SEMESTER - III
SYLLABUS

24MAP301	ADVANCED LINEAR ALGEBRA, COMPLEX ANALYSIS AND PARTIAL DIFFERENTIAL EQUATIONS	L	T	P	J	S	C	Year of Introduction
		3	1	2	0	5	5	2024

Preamble: This course introduces the concept of vector space, inner product, complex differentiation, complex integration and partial differential equations. The concepts discussed here are widely used in the modeling and analysis of a wide range of physical phenomena and has got application across all branches of engineering. After completing this course, students will acquire the ability to utilize the above concepts for solving mathematical problems more efficiently.

Prerequisite: A basic course in linear algebra, complex numbers and partial differentiation.

Course Outcomes: After the completion of the course the student will be able to

CO 1	Identify many familiar systems as vector spaces and operate them using vector space tools such as basis and dimension (Apply).
CO 2	Apply the concept of real and complex Inner product spaces for generating approximations and orthogonal projections (Apply).
CO 3	Use Cauchy-Riemann equations and the concept of harmonic functions for solving physical and engineering problems (Apply).
CO 4	Compute different types of contour integrals using Cauchy's residue theorem (Apply).
CO 5	Solve different types of Partial differential equations in engineering domains and solve it using appropriate methods (Apply).

<div align="center">CO - PO MAPPING</div>

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	✓	✓			✓				✓			✓
CO 2	✓	✓			✓				✓			✓
CO 3	✓	✓			✓				✓			✓
CO 4	✓	✓			✓				✓			✓
CO 5	✓	✓			✓				✓			✓

<div align="center">Assessment Pattern for Theory Component</div>

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse			✓	

<div align="center">Assessment Pattern for Lab Component</div>

Bloom's Category	Continuous Assessment Tools	
	Class work	Test1
Remember	✓	✓
Understand	✓	✓
Apply	✓	✓

Analyse	✓	
Evaluate		
Create		

Mark Distribution of CIA							

Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Practical [P]		Total Marks
		Assignment	Test-1	Test-2	Class work	Lab Exam	
3-1-2-0	5	10	12.5	12.5	10	10	**60**

Total Marks Distribution			
Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	60	40	2.5 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 2		2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x 8 = 40 marks) Time: 2.5 hours	40
	Total Marks: 0	Total Marks: [5x8 = 40 marks]	

SYLLABUS (45 Hours)

MODULE I: Vector Space (9 Hours)

(Text 1: Relevant topics from sections 2.1, 2.2, 2.3, 2.4, 2.5)
Vector Spaces, Subspaces -Definition and Examples. Linear independence of vectors, Linear span, Basis and dimension, Co-ordinate representation of vectors, Row space and Column space

MODULE II: Inner Product (9 Hours)

(Text 1: Relevant topics from sections 5.1, 5.2, 5.5)
Inner Product: Inner product spaces, properties of inner product, length and distance, Orthogonality, Cauchy-Schwarz inequality, Orthogonal projection, orthogonal complement, Orthonormal basis, Gram-Schmidt orthogonalization process.

MODULE III: Complex Differentiation (9 Hours)
(Text 2: Relevant topics from sections 13.3,13.4) Circles and disks half-planes, complex functions, limit, continuity and derivatives, analytic functions, Cauchy-Riemann equations, Laplace equation, Harmonic functions, harmonic conjugate functions
MODULE IV: Complex Integration (9 Hours)
(Text 2- Relevant topics from sections 14.1,14.2,14.3,14.4,15.4,16.1,16.2,16.3) Cauchy's integral theorem for simply connected domains (without proof), Cauchy's Integral formula for simply connected domains (without proof), Cauchy's Integral formula for derivatives of analytic functions, Taylor and Maclaurin series, Laurent's series, Poles and Residues, Evaluation of residues, Cauchy's residue theorem.
MODULE V: Partial Differential Equations (9 Hours)
(Text 3: Relevant topics from sections 17.1,17.2,17.3,17.4,17.5) Introduction, Formation of partial differential equations -elimination of arbitrary constants-elimination of arbitrary functions, Solutions of partial differential equations, Equations solvable by direct integration, Linear equations of the first order, Lagrange's linear equation.

Text books
1. Richard Bronson, Gabriel B. Costa, Linear Algebra-an introduction, 2nd edition, Academic press, 2007
2. Erwin Kreyszig, Advanced Engineering Mathematics, 10thEdition, John Wiley & Sons, 2016.
3. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 44th Edition, 2018.

