	Knowledge on science, mathematics and engineering fundamentals will enable students to conduct literature survey.
CO2	PO1	Students will be able to apply fundamentals of engineering to analyse various literatures in the field of Electronics engineering.
	PO2	Knowledge on fundamentals of engineering will be enable students to review research literature and analyse complex engineering problems reaching substantiated conclusions
	PO3	Students will be able to develop practical solutions to various engineering problem that meet the specified needs with appropriate consideration for the public health and safety.
	PO4	Research based knowledge will help students to synthesize and develop valid conclusions to complex civil engineering problems.

	PO6	Students will be able to analyse complex research problems in literatures by understanding the impact of professional engineering solutions in societal and environmental contexts.
	PO11	Students will be able to develop skills to analyse various literatures that will inculcate independent and lifelong learning.
	PSO1	Students will be able to apply fundamentals of engineering to analyse various literatures in the field of Electronics engineering.
CO3	PO1	Students will be able to apply the knowledge on mathematics and engineering fundamentals in the preparation of technical presentation.
	PO2	Students can review and present literatures about complex engineering problems using their knowledge in natural and engineering sciences.
	PO5	Students will be able to create and apply appropriate techniques and modern IT tools in the preparation of technical presentations in the field of Electronics engineering.
	PO7	Students can apply ethical principles and norms of engineering practice while preparing seminar presentations
	PO9	Student will be capable of communicating effectively on complex engineering activities with engineering community and make effective presentations along with report documentations.
	PO11	Students will be able to recognize the need for and have the preparation and ability to engage in independent and life-long learning broadest context of technological change
	PSO1	Students will be able to apply the knowledge on mathematics and engineering fundamentals in the preparation of technical presentation.
CO4	PO1	Knowledge on science, mathematics and engineering will enable students to present a technical document
	PO5	Students will be able to create and apply appropriate techniques and modern IT tools to give technical presentations in civil engineering topics.
	PO7	Students can apply ethical principles and norms of engineering practice in seminar presentations.
	PO9	Student will be capable of communicating effectively on complex engineering activities with engineering community and make effective presentations along with report documentations.
	PO11	Students will be able to recognize the need for and have the preparation and ability to engage in independent and life-long learning broadest context of technological change
	PSO1	Knowledge on science, mathematics and engineering will enable students to present a technical document
CO5	PO1	Students will be able to prepare a technical report by applying knowledge on various engineering fundamentals.

PO2	Knowledge on fundamentals of engineering will be enable students to review research literature and analyse complex engineering problems reaching substantiated conclusions in the form of a technical report.
PO3	Students will be able to develop a technical report with practical solutions to various engineering problem that meet the specified needs with appropriate consideration for the public health and safety.
PO4	Research based knowledge will help students to develop valid conclusions in the preparation of a technical report
PO6	Students can prepare a technical report by applying contextual knowledge to assess various societal and cultural issues.
PO7	Students can apply ethical principles and norms of engineering practice while preparing a technical report
PO9	Student will be capable to present complex engineering activities with engineering community with proper documentations.
PO11	Students will be able to recognize the need for and have the preparation and ability to engage in independent and life-long learning broadest context of technological change
PSO1	Students will be able to prepare a technical report by applying knowledge on various engineering fundamentals.

11. Curricular gaps (if any)

Nil

12.Course Enrichment Activities*

Sl No	Description	Proposed Activities	Relevance to POs and PSOs
	Nil		

13. Internal Assessment mark allocation (as per university curriculum)

Continuous Internal Evaluation - 100 marks

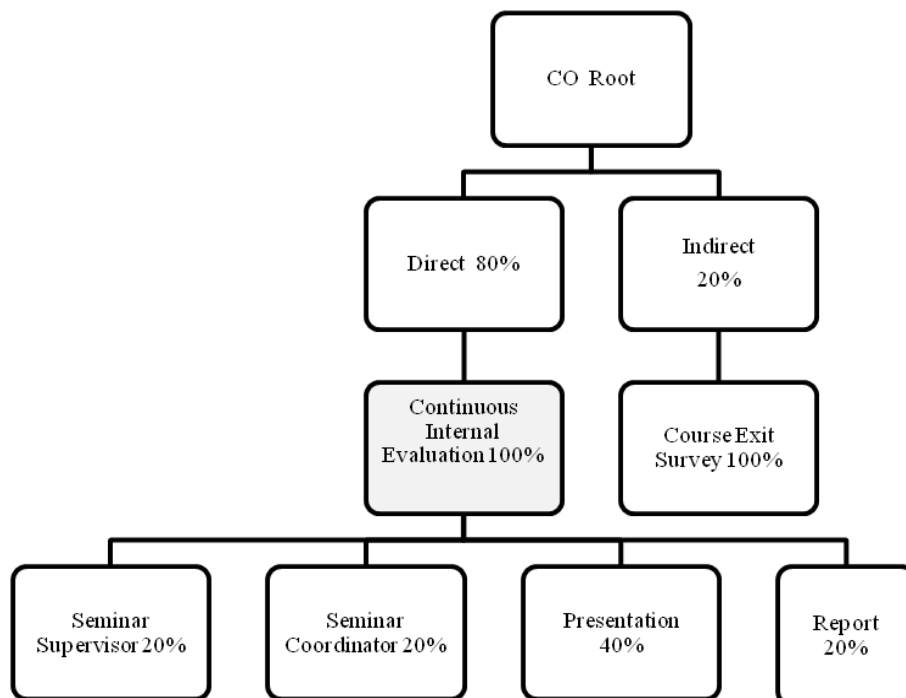
Total - 100 marks

14. Assessment – CO Mapping (Put 'x' if mapping is present)

Direct Assessment Tools**	CO1	CO2	CO3	CO4	CO5
Seminar Supervisor	x	x	x	x	x
Seminar Coordinator	x	x	x	x	x
Presentation	x	x	x	x	x
Report					x
InDirect Assessment Tools**	CO1	CO2	CO3	CO4	CO5
Course Exit Survey	x	x	x	x	x

15. Assessment Configuration

Seminar Supervisor	Seminar Coordinator	Presentation	Report	Total
20%	20%	40%	20%	100%



Prepared By : Dr. Rakesh S

Checked By : Dr. Leena T Timothy

1. Prescribed Syllabus

The course 'Project Work' is mainly intended to evoke the innovation and invention skills in a student. The course will provide an opportunity to synthesize and apply the knowledge and analytical skills learned, to develop as a prototype or simulation. The project extends to 2 semesters and will be evaluated in the 7th and 8th semester separately, based on the achieved objectives. One third of the project credits shall be completed in 7th semester and two third in 8th semester. It is recommended that the projects may be finalized in the thrust areas of the respective engineering stream or as interdisciplinary projects. Importance should be given to address societal problems and developing indigenous technologies.

2. Text Books (T)

Nil

3. Reference Books (R)

Nil

4. Web Sources (W)

W1. www.ieee.org

W2. www.springer.com

W3. www.sciencedirect.com

6. Course Objectives

1. To apply engineering knowledge in practical problem solving
2. To foster innovation in design of products, processes or systems
3. To develop creative thinking in finding viable solutions to engineering problems

7. Course Pre / Co-requisite

Nil

5. Course Outcomes

Upon completion of the course the students will be able to

- CO1. Model and solve real world problems by applying knowledge across domains. (Cognitive knowledge level: Apply)
- CO2. Develop products, process or technologies for sustainable and socially relevant applications. (Cognitive knowledge level: Apply)
- CO3. Function effectively as an individual and as a leader in diverse teams and to comprehend and execute designated tasks. (Cognitive knowledge level: Apply)
- CO4. Plan and execute tasks utilizing available resources within timelines, following ethical and professional norms. (Cognitive knowledge level: Analyze)
- CO5. Identify technology/research gaps and propose innovative/creative solutions. (Cognitive knowledge level: Analyze)
- CO6. Organize and communicate technical and scientific findings effectively in written and oral forms. (Cognitive knowledge level: Apply)

9. Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes

PO/ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
CO1	H	M	M	M	M	M	M	M	H	H	M	L	H	M	M
CO2	H	M	M	M	H	H	H	M	H	H	M	H	H	M	H
CO3	H								H	H	M	M	H		
CO4					M			H	M	M	H	M			M
CO5	H	H	H	L	M							H	H	L	M
CO6	M				M			M	H	H	M	L	H		M

10. Justification for CO-PO-PSO Correlation

CO	PO	Correlation	Justification Statement
CO1	PO1	H	The application of mathematics engineering fundamentals and specialized knowledge is essential for solving complex engineering problems that have real-world implications.
	PO2	M	The skills of problem identification, formulation, literature review, analysis using first principles, and reaching substantiated conclusions are essential for engineers and researchers to model and solve real-world problems effectively
	PO3	M	Students leverage their knowledge across domains to develop innovative and well-rounded solutions that address multifaceted real-world challenges while meeting the highest standards of ethics, safety, and environmental responsibility.
	PO4	M	The research-based knowledge provides the foundation for data-driven decision-making, enable interdisciplinary collaboration, and ensure that solutions are evidence-based, reliable, and effective.
	PO5	M	Students will be able to make informed decisions, optimize solutions, and effectively address complex challenges in an interdisciplinary context.
	PO6	M	Students will be able to approach real-world problems with a holistic perspective, taking into account the broader context and the well-being of society while applying their knowledge across domains to develop effective and responsible solutions.
	PO7	M	The students will be able to develop solutions that not only address immediate challenges but also contribute to long-term societal well-being and environmental sustainability.

	PO8	M	The students who adhere to ethical standards not only create solutions that are technically sound but also consider the broader societal and ethical implications, fostering trust, safety, and sustainability in their professional practice.
	PO9	H	To work effectively as an individual and as part of diverse teams in multidisciplinary settings is vital for modelling and solving real-world problems across domains. Collaboration, effective communication, leadership, and the ability to integrate diverse knowledge and perspectives are essential skills that enhance the problem-solving process and lead to more comprehensive and innovative solutions.
	PO10	H	The effective team work supports knowledge sharing, collaboration, knowledge transfer, and the dissemination of solutions and also can apply their knowledge to complex problems and work collectively to find innovative solutions.
	PO11	M	The students can contribute to efficient project execution, effective teamwork, and the successful implementation of solutions that meet societal needs while adhering to professional standards.
	PO12	L	The students who embrace continuous learning are better equipped to adapt to technological change, collaborate across disciplines, and innovate in their problem-solving efforts, ultimately contributing to more effective and relevant solutions for evolving challenges.
	PSO1	H	The students can leverage electronic systems and technology in innovative ways to address multifaceted challenges and contribute to interdisciplinary problem-solving efforts effectively.
	PSO2	M	the ability to analyze and synthesize experimental data from electronic systems enables the students to validate designs, make data-driven decisions, and collaborate effectively with experts from diverse fields, ultimately contributing to comprehensive and effective problem-solving efforts.
	PSO3	M	The students could efficiently analyze data, simulate systems, optimize designs, and collaborate effectively, ultimately contributing to comprehensive and effective problem-solving efforts.
CO2	PO1	H	The application of mathematics engineering fundamentals and specialized knowledge is essential for solving the development of products, process and technology.
	PO2	M	The skills of problem identification, formulation, literature review, analysis using first principles, and reaching substantiated conclusions are essential for engineers and researchers to analyze the product design

	PO3	M	Students leverage their knowledge across domains to design innovative and well-rounded solutions that address multifaceted real-world challenges while meeting the highest standards of ethics, safety, and environmental responsibility.
	PO4	M	The research-based knowledge provides the foundation for data-driven decision-making, enable interdisciplinary collaboration, and ensure that solutions are evidence-based, reliable, and effective.
	PO5	H	Students will be able to design, optimize solutions, and effectively address complex challenges in an interdisciplinary context.
	PO6	H	Students will be able to approach real-world problems with a holistic perspective, taking into account the broader context and the well-being of society while applying their knowledge across domains to develop effective and responsible products.
	PO7	H	The students will be able to develop solutions that not only address immediate challenges but also contribute to long-term societal well-being and environmental sustainability.
	PO8	M	The students who adhere to ethical standards not only create solutions in the designs that are technically sound but also consider the broader societal and ethical implications, fostering trust, safety, and sustainability in their professional practice.
	PO9	H	To work effectively as an individual and as part of diverse teams in multidisciplinary settings is vital for modelling and developing new products
	PO10	H	The effective team work supports knowledge sharing, collaboration, knowledge transfer, and the dissemination of solutions and also can apply their knowledge to complex problems and work collectively to find innovative solutions for developing products
	PO11	M	The students can contribute to efficient project execution, effective teamwork, and the successful implementation of solutions that meet societal needs while adhering to professional standards.
	PO12	H	The students who embrace continuous learning are better equipped to adapt to technological change, collaborate across disciplines, and innovate in their problem-solving efforts, ultimately contributing to more effective and relevant solutions to develop electronic products.
	PSO1	H	The students can leverage electronic systems and technology in innovative ways to address multifaceted challenges and contribute to interdisciplinary problem-solving efforts effectively.

	PSO2	M	the ability to analyze and synthesize experimental data from electronic systems enables the students to validate designs, make data-driven decisions, and collaborate effectively with experts from diverse fields, ultimately contributing to comprehensive and effective problem-solving efforts.
	PSO3	H	The students could efficiently design, simulate systems, optimize designs, and collaborate effectively, ultimately contributing to comprehensive and effective problem-solving efforts.
CO3	PO1	H	The application of knowledge in mathematics with strong technical foundations can comprehend complex problems, execute tasks effectively, and assume leadership roles to guide teams toward successful solutions.
	PO9	H	The students can able to do individual and team work function effectively as an individual and as a leader in diverse team and to comprehend and execute designed tasks.
	PO10	H	The students can able to communicate effectively as an individual and as a leader in diverse team and to comprehend and execute designed tasks.
	PO11	M	The students can handle project management and finance effectively as an individual and as a leader in diverse team and to comprehend and execute designed tasks.
	PO12	M	the students can gather more knowledge effectively as an individual and as a leader in diverse team and to comprehend and execute designed tasks results in lifelong learning.
	PSO1	H	The students can analyze and design electronic systems and technology in innovative ways to address new challenges and contribute to the solutions.
CO4	PO5	M	Students will be able to use modern tools to plan and execute tasks utilizing available resources within timelines, following ethical and professional norms.
	PO8	H	Students will be able to to plan and execute tasks utilizing available resources within timelines, following ethical and professional norms ethically.
	PO9	M	Able to do individual and team work to plan and execute tasks utilizing available resources within timelines, following ethical and professional norms.
	PO10	M	Students will be able to communicate to plan and execute tasks utilizing available resources within timelines, following ethical and professional norms.

	PO11	H	Able to handle project management and finance to plan and execute tasks utilizing available resources within timelines, following ethical and professional norms.
	PO12	M	Able to gather more knowledge to plan and execute tasks utilizing available resources within timelines, following ethical and professional norms results in lifelong learning.
	PSO3	M	The students could efficiently design, simulate systems, optimize designs, and collaborate effectively, ultimately contributing to comprehensive and effective problem-solving efforts.
CO5	PO1	H	Able to identify technology or research gaps and propose creative or innovative solutions using Engineering knowledge.
	PO2	H	Students will be able to analyse the research gaps and propose creative or innovative solutions.
	PO3	H	Students will be able to design or develop innovative solutions for research gaps.
	PO4	L	Students will be able to conducts investigations of complex problems for innovative solutions.
	PO5	M	Students will be able to use modern tools identify technology or research gaps and propose creative or innovative solutions.
	PO12	H	The students could gather more knowledge to identify technology or research gaps and propose creative or innovative solutions results in lifelong learning.
	PSO1	H	The students can leverage electronic systems and technology in innovative ways to address multifaceted challenges and contribute to interdisciplinary problem-solving efforts effectively.
	PSO2	L	The ability to analyze and synthesize experimental data from electronic systems enables the students to validate designs, make data-driven decisions, and collaborate effectively with experts from diverse fields, ultimately contributing to comprehensive and effective problem-solving efforts.
	PSO3	M	The students could efficiently design, simulate systems, optimize designs, and collaborate effectively, ultimately contributing to comprehensive and effective problem-solving efforts.
CO6	PO1	M	Students will be able to use modern tools to organize and communicate technical and scientific findings effectively in written and oral forms.
	PO5	M	Students will be able to use modern tools to organize and communicate technical and scientific findings effectively in written and oral forms.

	PO8	M	Students will be able to identify technology or research gaps and propose creative or innovative solutions ethically.
	PO9	H	Able to do individual and team work to identify technology or research gaps and propose creative or innovative solutions.
	PO10	H	Able to communicate to identify technology or research gaps and propose creative or innovative solutions.
	PO11	M	Able to handle project management and finance to identify technology or research gaps and propose creative or innovative solutions
	PO12	L	Able to gather more knowledge to identify technology or research gaps and propose creative or innovative solutions results in lifelong learning.
	PSO1	H	The students with expertise in electronic systems and technology have the potential to make significant contributions to interdisciplinary problem-solving efforts by applying their knowledge creatively and collaborating across domains
	PSO3	M	Students will be able to use modern tools for analysis is closely tied to the skill of organizing and communicating technical and scientific findings effectively.

11. Curricular gaps (if any)

Nil

12.Course Enrichment Activities*

Sl No	Description	Proposed Activities	Relevance to POs and PSOs
1	Talk	Patent Filing	PO1, PO2, PO3, PO4, PO10, PSO1
2	Talk	Innovation	PO1, PO2, PO3, PO4, PO10, PSO1

13. Internal Assessment mark allocation (as per university curriculum)

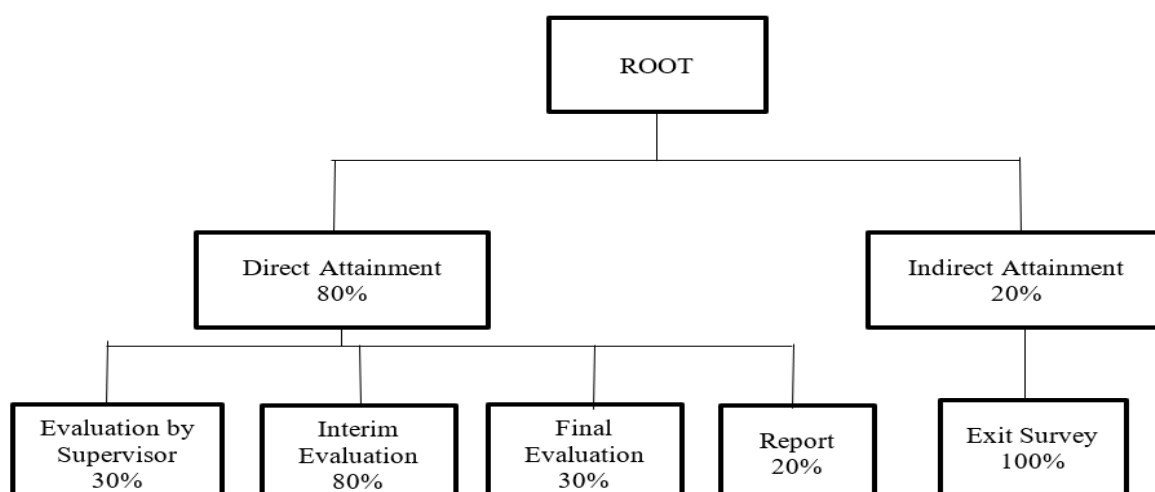
Project progress evaluation	- 30 marks
Interim evaluation	- 20 marks
Final evaluation	- 30 marks
<u>Report</u>	<u>- 20 marks</u>
<u>Total</u>	<u>- 100 marks</u>

14. Assessment – CO Mapping (Put 'x' if mapping is present)

Direct Assessment Tools**	CO1	CO2	CO3	CO4	CO5	CO6
Project progress evaluation	x	X	x	x	x	x
Interim evaluation by evaluation committee	x	X	x	x	x	x
Final evaluation by evaluation committee	x	X	x	x	x	x
Report						x

15. Assessment Configuration

Project progress evaluation	Interim evaluation by evaluation committee	Final Evaluation by evaluation committee	Report	Total
30%	20%	30%	20%	100%



Prepared By : Dr. Neenu Joseph

Checked By : Dr. Leena T Timothy

1. Prescribed Syllabus

I. MICROWAVE EXPERIMENTS (Minimum **Four** Experiments are mandatory)

1. Reflex Klystron Mode Characteristics.
2. GUNN diode characteristics.
3. VSWR and Frequency measurement.
4. Verify the relation between Guide wave length, free space wave length and cut off wave length for rectangular wave guide.
5. Unknown load impedance measurement using smith chart and verification using transmission line equation.
6. Measurement of Magic Tee characteristics.
7. Directional Coupler Characteristics.
8. Crystal Index Measurement.

II. OPTICAL EXPERIMENTS (Minimum **Three** Experiments are mandatory)

1. Setting up of Fiber optic Digital link.
2. Measurement of Numerical Aperture of a fiber.
3. Study of losses in Optical fiber.
4. Voltage vs. Current (V-I) characteristics of Laser Diode.
5. Voltage vs. Current (V-I) characteristics of LED.
6. Characteristics of Photodiode

III. ANTENNA EXPERIMENTS (Minimum **Three** Experiments are mandatory)

1. Familiarization of any antenna simulation software.
2. Simulation of Dipole Antenna.
3. Simulation of Patch Antenna.
4. Simulation of Antenna Array.
5. Study of Vector Network Analyzer.
6. Antenna Pattern Measurement

2. Objectives

- Provide practical experience in design and analysis of few electronic devices and circuits used for Microwave and Optical communication engineering.
- Familiarize students with simulation of basic Antenna experiments with simulation tools

3. Text Books (T)

- T1. Samuel Y. Liao, Microwave Devices and Circuits, 3/e, Pearson Education, 2003.
- T2. Gred Keiser Optical Fiber Communication 5/e Mc Graw Hill, 2013
- T3. Balanis, Antenna Theory and Design, 3/e, Wiley Publications.

4. Reference Books (R)

- R1. John D. Krauss, Antennas for all Applications, 3/e, TMH.
- R2. Thomas A. Milligan, Modern Antenna Design, IEEE PRESS, 2/e, Wiley Inter science.
- R3. N.O. Sadiku and S.V. Kulkarni, Principles of Electromagnetics, Sixth Edition, Oxford University Press, India, 2015 (Asian adaptation of 'M.N.O. Sadiku, Elements of Electromagnetics, Sixth International Edition, Oxford University Press')

5. Course Pre / Co-requisite

_Nil

6. Course Outcomes

- CO1. Familiarize the basic Microwave components and to analyse few microwave measurements and its parameters.
- CO2. Understand the principles of fiber-optic communications and analyse different kind of losses, signal distortion and other signal degradation factors.
- CO3. Design and simulate basic antenna experiments with simulation tools.

7. Mapping of Course Outcomes with Program Outcomes

PO/ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
CO1	H	H	H	H	M				H	H		H	H	H	M
CO2	H	H	H	M					H	H		H	H	M	
CO3	H	H	H	H	H				H	H		H	H	H	H

8. Justification for CO-PO-PSO Correlation

CO	PO	Justification Statement
CO1	PO1	The knowledge in the principles of Microwave devices will enable the students to apply the fundamentals of basic science and engineering. Hence highly correlated.
	PO2	Analysing the characteristics of Microwave devices will enable the students to study their parameters. Hence highly correlated.
	PO3	Analyzing microwave devices involves solving intricate engineering problems, considering factors like impedance matching, signal propagation, reflection, and attenuation will enable the students' problem-solving skills, a key component of applying advanced engineering concepts. Hence highly correlated.
	PO4	Analysing the characteristics of microwave devices, students will gain insights into parameters such as VSWR, Reflection coefficient, impedance matching, and power handling capabilities. Hence highly correlated.
	PO5	Analyzing microwave device characteristics , Students directly supports the effective application of tools like the Smith Chart to design, analyze, and optimize microwave circuits. Hence moderately correlated.
	PO9:	Developing students' abilities to effectively work both as individuals and as members of a team..

	PO10	Students will be able to comprehend and write effective reports & document the design and results.
	PO12	Knowledge in Microwave devices will enable the students to design complex circuits used in microwave communication systems. Hence highly correlated.
	PSO1	Understanding the characteristics of Microwave devices will enable the students to design different communication systems. Hence highly correlated.
	PSO2	Analyzing their characteristics is essential for designing efficient and reliable systems in the domain. One of the key ways to validate the design of microwave devices is through experimental data. Hence highly correlated.
	PSO3	Analyzing microwave device characteristics, Students directly supports the effective application of tools like the Smith Chart to design, analyze, and optimize microwave circuits
CO2	PO1	Understanding the principles of Optical Sources & detectors will enable the students to apply the knowledge in basic science and communication engineering. Hence highly correlated.
	PO2	Analysing the characteristics of Optical Sources and detectors to study different parameters. Hence highly correlated.
	PO3	As it involves the design of analog & digital optical link to study the power budget calculation in fiber. Hence highly correlated.
	PO4	Utilisation of research based knowledge by conducting experiments will enable the students to develop complex antenna parameters design.
	PO9	Students function effectively as an individual, and a member in a team to execute the work.
	PO10	Students will be able to comprehend and write effective reports & document the design and results..
	PO12	knowledge in Optical Sources and detectors will enable the students to design optical communication link used in fiber optic systems.
	PSO1	Knowledge in Optical Sources and detectors will enable the students absorb and apply the to design optical communication systems. Hence highly correlated.
	PSO2	Analyzing their characteristics is essential for designing efficient and reliable systems in the domain. One of the key ways to validate the design of microwave devices is through experimental data.
CO3	PO1	Knowledge in different antenna parameters will enable the students to apply them in complex antenna designs. Hence highly correlated.

	PO2	Understanding the parameters like the directivity and beam area of the antenna will enable the students to analyse the radiation pattern to study more details about. Hence highly correlated.
	PO3	Design of different antenna using different tools will enable the students to develop complex antenna parameters design. Hence highly correlated.
	PO4	Utilisation of research based knowledge by conducting experiments will enable the students to develop complex antenna parameters design. Hence highly correlated.
	PO5	Selection of appropriate modern tool will enable the students to design different features of antenna . Hence highly correlated.
	PO9	Students function effectively as an individual , and a member in a team to execute the work.
	PO10	Students will be able to comprehend and write effective reports & document the design and results..
	PO12	knowledge in Antenna radiation pattern will enable the students to design an antenna with high directivity & gain. Hence highly correlated.
	PSO1	Knowledge in antenna radiation will enable students to design different antennas used in communication systems. Hence highly correlated.
	PSO2	Students analyse the experimental data to validate the design of antenna & its parameters. Hence highly correlated.
	PSO3	Analyzing antenna radiation characteristics , will enable the students to use simulation tools like python to design, analyze, and optimize antenna characteristics. Hence highly correlated.

9. Curricular gaps (if any)

Optical communication-fiber structure, types , losses, link design (Not studied in their curriculum)

10. Course Enrichment Activities*

Sl No	Description	Proposed Activities	Relevance to POs and PSOs
1	Basics of Optical Communication by Prof. Tubin T X	Seminar	PO1, PO2, PO3, PSO1

11. Course Plan / Schedule of experiments

List of Experiments.

Weeks(W)	Experiments	Relevance to COs
	PART A	
1	Reflex Klystron Mode Characteristics.	CO1
2	VSWR and Frequency measurement.	CO1
3	Verify the relation between Guide wave length, free space wave length and cut off wave length for rectangular wave guide.	CO1
4	GUNN diode characteristics.	CO1
	PART B	
5	Setting up of Fiber optic Digital link.	CO2
6	Measurement of Numerical Aperture of a fiber	CO2
7	Study of losses in Optical fiber.	CO2
8	Voltage vs. Current (V-I) characteristics of Laser Diode	CO2
	PART C	
9	Antenna Pattern Measurement	CO3
10	Familiarization of any antenna simulation software.	CO3
11	Simulation of Dipole Antenna.	CO3
Total No. of Hours		33

12. Assessment Pattern

Continuous Internal evaluation - 75 marks

End Semester Examination - 75 marks

Total -150 marks

13. Evaluation criteria (as per syllabus)

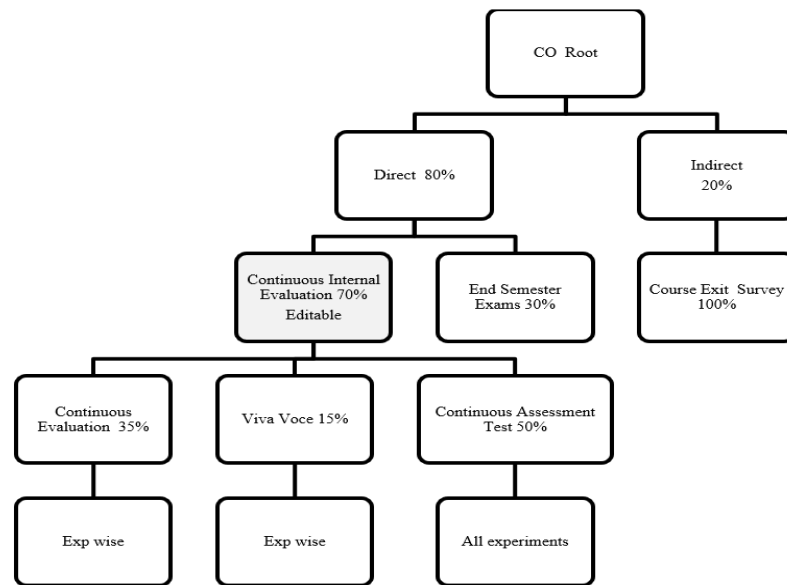
Sl. No.	Nature of Evaluation**	Evaluation Pattern**	Topics of Evaluation**	Duration**	Weightage of marks**
1	Continuous Internal evaluation (75 marks)				
a.	Attendance	15 marks	NA	NA	10%
b.	Continuous Evaluation & Viva-voce	30marks	Each experiment	NA	20%

c	Continuous Assessment Test	Design & Procedure – 10 marks performance & output– 10marks, viva – 10 marks , Total – 30 marks	All Experiments	3hrs	20%
2.	End Semester Examination (75 marks)				
a.	End semester Examination	Preliminary work- 15 marks, implementation – 10marks, performance,Output – 25 marks , viva –20 marks Record-5 marks. Total 75 marks	All Experiments	3hrs	50%

14. Assessment – CO Mapping (Put ‘ x’ if mapping is present)

	Tools**	Weightage#	CO1	CO2	CO3
Direct Assessment Tools	Continuous Evaluation Experiment wise CO mapping	25%	x	x	x
	Viva – Voce Experiment wise CO mapping	10%	x	x	x
	Continuous Assessment Test	35%	x	x	x
	End Semester Exam – 30%	30%	x	x	x
Indirect Assessment Tool	Course Exit Survey	100%	x	x	x

15. Assessment Configuration



Prepared by: Tubin T X

Checked by: Milna M J

Semester: 8

CONTENTS

SLOT	COURSE CODE	COURSES	L-T-P	HOURS	CREDIT
A	ECT 402	WIRELESS COMMUNICATION	2-1-0	3	3
B	ECT434	SECURE COMMUNICATION	2-1-0	3	3
	ECT474	ENTREPRENEURSHIP			
C	ECT416	MODERN COMMUNICATION SYSTEMS	2-1-0	3	3
	ECT426	REAL TIME OPERATING SYSTEM			
D	ECT448	LOW POWER VLSI	2-1-0	3	3
	ECT458	INTERNET OF THINGS			
E	ECT 404	COMPREHENSIVE VIVA VOCE	1-0-0	1	1
U	ECD416	PROJECT PHASE II	0-0-12	12	4

Course Code & Name: ECT402 WIRELESS COMMUNICATION**1. Prescribed Syllabus**

Module	Topic	Hours
1	Introduction to Wireless Communication Systems (8 Hours) 1.1 Introduction to Wireless Communication Systems (4): Generations: 2G, 3G, 4G, 5G. Wireless LAN, Bluetooth and Personal Area networks, Broadband Wireless Access -- WiMAX Technology. Wireless Spectrum allocation, Standards. 1.2 Cellular System Design Fundamentals (4): Frequency Reuse, channel assignment strategies, Handoff strategies, Interference and system capacity, trunking and grade off service, improving coverage and capacity – cell splitting, sectoring, microcells.	8
2	Wireless Channels (7 Hours) 2.1 Path loss and shadowing (1): Free space path loss, Two-Ray model, Shadowing, 2.2 Statistical Multipath Channel Models (4): Time-varying channel impulse response, Narrowband fading, Wideband fading models, Delay spread and Coherence bandwidth, Doppler spread and Coherence time, Flat fading versus frequency selective fading, Slow fading versus fast fading, Discrete-time model. 2.3 Capacity of Wireless Channels (2): Review of Capacity in AWGN, Capacity of flat fading channel – Ergodic capacity, Capacity with Outage, Capacity with CSI-R. (Derivations of capacity formulae are not required; Only expressions, computations and significance required.)	7
3	Modulation techniques (7 Hours) 2.1 Digital Signaling for Flat fading Channels (4): Analysis of Average Error Probability and Outage probability of BPSK in flat-fading channels. 2.2 Multi- carrier Modulation (3): Data transmission using multicarrier modulation for frequency-selective fading channels. Overlapping subchannels, Mitigation of Subcarrier Fading, Discrete Implementation of multicarrier – OFDM. Cyclic prefix, Peak-to-average-power-ratio.	7
4	Diversity, Equalization, and Multiple Access (8 Hours) 4.1 Diversity (3 hours): Receiver diversity – selection combining, maximal ratio combining. Transmitter diversity – Alamouti scheme for 2x2 MIMO. 4.2 Equalization (3): Equalization – Linear and non-linear equalization, Zero forcing, MMSE equalizers. LMS algorithm. Adaptive Equalization. 4.3 Multiuser Systems (2): Uplink and Downlink, Multiple Access, Frequency-Division Multiple Access (FDMA), Time-Division Multiple Access (TDMA), Code-Division Multiple Access (CDMA), Orthogonal Frequency- Division Multiple Access (OFDMA).	8
5	Radio Wave Propagation (7 Hours) Ground wave propagation, Plane earth reflection, Space wave and surface wave, Spherical earth propagation, Tropospheric waves, Ionospheric propagation, Effects of earth's magnetic field, Critical frequency, Maximum usable Frequency, Virtual height.	7

2. Text Books (T)

T1. Andrea Goldsmith, Wireless Communications, Cambridge University Press, 2005

T2. Theodore S. Rappaport, Wireless communication: Principles and Practice, 2/e, Pearson Education, 1990

3. Reference Books (R)

- R1. David Tse and Pramod Viswanath, Fundamentals of Wireless Communication, Cambridge University Press, 2005
- R2. Jochen Schiller, Mobile Communications, Pearson, 2008
- R3. Andreas F Molish, Wireless Communications, 2nd Edition, Wiley India Publications, 2013
- R4. W. C. Y. Lee, Mobile Cellular Telecommunication, McGraw Hill,
- R5. David A. Bell, Operational Amplifiers & Linear ICs, Oxford University Press, 2nd edition, 2010 Press, 2013.

4. Course Objectives

This course aims to introduce students to basic theory and principles of wireless communication systems in general, and cellular systems in particular. It also introduces basics of radio wave propagation.

5. Course Pre / Co-requisite

ECT 305 Analog and Digital Communication

6. Course Outcomes

After the completion of the course the student will be able to:

- CO1. Summarize the basics of cellular system and cellular design fundamentals.
- CO2. Describe the wireless channel models and discuss capacity of wireless channels.
- CO3. Analyze the performance of the modulation techniques for flat-fading channels and multicarrier modulation.
- CO4. Illustrate how receiver performance can be enhanced by various diversity techniques.
- CO5. Identify advantages of various equalization techniques and multiple-access techniques in wireless communication.
- CO6. Calculate system parameters such as antenna height, range, maximum usable frequency in different modes of radio wave propagation.

7. Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes

PO/ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H	H	M					M				M	H		
CO2	H	H	H	M	H				H	H		M	H	M	H
CO3	H	H	H		H				H	H			H		H
CO4	H	H	H		H				H	H			H		H
CO5	H	H	H	M	H				H	H		M	H	M	H
CO6	H	H	H						H	H			H		

8. Justification for CO-PO-PSO Correlation

CO	PO	Justification Statement
CO1	PO1	Understanding the basics of cellular systems are critical for the design and optimization of cellular networks. Hence highly correlated.
	PO2	Knowledge about cellular system design and fundamentals is essential for engineers to understand how cellular networks operate, how signals are transmitted and received. Hence highly correlated.
	PO3	Understanding the basics of cellular systems helps the students to develop the ability to apply their knowledge of cellular systems and design to assess the quality and reliability of wireless communication systems. Hence the correlation is medium
	PO8	Understanding the basics of cellular system will help the students to do engineering practice standards and use ethical concepts. Hence the correlation is medium
	PO12	Knowledge about the basics of cellular systems help the students to update their skills to stay current with the latest development in the field and hence recognizes the importance of life long learning. Hence the correlation is medium
	PSO1	Understanding the basics of cellular system will help the students to analyse and design various cellular networks. Hence highly correlated.
CO2	PO1	Analyzing different wireless channel models requires the knowledge in engineering fundamentals and mathematics. Hence highly correlated.
	PO2	Knowledge in wireless channel models and its capacity will help the students to design and analyze data and interpret results which are essential skills in engineering practice. Hence highly correlated.
	PO3	Knowledge about the capacity of wireless channels will help the students to design the solutions for different channels and hence highly correlated
	PO4	Knowledge about the capacity of wireless channels will help the students to analyse and interpret data and to perform synthesis of information. Hence the correlation is low
	PO5	Simulation of various wireless channel models will help the students to analyse different channels. Hence highly correlated.
	PO12	Knowledge about the capacity of wireless channels will help the students to understand the importance of channels and hence to compare it and hence medium correlated.
	PSO1	Knowledge in wireless channel models and its capacity will help the students to analyse and develop various communication systems. Hence highly correlated.
	PSO2	Knowledge in wireless channel models will enable the students to analyze the various wireless systems to validate the design
	PSO3	Simulation of various wireless channel models will help the students to analyse different channels used in cellular systems. Hence the correlation is medium
CO3	PO1	Analysing the performance of the modulation techniques requires knowledge in difference equations and hence highly correlated.
	PO2	Analysing the performance of the modulation techniques will help the students to identify the fundamental concepts of different channels and hence highly correlated
	PO3	Applying different modulation techniques for fading channels will help the students to analyse the performance of different channels and hence medium correlation is given.
	PO5	Simulating modulation techniques in wireless fading channels will help the students to

		apply current trends in engineering process and hence a high correlation is given.
	PO9	Analyzing modulation techniques for flat fading channels and multicarrier modulation often requires collaboration among individuals with diverse expertise, such as communication engineers, signal processing experts, and network designers and hence highly correlated.
	PO10	Analysis of modulation techniques in flat fading channels and multicarrier modulation will enable the students to prepare technical reports, presentations, and documentation and hence highly correlated.
	PSO1	Analyzing modulation techniques for communication systems involves a deep understanding in the design and development of various electronic components and hence highly correlated.
	PSO3	Knowledge of modulation techniques will help the students in the design, analysis and development of digital systems and hence a high correlation is given
CO4	PO1	Concept about receiver performance can be enhanced by various diversity techniques help the students to develop the ability for technical knowledge in the practical field for engineering
	PO2	Knowledge about variation of receiver performance by diversity techniques will help the students to improve the cellular system efficiency
	PO3	Demonstrating how receiver performance can be enhanced by various diversity techniques requires the knowledge about solutions for complex problems and hence it is highly correlated
	PO5	Knowledge in various diversity techniques and how it enhances the receiver performance provides the students to create and apply modern tools.
	PO9	Students can individually grasp the theoretical foundations of diversity techniques collaborate in teams to design, simulate, and implement diversity techniques in communication systems and hence it is highly correlated
	PO10	Understanding of the principles behind diversity techniques in communication systems will enable the students to document their project work including the design, implementation, and analysis of diversity techniques and hence it is highly correlated
	PSO1	Students will absorb theoretical knowledge regarding diversity techniques, including spatial, temporal, and frequency diversity. Hence highly correlated.
	PSO3	Knowledge in diversity techniques will help the students to design, analyse and develop various cellular systems. Hence highly correlated.
CO5	PO1	Knowledge about equalization techniques and multiple access techniques helps the students to apply mathematics fundamentals and hence highly correlated
	PO2	Equalization techniques and multiple access techniques requires identification of complex engineering problems and hence highly correlated
	PO3	Ability to identify various equalisation techniques requires the skill to design solutions to problems and hence highly correlated
	PO4	Evaluating and identifying the advantages of equalization and multiple access techniques in wireless communication inherently involves addressing complex problems and hence the correlation is medium
	PO5	Identification of different equalisation techniques help the students to model complex engineering activities and hence highly correlated

	PO9	Identifying the advantages of different equalisation and multiple access techniques often requires collaboration and teamwork to analyze complex scenarios, assess trade-offs, and arrive at optimal solutions and hence highly Correlated
	PO10	Identifying and articulating the advantages of different equalization and multiple access techniques to give presentations or reports explaining the advantages of these techniques and hence highly correlated
	PO12	Students will be introduced to the latest developments in equalization and multiple access techniques and This exposure encourages students to stay updated with industry trends, fostering a sense of continuous learning. Hence the correlation is medium
	PSO1	Attaining theoretical knowledge about various equalization and multiple access techniques, including their principles, algorithms, and mathematical foundations serves as the theoretical underpinning for their future work in electronic system design and hence highly correlated
	PSO2	Students will learn to design experiments or simulations to evaluate the performance of wireless communication systems employing equalization and multiple access techniques .Hence the correlation is medium
	PSO3	Knowledge in Equalization techniques and multiple access techniques will help the students to design, analyse and develop cellular systems. Hence high correlation is given
CO6	PO1	Knowledge about various system parameters in radio wave propagation helps the students to apply mathematics fundamentals and hence highly correlated
	PO2	Analysing system parameters in radio wave propagation requires identification of complex engineering problems and hence highly correlated
	PO3	Calculating system parameters in radio wave propagation involves development of solutions and hence highly correlated
	PO9	Students will individually absorb theoretical concepts related to radio wave propagation and students may collaborate in teams on projects that involve the design and analysis of wireless communication systems and hence highly correlated
	PO10	Students will be required to document their calculations, methodologies, and findings in reports or technical documents related to radio wave propagation and the calculations involved in determining system parameters and hence highly correlated
	PSO1	Students will apply their theoretical knowledge to design electronic systems, including wireless radio communication systems and hence highly correlated

9. Curricular gaps (if any)

Nil

10. Course Enrichment Activities*

Sl No	Description	Proposed Activities **	Relevance to POs and PSOs

1	NPTEL Video Based assignment	To compute the Bit error rate in fading	PO1,PO2,PO3,PO5,PO12, PSO1,PSO2,PSO3

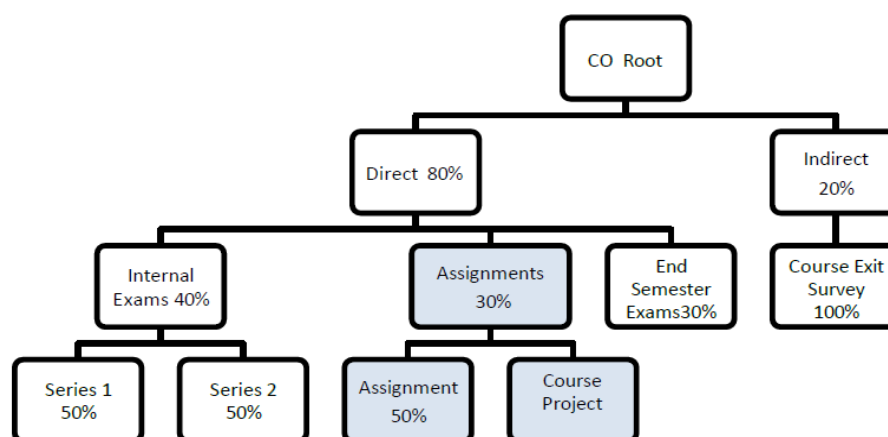
11. Internal Assessment mark allocation (as per university curriculum)

Attendance	- 10 marks
Continuous Assessment Test	- 25 marks
Assignment (s)	- 5 marks
<u>Course Project</u>	<u>- 10 marks</u>
<u>Total</u>	<u>- 50 marks</u>

12. Assessment – CO Mapping (Put ‘ x’ if mapping is present)

	Tools		Weightage	CO1	CO2	CO3	CO4	CO5	CO6
		Series 1	20%	x	x	x			
Direct Assessment Tools	Internal Exam(s) 40%	Series 2	20%			x	x	x	x
	Assignment (s)/ Course Project /Quiz etc. 30%	Assignment 1		x	x				
		Assignment 2					x	x	
		Course project		x	x	x	x	x	x
	End Semester Exam	30%		x	x	x	x	x	x
Indirect Assessment Tool	Course Exit Survey	100%		x	x	x	x	x	x

13. Assessment Configuration



14. Course Plan

Hour	Topic	Module	Reference(s)	Teaching Pedagogy
1	Generations: 2G, 3G, 4G, 5G.	1	T1	PPT
2	Generations: 2G, 3G, 4G, 5G(contd)	1	T1	PPT
3	Wireless LAN, Bluetooth and Personal Area networks, Broadband Wireless Access WiMAX Technology.	1	T1	Tutorial
4	Wireless Spectrum allocation, Standards	1	T1	PPT
5	Cellular concept, Frequency Reuse, channel assignment strategies,	1	T1	PPT
6	Cellular concept, Frequency Reuse, channel assignment strategies(contd)	1	T1	PPT
7	Interference and system capacity, trunking and grade off service.	1	T1	PPT
8	improving coverage and capacity – cell splitting, sectoring, microcells(contd)	1	T1	PPT
9	Free space path loss, Two-Ray model, Shadowing	2	T1,T2	PPT
10	Time-varying channel impulse response, Narrowband fading	2	T1,T2	Tutorial
11	Time-varying channel impulse response, Narrowband fading(contd)	2	T1,T2	PPT
12	Wideband fading models – Delay spread and Coherence bandwidth, Doppler spread and Coherence time	2	T1,T2	PPT
13	Flat fading versus frequency selective fading, Slow fading versus fast fading, Discrete-time model.	2	T1,T2	PPT
14	Review of Capacity in AWGN, Capacity of flat fading channel – Ergodic capacity, Capacity with Outage, Capacity with CSI-R.	2	T1,T2	PPT
15	Review of Capacity in AWGN, Capacity of flat fading channel – Ergodic capacity, Capacity with Outage, Capacity with CSI-R.	2	T1,T2	PPT
16	Average Probability of error and outage probability	3	R1	Tutorial
17	Performance evaluation of BPSK in flat fading channels	3	R1	PPT
18	Performance evaluation of BPSK in flat fading channels	3	R1	PPT
19	Multi carrier modulation in frequency-selective channel	3	R1	PPT
20	OFDM – DFT/IDFT, Cyclic Prefix	3	R1	PPT
21	OFDM – DFT/IDFT, Cyclic Prefix	3	R1	PPT
22	PAPR	3	T1,T2	PPT

23	Receiver Diversity – Selection combining, Maximal ratio combining	4	T1,T2	PPT
24	Receiver Diversity – Selection combining, Maximal ratio combining	4	T1,T2	Tutorial
25	Transmit Diversity – Alamouti for 2x2 MIMO	4	T1,T2	PPT
26	Equalization – linear and nonlinear	4	T1,T2	PPT
27	ZF and MMSE	4	T1,T2	PPT
28	LMS, Adaptive	4	T1,T2	PPT
29	Multiple access – FDMA, TDMA	4	T1,T2	PPT
30	CDMA, OFDMA	4	T1,T2	PPT
31	Ground wave propagation, Plane earth reflection	5	T1,T2	Tutorial
32	Space wave and surface wave	5	T1,T2	PPT
33	Spherical earth propagation, Tropospheric waves	5	T1,T2	PPT
34	Ionospheric propagation	5	T1,T2	PPT
35	Effects of earth's magnetic field	5	T1,T2	PPT
36	Critical frequency, Maximum usable Frequency, Virtual height.	5	T1,T2	PPT
37	Critical frequency, Maximum usable Frequency, Virtual height	5	T1,T2	PPT

15. Question bank

Module 1				
Sl. No.	Question	Marks	CO	BL
1	Give important features of 5G system.	3	CO1	L1
2	Discuss different handoff strategies.	3	CO1	L2
3	Explain about Frequency reuse	3	CO1	L2
4	List out different methods to improve coverage and capacity	3	CO1	L1
5	Define Grade of service in cellular communication systems	3	CO1	L1
6	Explain the term 'Trunking'	3	CO1	L2
7	Give important features of 4G system	3	CO1	L1
8	Compare between 3G and 4G systems	3	CO1	L2
9	Explain about WiMAX Technology	3	CO1	L2

10	Define Frequency planning	3	CO1	L1
11	Explain the concept of Channel borrowing strategy	3	CO1	L2
12	Define dwell time	3	CO1	L1
13	Define co-channel reuse ratio	3	CO1	L1
14	A total of 33MHz of bandwidth is allocated to an FDD cellular system which uses two 25kHz simplex channels to provide fullduplex voice & control channels. Compute the number of channels available per cell if the system uses 7- cell reuse.	6	CO1	L2
15	Explain about cell splitting? How does it improve system performance?	8	CO1	L2
16	Distinguish between Adjacent channel interference and co-channel interference	3	CO1	L2
17	Explain how Sectoring method improves system performance?	3	CO1	L2
18	Describe the method of identifying nearest co-channel neighbours of a particular cell in cellular communication systems	6	CO1	L2
19	Explain about Mobile assisted Hand-off	8	CO1	L2
20	How are co-channel signal-to-interference ratio, cluster size and system capacity are related to one another in a cellular system ? Explain with necessary equations.	7	CO1	L2
21	Explain the architecture of wireless LAN	7	CO1	L2
22	Explain in detail how microcell zone concept improves system performance in cellular communication systems	6	CO1	L2
23	Discuss in detail about different Wireless Spectrum allocation Standards	8	CO1	L2
24	Explain the architecture of Bluetooth	10	CO1	L2
25	If a total of 33 MHz of bandwidth is allocated to a particular FDD cellular telephone system which uses two 25 kHz simplex channels to provide full duplex voice and control channels, compute the number of channels available per cell if a system uses (a) 4-cell reuse, (b) 7- cell reuse (c) 12-cell reuse. If 1 MHz of the allocated spectrum is dedicated to control channels, determine an equitable distribution of control channels and voice channels in each cell for each of the three system	8	CO1	L3
26	Explain in detail about various channel assignment strategies	6	CO1	L2
27	A hexagonal cell within a 4-cell system has a radius of 1.387 km. A total of 60channels are used within the entire system. If the load per user is 0.029Erlangs, and $X = \text{call/hour}$, compute the following for an Erlang C system that has a 5% probability of a delayed call: (a) How many users per square kilometer will this system support? (a) What is the probability that a delayed call will have to wait for more than 10s? (c) What is the probability that a call will be delayed for more than 10 seconds?	6	CO1	L3

28	Define trunking and grade of service with relevant formulae	6	CO1	L1
29	In a cellular system using a 4-cell reuse pattern with a total bandwidth of 60MHz, if 2 channels of 30 kHz each are needed for a call, how many simultaneous calls can be accommodated in one cell and in one cluster?	6	CO1	L3
Module 2				
Sl. No.	Question	Mark	CO	BL
1.	Explain the term delay spread	3	CO2	L2
2.	Give the expression for capacity of flat fading AWGN channel with CSIR. Describe how it is obtained assuming AWGN capacity.	3	CO2	L1
3.	Explain about Free space path loss,	3	CO2	L2
4.	Explain about the small-scale fading effects due to multipath propagation	3	CO2	L2
5.	Define doppler shift	3	CO2	L1
6.	List out the various Parameters of Mobile Multipath Channels	3	CO2	L1
7.	Distinguish between mean excess delay and rms delay spread	3	CO2	L2
8.	Explain about Coherence Bandwidth	3	CO2	L2
9.	Explain how the parameter Doppler Spread affect the nature of the channel in a small-scale region.	3	CO2	L2
10.	Explain how the parameters coherence bandwidth affect the nature of the channel in a small-scale region.	3	CO2	L2
11.	Explain about Shannon capacity of a fading channel	3	CO2	L2
12.	Describe about the capacity with outage applicable to slowly varying channels	3	CO2	L2
13.	List out various Factors Influencing Small-Scale Fading and describe it in detail	7	CO2	L2
14. 15.	Consider a transmitter which radiates a sinusoidal carrier frequency of 1850MHz. For a vehicle moving 60 mph, compute the received carrier frequency if the mobile is moving (a) directly towards the transmitter, (b) directly away from the transmitter, (c) in a direction which is perpendicular to the direction of arrival of the transmitted signal.	6	CO2	L3
16.	Explain the effect of multipath propagation using 2-ray model.	8	CO2	L2
17.	Assuming narrow band fading model, derive statistical characterization of in-phase and quadrature components of a received signal when an unmodulated carrier is transmitted.	5	CO2	L3
18.	Derive time-varying impulse response of multipath wireless channel.	7	CO2	L3

19.	Consider a flat-fading channel with iid channel gains $g[i]$ which can take on values $g_1=0.05$ with probability $p_1=0.1$, $g_2=0.5$ with probability $p_2=0.5$, and $g_3=1$ with probability $p_3=0.4$. The transmit power is 10mW, noise spectral density $N_0 = 10^{-9}$ W/Hz, and channel bandwidth is 30kHz. Assume instantaneous CSI-R, but transmitter does not have CSI. Compute the capacity of the channel.	5	CO2	L2
20.	Explain in detail about different Types of Small-Scale Fading experienced by a signal propagating through a mobile radio channel	6	CO2	L2
21.	Compare between Flat Fading and Frequency Selective Fading	8	CO2	L2
22.	Compare between Fast Fading and Slow Fading	8	CO2	L2
23.	Describe in detail about the classification of Small scale fading Based on multipath time delay spread	8	CO2	L3
24.	Describe in detail about the classification of Small scale fading Based on Doppler spread	8	CO2	L2
25.	Describe in detail about the capacity of flat fading channels	6	CO2	L2
Module 3				
Sl. No.	Question		CO	BL
26.	Define outage probability.	3	CO4	L1
27.	What is the purpose of using cyclic prefix in an OFDM system?.	3	CO3	L1
28.	Define signal to noise ratio of an AWGN channel	3	CO3	L1
29.	Explain about the effect fading in AWGN channel	3	CO3	L2
30.	Discuss about average probability of error in AWGN	3	CO3	L2
31.	Define precoding wrt subcarrier fading	3	CO3	L1
32.	Define frequency Equalization	3	CO3	L1
33.	Define the term OFDM	3	CO4	L1
34.	List out different challenges in multicarrier systems	3	CO4	L1
35.	Define peak to average power ratio of a signal in OFDM	3	CO4	L1
36.	Define frequency and timing offset	3	CO4	L1
37.	Represent OFDM in matrix form	3	CO3	L1
38.	State the properties of DFT	5	CO3	L1
39.	Explain in detail about OFDM with FFT/IFFT implementation	3	CO3	L2

40.	Derive expression for average probability of error in BPSK under Rayleigh flat-fading when symbol duration is roughly equal to channel coherence time.	8	CO4	L3
41.	What is Peak-to-Average Power-Ratio (PAPR) in OFDM system? How can it be reduced ?	6	CO4	L1
42.	Determine the average SNR per bit of BPSK modulation in Rayleigh slow-fading channel such that 95% of the times, average probability of bit error is less than 10^{-4}	4	CO3	L3
43.	Explain multi-carrier modulation in OFDM.	3	CO3	L2
70	Discuss in detail about data transmission using multiple carriers	6	CO4	L2
71	Illustrate with equations the effect of multicarrier modulation with overlapping subchannels	6	CO4	L4
72	Explain in detail about the discrete implementation of multicarrier modulation	5	CO4	L2
73	Find the PAPR of a raised cosine pulse with $\beta=0,0.5,1$. Which pulse shape has lowest PAPR?	6	CO4	L3
Module 4				
Sl NO			CO	BL
1.	Consider a channel with impulse response $h(t) = \exp(-t/T) u(t)$. Find tap coefficients of a two-tap zero-forcing equalizer for this channel.	3	CO5	L1
2.	Why do we say that maximal ratio combining achieves full diversity?	3	CO5	L1
3.	Define space diversity	3	CO5	L1
4.	List out different methods to achieve frequency diversity	3	CO5	L1
5.	Define array gain wrt receiver diversity	3	CO5	L1
6.	Define diversity gain wrt receiver diversity	3	CO5	L1
7.	Differentiate between selection combining and maximal ratio combining	3	CO5	L2
8.	Illustrate with diagram the model of a linear combiner .	3	CO5	L4
9.	Define transmitter diversity	3	CO5	L1
10.	Comment on the diversity analysis for Noncoherent and differentially coherent modulation	3	CO5	L1
11.	What do you mean by Equalizer noise enhancement	3	CO5	L1
12.	Define fractionally spaced Equalization	3	CO5	L1
13.	List out various Multiple access techniques used in communication systems	3	CO5	L1
14.	Define OFDMA.	3	CO5	L1

15.	Explain Least-Mean-Square algorithm for equalization.	8	CO5	L2
16.	Compute the average probability of bit error of BPSK under maximal-ratio-combining two-branch diversity with iid Rayleigh fading. Average SNR on each branch is 10dB.	8	CO5	L2
17.	Describe Alamouti scheme for 2x2 MIMO.	7	CO5	L2
18.	Describe how multiple-access works on uplink and downlink in CDMA.	8	CO5	L2
19.	Explain in detail about Linear and nonlinear Equalizers	7	CO5	L2
20.	Illustrate the concept of Zero forcing equalizers	6	CO5	L4
21.	Describe about the purpose of a MMSE equalizer with noise whitening filter	5	CO5	L2
22.	Explain about Adaptive equalizer wrt training and tracking	6	CO5	L2
23.	Discuss in detail about various combining techniques and their performances in receiver diversity technique	5	CO5	L2
24.	Explain in detail about 1.FDMA 2.CDMA 3.TDMA	14	CO5	L2
Module 5				
1.	Distinguish between critical frequency and maximum usable frequency.	3	CO6	L2
2.	Define virtual height in antennas.	3	CO6	L1
3.	Define Sky wave and Ground Wave.	3	CO6	L1
4.	Give the factors that affect the propagation of radio waves?	3	CO6	L1
5.	Determine the height of the transmitting antenna to obtain a maximum distance of transmission up to 38km from a 24 meter high receiving antenna	3	CO6	L3
6.	What do you mean by MUF?	3	CO6	L1
7.	Define the term skin effect.	3	CO6	L1
8.	Define virtual height in radio wave Communication	3	CO6	L1
9.	Define the term critical frequency in radio wave communication	3	CO6	L1
10.	Explain about plane earth reflections in ground wave propagation.	3	CO6	L2
11.	Explain the structure of Ionosphere	3	CO6	L2
12.	It is required to establish a short-wave communication between two points in earth's surface separated by 1200 km. Calculate the maximum usable frequency and angle of take off the transmitted wave from the following data. Highest signal frequency return to earth after vertically upward propagation is 7.10MHz and virtual height of ionized layer is 200 km. Assume surface of earth to be flat.	8	CO6	L2
13.	Explain the refraction and reflection mechanisms in sky wave propagation.	6	CO6	L2
14.	VHF Communication is to be established with 50W transmitted at 100MHz. Calculate the LOS distance if the heights of transmitting and	8	CO6	L3

15.	receiving antennas are respectively 50 metres and 10m. Assuming the capture area of transmitting antenna is 25 square metres, calculate the field strength at the receiving antenna end neglecting ground reflected wave.	8	CO6	L2
16.	Explain about scattering phenomenon & Super refraction.	8	CO6	L2
17.	A radio transmitted operating at a frequency 1.69 MHz is required to provide a ground wave having strength of 0.5 mv/m at a distance of 16 km. The transmitting antenna with an efficiency of 50% produces a radiating field proportional to $\cos\theta$. Calculate the power transmitted.	6	CO6	L3
18.	Explain ground wave propagation in detail	6	CO6	L2
19.	Derive an expression for the LOS distance in km when the antenna heights above ground are h_t and h_r respectively for the transmitter and receiver antennas.	6	CO6	L2
20.	A receiving antenna is located at 80km from the transmitting antenna. The height of the transmitting antenna is 100m. What is the required height of the receiving antenna?	3	CO6	L2
21.	An HF radio communication is to be established between two points on the earth's surface. The points are at a distance of 2600km. The height of the ionosphere layer is 200km and critical frequency is 4MHz. Find maximum usable frequency.	7	CO6	L2
22.	Derive expression for critical frequency, maximum usable frequency and skip distance (assuming flat earth's surface) for sky wave propagation.	7	CO6	L2
23.	Discuss the field strength variation with skip distance & virtual height.	6	CO6	L2
24.	Discuss the atmospheric effects in space wave propagation.	6	CO6	L2
25	Two aircrafts are flying at altitudes of 3 Km and 5 Km respectively. What is the maximum possible distance along the surface of the earth over which they can have effective point to point communication? (Use effective radius of earth with $K=4/3$)	3	CO6	L3
26	The critical frequencies for F1 and F2 layers are observed as 5 MHz and 9 MHz respectively. Find the maximum electronic concentration of these two layers	6	CO6	L3

Prepared By : Ms.Milna M J

Checked By : Ms.Ambily Joseph



1. Prescribed Syllabus

Module	Topic	Hours
1	Basics of machine learning, supervised and unsupervised learning, examples, features, feature vector, training set, target vector, test set, feature extraction, over-fitting, curse of dimensionality. Review of probability theory, Gaussian distribution, decision theory	7
2	Regression: linear regression, error functions in regression, multivariate regression, regression applications, bias and variance. Classification : Bayes' decision theory, discriminant functions and decision surfaces, Bayesian classification for normal distributions, classification applications.	8
3	Linear discriminant based algorithm: perceptron, gradient descent method, perceptron algorithm, support vector machines, separable classes, non-separable classes, multiclass case.	6
4	Unsupervised learning: Clustering, examples, criterion functions for clustering, proximity measures, algorithms for clustering. Ensemble methods: boosting, bagging. Basics of decision trees, random forest, examples.	7
5	Dimensionality reduction: principal component analysis, Fischer's discriminant analysis. Evaluation and model Selection: ROC curves, evaluation measures, validation set, bias variance trade-off. Confusion matrix, recall, precision, accuracy.	7

2. Text Books (T)

T1. William Stallings, Cryptography and Network security: principles and practice", 4th Edition, Prentice Hall of India, New Delhi, 2006

3. Reference Books (R)

R1. Behrouz A. Forouzan, Cryptography and Network security Tata McGraw-Hill, 2008

R2. David S. Dummit & Richard M Foote, Abstract Algebra, 2nd Edition, Wiley India Pvt. Ltd., 2008.

R3. Tyagi and Yadav, Cryptography and network security, Dhanpatrai, 2012

R4. Douglas A. Stinson, Cryptography, Theory and Practice, 2/e, Chapman & Hall, CRC Press Company, Washington, 2005.

R5. Lawrence C. Washington, Elliptic Curves: Theory and Cryptography, Chapman & Hall, CRC Press Company, Washington, 2008.

4. Course Objectives

To impart the students about the theory and technology behind the secure communication

5. Course Pre / Co-requisite

NIL

6. Course Outcomes

At the end of this course student will be able to

- CO1. Explain network security services and mechanisms and the types of attacks they are designed for.
- CO2. Model the symmetric encryption process and different encryption techniques.
- CO3. Apply the concepts of group, ring, field, modular arithmetic, Euclidean algorithm, Finite fields and polynomial arithmetic.
- CO4. Illustrate the principles of modern symmetric ciphers like the Data Encryption Standard and Advanced Encryption Standard.
- CO5. Outline the concepts of public key cryptography, RSA algorithm, key distribution and management for public key systems
- CO6. Explain the requirements for authentication and the types of functions used to produce an authenticator

7. Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes

PO/ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H	H				H		H				H	H		
CO2	H	H	H		M	H						M	M		M
CO3	H	H			M							M	H		M
CO4	H	H				H		H				M	H		
CO5	H	H			M	H		H				M	H		M
CO6	H	H				H							H		

8. Justification for CO-PO-PSO Correlation

CO	PO	Justification Statement
CO1	PO1	Understanding of the concepts., services and mechanisms used to secure network systems, students will be able to make informed decisions when implementing, and managing secure network systems . Hence highly correlated.
	PO2	Emphasizing the importance of risk management and secure network design, students will be able to analyse and compare different types of services and mechanisms that are necessary to protect their networks from specific types of attacks. Hence highly correlated.
	PO6	Understanding of network security services and mechanisms helps students to identify potential security threats and make informed decisions on how to protect against them, thus ensuring the confidentiality, integrity, and availability of data and systems in accordance with industry standards and best practices..
	PO8	Demonstrating ethical and professional behavior in the area of network security, students will contribute to the overall reputation and success of the computing industry
	PO12	Implementation of advanced security features in computer communication ,students using the knowledge of security mechanisms and services .
	PSO1	Absorbing the concepts., services and mechanisms used to secure network systems, students will be able to make informed decisions when implementing, and managing secure network systems. . Hence highly correlated.
CO2	PO1	Understanding the symmetric encryption process, including key generation, encryption, and decryption, enable the students to design and implement secure communication protocols for transmitting sensitive information over public networks . Hence highly correlated.
	PO2	Understanding of symmetric encryption and different encryption techniques will enable students to analyze and evaluate the various encryption methods and protocols and compare the strengths and weaknesses of different encryption techniques is an important aspect of designing secure systems. Hence highly correlated.
	PO3	Knowledge in the process of symmetric encryption and the various techniques used, individuals can design secure communication systems and evaluate the security of existing systems. Hence highly correlated.
	PO5	Modelling of different encryption techniques will enable students to use modern engineering tools with an understanding of limitations.
	PSO1	Absorbing and applying the knowledge of encryption techniques,will enable the Students to implement secure communication protocols in cryptography . . Hence highly correlated.
CO3	PO1	Knowledge in the mathematical concepts like group, ring, field, modular arithmetic, Euclidean algorithm, individuals are able to develop sophisticated solutions to complex problems and contribute to the advancement of the field of computer science. Hence highly correlated.

	PO2	Applying the concepts of group, ring, field, modular arithmetic, and Euclidean algorithm, individuals can analyze and design algorithms and protocols, as well as understand and evaluate the security and efficiency of existing solutions. Hence highly correlated. . Hence highly correlated. . Hence highly correlated.
	PO5	Simulating the concepts of group, ring, field, modular arithmetic, Euclidean algorithm, finite fields and polynomial arithmetic will enable the students to use modern engineering tools for solving important problems in computer networks .
	PO8	Demonstrating ethical and professional behavior in the area of network security, individuals contribute to the overall reputation and success of the computing industry
	PO12	By using the knowledge in encryption process Students will develop more advanced algorithms in network security .
	PSO1	Absorbing and applying the knowledge of modular arithmetic ,will enable the Students to implement security features used in cryptography .Hence highly correlated.
CO4	PO1	Understanding principles of modern symmetric ciphers like DES and AES , will be enable students to explain secure systems and providing essential protection for sensitive information Hence highly correlated.
	PO2	Illustrating the principles of ciphers is crucial in understanding how they work, their strengths and weaknesses, and how they can be used to protect information Hence highly correlated.
	PO6	Knowledge in modern symmetric ciphers like DES and AES will enable the students to develop their critical thinking skills and to understand the complexities of data security.
	PO8	Knowledge and skill set in Ciphers will enable the students in their future careers and in contributing to the security and privacy of sensitive data.
	PO12	Reviewing the advanced materials on Encryption ,students will be able to develop advanced algorithms for security.
	PSO1	Absorbing and applying knowledge in symmetric ciphers ,Students will be able to implement secure communication protocols Hence highly correlated.
CO5	PO1	Knowledge and understanding of public key cryptography, RSA algorithm, key distribution, will enable the students to form the foundation for secure communication and data protection in various applications Hence highly correlated.
	PO2	Understanding of the fundamental principles of public key cryptography and its application in secure communication, will enable the students to implement secure communication systems and the protection of sensitive information Hence highly correlated.
	PO6	Knowledge public key cryptography, RSA algorithm, key distribution will enable the students to develop their critical thinking skills and to understand the complexities of data security.
	PO8	Demonstrating ethical and professional behavior in the area of network security, individuals contribute to the overall reputation and success of the computing industry
	PO12	Reviewing the advanced materials on public key cryptography will be able to develop advanced algorithms for security.
	PSO1	Absorbing and applying knowledge in public key cryptography, Students will be able to implement secure communication systems Hence highly correlated.

CO6	PO1	Knowledge in the requirements for authentication and the types of functions like hash, digital signature will enable the students to use their knowledge in basic computer networks. Hence highly correlated.
	PO2	Understanding the requirements for authentication and the types of functions used to produce an authenticator is essential for students in the field of information security. It will enable students to ensure the protection of sensitive data and information. Hence highly correlated.
	PO6	Understanding these concepts, students will be able to design and implement secure authentication systems that protect sensitive information and resources.
	PSO1	Absorbing and applying knowledge in authentication and the types of functions like hash, digital signature will enable the students to implement secure communication systems Hence highly correlated.

9. Curricular gaps (if any)

NIL

10. Course Enrichment Activities*

Sl No	Description	Proposed Activities **	Relevance to POs and PSOs
1.	Network Security, attacks, threats & security features	Talk on network Security Dr. Jeswin Roy D'Couth (HOD, Assoc. Professor, CSE Dept)	PO1,PO2, PO8,PO12

11. Internal Assessment mark allocation (as per university curriculum)

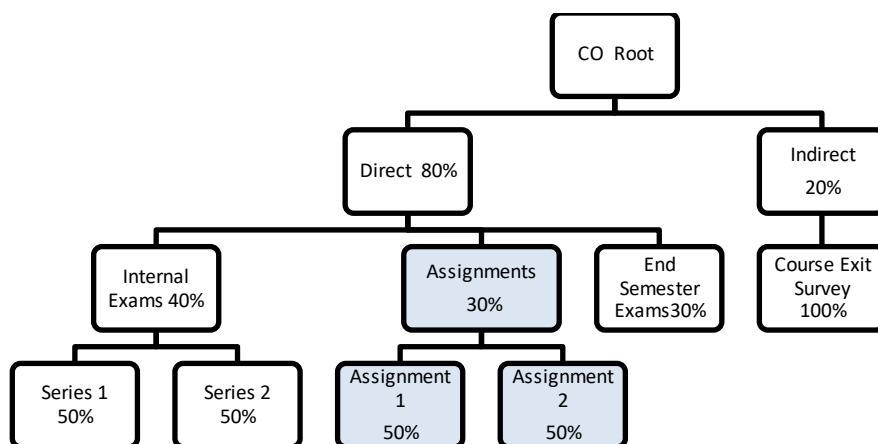
(Provide details as mentioned in syllabus)

Attendance	- 10 marks
Continuous Assessment Test	- 25 marks
Assignment (s)/ Course Project	- 15 marks
Total	- 50 marks

12. Assessment – CO Mapping (Put ‘ x’ if mapping is present)

	Tools		Weight age [#]	CO 1	CO 2	CO 3	CO 4	CO 5	CO 6
Direct Assessment Tools**	Internal Exam(s) 40%	Series 1	20%	x	X	x			
		Series 2	20%			x	x	x	x
	Assignment (s)/ Course Project 30%	Assignment1	15%		X	x			
		Assignment2	15%		X	x			
	End Semester Exam		30%	x	X	x	x	x	x
Indirect Assessment Tool	Course Exit Survey		100%	x	X	x	x	x	x

13. Assessment Configuration



14. Course plan

Hour	Topic Name	Module	Reference	Teaching Pedagogy
1	OSI system architecture, Security attacks – Passive attacks, Active attacks	1	T1, R1	Lecture
2	Security services- Authentication, Access Control, Data Confidentiality, Data integrity, Nonrepudiation, Availability service.	1	T1, R1	Lecture
3	Security Mechanisms	1	T1, R1	Lecture
4	A model for network security	1	T1, R1	Lecture
5	Symmetric cipher model, Cryptography, Cryptoanalysis	1	T1, R1	Lecture
6	Substitution techniques	1	T1, R1	Lecture
7	Hill Cipher	1	T1, R1	Tutorial
8	Transposition Techniques	1	T1, R1	Lecture
9	Modular arithmetic- congruence	2	T1, R1	Lecture
10	Residues, Inverses	2	T1, R1	Lecture
11	Euclidian algorithm	2	T1, R1	Lecture
12	Groups, Rings and Fields	2	T1, R1	Lecture
13	Finite Fields of the form GF(p)	2	T1, R1	Lecture
14	GF(2 ⁿ) field	2	T1, R1	Tutorial
15	Polynomial arithmetic	2	T1, R1	Lecture
16	Polynomial-addition, multiplication	2	T1, R1	Tutorial
17	Series Test 1	2	T1, R1	Exam
18	Block Cipher Principles and Stream Ciphers and Block Ciphers	3	T1, R1	Lecture
19	Feistel Cipher, Feistel Decryption algorithm	3	T1, R1	Lecture
20	The Data encryption standard	3	T1, R1	Lecture
21	DES Decryption	3	T1, R1	Lecture
22	The Avalanche effect	3	T1, R1	Lecture
23	The AES Cipher	3	T1, R1	Tutorial

24	substitute bytes transformation, Shift row transformation	3	T1, R1	Lecture
25	Mix Column transformation	3	T1, R1	Lecture
26	Problems based on AES Cipher	3	T1, R1	Lecture
27	Principles of public key cryptosystems	4	T1, R1	Lecture
28	Public key cryptosystems, Application for Public key cryptosystem requirements	4	T1, R1	Lecture
29	Fermat's theorem, Euler's Totient Function	4	T1, R1	Lecture
30	Euler's theorem	4	T1, R1	Lecture
31	RSA algorithm- Description of the algorithm	4	T1, R1	Tutorial
32	Key management, Distribution of public keys	4	T1, R1	Lecture
33	Publicly available directory, Public key authority, public key certificates, Distribution of secret keys using public key cryptograph	4	T1, R1	Lecture
34	Authentication requirements, authentication functions	5	T1, R1	Lecture
35	Message Encryption, Public Key Encryption	5	T1, R1	Lecture
36	Message Authentication Code, Hash function	5	T2, R1	Lecture
37	Series2	5	T2, R1	Exam

15. Question Bank

Module 1				
Sl. No.	Question	Marks	CO	BL
1.	Differentiate passive attack from active attack with example	3	CO1	L2
2.	List the 3 aspects of security?	3	CO1	L1
3.	Explain the security goals.	3	CO1	L2
4.	Define masquerade?	3	CO1	L1
5.	Brief on Replayng?	3	CO1	L1
6.	Define Denial of service.	3	CO1	L1
7.	List out the components of encryption algorithm	3	CO1	L1
8.	Define integrity.	3	CO1	L1
9.	Define Non repudiation.	3	CO1	L1
10.	Explain about Symmetric Ciphers.	3	CO2	L2
11.	Explain Symmetric Cipher Model	3	CO2	L2
12.	Explain Substitution Techniques.	3	CO2	L2
13.	Explain Caesar Cipher	3	CO2	L2
14.	Explain Mono alphabetic Cipher	3	CO2	L2
15.	Explain Play fair cipher	3	CO2	L2
16.	Explain Hill cipher.	3	CO2	L2
17.	Explain different Poly alphabetic Cipher	3	CO2	L2
18.	Explain one time pad.	3	CO2	L2
19.	Differentiate symmetric and asymmetric encryption?	5	CO1	L2

20.	Explain different attacks on Security Goals.	6	CO1	L2
21.	Discuss attacks on integrity. How it can be prevented?	5	CO1	L2
22.	Explain security services & mechanisms.	10	CO1	L2
23.	Describe specific and pervasive security mechanisms.	7	CO1	L2
24.	Explain about OSI Security model .	7	CO1	L2
25.	Use Playfair cipher to encipher the message “this is an exercise” using a secret key ‘GUIDANCE’.	7	CO2	L3
26.	Use hill cipher to encipher the message “we live in an insecure world”. $K = \begin{bmatrix} 3 & 2 \\ 5 & 7 \end{bmatrix}$	7	CO2	L3
27.	Discuss the properties of an ideal cryptographic system	7	CO2	L2
28.	Using the Key: PAY , do OTP for LAY .	7	CO2	L2
29.	Give the advantages of Poly Alphabetic Cipher	4	CO2	L1
30.	Encrypt the word SECURE using Key as 3 using Ceaser Cipher	7	CO2	L2
31.	Discuss the security of OTP	6	CO2	L2
32.	Encrypt the message NETWORK SECURITY with key as STALLINGS using Play fair cipher (ignore the space between words)	7	CO2	L3
33.	Encrypt the word COMMUNICATION with key as CRYPTO using play fair cipher.	7	CO2	L3
34.	Encrypt the word CRYPTO using Key as 4 using Ceaser Cipher	7	CO2	L2
35.	Use Playfair cipher to encipher the message “this is an exercise” using a secret key ‘GUIDANCE’.	7	CO2	L3
36.	Encrypt the message: “payransom” using Hill Cipher with the key. $K = \begin{bmatrix} 3 & 2 \\ 5 & 7 \end{bmatrix}$	8	CO2	L3
37.	Explain about transposition ciphers?	5	CO2	L2
38.	Use Brute force attack to decipher the following message enciphered by Alice using additive cipher. Suppose that Alice always uses a key that is close to her birthday, which is on the 13 th of the month: NCJAEZRCLASJLYODEPRLYZRCLASJLCPEHZDTPDZQLNZ TY	7	CO2	L3
Module 2				
Sl. No.		Marks	CO	BL
1.	Explain two facts of Euclids algorithm.	3	CO3	L2
2.	Explain extended Euclidean algorithm.	3	CO3	L2
3.	Explain congruence.	3	CO3	L2
4.	Explain the inverses of a number.	3	CO3	L2
5.	Explain how multiplicative inverse of a number calculated using Euclids algorithm.	3	CO3	L2
6.	List the properties of Group.	3	CO3	L1
7.	Explain the properties of abelian Group.	3	CO3	L2

8.	Explain Subgroup.	3	CO3	L2
9.	Explain properties of Ring.	3	CO3	L2
10.	Explain about Commutative Ring.	3	CO3	L2
11.	Explain Field.	3	CO3	L2
12.	Explain Galois Field.	3	CO3	L2
13.	Explain GF(p) Field	3	CO3	L2
14.	Explain GF (2^2)field.	3	CO3	L2
15.	Calculate $(6x^2 + x + 3)(5x^2 + 2)$ where the coefficients are in GF(10)	3	CO3	L2
16.	Find the results of following operations a)-18 mod 14 b)Add17 to 27 in Z_{14} c)multiplicative inverse of 8 in Z_{10}	6	CO3	L2
17.	Determine the multiplicative inverse of each non zero element in Z_{10}	5	CO3	L3
18.	Find gcd (1970, 1066) using Euclid's algorithm?	5	CO3	L3
19.	Define a group and distinguish between group & Commutative group	5	CO3	L2
20.	Solve the equation $3x+4 \equiv 6(\text{mod } 13)$.	5	CO3	L2
21.	Explain different algebraic Structures.	10	CO3	L2
22.	It is told in arithmetic that the remainder of an integer divided by 4 is the same as the remainder of division of the two rightmost digits by 4. Use the properties of mod operator to prove this claim	5	CO3	L2
23.	Find whether the set of whole numbers is an Abelian Group under addition. Justify.	5	CO3	L2
24.	Differentiate between group, ring, abelian group and field with examples.	10	CO3	L2
25.	In $GF(2^8)$, Find the inverse of (X^5) modulo $(X^8+X^4+X^3+X+1)$	6	CO3	L3
26.	Solve the equation $14x \equiv 12(\text{mod } 18)$.	6	CO3	L3
27.	Find whether the group $G = \langle Z_7, + \rangle$ is an abelian group or not. Justify your answer.	7	CO3	L3

Module 3

Sl. No.	Question	Marks	CO	BL
1	Differentiate between a block cipher and a stream cipher.	3	CO4	L2
2	Define the terms Word, Block and State	3	CO4	L1
3	Recognize the difference between diffusion and confusion.	3	CO4	L1
5	Explain the difference between S-boxes and D- boxes in DES?	3	CO4	L2
6	List out the essential ingredients of a symmetric cipher.	3	CO4	L1
8	How many bytes in State are affected by Shift Rows?	3	CO4	L1
9	Differentiate between Sub Bytes and Sub Word.	3	CO4	L2
10	Explain how the S-box is constructed?	3	CO4	L2
11	Write a note on mix columns?	3	CO4	L1
12	Give the basic permutations and substitution in DES.	3	CO4	L1
13	Describe the avalanche effect.	3	CO4	L1
14	Discuss four transformations used in Advanced Encryption Standard	10	CO4	L2
15	Explain AES algorithm	15	CO4	L2
16	Explain the mix column operation in AES	6	CO4	L2
17	With necessary diagrams, explain DES	10	CO4	L2
18	Explain the round operation in DES Encryption	6	CO4	L2

Module 4

Sl. No.	Question	Marks	CO	BL
1	State the Fermat's Theorem & Euler's theorem	3	CO5	L1
2	Explain the requirements for public key cryptography	3	CO5	L2

3	Explain Fermat's theorem and Euler totient function with an example each.	3	CO5	L2
4	Use Euler's theorem to find a number between 0 and 28 with congruent to 6 modulo 35	3	CO5	L2
5	Using Fermat's theorem find $3^{201} \bmod 11$	3	CO5	L2
6	State Euler's theorem. Check whether Euler's theorem holds for $a = 3$ and $n = 10$	3	CO5	L2
7	List the requirements for public key cryptography	3	CO5	L1
8	Explain applications of Public key cryptosystem.	3	CO5	L2
9	State Fermat's theorem. Using Fermat's theorem find 1) $3^{31} \bmod 7$ 2) $7^{121} \bmod 31$	6	CO5	L3
10	With a neat sketch about key distribution scenario explain the key control schemes in cryptography.	10	CO5	L2
11	Explain in detail about confidentiality using symmetric key and public key Cryptography.	8	CO5	L2
12	Explain Public key cryptosystem.	10	CO5	L2
13	Give a detailed explanation regarding the various Key management techniques.	10	CO5	L2
14	Explain the Distribution of Secret Key	7	CO5	L2
15	Explain the Distribution of Public Key	7	CO5	L2
16	Explain about public key Certification	8	CO5	L2
17	Explain in detail about RSA algorithm highlighting its computational aspects and security.	6	CO5	L2
18	Explain in detail about RSA algorithm highlighting its computational aspects and security.	10	CO5	L2
19	Explain RSA algorithm with parameters $p = 3$, $q = 11$, $e = 7$ and $M = 5$	15	CO5	L3
20	Explain Diffie- Hellman public key cryptosystem with an example	10	CO5	L2
21	Encrypt the plaintext 88 using RSA algorithm assuming $p = 17$, $q = 11$ & $e = 7$	10	CO5	L3

Module 5

Sl. No.		Marks	CO	BL
1	Define Message Authentication code? Explain its functions and basic uses.	3	CO6	L2
2	List out the message authentication Requirements.	3	CO6	L1
3	Define the classes of message authentication function.	3	CO6	L1
4	Define Hash function	3	CO6	L1
5	Differentiate Message Authentication Code and Hash function.	3	CO6	L2
6	List out different types of attacks addressed by message authentication?	3	CO6	L1
7	Explain What do you mean by one way property in hash function?	3	CO6	L2
8	Describe about Hash Function. How its algorithm is designed? Explain its features & properties?	3	CO6	L2
9	Define the 3 classes of functions which can be used to produce an authenticator	3	CO6	L1
10	Describe a hash function. Illustrate the different ways in which hash function can be used to provide message authentication. Describe the confidentiality and authentication implications of the different approaches.	10	CO6	L2
11	Illustrate the basic uses of message encryption	7	CO6	L2
12	Explain authentication using message authentication code	7	CO6	L2

13	Explain any two message authentication methods in detail with necessary diagrams	7	CO6	L2
14	Differentiate between a message authentication code and a one-way hash function	7	CO6	L2

Prepared By : Mr.Tubin T X

Checked By : Milna M J

Course Code & Name: ECT474 Enterpraunership**1. Prescribed Syllabus**

Module	Topic	Hours
1	Entrepreneurship: definition, requirements to be an entrepreneur, entrepreneur and intrapreneur, entrepreneur and manager, growth of entrepreneurship in India, women entrepreneurship, rural and urban entrepreneurship. Entrepreneurial Motivation: motivating factors, motivation theories- Maslow's need hierarchy theory, McClelland's acquired need theory, government's policy actions towards entrepreneurial motivation, entrepreneurship development programmes	6
2	Types of Enterprises and Ownership Structure: small scale, medium scale and large-scale enterprises, role of small enterprises in economic development; proprietorship, partnership, limited companies and co-operatives: their formation, capital structure and source of finance.	8
3	Institutional Support and Policies: institutional support towards the development of entrepreneurship in India, technical consultancy organizations, Government programs, policies, incentive and institutional networking for enterprise setting, women entrepreneurship development in India, promotional schemes.	7
4	Projects: identification and selection of projects, project report, contents and formulation, elements of project formulation, project design and network analysis, concept of project evaluation, methods of project evaluation: internal rate of return method and net present value method.	7
5	Management of Enterprises: objectives and functions of management, scientific management, general and strategic management; introduction to human resource management: planning, job analysis, training, recruitment and selection, marketing and organizational dimension of enterprises; enterprise financing, raising and managing capital, shares, debentures, bonds, cost of capital; break- even analysis, balance sheet analysis.	6

2. Text Books (T)

T1. Ram Chandran, Entrepreneurial Development, Tata McGraw Hill, New Delhi, 2008

T2. Saini, J. S. Entrepreneurial Development Programmes and Practices, Deep & Deep Publications, 2012

3. Reference Books (R)

R1. Khanka, SS. Entrepreneurial Development, S Chand & Company Ltd. New Delhi, 2007

R2. Badhai, B Entrepreneurship for Engineers, Dhanpat Rai & co, 2006

R3. Desai, Vasant, 'Project Management and Entrepreneurship', Himalayan Publishing, Mumbai, 2017

R4. Gupta, Srinivasan, 'Entrepreneurial Development', S Chand & Sons, New Delhi, 2020

R5. Kuratko and Rao, Entrepreneurship, Cengage Learning, 2012

4. Course Objectives

The objective of this course is to understand the knowledge of entrepreneurship and apply in the organization.

5. Course Pre / Co-requisite

Students should have a basic knowledge in management

6. Course Outcomes

CO1: Explain the fundamental concepts of entrepreneurship

CO2: Explain entrepreneurial motivation and motivation theories

CO3: Analyze types of enterprises and ownership structure

CO4: Apply project evaluation methods

CO5: Evaluate enterprise financial strength

7. Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes

PO/ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1								M		L		H			
CO2								M		L		H			
CO3								M		L		H			
CO4	M		M		M					L	H	H	L		
CO5	M		M		M					L	H	H			

8. Justification for CO-PO-PSO Correlation

CO	PO	Justification Statement
CO1	PO8	As students emphasize the importance of ethical decision-making and responsible business practices as fundamental principles of entrepreneurship.
	PO10	As students demonstrate effective communication skills, explaining fundamental entrepreneurship concepts clearly and persuasively in professional and business contexts.
	PO12	As students demonstrate continuous learning and adaptability, essential skills for navigating the dynamic entrepreneurial landscape.
	PSO 1	As students leverage their technical expertise in electronics and communication engineering to innovate, design, and develop electronic products and solutions with entrepreneurial vision.
CO2	PO8	students ensure ethical financial practices, transparency, and integrity in financial analysis and decision-making.
	PO10	As students communicate financial analysis, insights, and reports to stakeholders for informed decision-making.
	PO12	As students are equipped with essential financial management principles for assessing and making informed decisions on an enterprise's financial viability.
	PSO 1	As Students apply knowledge in Electronics and Communication Engineering in developing innovative electronic systems, driven by entrepreneurial motivation and informed by motivation theories.
CO3	PO8	As students emphasize on ethical considerations in business formation, ownership responsibilities, and corporate governance.
	PO10	As students emphasize the importance of effectively conveying business models, ownership structures, and enterprise analysis to stakeholders through clear and professional communication.

	PO12	As students foster continuous learning to adapt to evolving business models, regulatory frameworks, and entrepreneurial best practices.
	PSO 1	As students apply their domain knowledge in Electronics and Communication Engineering to make informed decisions on enterprise models and ownership structures for technology-driven ventures.
CO4	PO1	As students use fundamental engineering principles and analytical techniques to assess the feasibility, efficiency, and impact of projects.
	PO3	As students demonstrate their ability to design, analyze, and assess engineering solutions through systematic evaluation techniques to ensure efficiency, feasibility, and effectiveness.
	PO5	As students use modern engineering and management tools for effective analysis, assessment, and decision-making in project evaluation.
	PO10	As students use the clear and effective communication of project assessments, findings, and justifications for informed decision-making.
	PO11	As students understand the importance of financial principles, resource management, and strategic decision-making in evaluating and managing engineering projects effectively.
	PO12	As students recognize the need for continuous learning and adaptation to evolving evaluation techniques, industry standards, and best practices in project assessment.
	PSO 1	As students assess engineering projects using technical, economic, and feasibility criteria to optimize the design and development of electronic systems.
CO5	PO1	As students apply fundamental mathematical, scientific, and engineering principles to analyze financial data and assess the economic viability of an enterprise.
	PO3	As students apply analytical and problem-solving skills to develop effective financial strategies and solutions for sustainable business growth.
	PO5	As students use modern financial tools, software, and analytical techniques to assess and interpret an enterprise's financial performance effectively.
	PO10	As students understand how to effectively interpret, document, and communicate financial insights to stakeholders for informed decision-making.
	PO11	As students apply financial principles and management skills to assess and ensure the economic viability of an enterprise.
	PO12	As students recognize the need for continuous learning and adaptation to evolving financial tools, market trends, and economic conditions for informed decision-making.
	PSO 1	As students understand the importance of cost-effective design, economic feasibility, and financial viability in the development of electronic systems

9. Curricular gaps (if any):

Nil

10. Course Enrichment Activities*

Sl No	Description	Proposed Activities **	Relevance to POs and PSOs
1	Business proposal writing	Workshop	PO1, PO2, PO4, PO4, PO10, PO12, PSO1

11. Internal Assessment mark allocation (as per university curriculum)

Attendance	- 10 marks
Continuous Assessment Test	- 25 marks

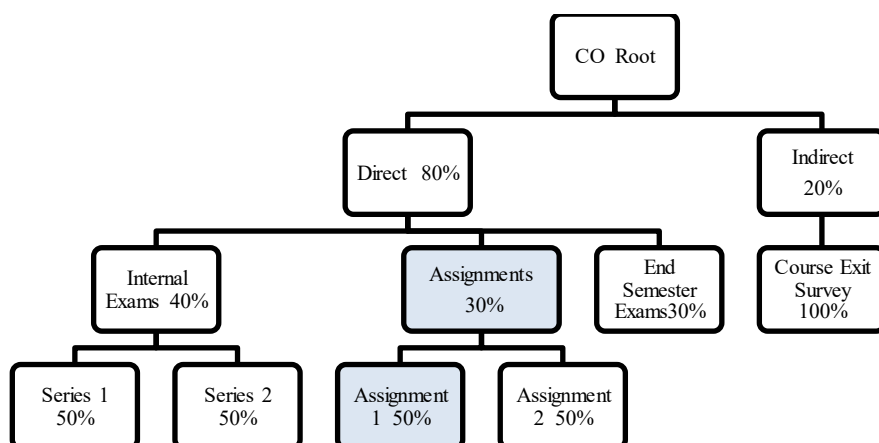
Assignment (s)/ Course Project - 15 marks

Total - 50 marks

12. Assessment – CO Mapping (Put ‘ x’ if mapping is present)

	Tools		Weightage [#]	CO1	CO2	CO3	CO4	CO5
Direct Assessment Tools	Internal Exam(s) 40%	Series 1	20%	x	x			
		Series 2	20%			x	x	
	Assignment (s)/ Course Project 30%	Assignment 1	15%	x	x			
		Assignment 2	15%	x	x	x	x	x
	End Semester Exam		30%	x	x	x	x	x
Indirect Assessment Tool	Course Exit Survey		100%	x	x	x	x	x

13. Assessment Configuration



14. Course plan

Hour	Topic	Module	Reference(s)	Teaching Pedagogy
1	Entrepreneurship: definition, requirements to be an entrepreneur, entrepreneur and intrapreneur,	1	T1, R1	Lecture+PPT
2	Entrepreneur and manager, growth of entrepreneurship in India,	1	T1, R1	Lecture+PPT
3	women entrepreneurship		T1, R1	Lecture+PPT
4	Rural and urban entrepreneurship.	1	T1, R1	Group Discussion
5	Entrepreneurial motivation: motivating factors, motivation theories, Maslow's Need Hierarchy Theory.	1	T1, R1	Lecture+PPT
6	McClelland's acquired need theory, government's policy actions towards entrepreneurial motivation.	1	T1, R1	Lecture+PPT

7	Entrepreneurship development programmes.	1	T1, R1	Lecture+PPT
8	Types of enterprises and ownership structure	2	T1, R1	Lecture+PPT
9	Small scale, medium scale and large scale enterprises.	2	T1, R1	Lecture+PPT
10	Role of small enterprises in economic development.	2	T1, R1	Lecture+PPT
11	Proprietorship, partnership	2	T1, R1	Lecture+PPT
12	Limited companies	2	T1, R1	Lecture+PPT
13	Co-operatives: their formation, capital structure and source of finance	2	T1, R1	Lecture+PPT
14	Institutional support and policies	3	T1, R1	Lecture+PPT
15	Institutional support towards the development of entrepreneurship in India	3	T1, R1	Lecture+PPT
16	Technical consultancy organizations	3	T1, R1	Lecture+PPT
17	Government programs, policies, incentive and institutional networking for enterprise setting.	3	T1, R1	Lecture+PPT
18	Women entrepreneurship development in India	3	T1, R1	Lecture+PPT
19	Promotional schemes.	3	T1, R1	Lecture+PPT
20	Projects	4	R3	Lecture+PPT
21	Identification and selection of projects	4	R3	Lecture+PPT
22	Project report, contents and formulation.	4	R3	workshop
23	Elements of project formulation,	4	R3	Lecture+PPT
24	Project design and network analysis.	4	R3	Lecture+PPT
25	Concept of project evaluation, methods of project evaluation	4	R3	Lecture+PPT
26	Internal rate of return method	4	R3	Lecture+PPT
27	Net present value method.	4	R3	Lecture+PPT
28	Management of Enterprises		R3	Lecture+PPT
29	Objectives and functions of management, scientific management, general and strategic management.	5	R3	Lecture+PPT
30	Introduction to human resource management, planning, job analysis.	5	R3	Lecture+PPT
31	Training, recruitment and selection	5	R3	Lecture+PPT
32	Marketing and organizational dimension of enterprises.	5	R3	Lecture+PPT
33	Enterprise financing, raising and managing capital, shares, debentures bonds, cost of capital	5	R3	Lecture+PPT
34	Break- even analysis	5	R3	Lecture+PPT
35	Balance sheet analysis.	5	R3	Lecture+PPT

15. Question Bank

Module 1				
Sl. No.	Question	Marks	CO	BL
1	What is the support for innovation and entrepreneurship from Government of India?	3	CO1	L2

2	Which are the important criteria that GEDI adopts to release Global Entrepreneurship Index of various countries?	3	CO1	L2
3	What distinguishes an entrepreneur from other business professionals?	3	CO1	L2
4	Explain any one motivation theory in detail	3	CO1	L2
5	Differentiate between Entrepreneur and Intrapreneur	3	CO1	L2
6	Explain the need for entrepreneurial development programmes.	3	CO1	L2
7	How does a manager differ from an entrepreneur	3	CO1	L2
8	Explain different Types of entrepreneurs	3	CO1	L2
9	Describe the types of entrepreneurs. Which one do you think most suitable for India	10	CO1	L2
10	Explain McClelland achievement and acquired needs theory	4	CO1	L2
11	Present the major points of distinction between an entrepreneur and a manager.	10	CO1	L2
12	Explain Maslow's need hierarchy theory of motivation	4	CO1	L2
13	Explain Maslow's and McClelland's need theory.	7	CO1	L2
14	Write notes on rural and urban entrepreneurship	7	CO1	L2
15	Explain the role of Entrepreneurial Development Programme (EDP)	7	CO1	L2
16	Examine the growth of entrepreneurship in India over the past decade.	7	CO1	L2
17	Explain the requirements for being a successful entrepreneur	8	CO1	L2
18	Illustrate government policy actions towards entrepreneurial motivation	6	CO1	L2
19	Compare rural and urban entrepreneurship.	4	CO1	L2
20	Discuss entrepreneurial motivational theories	10	CO1	L2
21	Explain Maslow's need hierarchy theory of motivation	6	CO1	L2
22	Explain the growth of Entrepreneurship in India	8	CO1	L2
23	Describe Entrepreneurship development programs	8	CO1	L2
24	Explain McClelland achievement and acquired needs theory	6	CO1	L2
Module 2				
Sl. No.	Question	Marks	CO	BL
1	What are the different types of cooperative society?	3	CO2	L2
2	Which are the various types of private limited companies?	3	CO2	L2
3	Differentiate between small scale, medium-scale, and large-scale enterprises.	3	CO2	L2
4	Describe the characteristics of cooperative enterprises.	3	CO2	L2
5	State the advantages of partnership companies	3	CO2	L2
6	"In proprietorship form of business, both entrepreneur and manager are the same person". Comment your views on the above statement	3	CO2	L2
7	Describe the purpose of a partnership deed?	3	CO2	L2
8	Explain the structure of co-operative society.	3	CO2	L2
9	Describe the characteristics of SSI.	10	CO2	L2
10	Write the advantages of partnership?	4	CO2	L2
11	What is sole proprietorship? Write its features and disadvantages.	6	CO2	L2
12	Explain micro-small and medium enterprises (SMEs) in India and the role of MSMEs in India	8	CO2	L2
13	Explain the various types of ownership available to entrepreneurs.	6	CO2	L2

	Discuss each form in brief.			
14	Explain the capital structure of limited companies, including the issuance of shares and types of shares. How do limited companies raise capital, and what factors influence their decisions on capital structure?	8	CO2	L2
15	Explain the process of forming a sole proprietorship.	6	CO2	L2
16	Discuss the formation, governance, and capital structure of a partnership business. What are the key considerations when entering into a partnership agreement, and how do partnerships differ from other ownership structures?	8	CO2	L2
17	Classify the ownership structures associated with entrepreneurship	6	CO2	L1
18	Summarize how Small-Scale Industries help in entrepreneurship development	8	CO2	L2
19	Examine the role of small-scale industries in Indian economy	8	CO2	L2
20	List the features of limited companies	6	CO2	L1
21	Classify different types of business ownerships.	8	CO2	L2
22	Explain the various sources of finance in cooperative society	6	CO2	L2
23	Describe the role of small enterprises in the economic development of a country.	6	CO2	L2
24	Illustrate the impact of cooperative societies in rural India	8	CO2	L2
Module 3				
Sl. No.	Question	Marks	CO	BL
1	Describe any three central government projects providing institutional support towards the development of entrepreneurship in India	3	CO3	L2
2	Enlist the important government schemes for women entrepreneurship	3	CO3	L1
3	What strategies have been implemented to address the challenges faced by rural entrepreneurs in India?	3	CO3	L2
4	Explain about the institutions and centres administered by SIDO (Small Industries Development Organisation)	3	CO3	L2
5	What are the needs for institutional networking in enterprise setting.	3	CO3	L2
6	Explain the role of non-government institutions in supporting entrepreneurship development	3	CO3	L2
7	Discuss various functions of NABARD.	3	CO3	L2
8	List the women entrepreneurial development schemes in India	3	CO3	L1
9	Describe about the institutional support system towards the development of entrepreneurship in India by the Central Government.	9	CO3	L2
10	What are the benefits of entrepreneurial networks?	5	CO3	L2
11	What are the advantages of providing incentives to entrepreneurs.	9	CO3	L2
12	Write about the advantages & disadvantages of business networking.	5	CO3	L2
13	Explain the functions of various Non Government Institutions.	7	CO3	L2
14	Write a short note on women entrepreneurs with examples	7	CO3	L2
15	How has the regulatory environment in India evolved to facilitate entrepreneurship, and what reforms have been introduced in recent years?	7	CO3	L2
16	Explain the various women entrepreneurship schemes of the	7	CO3	L2

	government in detail			
17	Discuss any four central government supporting institutions.	8	CO3	L2
18	Examine the role of technical consultancy organizations in entrepreneurship development	6	CO3	L2
19	Describe different promotional schemes for women entrepreneurship	6	CO3	L2
20	Explain Government incentives for promotion of entrepreneurship in India	8	CO3	L2
21	Explain the challenges faced by women in starting and successfully running an enterprise.	8	CO3	L2
22	Write short notes on government policies to foster entrepreneurship	6	CO3	L2
23	Outline the specific government programs implemented in India aimed at stimulating and supporting the start-up ecosystem	8	CO3	L2
24	Describe any three state government institutions created for supporting entrepreneurship	6	CO3	L2
Module 4				
Sl. No.	Question	Marks	CO	BL
1	What is a project report? What it consists of?	3	CO4	L1
2	Give the structure of a project design.	3	CO4	L1
3	How does project identification differ in the public and private sectors?	3	CO4	L2
4	Why is project evaluation an essential step in the project management lifecycle?	3	CO4	L2
5	List the steps associated with project identification.	3	CO4	L1
6	Explain the criteria to be followed while performing project selection.	3	CO4	L2
7	Explain the different stages of project design.	3	CO4	L2
8	Explain why project evaluation is important	3	CO4	L2
9	What are the merits and demerits of critical path method?	7	CO4	L2
10	Distinguish between PERT (Program evaluation and review technique) and CPM (Critical path method) of network techniques.	7	CO4	L2
11	What is project evaluation and what are the various evaluation methods? Explain any two methods.	10	CO4	L2
12	What are the benefits of project evaluation?	4	CO4	L2
13	Analyse this investment using NPV method . Arun needs Rs.1000 now and will pay you back Rs.1350 in a year. Is that a good investment when you can get at 10% per year. ? Justify your answer	8	CO4	L3
14	Explain the significance of market analysis in project report and its impact on project formulation	6	CO4	L2
15	Explain Internal Rate of Return(IRR) and Net Present Value (NPV) method	6	CO4	L2
16	How can network analysis techniques like the Critical Path Method (CPM) and Program Evaluation and Review Technique (PERT) be applied in project planning?	8	CO4	L2
17	Explain the need for network analysis in project management.	6	CO4	L2
18	Describe any two methods of network analysis used in project management	8	CO4	L2

19	Demonstrate Net Present Value method and Internal Rate of Return method with an example	8	CO4	L2
20	Explain different stages of project appraisal	6	CO4	L2
21	Explain different steps involved in project formulation	8	CO4	L2
22	Explain the comprehensive components that should be incorporated into a project report to ensure its effectiveness and clarity	6	CO4	L2
23	Describe project network analysis techniques used in project management	6	CO4	L2
24	Illustrate Net Present Value and Internal rate of return with an example	8	CO4	L2
Module 5				
Sl. No.	Question	Marks	CO	BL
1	Explain raising and managing capital.	3	CO5	L2
2	What does the term 'job requirement' mean?	3	CO5	L1
3	Explain the concept of job analysis and its role in matching the right talent to specific job roles.	3	CO5	L2
4	Differentiate between shares, bonds and debentures	3	CO5	L2
5	Explain the key objectives of management of enterprises	3	CO5	L2
6	Differentiate between shares and debentures.	3	CO5	L2
7	What are the key management functions in relation to entrepreneurship	3	CO5	L2
8	Explain the need for human resource planning.	3	CO5	L2
9	What is working capital? Why is it important for any enterprise? Explain.	9	CO5	L2
10	Discuss, with suitable examples, the functions of modern marketing.	5	CO5	L2
11	Explain the objectives and functions of management.	7	CO5	L2
12	Write short notes on training, recruitment and selection	7	CO5	L2
13	Discuss the significance of marketing in the growth and sustainability of an enterprise.	7	CO5	L2
14	What is break-even analysis, and how does it help enterprises determine profitability and risk levels?	7	CO5	L2
15	How does the process of workforce planning contribute to effective human resource management?	7	CO5	L2
16	How can balance sheet analysis aid in assessing an enterprise and financial health and identifying areas for improvement?	7	CO5	L2
17	Elaborate the principles underlying scientific management.	6	CO5	L2
18	Explain the steps involved in raising and managing capital for a business at an operational level?	8	CO5	L2
19	Write short notes on Break even analysis and balance sheet analysis.	6	CO5	L2
20	Describe the different process involved in recruitment and selection process in an enterprise.	8	CO5	L2
21	Explain the Process of strategic management and its benefits	8	CO5	L2
22	Discuss the goals of marketing	6	CO5	L2
23	Classify the Organizational dimension of enterprises	8	CO5	L2
24	Explain different types of capital raising	6	CO5	L2

Prepared By : Sonu Kunjannamma Varghese

Checked by : Thomas Felix

Course Code & Name: ECT416 Modern Communication System

1. Prescribed Syllabus

Module	Topic	Hours
1	Module 1: Cellular Communication System Need for Multi carrier system, Basics of Orthogonal Frequency Division Multiplexing (OFDM), Multiple access for OFDM systems, Orthogonal Frequency Division Multiple Access (OFDMA), Single carrier Frequency Division Multiple Access (SC-FDMA). Cellular concept, path loss and shadowing, Doppler shift, Multipath effect, Significance of diversity in wireless communication systems.	8
2	Module 2: Short Range Communication System Introduction to current wireless technologies, background and current scenario, future wireless network requirements, IEEE 802.11 (Wi-Fi) standards and applications (IEEE 802.11a/b/g/n/ac/ax), HiperLAN technology, WPAN (IEEE 802.15.1, IEEE 802.15.3 & IEEE 802.15.4) and WMAN (IEEE 802.16a -WiMAX), Space time wireless standards, IEEE 802.16 (Wi-Max standard), 3GPP-LTE standard, Millimeter wave characteristics, Channel performance at 60 GHz, Development of millimeter wave standards, Indoor and outdoor applications for millimeter wave communications. 6G Networks – Use Cases and Technologies.	9
3	Module 3: IoT System Introduction of IoT, characteristics, physical and logical design of IoT, IoT Enabling Technologies – Wireless Sensor networks, Cloud computing. Introduction to IoT, Evolution of IoT, IoT Networking Components. IoT Connectivity Technologies – Zigbee, Wireless HART, RFID, NFC, LoRa, WiFi, Bluetooth. IoT Communication Technologies – Infrastructure Protocols – IPv6, 6LoWPAN, Data Protocols – MQTT, MQTT-SN, CoAP. IoT Case Studies and Future Trends – Agricultural IoT, Vehicular IoT, Healthcare IoT.	7
4	Module 4: Intelligent Transport System Introduction to Intelligent Vehicular Communication – Evolution, Vehicular Networks and ITS, Vehicular Communication Standards/ Technologies – DSRC, IEEE 802.11p WAVE, IEEE 1609, IEEE 802.15.7 - Visible Light Communication (VLC), 4G/5G-Device to Device (D2D), 6G Cellular Networks and Connected Autonomous Vehicles, Operational Scenario – Collision Avoidance.	6
5	Module 5: Software Defined Radio System Software radio concepts, Operating frequency bands, Transmitter and Receiver specifications of SDR, Architecture of SDR, Introduction of cognitive radio,	5

2. Text Books (T)

- T1. Aditya K. Jagannatham, “Principles of Modern Wireless Communication Systems”, Tata McGraw Hill, 2016.
- T2. T.L. Singal, “Wireless Communications”, Tata McGraw Hill Education Private Limited, Second Edition, 2011.
- T3. K. C. Huang, Z. Wang, “Millimeter Wave Communication systems”, John Wiley & Sons.
- T4. Sudip Misra, Anandarup Mukherjee & Arijit Roy. “Introduction to IoT”. Cambridge University Press. 2021.
- T5. George J. Dimitrakopoulos. “Current Technologies in Vehicular Communication”, Springer International Publishing, 2017.
- T6. He, J., Yang, K. and Chen, H.H, “6G Cellular Networks and Connected Autonomous Vehicles”, IEEE Network, vol. 35, no. 4, pp. 255 -261, 2020.
- T7. Walter Tuttlebee, “SDR Enabling Technologies”, John Wiley.
- T8. Huseyin Arslan, “Cognitive Radio, SDR and Adaptive Wireless System”, Springer, 2007.

3. Reference Books (R)

- R1. Dipankar Raychaudhuri, Mario Gerla, “Emerging Wireless Technologies and the Future Mobile Internet”, Cambridge University Press, 2011.
- R2. Arshdeep Bahga, A., & Vijay Madisetti V. “Internet of Things: A hands-on approach”. Vpt., 2014.
- R3. Paul, A., Chilamkurti, N., Daniel, A. and Rho, S. “Intelligent vehicular networks and communications: fundamentals, architectures and solutions”. Elsevier, 2016.
- R4. Peter B. Kenington, ‘RF and baseband techniques for software defined radio’, Artech House Mobile Communication, 2005.

4. Course Objectives

This course aims to impart knowledge on the basics of modern communication systems and the breakthrough wireless technologies.

5. Course Pre / Co-requisite

- ✓ MAT 204 Probability, Random Process and Numerical Methods,
- ✓ ECT 305 Analog and Digital Communication,
- ✓ ECT 306 Information Theory and Coding

6. Course Outcomes

After completion of the course, students will be able to

- CO1. Explain OFDM, OFDMA and SC-FDMA techniques used in cellular communication
- CO2. Discuss the different wireless communication standards for short range communication
- CO3. Explain the IoT architecture and various connectivity technologies used in IoT Systems
- CO4. Understand the various communication standards for connected autonomous vehicles
- CO5. Explain the significance and architecture of software defined radio and cognitive radio

7. Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H	H	H		M								H		
CO2	H	H	H			H						M	H		
CO3	H	H	H			H							H		
CO4	H	H	H			H						M	H	M	H
CO5	H	H	H		M							M	H		M

8. Justification for CO-PO-PSO Correlation

CO	PO/PSO	Justification Statement
CO1	PO1	Knowledge of mathematics and engineering fundamentals will help students to explain OFDM, OFDMA and SC-FDMA techniques
	PO2	The analysis of multiplexing techniques will enable students to use differential equations to reach substantiated conclusions.
	PO3	By understanding concepts related to electromagnetic vector fields students will be able to design solutions to problems in electrostatics and magneto statics
	PO5	By the contextual knowledge of multiplexing techniques, students will be able to use modern tools to design of communication system
	PSO1	By applying the knowledge in basic static electric and magnetic fields, students will be able to develop systems based on electromagnetics.
CO2	PO1	Knowledge of Maxwell's equation in different forms enable students to use differential and integral calculus to solve diverse problems.
	PO2	The analysis of Maxwell's equation helps the students to use vector calculus, differential equations and use the basic Gauss laws and Faradays law.
	PO3	By understanding Maxwell's equation in different form, students will be able to design solutions to problems related to static and time varying fields.
	PO4	By referring the journal papers and collecting data, students will be able to interpret the information related to Maxwell's equation and its applications and provide valid conclusions.
	PO12	By applying Maxwells equations as a mathematical model for electric, optical, and radio technologies, students will recognize the need for persistent learning.
	PSO1	Applying the knowledge of Maxwell's equations and its diverse applications will help students in developing systems based on electronic communication.
	PSO2	Analysis of Maxwell's equation in different forms helps students in analysis of system related to communication system and validate the design.

CO3	PO1	The knowledge of electromagnetic wave propagation in different media will enable students to apply the fundamental laws like Gauss's law.
	PO2	Understanding the electromagnetic wave propagation helps the students to analyse the reflection and refraction of waves at boundaries.
	PO3	The analysis of electromagnetic wave propagation and wave polarization will help students to design systems related to electromagnetic communication thereby developing solutions to cater to specific needs.
	PO4	By conducting investigation by referring papers and collecting data on wave propagation in different media, students will be able to interpret data related to perfect dielectric, lossy medium and conductor.
	PO12	By understanding the vast applications of propagation of electromagnetic waves and polarization by referring recent papers, students will recognize the need for persistent learning and updating recent trends.
	PSO1	Applying the knowledge of electromagnetic wave propagation through different media will help students in developing systems based on electromagnetic communication.
	PSO2	Analysing and evaluating the data related propagation of EM waves will help the students to validate the design of the systems related to electromagnetic communication.
CO4	PO1	Knowledge of transmission line parameters and the use of smith chart will help students to use basic graphical and analytical method to solve problems related impedance matching etc.
	PO2	Analysis of transmission lines using graphical and analytical methods, the students will use partial differential equations and solution of algebraic equations to find the parameters of transmission line.
	PO3	Analysing the characteristics of transmission lines using Smith chart will enable the students to design a transmission line that meet specified needs.
	PO4	By conducting investigation by referring papers and collecting data, students will be able to evaluate the characteristics of transmission lines.
	PO5	Using online smith chart tools, students will be able to design matching networks, impedance calculation etc
	PO12	With the knowledge of graphical measuring tool which is used to solve problems related to RF transmission lines, for impedance matching etc, students will recognize the need for persistent learning and updating recent trends.
	PSO1	Applying the knowledge of smith charts and the characteristics of transmission lines, students will be able to develop systems related to electromagnetic communication.
	PSO2	Evaluating the data related to transmission line parameters using Smith chart will help students to analyse transmission line problems and validate the design.

	PSO3	Using modern online Smith chart tools, students will be able to analyse the characteristics of transmission lines for solution of problems related to impedance matching, VSWR etc.
CO5	PO1	With the knowledge of EM wave propagation in waveguides, students will apply differential equations and algebraic expressions in the solution of problems.
	PO2	For analysing and evaluating modes of propagation in waveguides, students will use the solution of partial differential equations to calculate group velocity, phase velocity etc..
	PO3	Analysing the characteristics of waveguides will enable the students to find solutions to problems related to different modes of propagation.
	PO4	By referring papers and interpretation of data, students will be able to evaluate the electromagnetic wave propagation in waveguides.
	PO12	By analysing the propagation of electromagnetic waves and understanding vast range of practical everyday applications that includes diverse uses as communication by cell phone, radio broadcasting, microwaves etc will instil students to constantly update the recent trends.
	PSO1	Knowledge of propagation of electromagnetic waves in waveguides helps students in developing electromagnetic communication system.
	PSO2	Evaluating the data related to propagation of EM waves in waveguides helps students to analyse the characteristics of waveguides to validate the design.

9. Curricular gaps (if any)

Nil

10. Course Enrichment Activities

Sl No	Description	Proposed Activities	Relevance to POs and PSOs
1	Nil		

11. Internal Assessment mark allocation (as per university curriculum)

(Provide details as mentioned in syllabus)

Continuous Assessment Test - 40 marks

Assignment (s)/ Course Project - 10 marks

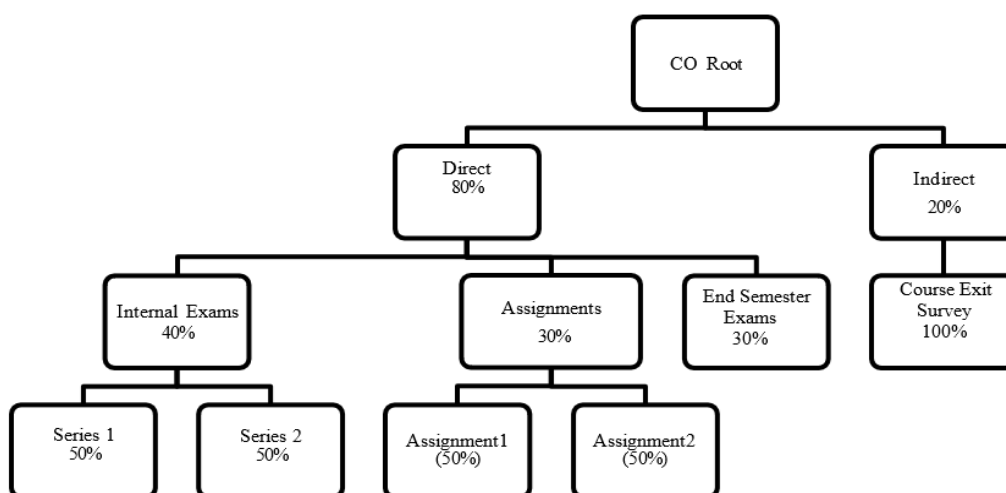
Total - 50 marks

12. Assessment – CO Mapping (Put ‘x’ if mapping is present)

	Tools		Weightage	CO1	CO2	CO3	CO4	CO5
		Series 1	20%	x	x	x		

Direct Assessment Tools	Internal Exam(s) 40%	Series 2	20%			x	x	x
	Assignment 30%	Assignment 1			x	x		
		Assignment 2					x	x
	End Semester Exam		30%	x	x	x	x	x
Indirect Assessment Tool	Course Exit Survey		100%	x	x	x	x	x

13. Assessment Configuration



14. Course Plan

Hour	Topic	Module	Reference	Teaching Pedagogy
1.	Introduction to IoT	3	Reference 4	Lecture
2.	Evolution of IoT	3	Reference 4	Lecture
3.	physical and logical design of IoT	3	Reference 4	Lecture
4.	IoT Enabling Technologies Wireless Sensor networks, Cloud computing	3	Reference 4	Lecture
5.	Networking Components	3	Reference 4	Lecture
6.	IoT Connectivity Technologies Zigbee, Wireless HART, RFID , NFC	3	Reference 4	Lecture
7.	IoT Connectivity Technologies LoRa, WiFi, Bluetooth	3	Reference 4	Lecture

8.	IoT Case Studies and Future Trends Vehicular IoT, Healthcare IoT.	3	Reference 4	Lecture
9.	Tutorial session on module 3	3	Reference 4	Lecture
10.	IoT Case Studies and Future Trends Agricultural IoT	3	Reference 4	Lecture
11.	Tutorial session on module 3	3	Reference 4	Tutorial
12.	IoT Case Studies and Future Trends Vehicular IoT, Healthcare IoT.	4	Reference 5	Lecture
13.	Introduction to Intelligent Vehicular Communication Evolution	4	Reference 5	Lecture
14.	Vehicular Networks and ITS, Vehicular Communication Standards	4	Reference 5	Lecture
15.	Industrial Visit	6		Lecture
16.	Technologies DSRC, IEEE 802.11p WAVE,	4	Reference 5	Lecture
17.	IEEE 1609,	4	Reference 5	Lecture
18.	IEEE 802.15.7 - Visible Light Communication (VLC)	4	Reference 5	Lecture
19.	4G/5G-Device to Device (D2D),6G Cellular Networks	4	Reference 5	Lecture
20.	Tutorial session on module 4	4	Reference 5	Tutorial
21.	Software radio concepts, Operating frequency bands, Transmitter and Receiver specifications of SDR	5	Reference 6	Lecture
22.	Architecture of SDR	5	Reference 6	Lecture
23.	Introduction of cognitive radio, significance of cognitive radio and spectrum subleasing,	5	Reference 6	Lecture
24.	spectrum sharing in cognitive radio	5	Reference 6	Lecture
25.	Implementation of cognitive radio	5	Reference 6	Lecture
26.	Tutorial Session on module 5	5	Reference 6	Tutorial
27.	Need for Multi carrier systemBasics of Orthogonal Frequency Division Multiplexing (OFDM)	1	Reference 5	Lecture
28.	Multiple access for OFDM systems	1	Reference 5	Lecture
29.	Orthogonal Frequency Division Multiple Access (OFDMA)	1	Reference 1	Lecture
30.	Single carrier Frequency Division Multiple Access (SC-FDMA)	1	Reference 1	Lecture
31.	Cellular concept, path loss and shadowing, doppler shift,	1	Reference 1	Lecture
32.	Significance of diversity in wireless communication systems	1	Reference 1	Lecture
33.	Tutorial session on module 1	1	Reference 1	Tutorial
34.	Introduction to current wireless technologies, background and current scenario, future wireless network requirements	2	Reference 2	Lecture
35.	IEEE 802.11 (Wi-Fi) standards and applications (IEEE 802.11a/b/g/n/ac/ax)	2	Reference 2	Lecture
36.	HiperLAN technology	2	Reference 2	Lecture
37.	WPAN (IEEE 802.15.1, IEEE 802.15.3 & IEEE 802.15.4)	2	Reference 2	Lecture
38.	WMAN (IEEE 802.16a - WiMAX), 3GPP-LTE standard	2	Reference 2	Lecture
39.	WPAN (IEEE 802.15.1	2	Reference 2	Lecture
40.	IEEE 802.15.3 & IEEE 802.15.4	2	Reference 2	Lecture
41.	Millimeter wave characteristics, Channel performance at 60 GHz, Development of millimeter wave standards. Indoor and outdoor applications for millimeter	2	Reference 2	Lecture

42.	Tutorial session module 2	2	Reference 2	Tutorial

15. Question Bank

Module 1				
Sl. No.	Question	Marks	CO	BL
1.	Explain inter-carrier interference in OFDM systems.	3	CO1	L1
2.	Determine the maximum speed of a vehicle in a mobile communication system experiencing a maximum Doppler frequency shift of 70 Hz and a frequency of transmission 900 MHz.	3	CO1	L1
3.	What is the need for adding cyclic prefix to the OFDM sequence?	3	CO1	L1
4.	Draw and explain the SC-FDMA transmitter and receiver schematic	3	CO1	L1
5.	Briefly explain free space propagation model in wireless communication	3	CO1	L2
6.	A mobile subscriber travels at a uniform speed of 60 km/h. Compute the time between fades if the mobile uses (i) a cellphone operating at 900 MHz (ii) a PCS phone operating at 1900 MHz Comment on the results obtained.	3	CO1	L2
7.	What are the basics of Orthogonal Frequency Division Multiplexing (OFDM). Explain the block diagram of OFDM transmitter and receiver?	3	CO1	L3
8.	How does multiple access techniques work in OFDM systems?	3	CO1	L2
9.	What is Orthogonal Frequency Division Multiple Access (OFDMA)?	3	CO1	L2
10.	Explain Single Carrier Frequency Division Multiple Access (SC-FDMA) with the help of block diagram?	3	CO1	L1
11.	Can you explain the concept of cellular communication?	3	CO1	L1
12.	What is path loss and shadowing in wireless communication?	8	CO1	L3
13.	How does Doppler shift affect wireless communication?	6	CO1	L3
14.	What is the multipath effect in wireless communication?	8	CO1	L3
15.	Why is diversity significant in wireless communication systems?	6	CO1	L3
16.	Explain 2 ray propagation model in wireless communication systems?	6	CO1	L3

Module 2				
Sl. No.	Question	Marks	CO	BL
1.	Write the physical layer specifications of IEEE 802.16 WMAN technology.	3	CO2	L2
2.	What are the main challenges in utilizing a 60 GHz channel for millimeter wave communication?	3	CO2	L2

3.	Write any three indoor and outdoor applications of millimeter wave communication.	3	CO2	L2
4.	Compare the three different IEEE 802.15 WPAN standards	3	CO2	L1
5.	Briefly explain the different elements to be considered while considering an existing backhaul network to support a millimeter wave network.	3	CO2	L1
6.	Discuss the advantages and disadvantages of WLAN technology	3	CO2	L2
7.	What are the current wireless technologies in use today, and what is their background and current scenario?	3	CO2	L2
8.	What are the future requirements for wireless networks?	3	CO2	L2
9.	Explain the IEEE 802.11 (Wi-Fi) standards and their applications? Specifically, discuss IEEE 802.11a, 802.11b, 802.11g, 802.11n, 802.11ac, and 802.11ax.	3	CO2	L2
10.	Explain the architecture of 802.11 WLAN Technology? (Both infrastructure based and infrastructure less ad-hoc architecture with figures)	3	CO2	L2
11.	What is HiperLAN technology and how does it differ from IEEE 802.11 (Wi-Fi)?	5	CO2	L2
12.	Explain the architecture of HIPER LAN Technology?	5	CO2	L2
13.	Describe WPAN (IEEE 802.15.1, IEEE 802.15.3, and IEEE 802.15.4) standards ?	5	CO2	L2

14	Explain the architecture of IEEE 802.15.1 Bluetooth network ?	5	CO2	L2
15	Explain the architecture of WMAN (IEEE 802.16a - WiMAX) standards?	10	CO2	L2
16	What are space-time wireless standards and how do they enhance wireless communication?	5	CO2	L2
17	Explain the IEEE 802.16 (WiMAX) standard and its applications.	5	CO2	L2
18	What is the 3GPP-LTE standard and how does it contribute to wireless communication?	6	CO2	L2
19	Discuss the characteristics of millimeter waves and their relevance in wireless communication.	5	CO2	L2
20	How does channel performance differ at 60 GHz for wireless communication?	5	CO2	L3
21	What are the use cases and technologies expected in 6G networks?	6	CO2	L2

Module 3

Sl. No.	Question	Marks	CO	BL
1.	Describe the various IoT networking components?	3	CO3	L1

2.	What is LoRaWAN? How is it different from LoRa?	3	CO3	L2
3.	Explain the principle of operation of MQTT data protocol employed in IoT networks.	3	CO3	L2
4.	Briefly describe the architecture of healthcare IoT system.	3	CO3	L1
5.	Briefly explain Zigbee protocol stack used in IoT Systems.	3	CO3	L2
6.	Discuss the salient features of the CoAP protocol	3	CO3	L2
7.	What is IoT (Internet of Things) and what are its characteristics?	3	CO3	L1
8.	Explain evolution of IoT?	3	CO3	L2
9.	Explain the physical and logical design aspects of IoT.	3	CO3	L1
10.	Explain communication models in IoT with figures?	3	CO3	L2
11.	Explain different IoT layers and protocols and services provided by each layer?	3	CO3	L2
12.	Explain communication APIs in IoT with fig?	7	CO3	L2
13.	Explain the block diagram of an IoT device?	7	CO3	L2
14.	Explain different IoT enabling technologies?	7	CO3	L3
15.	How do wireless sensor networks contribute to IoT?	7	CO3	L3
16.	What is cloud computing, mention its advantages and disadvantages?	7	CO3	L2
17.	Explain 4 cloud deployment models in IoT?	5	CO3	L2
18.	Explain cloud service models?	7	CO3	L2
19.	Explain the architecture/ protocol stack in zigbee with explanation of each layer	9	CO3	L3
20.	Explain the network topologies in zigbee protocol	9	CO3	L2
21.	Explain the advantages, disadvantages, applications of zigbee	9	CO3	L2
22.	Explain the architecture of wireless HART with figure	5	CO3	L2
23.	Explain the protocol stack of wireless HART	7	CO3	L2
24.	Explain the architecture of LoRa	9	CO3	L3
25.	Explain the characteristics and architecture of WIFI	9	CO3	L2
26.	Explain the architecture and protocol stack in Bluetooth	9	CO3	L2

27.	Explain working principle of RFID and its types with neat figure	5	CO3	L2
28.	Explain working principle of NFC with figure	7	CO3	L2
29.	Discuss the infrastructure protocols used in IoT communication such as IPv6 and 6LoWPAN.	9	CO3	L3
30.	Explain the data protocols commonly used in IoT, such as MQTT, MQTT-SN, and CoAP?	9	CO3	L2
31.	Explain the working principle of MQTT with fig	9	CO3	L2
32.	Compare MQTT and MQTT-SN	5	CO3	L2
33.	Explain the working principle of CoAP with neat figure	7	CO3	L2
34.	Explain the architecture of agricultural IoT	9	CO3	L3
35.	Explain the architecture of Vehicular IoT	9	CO3	L2
36.	Explain the architecture of Health care IoT	7	CO3	L2
Module 4				
Sl. No.	Question	Marks	CO	BL
1	What are the advantages of VLC standard over other communication standards in vehicular communication?	3	CO3	L1
2	Mention the main limitations of IEEE 802.11p standard compared to cellular communication in connected autonomous vehicles	3	CO3	L2
3	Explain the key components of connected autonomous vehicles in 6G communications with the help of a diagram.	3	CO3	L1
4	Describe how collision avoidance can be achieved through vehicular communication	3	CO3	L2
6	With the help of a diagram, explain the architecture of ITS system utilizing VLC standard for V2X communication	3	CO4	L1
7	Briefly explain IEEE 1609 standard used in vehicular communication.	3	CO4	L2
8	Explain the applications of IEEE 802.11P	3	CO4	L3
9	Explain the DSRC protocol with its limitations and advantages	3	CO4	L1
10	Explain the architecture of VLC Standard	3	CO4	L1
11	Explain 4G/5G D2D infrastructure in V2V and V2V communication	7	CO3	L2
12	Explain the architecture of CAV in 6G era	7	CO3	L2

Module 5				
Sl. No.	Question	Marks	CO	BL
1.	List the main SDR transmitter specifications?	3	CO 4	L1
2.	Describe spectrum subleasing and sharing in cognitive radio.	3	CO 5	L1
3.	Briefly explain the low IF receiver architecture for SDR.	3	CO 5	L2
4.	Describe software defined radio with the help of functional block diagram.	3	CO 5	L1
5.	Discuss about the implementation of cognitive network.	3	CO 5	L1
6.	What are the fundamental concepts and principles of software radio, and how does it differ from traditional hardware-based radio systems?	3	CO 5	L2
7.	What are the commonly used operating frequency bands in software- defined radios (SDRs), and how are they selected based on specific applications or regulations?	3	CO 5	L1
8.	What are the key transmitter specifications to consider in the design of a software-defined radio (SDR), such as output power, modulation schemes, and bandwidth capabilities?	3	CO 5	L2
9.	What are the important receiver specifications for an SDR, including sensitivity, selectivity, dynamic range, and demodulation capabilities?	3	CO 4	L1
10.	Can you provide an overview of the architecture of a software- defined radio (SDR), including the various components and their functions in enabling software-based signal processing?	9	CO3	L3
11.	What is cognitive radio, and how does it differ from conventional radio systems?	9	CO3	L2
12.	What is the significance of cognitive radio in terms of improving spectrum utilization, mitigating interference, and enabling dynamic spectrum access?	9	CO3	L2
13.	Could you explain the concept of spectrum subleasing and how it relates to cognitive radio in terms of spectrum sharing and management?	5	CO3	L2
14.	List the main SDR transmitter specifications?	7	CO3	L2

Prepared By: Dr. Saju A

Checked by: Milna M J

1. Prescribed Syllabus

Module	Topic	Hours
1	Operating system: Types, Objectives and functions, Kernel, Process - States, Process Control Block, Operations on processes.	6
2	Process Scheduling: FCFS, SJF, Priority, Round-Robin, Multilevel Queue and Multilevel Feedback Queue Scheduling. Thread: Structure. User and kernel level threads, multi-threading models, multiprocessor scheduling.	7
3	Real Time Operating Systems: Structure and characteristics of Real Time Systems, Task: Task states, Task synchronization -Semaphores- types, Inter task communication mechanisms: message queues, pipes, event registers, signals, Exceptions and interrupt handling.	8
4	Task constraints, Task scheduling: Aperiodic task scheduling: EDD, EDF, LDF, EDF with precedence constraints. Periodic task scheduling: Rate monotonic and Deadline monotonic, Real time Kernel- Structure, State transition diagram, Kernel primitives.	8
5	Features of FreeRTOS and Linux Commercial real time operating systems: PSOS, VRTX, RT Linux- Features and application only. Case study of (Kernel design, threads and task scheduling) RTOS: Micro/OS-II. RTOS control system used in real life applications - in adaptive cruise control.	6

2. Objectives

- Identify the basics of general operating systems.
- Understand the structure and the scheduling operations performed by the operating systems.
- Introduce Real Time Operating Systems, its basic structure, building blocks and various operations.
- Summarize the different scheduling algorithms used in RTOS.
- Identify the different applications of real time operating systems

3. Text Books (T)

T1.Abraham Silberschatz- ‘Operating System Principles’: Wiley India,7th Edition, 2011

T2.William Stallings –‘Operating Systems- Internals And Design Principles’, Prentice Hall, 7th Edition, 2011

T3.Qing Li – ‘Real-Time Concepts For Embedded Systems ‘, Cmp Books, 2013

T4.Giorgio C. Buttazzo, -‘Hard Real-Time Computing Systems Predictable Scheduling Algorithms And Applications’, Kluwer Academic Publishers.

4. Reference Books (R)

R1. Tanenbaum -‘Modern Operating Systems’ ,Pearson Edition, 3/e, 2007.

R2. Jean J Labrosse , ‘Micro C/OS-II, The Real Time Kernel’ , CMP Books, 2011

R3. Rajib Mall, ‘Real-Time Systems: Theory and Practice ‘ , 2008.

R4. David E. Simon 'An Embedded Software Primer', Pearson 2012

R5. Raj Kamal, 'Embedded Systems – Architecture, Programming and Design', Tata McGraw Hill

5. Course Pre / Co-requisite

ECT 206 Computer Architecture and Microcontrollers.

6. Course Outcomes

The student will be able to

CO1: Summarize the Functions and Structure for general purpose operating systems.

CO2: Use different scheduling algorithm on process and threads.

CO3: Interpret a real time operating system along with its synchronization, communication and interrupt handling tools.

CO4: Illustrate task constraints and analyse different scheduling algorithms on tasks.

CO5: Illustrate the applications of real time operating systems.

7. Mapping of Course Outcomes with Program Outcomes

PO/ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	H	H	H	M	H				M			H	H		
CO 2	M	H										M	H		H
CO 3	M	H					M					M	H		
CO 4	M	M					M					M	H		H
CO 5	M	H	M				H				M	M	H		

8. Justification for CO-PO-PSO Correlation

CO	PO/PSO	Justification Statement
CO1	PO1	Knowledge in the functions of General-purpose operating system helps to apply their knowledge to solve complex engineering problems.
	PO2	Applying different functions of operating systems to find solutions to complex engineering problems.
	PO3	Understanding the basic concept of operating systems in design and development of various engineering problems.
	PO4	Applying knowledge in the functionality of operating system in the field of research to find out valid conclusions.
	PO5	Applying modern tools in operating system platform in modelling and designing of engineering solutions.
	PO9	Knowledge in fundamental of operating systems will be able to function effectively as a team to find solutions to existing problems.
	PO12	Knowledge in the basic functionality of operating systems helps student in lifelong learning process in engineering.

	PSO1	Knowledge in Design process students will be able to design and develop electronic products.
CO2	PO1	Applying fundamental concepts of digital electronics, computer organization and microcontrollers for understanding interfacing of Embedded Processors with peripherals.
	PO2	Students will be able to analyse the characteristics and quality attributes of complex systems and processors for interfacing of Embedded Processors with peripherals.
	PO3	Knowledge in communication standards and protocols for interfacing of Embedded Processors with peripherals.
	PO5	Students will be able to use the modern communication standards and protocols for interfacing peripherals with embedded systems.
	PO8	Knowledge in ethics involved in a design process using peripherals.
	PO12	Students will be able to develop skills to analyse various literatures that will inculcate independent and lifelong learning.
	PSO1	Applying contextual knowledge of Electronics and Communication Engineering for design of embedded systems with peripherals.
	PSO3	Students will be able to Analyse Embedded system design by using modern engineering tool.
CO3	PO1	Applying fundamental concepts of Engineering to understand the ARM processor architecture and pipeline processor organization.
	PO2	Students will be able to analyse the characteristics and quality attributes of complex systems and processors for understanding the ARM processor architecture and pipeline processor organization.
	PO3	Students will be able to understand ARM Processor Fundamentals for designing solutions for complex engineering problems.
	PO5	Students will be able to use the modern ARM architecture for the solution of engineering problems.
	PO8	Knowledge in an embedded system design process using RTOS.
	PO9	Students will be able to undertake projects as part of assignments which facilitate teamwork.
	PO12	knowledge in advanced processors like ARM for embedded system development.
	PSO1	Students will be able to absorb and apply contextual knowledge of Electronics and Communication Engineering in design of solutions using ARM processor.
	PSO3	Students will be able to use modern tools solving real life problems.
CO4	PO1	Students will be able to apply fundamental concepts of digital electronics for understanding interfacing of Embedded Processors with peripherals.
	PO2	Students will be able to review literature using principles of engineering sciences for interfacing of Embedded Processors with peripherals.
	PO3	Knowledge in the interfacing of Embedded Processors with peripherals for designing solutions for complex engineering problems.
	PO5	Students will be able to use the modern development cycle for design of embedded systems.
	PO12	Students will be able to recognize the need for and have the preparation and ability to engage in independent and life-long learning broadest context of technological change.
	PSO1	Knowledge on Embedded system design will help them to attain knowledge in different Electronic Design.

	PSO3	Students will be able to use modern tools in programming to develop software for Embedded Systems.
CO5	PO1	Students will be able to apply fundamental concepts of Engineering to understand the Real Time Operating Systems.
	PO2	Students will be able to analyse the characteristics and quality attributes of complex systems and processors for understanding the Real Time Operating Systems.
	PO3	Students will be able to introduced to the Real Time Operating Systems for designing solutions for complex engineering problems.
	PO5	Students will be able to use the modern Real Time Operating Systems for the solution of engineering problems.
	PO8	Students will be able to introduced to responsibility and ethics involved in an Real Time Operating Systems.
	PO12	knowledge in Real Time Operating Systems for design of futuristic embedded system development.
	PSO1	Students will be able to absorb and apply contextual knowledge of Electronics and Communication Engineering in design of solutions using Real Time Operating Systems.

9. Curricular gaps (if any)

Nil

10. Course Enrichment Activities*

Sl No	Description	Proposed Activities **	Relevance to POs and PSOs
1.	Processors in computing devices and Mobile phones are improving very fast which needs to be introduced	Seminar on Latest Trends in Embedded Systems	PO1, PO8, PO10, PO12

11. Internal Assessment mark allocation (as per university curriculum)

(Provide details as mentioned in syllabus)

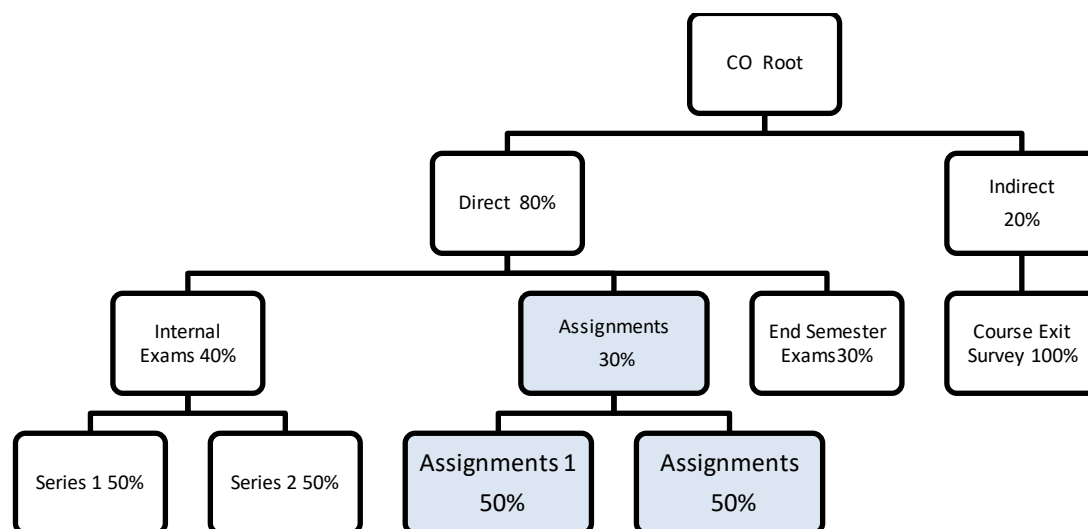
Attendance	- 10 marks
Continuous Assessment Test	- 25 marks
<u>Assignment (s)/ Course Project</u>	- 15 marks
<u>Total</u>	- 50 marks

12. Assessment – CO Mapping (Put's' if mapping is present)

	Tools		Weightage	CO1	CO2	CO3	CO4	CO5
Direct Assessment Tools	Internal Exam(s) 40%	Series 1	20%	x	x			
		Series 2	20%			x	x	
	Assignment (s)/ 30%	Assignment 1	15%	x	x			
		Assignment 2	15%			x	x	x
	End Semester Exam		30%	x	x	x	x	x

Indirect Assessment Tool	Course Exit Survey	100%	x	x	x	x	x

13. Assessment Configuration



14. Course Plan

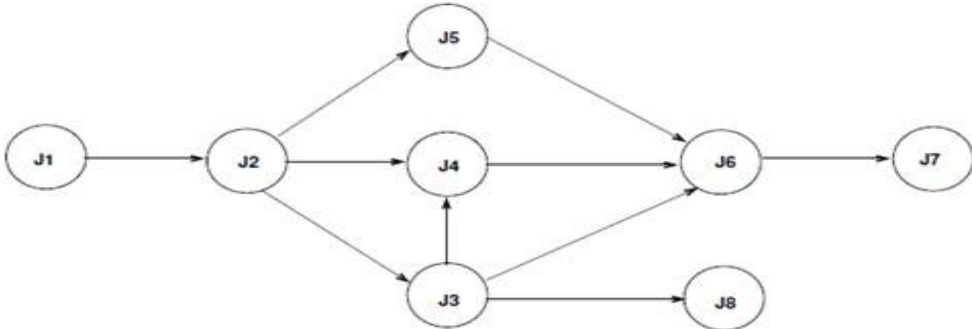
Hour	Topic	Module	Reference(s)	Teaching Pedagogy
1	Types of Operating system	I	T1, R1	Lecture
2	Operating system Objectives and functions	I	T1, R1	Lecture
3	Kernel in Operating System	I	T1, R1	Lecture
4	Process - States	I	T1, R1	Tutorial
5	Process - States	I	T1, R1	Lecture
6	Process Control Block	I	T1, R1	Lecture
7	Operations on processes	I	T1, R1	Lecture
8	Process Scheduling: FCFS	II	T2, R1	Tutorial
9	Process Scheduling: SJF	II	T2, R1	Lecture
10	Process Scheduling: Priority,	II	T2, R1	Lecture
11	Process Scheduling: Round-Robin	II	T2, R1	Lecture
12	Multilevel Queue and Multilevel Feedback Queue Scheduling.	II	T2, R1	Tutorial
13	Thread: Structure	II	T2, R1	Lecture
14	User and kernel level threads, multi-threading models	II	T2, R1	Lecture

15	Multiprocessor scheduling.	II	T2, R1	Lecture
16	Structure and characteristics of Real Time Systems	III	T2, R1	Tutorial
17	Structure and characteristics of Real Time Systems	III	T2, R1	Lecture
18	Task: Task states, Task synchronization	III	T2, R1	Lecture
19	Semaphores- types	III	T2, R1	Lecture
20	Inter task communication mechanisms	III	T2, R1	Tutorial
21	Inter task communication mechanisms	III	T2, R1	Lecture
22	Message queues, pipes	III	T2, R1	Lecture
23	Event registers, signals	III	T2, R1	Lecture
24	Event registers, signals	III	T2, R1	Tutorial
25	Exceptions and interrupt handling.	III	T2, R1	Lecture
26	Task constraints, Task scheduling	IV	T2, R3	Lecture
27	Aperiodic task scheduling: EDD	IV	T2, R3	Lecture
28	Aperiodic task scheduling: EDF	IV	T2, R3	Tutorial
29	Aperiodic task scheduling: EDF	IV	T2, R3	Lecture
30	Aperiodic task scheduling: LDF	IV	T2, R3	Lecture
31	Periodic task scheduling: Rate monotonic	IV	T2, R3	Lecture
32	Periodic task scheduling: Deadline monotonic	IV	T2, R3	Tutorial
33	Periodic task scheduling: Deadline monotonic	IV	T2, R3	Lecture
34	Real time Kernel- Structure, State transition diagram	IV	T2, R3	Lecture
35	Kernel primitives	IV	T2, R3	Lecture
36	Features of Free RTOS and Linux	V	T3, R3	Tutorial
37	Commercial real time operating systems: PSOS	V	T2, R3	Lecture
38	RT Linux- Features and application	V	T2, R3	Lecture
39	Commercial real time operating systems: VRTX	V	T2, R3	Lecture
40	Case study of (Kernel design, threads and task scheduling)	V	T2, R3	Tutorial
41	RTOS: Micro/OS-II.	V	T2, R3	Lecture
42	Case study of (Kernel design, threads and task scheduling) RTOS: Micro/OS-II.	V	T2, R3	Lecture
43	RTOS control system used in real life applications - in adaptive cruise control.	V	T2, R3	Lecture
44	RTOS control system used in real life applications - in adaptive cruise control.	V	T2, R3	Tutorial

15. Question Bank

	Module 1																		
Sl. No.	Questions	Marks	CO	BL															
1	Explain any three objectives of an operating system	3	CO1	L2															
2	Draw the process state transition diagram and explain	3	CO1	L3															
3	Mention the importance of kernel in an operating system. Explain the mainservices offered by kernel.	5	CO1	L3															
4	Explain any three types operating systems in detail.	9	CO1	L2															
5	Draw and explain the structure of a process control block in an operating system.	7	CO1	L3															
6	Explain the functions of operating system as viewed from the used side.	7	CO1	L2															
7	Define process. Illustrate the structure of a process in memory.	3	CO1	L2															
8	List any three types of operating systems with an example.	3	CO1	L1															
9	Explain any four functions provided by operating system services for the user.	8	CO1	L2															
10	List the information stored in a process control block.	6	CO1	L1															
11	Draw and explain five- state process state transition diagram.	8	CO1	L3															
12	What is meant by kernel in an operating system? Explain the services offered by kernel in an operating system.	6	CO1	L2															
	Module 1I																		
1	Describe the features of multilevel feedback queue scheduling algorithm	3	CO2	L2															
2	List the problems associated with multi-process scheduling. How they can besolved?	3	CO2	L1															
3	Differentiate process and thread in a system. Explain about multithreadingmodels.	7	CO2	L1															
4	Explain the Shortest Remaining Time Next scheduling algorithm with anexample	7	CO2	L2															
5	Illustrate the different levels of scheduling in a system with a neat diagram.	6	CO2	L2															
6	Schedule the following processes with SJF and Round Robin algorithms and compare their performances. Assume that all processes are arriving at time zero.Take a suitable time quantum for scheduling. <table><tr><td>Process</td><td>st Time(ms)</td><td>Priority</td></tr><tr><td>P1</td><td>10</td><td>2</td></tr><tr><td>P2</td><td>13</td><td>3</td></tr><tr><td>P3</td><td>20</td><td>1</td></tr><tr><td>P4</td><td>7</td><td>4</td></tr></table>	Process	st Time(ms)	Priority	P1	10	2	P2	13	3	P3	20	1	P4	7	4	8	CO2	L3
Process	st Time(ms)	Priority																	
P1	10	2																	
P2	13	3																	
P3	20	1																	
P4	7	4																	
7	Define any three criteria for comparing scheduling algorithm.	3	CO2	L1															

8	What is meant by starvation in process scheduling?	3	CO2	L2
9	Three processes with process IDs P1, P2, P3 with estimated execution time 4, 6, 5 milliseconds and priorities 1, 0, 3 (0-highest priority, 3-lowest priority) respectively enters the ready queue together. Process P4 with estimated execution time 6 milliseconds and priority 2 enters the “Ready” queue after 5 Millisecond. Calculate waiting Time and Turn Around Time for each Process and the average Waiting time and average Turnaround time (Assuming there is no I/O waiting for the processes.) in non-preemptive priority-based scheduling algorithm	8	CO2	L3
10	Explain Multilevel queue scheduling algorithm with an example.	6	CO2	L2
11	Explain the concept of ‘Multithreading’. What are the advantages of multithreading.	8	CO2	L2
12	Explain Multilevel feedback queue scheduling with an example.	6	CO2	L2
Module III				
1	Define exception. Explain the different classes of exceptions.	3	CO3	L1
2	Explain suspended, pended and delayed tasks.	3	CO3	L2
3	Explain the different types of semaphores used in a real time system.	8	CO3	L2
4	Draw the structure and explain the characteristics of a real time operating systems. Illustrate the same with an example.	6	CO3	L2
5	Describe any two inter task communication mechanisms used in RTOS with relevant diagrams.	8	CO3	L2
6	Explain how exceptions and interrupts helps in designing an embedded system.	6	CO3	L2
7	Define real-time system. List three characteristics of an RTOS.	3	CO3	L1
8	Differentiate between signal and a normal interrupt.	3	CO3	L2
9	Differentiate between the three types of semaphores with the help of state diagrams.	9	CO3	L2
10	Define exceptions and interrupts. List the three areas of application of exceptions and interrupts.	5	CO3	L1
11	Define message queue. Illustrate its associated parameters and supporting data structures.	9	CO3	L1
12	What is priority inversion?	5	CO3	L2
Module IV				
1	State Jackson’s algorithm for real time scheduling. Illustrate it with an example.	3	CO4	L1
2	Explain the classification of real time tasks based on deadline.	3	CO4	L2
3	Explain the timing constraints of a Real Time Operating System	7	CO4	L2
4	List the performance measure of a real time scheduling algorithm.	9	CO4	L1

5	Given a set of 6 aperiodic tasks with the following precedence relations: $A \rightarrow B, A \rightarrow C, B \rightarrow D, B \rightarrow E, C \rightarrow F$ The execution time C, arrival times r and absolute deadlines d are as follows. <table><tr><td></td><td>A</td><td>B</td><td>C</td><td>D</td><td>E</td><td>F</td></tr><tr><td>C</td><td>2</td><td>2</td><td>2</td><td>2</td><td>2</td><td>1</td></tr><tr><td>d</td><td>4</td><td>10</td><td>8</td><td>6</td><td>10</td><td>12</td></tr><tr><td>r</td><td>0</td><td>1</td><td>1</td><td>3</td><td>7</td><td>9</td></tr></table> Draw the schedule for the case when the EDF policy releases a task after all its predecessors have finished execution.		A	B	C	D	E	F	C	2	2	2	2	2	1	d	4	10	8	6	10	12	r	0	1	1	3	7	9	5	CO4	L3
	A	B	C	D	E	F																										
C	2	2	2	2	2	1																										
d	4	10	8	6	10	12																										
r	0	1	1	3	7	9																										
6	Explain the precedence constraints in a real time task with an example.	3	CO4	L2																												
7	Draw the minimum state transition diagram of a real-time kernel.	3	CO4	L2																												
8	Construct the schedule graphically based on LDF. <table><tr><td></td><td>J1</td><td>J2</td><td>J3</td><td>J4</td><td>J5</td><td>J6</td><td>J7</td><td>J8</td></tr><tr><td>C_i</td><td>3</td><td>4</td><td>2</td><td>3</td><td>3</td><td>2</td><td>2</td><td>1</td></tr><tr><td>D_i</td><td>5</td><td>8</td><td>11</td><td>12</td><td>15</td><td>20</td><td>19</td><td>18</td></tr></table> 		J1	J2	J3	J4	J5	J6	J7	J8	C _i	3	4	2	3	3	2	2	1	D _i	5	8	11	12	15	20	19	18	10	CO4	L3	
	J1	J2	J3	J4	J5	J6	J7	J8																								
C _i	3	4	2	3	3	2	2	1																								
D _i	5	8	11	12	15	20	19	18																								
9	Verify the stimulability and construct the schedule according to the Rate Monotonic algorithm for the following set of periodic tasks: <table><tr><td></td><td>C_i</td><td>T_i</td></tr><tr><td>T1</td><td>0.5</td><td>3</td></tr><tr><td>T2</td><td>1</td><td>4</td></tr><tr><td>T3</td><td>2</td><td>6</td></tr></table>		C _i	T _i	T1	0.5	3	T2	1	4	T3	2	6	10	CO4	L3																
	C _i	T _i																														
T1	0.5	3																														
T2	1	4																														
T3	2	6																														
10	Drawthe detailed process state transition diagram and explain each state.	9	CO4	L2																												
11	Differentiate between rate monotonic and deadline monotonic algorithm	4	CO4	L2																												
12	Explain EDD algorithm with an example.	4	CO4	L2																												
	Module V																															
1	Compare the features of PSOS and VTRX	3	CO5	L2																												
2	List the heap implementation schemes used in Free RTOS. Mention the functionsof each.	3	CO5	L1																												

3	Explain any four features of Free RTOS.	8	CO5	L2
4	Describe the inter-process communication techniques used in Micro C/OS-II.	6	CO5	L2
5	Explain the features of RTLinux RTOS	4	CO5	L2
6	With a suitable requirement table and block diagram explain the real time operating system used in an adaptive cruise control system.	10	CO5	L2
7	List any three features of Free RTOS.	3	CO5	L1
8	List any three applications of RT Linux.	3	CO5	L1
9	Write the prototype of MUCOS service function to create a task. List the parameters passed? List the parameters returned.	8	CO5	L1
10	List six features of Linux in its Scheduling system.	6	CO5	L1
11	Explain the functions of an Adaptive Cruise Control System in a car with the help of a block diagram.	8	CO5	L2
12	List three features and three applications of pSOS.	6	CO5	L1

Prepared By : Mr. Gregorious Jose C

Checked By : Dr. Saju A

1. Prescribed Syllabus

Module	Topic	Hours
1	Physics of Power dissipation in MOSFET devices Need for low power circuit design, MIS Structure, Short channel effects-surface scattering, punch through, velocity saturation, impact ionization Hot electron effects, Drain Induced Barrier Lowering, Deep submicron transistor design issues.	6
2	Sources of power dissipation in CMOS -Dynamic Power Dissipation: Charging and Discharging capacitance power dissipation , Short Circuit Power: Short Circuit Current of Inverter , Short circuit current dependency with input and output load , Glitching Power, Static Power Dissipation, Leakage Power Dissipation, Gate level power analysis : Capacitive, internal and Static power dissipation of gate level circuit.	8
3	Power Reduction Techniques :Supply voltage Scaling Approaches: Multi VDD and Dynamic VDD, leakage power reduction Techniques – Transistor stacking, VTCMOS,MTCMOS, DTCMOS, Power gating, Clock gating for Dynamic power dissipation, Transistor and Gate Sizing for Dynamic and Leakage Power Reduction	7
4	Circuit design style - clocked design style- Basic concept, Domino logic (domino NAND gate), Differential Current Switch Logic. Non clocked circuit design style-fully complementary logic. NMOS and pseudo –NMOS logic, differential cascade voltage switch logic(DCVS)	7
5	Adiabatic switching – Adiabatic charging, adiabatic amplification, One stage and two stage adiabatic buffer, Adiabatic logic gates, pulsed power supplies, Reversible logic basic concepts.	6

16. Text Books (T)

T1. Gray Yeap, Practical low power digital VLSI design, Springer, 1998

T2. Kaushik Roy, Sharat C Prasad, Low power CMOS VLSI circuit design, Wiley India, 2000

17. Reference Books (R)

R1. Abdellatif Bellaouar, Mohamed I Elmasry, Low power digital VLSI design, Kluwer Academic, 1995

R2. Anatha P Chandrakasan, Robert W Brodersen, Low power digital CMOS Design, Kluwer Academic, 1995

R3. Christian Piguet, Low power CMOS circuits, Taylor & Francis, 2006

R4. Kiat Seng Yeo, Kaushik Roy, Low voltage, low power VLSI sub systems, Tata McGraw Hill, 2004

18. Course Objectives

This course aims to impart the basic knowledge in designing of Low power VLSI Circuits .

19. Course Pre / Co-requisite

✓ ECT 203 Logic Circuit Design

✓ ECT 201 Solid State Devices

20. Course Outcomes

After the completion of course student will be able to

CO1. Identify various short channel effects and various sources of power dissipation in MOSFET.

CO2. Apply various power reduction techniques to circuits.

CO3. Apply various clocked and non clocked design styles for logic implementation.

CO4. Apply Adiabatic and reversible logic for circuit implementation.

21. Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes

PO/ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H	H	L							M			H		
CO2	H	H	M	M	H				H	H		M	H	M	H
CO3	H	H	H		H			M	H	H		M	H		H
CO4	H	H	M	L						M			H	L	

22. Justification for CO-PO-PSO Correlation

CO	PO/PS O	H/M/ L	Justification Statement
CO1	PO1	H	The students will be able to apply the basic knowledge of mathematics and engineering fundamentals to understand concepts of single stage amplifiers
	PO2	H	The students will be able to analyse various Single stage Amplifiers with different types of loads by using first principles of mathematics.
	PO3	L	The students will be able to design various single stage amplifier with different types of loads
	PSO1	H	The students will be able to absorb and apply the concept of single stage amplifier using MOSFET for the design and development of digital electronic systems.
CO2	PO1	H	The students will be able to apply the basic knowledge of mathematics and engineering fundamentals to understand concepts of Differential Pair and Single stage amplifier
	PO2	H	The students will be able to analyze different types of Differential Amplifiers and find out the input and output impedances of amplifier
	PO3	M	The students will be able to design different types of Differential Amplifiers and find out the gain of the amplifier
	PO4	M	The students will be able to use the experimental methods used to reduce the low power design in microelectronics
	PO5	H	The students will be able to design and implement the various types of differential pair circuit using LT SPICE
	PO9	M	The students will be able to contribute in their individual capacity as well as work as an effective team for the fulfilment of their course project.

	PO10	H	The students will be able to demonstrate the ability to use appropriate circuit design for effectively communicating the design and solution to the problem statement formulated
	PO12	H	The students will be able to recognize the need for innovative thinking in CMOS design to engage in independent and lifelong learning
	PSO1	H	The students will be able to absorb and apply the concept of Combinational logic function for the analysis and design of differential and single stage amplifier
	PSO2	M	The students will be able to use the complex methods used to reduce the low power design in microelectronics
	PSO3	H	The students will be able to design and implement the various types of differential pair circuit using LT SPICE
CO3	PO1	H	The students will be able to apply the basic knowledge of mathematics and engineering fundamentals to understand different types current mirror circuits
	PO2	H	The students will be able to analyze different types of current mirrors with respect to gain by using first principles of mathematics.
	PO3	H	The students will be able to design different types of Current Mirror Circuit and find out the gain of the amplifier
	PO5	H	The students will be able to design and implement the various types of current mirror circuit using LT SPICE
	PO9	H	The students will be able to contribute in their individual capacity as well as work as an effective team for the fulfilment of their course project.
	PO10	H	The students will be able to demonstrate the ability to use appropriate circuit design for effectively communicating the design and solution to the problem statement formulated
	PO12	M	The students will be able to recognize the need for innovative thinking in CMOS design to engage in independent and lifelong learning
	PSO1	H	The students will be able to absorb and apply the concept of current mirror circuit for the design and development of digital electronic systems
	PSO3	H	The students will be able to design and implement the various types of current mirror circuit using the modern tool like LT SPICE
CO4	PO1	H	The students will be able to apply the basic knowledge of mathematics and engineering fundamentals to understand concepts of frequency responses of adiabatic circuits
	PO2	H	The students will be able to analyze frequency response of adiabatic amplifiers
	PO3	M	The students will be able to design frequency response of adiabatic amplifiers
	PO4	L	The students will be able to use the experimental methods used to reduce the adiabatic circuits in microelectronics
	PSO1	H	The students will be able to absorb and apply the concept of sequential logic function for the design and development of digital electronic systems
	PSO2	L	The students will be able to use the complex methods used to reduce the adiabatic circuits in microelectronics

23. Curricular gaps (if any)

Nil

24. Course Enrichment Activities

Sl No	Description	Proposed Activities	Relevance to POs and PSOs
1	Expert talk	Low power techniques	PO1, PO2, PO12, PSO1

25. Internal Assessment mark allocation (as per university curriculum)

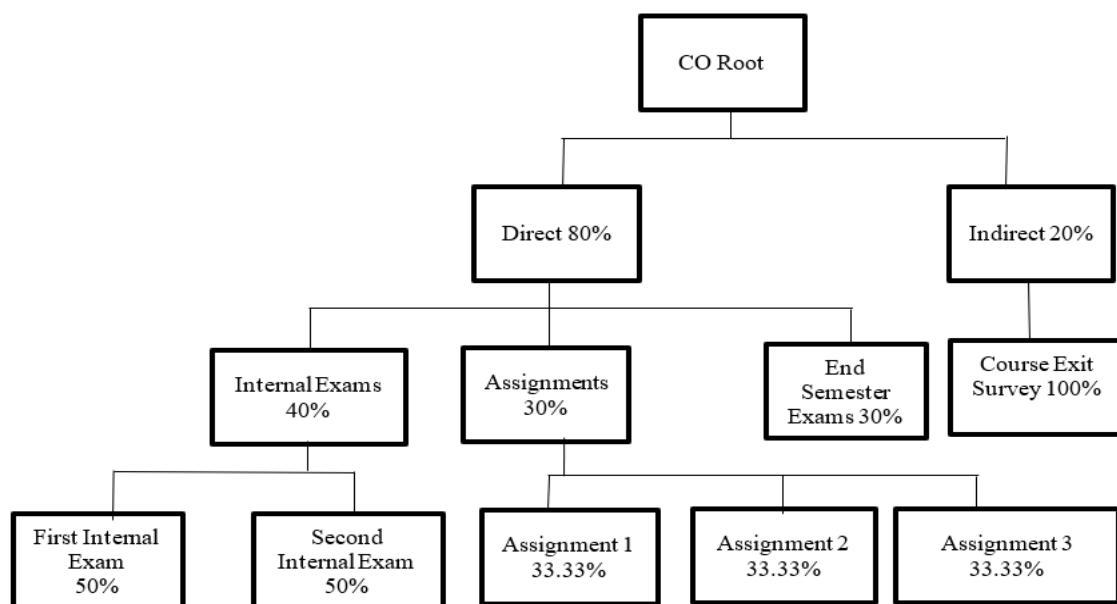
(Provide details as mentioned in syllabus)

Attendance	- 10 marks
Continuous Assessment Test	- 25 marks
Assignment	- 10 marks
Course Project	- 5 marks
Total	- 50 marks

26. Assessment – CO Mapping (Put ‘ x’ if mapping is present)

	Tools	Weightage [#]	CO1	CO2	CO3	CO4
Direct Assessment Tools	Internal Exam(s) 40%	Series 1	20%	x		x
		Series 2	20%		x	
		Assignment 1	10%	x	x	
		Assignment 2	10%	x		x
		Assignment 3	10%		x	x
	End Semester Exam		30%	x		x
Indirect Assessment Tool	Course Exit Survey		100%	x		x

13. Assessment Configuration



14. Course Plan

Hour	Topic Name	Module	Reference	Teaching Pedagogy
1	Need for low power circuit design	1	T1, R1	Lecture
2	MIS Structure	1	T1, R1	Lecture
3	Short channel effects-surface scattering, punch through, velocity saturation,	1	T1, R1	Lecture
4	impact ionization, Hot electron effects	1	T1, R1	Lecture
5	Drain Induced Barrier Lowering.	1	T1, R1	Lecture
6	Deep submicron transistor design issues.	1	T1, R1	Lecture
7	Dynamic Power Dissipation: Charging and Discharging capacitance power dissipation	2	T1, R1	Tutorial
8	Short Circuit Power: Short Circuit Current of Inverter	2	T1, R1	Lecture
9	Short circuit current dependency with input and output load	2	T1, R1	Lecture
10	Glitching Power,	2	T1, R1	Lecture
11	Static Power Dissipation	2	T1, R1	Lecture
12	Leakage Power Dissipation	2	T1, R1	Lecture
13	Leakage Power Dissipation	2	T1, R1	Lecture
14	Gate level power analysis: Capacitive, internal	2	T1, R1	Tutorial
15	Static power dissipation of gate level circuit.	2	T1, R1	Lecture
16	Series 1 Exam	1,2		Exam
17	Supply voltage Scaling Approaches: Multi VDD and Dynamic VDD	3	T1, R1	Tutorial
18	Leakage power reduction Techniques – Transistor stacking	3	T1, R1	Exam
19	VTCMOS,MTCMOS, DTCMOS	3	T1, R1	Lecture
20	Power gating	3	T1, R1	Lecture
21	Clock gating for Dynamic power dissipation	3	T1, R1	Lecture
22	Transistor and Gate Sizing for Dynamic and Leakage Power Reduction	3	T1, R1	Lecture

23	Transistor and Gate Sizing for Dynamic and Leakage Power Reduction	3	T1, R1	Lecture
24	Clocked design style- Basic concept	4	T1, R1	Tutorial
25	Domino logic	4	T1, R1	Lecture
26	Differential Current Switch Logic	4	T1, R1	Lecture
27	Non clocked circuit design style-fully complementary logic	4	T1, R1	Lecture
28	NMOS and pseudo –NMOS logic	4	T1, R1	Lecture
29	Differential Cascade Voltage Switch logic(DCVS)	4	T1, R1	Lecture
30	Adiabatic charging	5	T1, R1	Lecture
31	adiabatic amplification	5	T1, R1	Lecture
32	adiabatic amplification	5	T1, R1	Tutorial
33	One stage adiabatic buffer	5	T1, R1	Lecture
34	two stage adiabatic buffer	5	T1, R1	Lecture
35	Adiabatic logic gates, pulsed power supplies	5	T1, R1	Lecture
36	Reversible logic basic concepts	5	T1, R1	Lecture
37	Series 2 Exam	5	T2, R1	Exam

15. Question Bank

Module 1				
Sl. No.	Question	Marks	CO	BL
1.	Define DIBL	3	CO1	L1
2.	Discuss the need for low power VLSI Design	3	CO1	L1
3.	Define surface scattering	3	CO1	L1
4.	Define impact Ionization	3	CO1	L1
5.	Define short channel defects in CMOS	3	CO1	L1
6.	Draw MIS structure	3	CO1	L1
7.	Define punch through	3	CO1	L1
8.	Define hot electrons	3	CO1	L1

9.	Define Velocity Saturation	3	CO1	L1
10.	Define Deep submicron transistor	3	CO1	L1
11.	Explain the concept of Drain Induced Barrier Lowering.	7	CO1	L2
12.	Explain the various mechanisms for transistor leakage in deep submicron transistors.	7	CO1	L2
13.	Explain Velocity saturation with neat diagram	7	CO1	L2
14.	Explain Impact Ionization with neat diagram	7	CO1	L2
15.	Explain Hot electrons effect with neat diagram	7	CO1	L2
16.	Explain Surface scattering with neat diagram	7	CO1	L2
17.	Explain punch through with neat diagram	7	CO1	L2
18.	Explain modes of operations in MOS	7	CO1	L2
19.	Explain short channel effects in detail	7	CO1	L2
20.	Explain the energy band diagram of MIS structure.	8	CO1	L2
21.	Describe various transistor leakage mechanisms in deep Submicron transistors.	6	CO1	L2
22.	Explain various short channel effects.	8	CO1	L2
23.	Explain how the power efficiency of a chip can be measured?	6	CO1	L2
24.	How can short channel effects be minimized?	6	CO1	L2
Module 2				
Sl. No.	Question	Marks	CO	BL
1.	Explain the dependency of short circuit current with output load?	3	CO1	L1
2.	Explain dynamic power dissipation?	3	CO1	L2
3.	Explain Static power dissipation?	3	CO1	L1
4.	Define glitching power dissipation?	3	CO1	L1
5.	Define Short circuit power dissipation?	3	CO1	L1
6.	Define charging capacitor power dissipation?	3	CO1	L1
7.	Define discharging capacitor power dissipation?	3	CO1	L1

8.	Draw a CMOS inverter and explain its working	3	CO1	L2
9.	Explain internal power analysis	3	CO1	L2
10.	Explain Capacitive power analysis	3	CO1	L2
11.	Explain capacitive power analysis in detail	7	CO1	L2
12.	Explain gate level power analysis in detail	7	CO1	L2
13.	Explain switching power dissipation in detail	7	CO1	L2
14.	How the subthreshold leakage occurs in CMOS	7	CO1	L2
15.	How the gate leakage occurs in CMOS	7	CO1	L2
16.	How the junction leakage occurs in CMOS	7	CO1	L2
17.	Explain the glitching power dissipation in detail	7	CO1	L2
18.	Explain short circuit power dissipation in detail	7	CO1	L2
19.	Explain static power dissipation in detail	7	CO1	L2
20.	Explain Dynamic power dissipation in detail	7	CO1	L2
21.	Explain about the power dissipation in CMOS and its types	10	CO1	L2
22.	With the help of a neat diagram, explain impact ionization	7	CO1	L2
23.	Explain switching power dissipation in CMOS inverter.	7	CO1	L2
24.	Describe power dissipation due to glitches.	7	CO1	L2
25.	What is the effect of short circuit current in power dissipation?	5	CO1	L2
26.	Explain how capacitance can be estimated at gate level?	7	CO1	L2
27.	Explain the formation of glitches in circuits ? Explain various methods for eliminating the glitches	7	CO1	L2
28.	Explain the various sources of leakage power in MOSFET	7	CO1	L2
29.	A 16 bit bus operating in 5V and 66MHz clock rate is driving capacitance of 2pF/Bit. Each bit is estimated to have a toggling probability of 0.25 at each clock cycle. Calculate the power dissipated in operating the bus.	7	CO1	L2
Module 3				
1.	Describe leakage power reduction using MTCMOS	3	CO2	L1
2.	Define Slack time of logic gate	3	CO2	L1

3.	Brief on voltage scaling	3	CO2	L1
4.	Define transistor gating	3	CO2	L1
5.	Define Transistor sizing?	3	CO2	L1
6.	Define clock gating?	3	CO2	L1
7.	Brief on Transistor stacking	3	CO2	L1
8.	Define Multi VDD techniques	3	CO2	L1
9.	Define Dynamic VDD techniques	3	CO2	L1
10.	Explain MTCMOS	3	CO2	L2
11.	Explain multi VDD techniques in detail	7	CO2	L2
12.	Explain Dynamic VDD techniques in detail	7	CO2	L2
13.	Explain MTCMOS with neat diagram	7	CO2	L2
14.	Explain DTCMOS with neat diagram	7	CO2	L2
15.	Explain Transistor stacking in detail	7	CO2	L2
16.	Explain VTCMOS with neat diagram	7	CO2	L2
17.	Explain Gate sizing for Leakage power reduction in detail	7	CO2	L2
18.	Explain Power Gating for dynamic power dissipation in detail	7	CO2	L2
19.	Explain Clock Gating for dynamic power dissipation in detail	7	CO2	L2
20.	Explain transistor sizing for Dynamic power reduction in detail	7	CO2	L2
21.	Explain Gate sizing for Dynamic power reduction in detail	7	CO2	L2
22.	Explain transistor sizing for Leakage power reduction in detail	7	CO2	L2
23.	Illustrate with examples how low threshold device and high threshold device can be effectively used for power reduction.	7	CO2	L2
24.	Explain dynamic supply voltage scaling mechanism for power reduction.	7	CO2	L2
25.	Briefly explain dynamic and leakage power reduction using transistor sizing.	7	CO2	L2
26.	Illustrate various mechanisms by which power consumption of 6T RAM cells can be reduced.	7	CO2	L2
Module 4				
1	List the advantages and Disadvantages of Clocked design.	3	CO3	L1

2	Explain the methods to overcome charge sharing problem.	3	CO3	L1
3	Define Domino Logic	3	CO3	L1
4	Define pseudo NMOS Logic	3	CO3	L1
5	Compare clocked design and non-clocked design?	3	CO3	L1
6	Brief on DCVS	3	CO3	L1
7	Design NOT using CPL	3	CO3	L2
8	Design OR using CPL	3	CO3	L3
9	Design NOT using NMOS logic	3	CO3	L2
10	Design OR using NMOS Logic	3	CO3	L3
11	Explain Nonclocked design in detail	7	CO3	L2
12	Explain clocked design in detail	7	CO3	L2
13	Design AND using NMOS logic	7	CO3	L3
14	Design XOR using Pseudo NMOS logic	7	CO3	L3
15	Design AND using NMOS logic	7	CO3	L3
16	Design XOR using Pseudo NMOS logic	7	CO3	L3
17	Design AND using CPL	7	CO3	L3
18	Design XOR using CPL	7	CO3	L3
19	Design OR/NOR and AND/NAND gates using complementary pass transistor logic.	7	CO3	L3
20	Design a two input XOR gate using Pseudo-NMOS logic.	7	CO3	L3
21	List out the features of fully complementary logic	7	CO3	L2
22	Explain the working of DCVS Logic with an example.	7	CO3	L2
23	Implement the Logic Function $(A+B+C+D)'$ using clocked CMOS logic.	7	CO3	L3
24	Explain charge sharing in clocked CMOS logic	7	CO3	L2
25	What is Domino CMOS logic? Mention two advantages	7	CO3	L2
26	Explain the working of a precharged high DCSL	7	CO3	L2
27	Implement the function $F = [(a+b)(c+d)]'$ in NMOS logic and domino logic.	7	CO3	L3
28	Implement the function $F = (A+CD)$ in DCVS logic	7	CO3	L3
29	Explain how charge sharing problem occur in logic design. How it can be eliminated?	7	CO3	L2
30	Differentiate precharge high and precharge low DCSL.	7	CO3	L2
Module 5				
1.	Draw the schematic and logic symbol of an Adiabatic amplifier	3	CO4	L1
2.	List the disadvantages of Retractable cascade of Adiabatic logic Gates	3	CO4	L1
3.	Brief on adiabatic charging	3	CO4	L1
4.	Brief on adiabatic amplification	3	CO4	L1

5.	List out adiabatic logic gates	3	CO4	L1
6.	Explain adiabatic charging in detail	7	CO4	L2
7.	Explain adiabatic amplification in detail	7	CO4	L2
8.	With neat logic diagram explain the working of one stage adiabatic buffer	7	CO4	L2
9.	With neat logic diagram explain the working of two stage adiabatic buffer	7	CO4	L2
10.	Explain Adiabatic logic gates in detail	7	CO4	L2
11.	Explain pulsed power supplies in detail	7	CO4	L2
12.	Explain reversible logic in detail	7	CO4	L2
13.	Implement AND/NAND gate using adiabatic logic.	7	CO4	L2
14.	With the help of a neat diagram, explain one stage adiabatic buffer.	7	CO4	L2
15.	Describe the working of one stage adiabatic buffer.	7	CO4	L2
16.	Explain pulsed power supply? Describe its importance in adiabatic logic.	7	CO4	L2
17.	Describe various reversible gate structures.	7	CO4	L2
18.	Implement OR and AND function using Fredkin gate.	7	CO4	L3

Prepared by: Dr. Neenu Joseph

Checked by: Ambily Joseph

Course Code & Name: ECT458 Internet Of Things

1. Prescribed Syllabus

Module	Topic	Hours
1	Introduction to IoT technology: Definitions and Characteristics of IoT, IoT Architectural View, Physical Design of IOT, Logical Design of IoT-IoT Functional blocks, IoT communication models, IoT Enabling Technologies, IoT Levels & Deployment Templates.	6
2	IoT and M2M- M2M, Difference between IoT and M2M, SDN and NFV for IoT, Smart Objects: The “Things” in IoT: Sensors, Actuators, and Smart Objects, Sensor Networks- Wireless Sensor Networks (WSNs), Communication Protocols for Wireless Sensor Networks- Connecting Smart Objects- Communication Criteria.	8
3	Unified Data Standards –Protocols –IEEE 802.15.4 -The Physical Layer, The Media- Access Control Layer, Uses of 802.15.4 ,The Future of 802.15.4: 802.15.4e and 802.15.4g– Modbus– ZigBee-Zigbee Architecture- LoRaWAN -Standardization and Alliances, Physical Layer, MAC Layer, Topology, LTE-M, NB-IoT-Network layer –The next generation: IP-based protocols - 6LoWPAN and RPL, Overview of the 6LoWPAN Adaptation Layer .	7
4	Data Collection, storage and computing Using a Cloud Platform-Introduction, Cloud Computing Paradigm for Data Collection, Storage and Computing-Cloud ComputingParadigm, Cloud Deployment Models- Everything as a Service and Cloud Service Models- SaaS, PaaS, IaaS, DaaS. Cloud based platforms-XIVELY, NIMBITS. IoT Physical Devices & Endpoints-IoT Device-Building blocks – Raspberry-Pi -Board- Linux on Raspberry-Pi-Raspberry-Pi Interfaces (serial, SPI, I2C). Raspberry Pi interfacing and programming examples using python (LED, switch, sensor, serial, SPI, I2C devices). Controlling GPIO outputs and displaying sensor readings using web interface/cloud (Python programming is required only for assignments and projects and not for examinations. Other end nodes and platforms can also be used).	7
5	IoT privacy, security and vulnerabilities solutions, vulnerabilities, security requirements, threat analysis, security tomography, layered attacker model, Identity management, access control, secure message communication. Smart and Connected Cities-An IoT Strategy for Smarter Cities-Vertical IoT Needs for Smarter Cities, Global vs. Siloed Strategies-Smart City IoT Architecture-Street Layer, City Layer, Data Center Layer, Services Layer-Smart City Security Architecture - Smart City Use-Case Examples – Street lighting, smart parking, smart traffic and air pollution monitoring	6

2. Text Books (T)

- T1. Vijay Madiseti and Arshdeep Bahga, “Internet of Things (A Hands-on- Approach)”, 1st Edition, VPT, 2014 (Module1,2,4)
- T2. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry,
- T3. IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things, Cisco Press, 2017. (Module2,3,5)
- T4. Rajkamal, “Internet of Things : Architecture and Design Principles”, McGraw Hill (India) Private Limited.
- T5. Raspberry Pi Cookbook, Software and Hardware Problems and solutions, Simon Monk, O'Reilly (SPD), 2016, ISBN.

3. Reference Books (R)

- R1. Olivier Hersent, David Boswarthick, Omar Elloumi , “The Internet of Things –Key applications and Protocols”, Wiley, 2012 (Module 3)
- R2. Al-Fuqaha et al. Internet of things: A survey on enabling technologies, protocols, and applications. IEEE Communications Surveys & Tutorials (2015), pp. 2347- 2376.
- R3. The Internet of Things (The MIT Press Essential Knowledge series) Paperback – March 20, 2015 by Samuel Greengard
- R4. The Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems, Ovidu Vermesan and Peter Friess, River Publishers.
- R5. Internet of Things - From Research and Innovation to Market Deployment-RIVER PUBLISHERS, PETER FRIESS, OVIDIU VERMESAN (Editors)
- R6. Internet of Things Security and DataProtection, Sébastien Ziegler, Springer International Publishing 2019.

4. Course Objectives

This course aims to develop skills in IoT system development and to apply the same in real life applications.

5. Course Pre / Co-requisite

ECT342 Embedded systems

6. Course Outcomes

- CO1. Understand the IoT fundamentals and architecture modelling
- CO2. Understand the smart things in IoT and functional blocks
- CO3. To understand the communication networks and protocols used in IoT.
- CO4. To understand the cloud resources, data analysis and applications.
- CO5. To apply the IoT processes in embedded applications

7. Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes

PO/ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	H	H	M		L			M					H		L
CO2	H	H	H		H			M					H		H
CO3	H	H	H		H			M	H				H		H
CO4	H	H			H							M	H		H

CO5	H	H		M									H	M	

8. Justification for CO-PO-PSO Correlation

CO1	PO1	Applying principles of mathematics, science, and engineering enables students to understand the components and functionalities of smart IoT devices.
	PO2	Understanding the roles and interactions of IoT smart devices and functional blocks helps students analyze and interpret complex engineering problems, leading to effective solutions.
	PO3	Designing solutions for IoT challenges by leveraging knowledge of smart devices equips students with the ability to meet specific needs and overcome technical barriers.
	PO5	Utilizing modern tools and technologies effectively helps students understand and apply the functional capabilities of smart devices in IoT systems.
	PO8	Considering the ethical and societal impacts of IoT devices encourages students the responsible design and deployment strategies that prioritize user safety and privacy.
	PSO1	Applying core electronics engineering concepts in the design, analysis, and development of IoT systems, students will be able to bridge theoretical knowledge with practical applications in electronic systems.
	PSO3	Using modern engineering tools, students can Simulate IoT architectures., analyse the performance of wireless communication protocols and Test hardware and software integration in embedded systems.
	PO1	Applying principles of mathematics, science, and engineering enables students to understand the components and functionalities of smart IoT devices.
	PO2	Understanding the roles and interactions of IoT smart devices and functional blocks helps students analyze and interpret complex engineering problems, leading to effective solutions.
	PO3	Designing solutions for IoT challenges by leveraging knowledge of smart devices equips students with the ability to meet specific needs and overcome technical barriers.
	PO5	Utilizing modern tools and technologies effectively helps students understand and apply the functional capabilities of smart devices in IoT systems.
	PO8	Considering the ethical and societal impacts of IoT devices encourages responsible design and deployment strategies that prioritize user safety and privacy
	PSO1	Understanding smart devices, such as sensors, actuators, and edge computing devices, enables students to connect the principles of Electronics and Communication Engineering to real-world IoT applications.
	PSO3	Understanding the smart devices equips students to use modern tools such as Simulation tools for analyzing system behavior and Programming platforms (e.g., Arduino IDE, Raspberry Pi Python libraries) for implementing functional IoT systems.
	PO1	Applying core engineering principles enables students to comprehend and design communication mechanisms essential for IoT system interoperability.

PO2	Understanding network protocols and their impact on system performance equips students with the skills to analyze and address communication challenges in IoT systems.
PO3	Designing communication networks and protocols allows students to create reliable, efficient, and scalable IoT systems tailored to specific requirements.
PO5	Utilizing modern tools to analyze and design communication protocols enhances students' practical skills and proficiency with engineering tools.
PO8	Considering the ethical implications of communication choices promotes responsible decision-making regarding data security and privacy in IoT systems
PO9	Providing foundational knowledge about network protocols will help students apply them individually or in collaboration with others to address communication challenges in IoT projects.
PSO1	Understanding Communication networks & protocols helps students to apply foundational principles of wireless communication, signal processing, and network theory to IoT systems.
PSO3	Understanding communication protocols allows students to select the best protocols and use engineering tools to Simulate communication scenarios and measure performance metrics and Optimize network configurations to minimize power consumption or maximize data throughput.
PO2	Applying engineering principles to manage cloud-based resources and analyze data helps students address challenges in IoT system applications.
PO5	Utilizing modern tools for managing cloud environments, analyzing data, and developing IoT applications enhances students' ability to create effective solutions.
PO12	Understanding cloud resources and their applications equips students to adapt to new tools, platforms, and technologies, fostering a commitment to lifelong learning.
PSO1	Understanding cloud resources involves using cloud platforms (e.g., AWS, Azure, Google Cloud) to store, process, and analyze data generated by embedded systems in IoT applications, this knowledge allows students to connect embedded systems to the cloud for real-time data streaming and remote control.
PSO3	Provides students with the knowledge to apply electronics engineering principles in the design, analysis, and development of communication protocols for IoT systems.
PO1	Understanding engineering principles enables students to integrate IoT processes into embedded systems, demonstrating proficiency in designing and analyzing practical solutions.
PO2	Applying IoT processes in embedded applications helps students identify and address real-world problems using innovative IoT solutions.
PO4	Investigating IoT processes such as sensing, data acquisition, and communication protocols enables students to address specific application needs effectively.
PSO1	Applying knowledge of IoT processes allows students to design and implement embedded applications, integrating sensors, data processing units, and communication systems.

	PSO2	Utilizing engineering knowledge enables students to manage and execute IoT projects, considering resource allocation, budgeting, and timelines for successful outcomes.

9. Curricular gaps (if any):

Nil

10. Course Enrichment Activities*

Sl No	Description	Proposed Activities	Relevance to POs and PSOs
1	Nil		

11. Internal Assessment mark allocation (as per university curriculum)

Attendance - 10 marks

Continuous Assessment Test - 25 marks

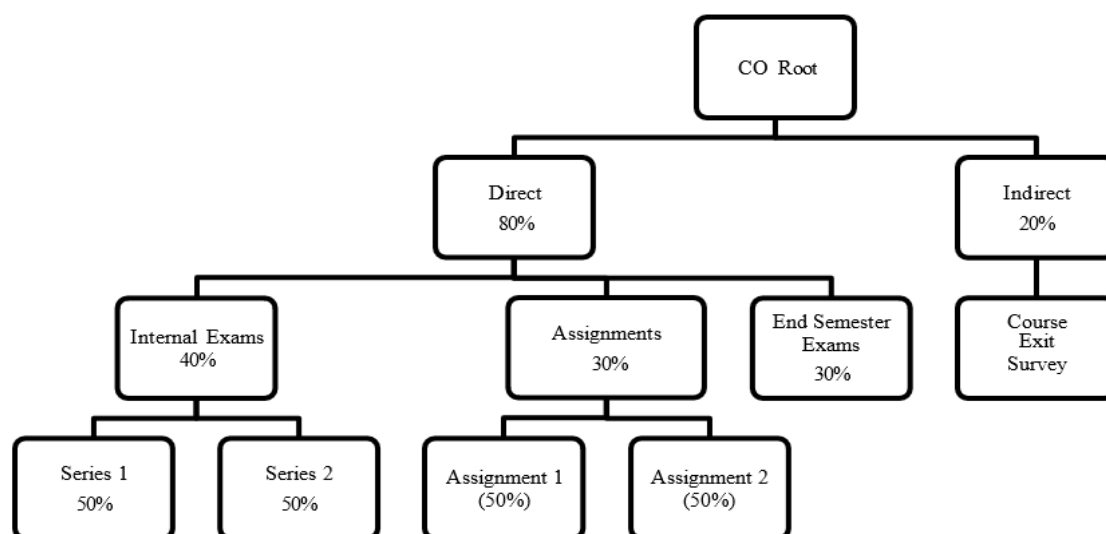
Assignment (s)/ Course Project - 15 marks

Total - 50 marks

12. Assessment – CO Mapping (Put ‘ x’ if mapping is present)

	Tools		Weight age	CO 1	CO 2	CO 3	CO 4	CO 5
Direct Assessment Tools**	Internal Exam(s) 40%	Series 1	20%	x	x	x		
		Series 2	20%			x	x	x
	Assignment (s)/ Course Project /Quiz etc. 30%	Assignment 1	15%	x	x			
		Assignment 2	15%			x	x	x
	End Semester Exam		30%	x	x	x	x	x
Indirect Assessment Tool	Course Exit Survey		100%	x	x	x	x	x

12. Assessment Configuration



13. Course plan

Hour	Topic	Module	Reference(s)	Teaching Pedagogy
Mod 1	Introduction to Internet of Things- 7Hrs			
1	Introduction, definition and characteristics	1	R1	Lecture
2	IoT architectural view	1	R1	Lecture
3	Physical and logical design of IoT	1	R1	Lecture
4	IoT functional blocks	1	R1	Tutorial
5	IoT communication models	1	R1	Lecture
6	IoT enabling technologies	1	R1	Lecture
7	IoT deployment levels	1	R1	Lecture
Mod 2	Essential components of IoT- 7Hrs	2		
8	IoT and M2M	2	R2	Lecture
9	SDN and NFV for IoT	2	R2	Lecture
10	Sensors, Actuators, and Smart Objects	2	R2	Lecture
11	Wireless Sensor Networks (WSNs)	2	R2	Tutorial
12	Communication Protocols for Wireless Sensor Networks	2	R2	Lecture
13	Communication Protocols for Wireless Sensor Networks	2	R2	Lecture
14	Connecting Smart Objects- Communication Criteria.	2	R2	Lecture
Mod 3	IoT protocols- 7Hrs	3	R1	Lecture
15	IEEE 802.15.4 protocols	3	R2	Lecture
16	Zigbee	3	R2	Tutorial
17	LoRaWAN -Standardization and Alliances	3	R2	Lecture

18	Physical Layer, MAC Layer, Topology	3	R5	Lecture
19	LTE-M, NB-IoT-Network layer	3	R5	Lecture
20	6LoWPAN and RPL	3	R5	Lecture
21	6LowPaN and RPL	3	R5	Lecture
Mod 4	Cloud storage and Programming the end device-9Hrs			
22	Cloud Computing Paradigm for Data Collection	4	R5	Lecture
23	Storage and Computing-Cloud Computing Paradigm	4	R5	Lecture
24	Cloud Deployment Models-Everything as a Service and Cloud Service Models-SaaS, PaaS, IaaS, DaaS	4	R5	Lecture
25	Cloud based platforms-XIVELY	4	R5	Lecture
26	Cloud based platforms- NIMBITS	4	R5	Lecture
27	IoT Physical Devices & Endpoints-IoT Device-Building blocks	4	R5	Lecture
28	Raspberry Pi interfacing and programming examples using python (LED, switch, sensor, serial, SPI, I2C devices).	4	R5	Lecture
29	Raspberry Pi interfacing and programming examples using python (LED, switch, sensor, serial, SPI, I2C devices).	4	R5	Tutorial
30	Controlling GPIO outputs and displaying sensor readings using web interface/cloud	4	R5	Lecture
Mod 5	Security and Applications-6 Hrs			
31	IoT privacy, security and vulnerabilities solutions	5	R5	Lecture
32	security requirements, threat analysis, security tomography, layered attacker model	5	R8	Lecture
33	Identity management, access control, secure message communication.	5	R5	Lecture
34	Smart and Connected Cities-An IoT Strategy for Smarter Cities	5	R5	Lecture
35	Smart City IoT Architecture	5	R5	Lecture
36	Smart City Security Architecture	5	R5	Lecture

14. Question Bank

	Module 1			
Sl No	Question	Marks	CO	BL
1	Explain what do you mean by logical design of IoT. What does it include?	3	CO1	L2
2	Explain the IoT enabling technologies	3	CO1	L2

3	Explain the different characteristics of IoT.	3	CO1	L2
4	List the different levels of IoT with an example.	3	CO1	L1
5	Explain the basic elements of an IoT system.	3	CO1	L2
6	List few applications of IoT.	3	CO1	L1
7	Explain any two link layer protocols.	3	CO1	L2
8	Enlist few applications of TCP protocol.	3	CO1	L1
9	Explain TCP handshake and termination.	3	CO1	L2
10	List advantages and disadvantages of TCP protocol.	3	CO1	L1
11	Give few advantages of UDP over TCP.	3	CO1	L1
12	Explain Request – Response communication model of IoT.	3	CO1	L2
13	List few examples of wireless sensor networks.	3	CO1	L1
14	Describe Cloud computing.	3	CO1	L2
15	Discuss on big data analytics.	3	CO1	L2
16	Explain Publish- Subscribe communication model of IoT.	3	CO1	L2
17	Explain Web-socket based communication API.	3	CO1	L2
18	Explain what do you mean by logical design of IoT. What does it include?	5	CO1	L2
19	Explain with figure Level-3 IoT system. Give an example.	7	CO1	L2
20	Define IoT. Explain the different characteristics of IoT.	7	CO1	L2
21	Explain with figure Level-5 IoT system. Give an example.	7	CO1	L2
22	Explain different communication models used in IoT.	8	CO1	L2
23	Explain with figure the architectural view of IoT.	6	CO1	L2
24	Explain with figure the IoT Functional blocks.	6	CO1	L2
25	Explain the different protocols used in the link layer, network layer, transport layer and application layer protocols.	9	CO1	L2
26	Differentiate between IPv4 and IPv6 protocols.	6	CO1	L2
27	Explain TCP and UDP protocols.	8	CO1	L2
28	Discuss about any three application layer protocols.	8	CO1	L2
Module 2				
Sl No	Question	Marks	CO	BL

1	Define Sensors, Actuators, and Smart Objects.	3	CO2	L1
2	List the differences between IoT and M2M.	3	CO2	L1
3	Explain why SDN is preferred rather than conventional network architectures?	3	CO2	L2
4	Define a smart object. Explain the four defining characteristics of a Smart Object.	3	CO2	L2
5	Explain M2M communication.	3	CO2	L2
6	List few applications of M2M communication.	3	CO2	L1
7	Explain three main components of SDN.	3	CO2	L2
8	Describe the function of an actuator.	3	CO2	L2
9	Explain the communication patterns of smart objects.	3	CO2	L2
10	Explain different categories of sensor networks.	7	CO2	L2
11	Explain any three types of sensors with suitable examples.	9	CO2	L2
12	Differentiate between M2M and IoT.	5	CO2	L2
13	Explain the issues of conventional networking architectures? How is it solved in SDN?	7	CO2	L2
14	Explain with figure Network Function Virtualization use case for IoT.	7	CO2	L2
15	Define smart objects. What are their defining characteristics and the trends?	9	CO2	L2
16	Explain the limitations of smart objects in WSNs.	5	CO2	L2
17	Explain the characteristics and attributes to be considered when selecting and dealing with connecting smart objects.	8	CO2	L2
18	Explain Wireless Sensor Networks.	6	CO2	L2
19	Explain the general architecture of M2M systems.	7	CO2	L2
20	Explain the functions of Data plane and control plane in SDN.	6	CO2	L2
21	Describe SDN architecture.	7	CO2	L2
22	Explain NFV architecture.	7	CO2	L2
Module 3				
Sl No	Question	Marks	CO	BL
1	Outline the advantages of 6LoWPAN.	3	CO3	L1
2	Explain any three features of NB-IoT.	3	CO3	L2
3	Describe the working of Modbus.	3	CO3	L2
4	Enlist the key features of RPL.	3	CO3	L1

5	Explain the three classes of LoRaWAN devices.	3	CO3	L2
6	Describe the working of Zigbee.	3	CO3	L2
7	Enlist the functions of Physical Layer.	3	CO3	L1
8	List the functions of MAC Layer.	3	CO3	L1
9	Describe the working of LoRaWAN alliances.	3	CO3	L2
10	Explain the working of LoRaWAN.	3	CO3	L2
11	List the advantages of LoRaWAN.	3	CO3	L1
12	Explain the function of a LoRaWAN gateway.	3	CO3	L2
13	Explain the significance of 6LoWPAN Adaptation Layer.	3	CO3	L2
14	List the features of IEEE 802.15.4.	3	CO3	L1
15	Describe the modifications included in IEEE 802.15.4 e and g versions as compared to IEEE 802.15.4	3	CO3	L2
16	Explain IEEE 802.15.4 physical layer, MAC layer and security implementation with the help of frame formats.	8	CO3	L2
17	Describe the working of RPL.	6	CO3	L2
18	Explain LoraWAN architecture. Give a detailed description of the physical layer and MAC layer of LoraWAN.	8	CO3	L2
19	Describe the architecture of LTE-M.	6	CO3	L2
20	Explain the frame format of IEEE 802.15.4	6	CO3	L2
21	Explain the topology of IEEE 802.15.4	6	CO3	L2
22	Describe the key features of LoRa modulation.	6	CO3	L2
23	Explain the key features of LTE-M.	6	CO3	L2
24	Describe NB-IoT network Layer.	7	CO3	L2
25	Explain the architecture of 6LoWPAN.	7	CO3	L2
26	List few advantages & disadvantages of 6LoWPAN over LoRaWAN.	6	CO3	L1
Module 4				
Sl No	Question	Marks	CO	BL
1	Describe Cloud computing.	3	CO4	L2
2	List different Cloud Deployment Models	3	CO4	L1
3	List the reasons for employing Raspberry Pi as the development platform for IoT applications.	3	CO4	L1
4	Explain few concerns related to cloud computing.	3	CO4	L2

5	Enlist the main components of Raspberry Pi.	3	CO4	L1
6	Give few examples for cloud platforms.	3	CO4	L1
7	Describe IaaS.	3	CO4	L2
8	Explain PaaS.	3	CO4	L2
9	Describe SaaS.	3	CO4	L2
10	Describe the working of UART.	3	CO4	L2
11	List the key features of UART.	3	CO4	L1
12	List the advantages & disadvantages of I2C.	3	CO4	L1
13	Explain the working of SPI.	7	CO4	L2
14	Describe the working of Inter-integrated Circuit.	7	CO4	L2
15	Explain all four cloud service models.	8	CO4	L2
16	Describe virtualization in the domain of cloud computing.	6	CO4	L2
17	Explain the block diagram of an IoT device.	8	CO4	L2
18	Describe the features of Raspberry Pi.	6	CO4	L2
19	Explain the characteristics of cloud computing.	6	CO4	L2
20	Describe IoT cloud based data collection, storage and computing using Xively.	8	CO4	L2
21	Explain IoT cloud based data collection, storage and computing using NIMBITS.	8	CO4	L2
22	Describe the basic building blocks of an IoT device.	7	CO4	L2
23	Describe the hardware components of Raspberry Pi.	8	CO4	L2
24	List few reasons for Employing Raspberry Pi as a Development Platform for IoT Applications.	6	CO4	L1
25	Explain any two Raspberry Pi interfaces.	8	CO4	L2
Module 5				
Sl No	Question	Marks	CO	BL
1	Enlist any three IoT security challenges.	3	CO5	L1
2	Explain Layered attacker model.	3	CO5	L2
3	List any six top-10 vulnerabilities in IoT applications.	3	CO5	L1
4	List the advantages of using Layered attacker model.	3	CO5	L1
5	Explain security tomography.	3	CO5	L2

6	List the functions of IoT security function group.	3	CO5	L1
7	Explain the vulnerabilities of IoT.	3	CO5	L2
8	Describe different types of attackers in a layered model.	3	CO5	L2
9	Explain the attacks happening in a physical layer and solutions for the same.	3	CO5	L2
10	List the benefits of smart street lighting.	3	CO5	L1
11	Enlist the technologies used in smart parking.	3	CO5	L1
12	Explain the key components of smart air pollution monitoring systems.	3	CO5	L2
13	Describe the key components of smart traffic monitoring systems.	3	CO5	L2
14	Differentiate between global & siloed strategies in smart cities.	3	CO5	L2
15	Illustrate how a smart traffic control system functions with the help of a diagram.	7	CO5	L3
16	Demonstrate how a smart parking system functions with an illustration.	7	CO5	L3
17	Illustrate how a smart air pollution monitoring system functions with the help of a diagram.	7	CO5	L3
18	Demonstrate how a smart street lighting system functions with an illustration.	7	CO5	L3
19	Describe the security challenges faced by IoT systems.	7	CO5	L2
20	Explain the functions of a security function group of an IoT system.	7	CO5	L2
21	Describe Layered attacker model with the help of a diagram.	8	CO5	L2
22	Explain the IoT strategy for smart cities.	6	CO5	L2
23	Discuss about any two IoT use cases for smart cities	6	CO5	L2
24	Describe the benefits of smart cities.	6	CO5	L2
25	Explain the 4-layer IoT architecture of a smart city.	8	CO5	L2
26	List the Key features of smart street lighting.	6	CO5	L1
27	Describe the architecture of smart street lighting.	7	CO5	L2

Prepared By : Pearl Antonette Mendez

Checked by : Gregorious Jose C

1. Prescribed Syllabus

- ✓ The course should be mapped with a faculty and classes shall be arranged for practicing questions based on the core courses listed in the curriculum.
- ✓ The viva voce will be conducted by the same three-member committee assigned for final project phase II evaluation. It comprises of Project coordinator, expert from
- ✓ Industry/research Institute and a senior faculty from a sister department.
- ✓ The pass minimum for this course is 25.
- ✓ The mark will be treated as internal and should be uploaded along with internal marks of other courses.
- ✓ Comprehensive Viva should be conducted along with final project evaluation by the three-member committee.

2. Text Books (T)

- T1. Ben G. Streetman and Sanjay Kumar Banerjee, Solid State Electronic Devices, Pearson 6/e, 2010.
- T2. Mano M.M., Ciletti M.D., “Digital Design”, Pearson India, 4th Edition. 2006
- T3. Valkenburg V., “Network Analysis”, Pearson, 3/e, 2019.
- T4. Robert Boylestad and L Nashelsky, “Electronic Devices and Circuit Theory”, 11/e Pearson, 2015.
- T5. Alan V. Oppenheim and Alan Willsky, Signals and Systems, PHI, 2/e, 2009
- T6. Muhammed Ali Mazidi & Janice Gilli Mazidi, R.D. Kinley, The 8051 microcontroller and Embedded System, Pearson Education, 2nd edition.
- T7. Proakis, J.G. & Manolakis, D.G., “Digital Signal Processing: Principles, Algorithms & Applications”, 3/e Prentice Hall of India, 1996.
- T8. Roy D. C. and S. B. Jain, Linear Integrated Circuits, New Age International, 3/e, 2010
- T9. Simon Haykin, Communication Systems, Wiley.
- T10. Balanis, Antenna Theory and Design, 3/e, Wiley Publications.

3. Reference Books (R)

- R1. Neamen, Semiconductor Physics and Devices, McGraw Hill, 4/e, 2012
- R2. Wakerly J.F., “Digital Design: Principles and Practices,” Pearson India, 4th 2008
- R3. Edminister, “Electric Circuits – Schaum’s Outline Series”, McGraw-Hill, 2009.
- R4. Razavi B., “Fundamentals of Microelectronics”, Wiley, 2015
- R5. B P. Lathi, Principles of Signal Processing & Linear systems, Oxford University Press.
- R6. Mano M M, Computer System Architecture, 3rd Ed, Prentice Hall of India.
- R7. DFRanco S., Design with Operational Amplifiers and Analog Integrated Circuits, 3/e, Tata McGraw Hill, 2008
- R8. “Principles of Digital Communication,” R. Gallager, Oxford University Press
- R9. Collin R.E, Antennas & Radio Wave Propagation, McGraw Hill. 1985.

4. Course Objectives

The objective of this Course viva is to ensure the basic knowledge of each student in the most fundamental core courses in the curriculum. The viva voce shall be conducted based on the core subjects studied from third to eighth semester. This course helps the learner to become competent in placement tests and other competitive examinations.

5. Course Pre / Co-requisite

- All courses from S3 to S8

6. Course Outcomes

After the successful completion of the course the students will be able to

CO1. Effectively comprehend the knowledge gained in the specified courses.

CO2. Comprehend the question asked and answer them with confidence.

7. Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes

PO/ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H	H							M	M		M	H		
CO2	H	H							M	M		M	H		

8. Justification for CO-PO-PSO Correlation

CO	PO/PSO	Justification
CO1	PO1	Comprehensive knowledge gained from mathematics and engineering fundamentals contribute to solving complex engineering problems
	PO2	Comprehensive knowledge gained in basic courses relevant to the Electronics and Communication Engineering to identify, formulate, review research literature, and analyze complex engineering problems
	PO9	Comprehensive knowledge gained from Electronics and communication-based courses will enable the student to become a productive member of a project team
	PO10	Comprehensive knowledge gained in basic courses in Electronics and Communication contribute to demonstrate knowledge and understanding of the engineering principles and apply these to one's own work.
	PO12	The student will become aware of the need for lifelong learning and the continued upgrading of technical knowledge
	PSO1	Comprehensive knowledge in various domains of Electronics and Communication helps the student to design and implement electronic circuits on the demands of the society
CO2	PO1	Comprehensive knowledge gained from mathematics and engineering fundamentals contribute to solving complex engineering problems
	PO2	Comprehensive knowledge gained in basic courses relevant to the Electronics and Communication to identify, formulate, review research literature, and analyze complex engineering problems.
	PO9	Comprehensive knowledge gained from Electronics courses will enable the student to effectively interpret and address challenges, whether working individually or in a team

	PO10	Comprehensive knowledge gained in basic courses in Electronics and Communication to demonstrate knowledge and understanding of the engineering principles and apply these to one's own work.
	PO12	The student will become aware of the need for lifelong learning and the continued upgrading of technical knowledge
	PSO1	Comprehensive knowledge in various domains of Electronics and Communication helps the student to design and implement electronic circuits based on the demands of the society

9. Curricular gaps (if any)

Nil

10. Course Enrichment Activities*

Nil

11. Internal Assessment mark allocation (as per university curriculum)

(Provide details as mentioned in syllabus)

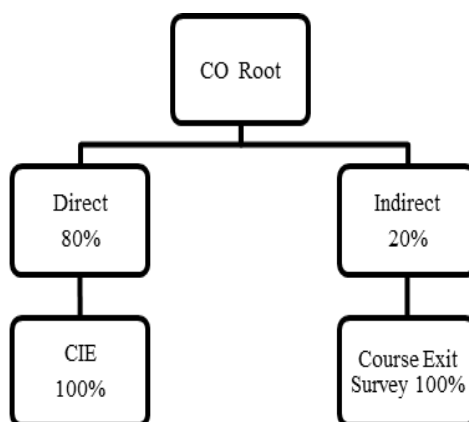
Continuous Internal Evaluation - 50 marks

Total - 50 marks

12. Assessment – CO Mapping(Put ' x' if mapping is present)

	Tools	Weightage	CO1	CO2
Direct Assessment Tools	Continuous Internal Evaluation	100%	x	x
Indirect Assessment Tool	Course Exit Survey	100%	x	x

13. Assessment Configuration



Prepared by: Dr. Neenu Joseph

Checked by: Arun V

Course Code & Name: ECD416 Project Phase II

1. Prescribed Syllabus

The course 'Project Work' is mainly intended to evoke the innovation and invention skills in a student. The course will provide an opportunity to synthesize and apply the knowledge and analytical skills learned, to develop as a prototype or simulation. The project extends to 2 semesters and will be evaluated in the 7th and 8th semester separately, based on the achieved objectives. One third of the project credits shall be completed in 7th semester and two third in 8th semester. It is recommended that the projects may be finalized in the thrust areas of the respective engineering stream or as interdisciplinary projects. Importance should be given to address societal problems and developing indigenous technologies.

Phase 2 Targets

- Ø In depth study of the topic assigned in the light of the report prepared under Phase – I
 - Ø Review and finalization of the approach to the problem relating to the assigned topic.
 - Ø Preparing a detailed action plan for conducting the investigation, including teamwork.
 - Ø Detailed Analysis/ Modeling / Simulation/ Design/ Problem Solving/Experiment as needed.
 - Ø Final development of product/ process, testing, results, conclusions and future directions.
 - Ø Preparing a paper for Conference Presentation/ Publication in Journals, if possible.
 - Ø Presenting projects in Project Expos conducted by the University at the cluster level and/ or state level as well as others conducted in India and abroad.
 - Ø Filing Intellectual Property Rights (IPR) if applicable.
 - Ø Preparing a report in the standard format for being evaluated by the Department Assessment Board.
- Final project presentation and viva voce by the assessment board including the external expert.

Evaluation Guidelines & Rubrics

Total: 150 marks (Minimum required to pass: 75 marks).

- Ø Project progress evaluation by guide: 30 Marks.
- Ø Two interim evaluations by the Evaluation Committee: 50 Marks (25 marks for each evaluation).
- Ø Final evaluation by the Final Evaluation committee: 40 Marks
- Ø Quality of the report evaluated by the evaluation committee: 30 Marks

(The evaluation committee comprises HoD or a senior faculty member, Project coordinator and project supervisor. The final evaluation committee comprises of Project coordinator, expert from Industry/research/academic Institute and a senior faculty from a sister department). **Text Books (T)**

2. Reference Books (R)

3. Web Sources (W)

- W1. www.ieee.org
- W2. www.springer.com
- W3. www.sciencedirect.com

4. Course Objectives

1. To apply engineering knowledge in practical problem solving
2. To foster innovation in design of products, processes or systems
3. To develop creative thinking in finding viable solutions to engineering problems

5. Course Pre / Co-requisite

Nil

6. Course Outcomes

Upon completion of the course the students will be able to

- CO1. Model and solve real world problems by applying knowledge across domains. (Cognitive knowledge level: Apply)
- CO2. Develop products, process or technologies for sustainable and socially relevant applications. (Cognitive knowledge level: Apply)
- CO3. Function effectively as an individual and as a leader in diverse teams and to comprehend and execute designated tasks. (Cognitive knowledge level: Apply)
- CO4. Plan and execute tasks utilizing available resources within timelines, following ethical and professional norms. (Cognitive knowledge level: Analyze)
- CO5. Identify technology/research gaps and propose innovative/creative solutions. (Cognitive knowledge level: Analyze)
- CO6. Organize and communicate technical and scientific findings effectively in written and oral forms. (Cognitive knowledge level: Apply)

7. Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes

PO/ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
CO1	H	M	M	M	M	M	M	M	H	H	M	L	H	M	M
CO2	H	M	M	M	H	H	H	M	H	H	M	H	H	M	H
CO3	H								H	H	M	M	H		
CO4					M			H	M	M	H	M			M
CO5	H	H	H	L	M							H	H	L	M
CO6	M				M			M	H	H	M	L	M		M

8. Justification for CO-PO-PSO Correlation

CO	PO	Correlation	Justification Statement
CO1	PO1	H	The application of mathematics engineering fundamentals and specialized knowledge is essential for solving complex engineering problems that have real-world implications.
	PO2	M	The skills of problem identification, formulation, literature review, analysis using first principles, and reaching substantiated conclusions are essential for engineers and researchers to model and solve real-world problems effectively
	PO3	M	Students leverage their knowledge across domains to develop innovative and well-rounded solutions that address multifaceted real-world challenges while meeting the highest standards of ethics, safety, and environmental responsibility.

PO4	M	The research-based knowledge provides the foundation for data-driven decision-making, enable interdisciplinary collaboration, and ensure that solutions are evidence-based, reliable, and effective.
PO5	M	Students will be able to make informed decisions, optimize solutions, and effectively address complex challenges in an interdisciplinary context.
PO6	M	Students will be able to approach real-world problems with a holistic perspective, taking into account the broader context and the well-being of society while applying their knowledge across domains to develop effective and responsible solutions.
PO7	M	The students will be able to develop solutions that not only address immediate challenges but also contribute to long-term societal well-being and environmental sustainability.
PO8	M	The students who adhere to ethical standards not only create solutions that are technically sound but also consider the broader societal and ethical implications, fostering trust, safety, and sustainability in their professional practice.
PO9	H	To work effectively as an individual and as part of diverse teams in multidisciplinary settings is vital for modelling and solving real-world problems across domains. Collaboration, effective communication, leadership, and the ability to integrate diverse knowledge and perspectives are essential skills that enhance the problem-solving process and lead to more comprehensive and innovative solutions.
PO10	H	The effective team work supports knowledge sharing, collaboration, knowledge transfer, and the dissemination of solutions and also can apply their knowledge to complex problems and work collectively to find innovative solutions.
PO11	M	The students can contribute to efficient project execution, effective teamwork, and the successful implementation of solutions that meet societal needs while adhering to professional standards.
PO12	L	The students who embrace continuous learning are better equipped to adapt to technological change, collaborate across disciplines, and innovate in their problem-solving efforts, ultimately contributing to more effective and relevant solutions for evolving challenges.
PSO1	H	The students can leverage electronic systems and technology in innovative ways to address multifaceted challenges and contribute to interdisciplinary problem-solving efforts effectively.

	PSO2	M	the ability to analyze and synthesize experimental data from electronic systems enables the students to validate designs, make data-driven decisions, and collaborate effectively with experts from diverse fields, ultimately contributing to comprehensive and effective problem-solving efforts.
	PSO3	M	The students could efficiently analyze data, simulate systems, optimize designs, and collaborate effectively, ultimately contributing to comprehensive and effective problem-solving efforts.
CO2	PO1	H	The application of mathematics engineering fundamentals and specialized knowledge is essential for solving the development of products, process and technology.
	PO2	M	The skills of problem identification, formulation, literature review, analysis using first principles, and reaching substantiated conclusions are essential for engineers and researchers to analyze the product design
	PO3	M	Students leverage their knowledge across domains to design innovative and well-rounded solutions that address multifaceted real-world challenges while meeting the highest standards of ethics, safety, and environmental responsibility.
	PO4	M	The research-based knowledge provides the foundation for data-driven decision-making, enable interdisciplinary collaboration, and ensure that solutions are evidence-based, reliable, and effective.
	PO5	H	Students will be able to design, optimize solutions, and effectively address complex challenges in an interdisciplinary context.
	PO6	H	Students will be able to approach real-world problems with a holistic perspective, taking into account the broader context and the well-being of society while applying their knowledge across domains to develop effective and responsible products.
	PO7	H	The students will be able to develop solutions that not only address immediate challenges but also contribute to long-term societal well-being and environmental sustainability.
	PO8	M	The students who adhere to ethical standards not only create solutions in the designs that are technically sound but also consider the broader societal and ethical implications, fostering trust, safety, and sustainability in their professional practice.
	PO9	H	To work effectively as an individual and as part of diverse teams in multidisciplinary settings is vital for modelling and developing new products

	PO10	H	The effective team work supports knowledge sharing, collaboration, knowledge transfer, and the dissemination of solutions and also can apply their knowledge to complex problems and work collectively to find innovative solutions for developing products
	PO11	M	The students can contribute to efficient project execution, effective teamwork, and the successful implementation of solutions that meet societal needs while adhering to professional standards.
	PO12	H	The students who embrace continuous learning are better equipped to adapt to technological change, collaborate across disciplines, and innovate in their problem-solving efforts, ultimately contributing to more effective and relevant solutions to develop electronic products.
	PSO1	H	The students can leverage electronic systems and technology in innovative ways to address multifaceted challenges and contribute to interdisciplinary problem-solving efforts effectively.
	PSO2	M	the ability to analyze and synthesize experimental data from electronic systems enables the students to validate designs, make data-driven decisions, and collaborate effectively with experts from diverse fields, ultimately contributing to comprehensive and effective problem-solving efforts.
	PSO3	H	The students could efficiently design, simulate systems, optimize designs, and collaborate effectively, ultimately contributing to comprehensive and effective problem-solving efforts.
CO3	PO1	H	The application of knowledge in mathematics with strong technical foundations can comprehend complex problems, execute tasks effectively, and assume leadership roles to guide teams toward successful solutions.
	PO9	H	The students can able to do individual and team work function effectively as an individual and as a leader in diverse team and to comprehend and execute designed tasks.
	PO10	H	The students can able to communicate effectively as an individual and as a leader in diverse team and to comprehend and execute designed tasks.
	PO11	M	The students can handle project management and finance effectively as an individual and as a leader in diverse team and to comprehend and execute designed tasks.

	PO12	M	the students can gather more knowledge effectively as an individual and as a leader in diverse team and to comprehend and execute designed tasks results in lifelong learning.
	PSO1	H	The students can analyze and design electronic systems and technology in innovative ways to address new challenges and contribute to the solutions.
CO4	PO5	M	Students will be able to use modern tools to plan and execute tasks utilizing available resources within timelines, following ethical and professional norms.
	PO8	H	Students will be able to to plan and execute tasks utilizing available resources within timelines, following ethical and professional norms ethically.
	PO9	M	Able to do individual and team work to plan and execute tasks utilizing available resources within timelines, following ethical and professional norms.
	PO10	M	Students will be able to communicate to plan and execute tasks utilizing available resources within timelines, following ethical and professional norms.
	PO11	H	Able to handle project management and finance to plan and execute tasks utilizing available resources within timelines, following ethical and professional norms.
	PO12	M	Able to gather more knowledge to plan and execute tasks utilizing available resources within timelines, following ethical and professional norms results in lifelong learning.
	PSO3	M	The students could efficiently design, simulate systems, optimize designs, and collaborate effectively, ultimately contributing to comprehensive and effective problem-solving efforts.
CO5	PO1	H	Able to identify technology or research gaps and propose creative or innovative solutions using Engineering knowledge.
	PO2	H	Students will be able to analyse the research gaps and propose creative or innovative solutions.
	PO3	H	Students will be able to design or develop innovative solutions for research gaps.
	PO4	L	Students will be able to conducts investigations of complex problems for innovative solutions.
	PO5	M	Students will be able to use modern tools identify technology or research gaps and propose creative or innovative solutions.

	PO12	H	The students could gather more knowledge to identify technology or research gaps and propose creative or innovative solutions results in lifelong learning.
	PSO1	H	The students can leverage electronic systems and technology in innovative ways to address multifaceted challenges and contribute to interdisciplinary problem-solving efforts effectively.
	PSO2	L	The ability to analyze and synthesize experimental data from electronic systems enables the students to validate designs, make data-driven decisions, and collaborate effectively with experts from diverse fields, ultimately contributing to comprehensive and effective problem-solving efforts.
	PSO3	M	The students could efficiently design, simulate systems, optimize designs, and collaborate effectively, ultimately contributing to comprehensive and effective problem-solving efforts.
CO6	PO1	M	Students will be able to use modern tools to organize and communicate technical and scientific findings effectively in written and oral forms.
	PO5	M	Students will be able to use modern tools to organize and communicate technical and scientific findings effectively in written and oral forms.
	PO8	M	Students will be able to identify technology or research gaps and propose creative or innovative solutions ethically.
	PO9	H	Able to do individual and team work to identify technology or research gaps and propose creative or innovative solutions.
	PO10	H	Able to communicate to identify technology or research gaps and propose creative or innovative solutions.
	PO11	M	Able to handle project management and finance to identify technology or research gaps and propose creative or innovative solutions
	PO12	L	Able to gather more knowledge to identify technology or research gaps and propose creative or innovative solutions results in lifelong learning.
	PSO1	H	The students with expertise in electronic systems and technology have the potential to make significant contributions to interdisciplinary problem-solving efforts by applying their knowledge creatively and collaborating across domains

	PSO3	M	Students will be able to use modern tools for analysis is closely tied to the skill of organizing and communicating technical and scientific findings effectively.

9. Curricular gaps (if any)

Nil

10.Course Enrichment Activities*

Nil

11. Internal Assessment mark allocation (as per university curriculum)

Project progress evaluation	- 30 marks
Interim evaluation	- 20 marks
Final evaluation	- 30 marks
Report	- 20 marks
<u>Total</u>	<u>- 100 marks</u>

12. Assessment – CO Mapping (Put ‘x’ if mapping is present)

Direct Assessment Tools**	CO1	CO2	CO3	CO4	CO5	CO6
Project progress evaluation	x	x	x	x	x	x
Interim evaluation by evaluation committee	x	x	x	x	x	x
Final evaluation by evaluation committee	x	x	x	x	x	x
Report						x

13. Assessment Configuration

Project progress evaluation	Interim evaluation by evaluation committee	Final Evaluation by evaluation committee	Report	Total
30%	20%	30%	20%	100%

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