References
1. Peter V. O'Neil, Advanced Engineering Mathematics, Cengage, 7th Edition, 2012
2. Gilbert Strang, Linear Algebra and It's Applications, 4th edition, Cengage Learning, 2006
3. Seymour Lipschutz, Marc Lipson, Schaum's outline of linear algebra, 3rd Ed., Mc Graw Hill Edn.2017
4. David C Lay, Linear algebra and its applications,3rd edition, Pearson
5. Prof. Premananda Bera, Advanced Linear Algebra, IIT Roorkee, [NPTEL], https://nptel.ac.in/courses/111107164 (Relevant sections)
6. Prof. Gilbert Strang, Linear Algebra [MITOPENCOURSEWARE], Massachusetts Institute of Technology, https://ocw.mit.edu/courses/18-06-linear-algebra-spring-2010/ (Relevant sections)

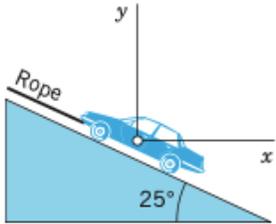| No.		No. ofHours [45 hours]
COURSE CONTENTS AND LECTURE SCHEDULE		
MODULE 1 [9 hours]		
1.1	Defining of vector spaces	1
1.2	Vector space examples	1
1.3	Subspaces	1
1.4	Linear dependence and independence	1
1.5	Basis and dimension	1
1.6	Basis and dimension(continued)	1
1.7	Co-ordinate representation	1
1.8	Row space, column space	1
1.9	Row space, column space(continued)	1
MODULE II [9 hours]		
2.1	Inner Product: inner product spaces	1
2.2	Inner Product: inner product spaces(continued)	1
2.3	Properties of inner product	1
2.4	Length and distance	1
2.5	Cauchy-Schwarz inequality	1
2.6	Orthogonality, Orthogonal complement	1
2.7	Orthonormal bases	1
2.8	Gram Schmidt orthogonalization process	1
2.9	Orthogonal projection	1
MODULE III [9 hours]		
3.1	Complex function, limit	1
3.2	Continuity of complex functions	1
3.3	Derivatives of complex functions	1
3.4	Analytic functions	1
3.5	Cauchy-Riemann equations	1
3.6	Cauchy-Riemann equations(continued)	1
3.7	Harmonic functions	1
3.8	Finding harmonic conjugate	1
3.9	Finding harmonic conjugate(continued)	1
MODULE IV [9 hours]		
4.1	Cauchy integral theorem (without proof) on simply connected domain	1
4.2	Cauchy Integral formula (without proof)	1
4.3	Cauchy Integral formula for derivatives of analytic functions	1
4.4	Taylor's series and Maclaurin series	1
4.5	Laurent series	1

4.6	Poles and Residues	1
4.7	Evaluation of residues	1
4.8	Evaluation of residues (continued)	1
4.9	Cauchy's residue theorem	1
MODULE V [9 hours]		
5.1	Introduction to Partial differential equations	1
5.2	Formation of partial differential equations Elimination of arbitrary constants	1
5.3	Formation of partial differential equations -Elimination of arbitrary functions	1
5.4	Solutions of partial differential equations	1
5.5	Equations solvable by direct integration	1
5.6	Equations solvable by direct integration(continued)	1
5.7	Linear equations of the first order- Lagrange's linear equation	1
5.8	Linear equations of the first order- Lagrange's linear equation(continued)	1
5.9	Linear equations of the first order- Lagrange's linear equation(continued)	1

LESSON PLAN FOR LAB COMPONENT

No.	Topic	No. of Hours	Experiment
1.	Linearly independence and dependence	2	Check the Linearly independence and dependence
2	Vector space	3	Finding basis, dimension of vector spaces
		3	Finding row space and column space
3	Inner product	2	Inner product: length and distance
4	Orthogonality	2	Finding orthogonal compliment
		2	Finding orthogonal projection
5	Line integral	2	Evaluating complex line integral
6	Taylor's and Maclaurin series	3	Evaluating Taylor's and Maclaurin series of functions
7	Solution of PDE	3	Solution of Lagrange's Linear Differential Equation

CO Assessment Questions	
1	1. Consider a three-phase power system with three phase voltages: V1 = 100∠0° V, V2 = 100∠-120° V, and V3 = 100∠120° V. (V1 = 100∠0° indicates that the first phase voltage in the system has a magnitude of 100 volts and a phase angle of 0 degrees) These voltages represent the three phases of a balanced power system. Show that the set of phase voltages forms a basis for the vector space of complex numbers C.

Determine the dimension of the vector space spanned by the three phase voltages. Given a complex number Z = 50 + j50, express it as a linear combination of the phase voltages V1, V2, and V3.

2. Using CAS, determine the basis vectors and the dimension of a vector space spanned by a given set of vectors?

3. **Team Work**: Consider a linear circuit with three electrical components: R1, L1, and C1. The impedance of R1 is 10 Ω, the impedance of L1 is j20 Ω, and the impedance of C1 is -j30 Ω. Define a vector space V that represents all possible combinations of the three impedances (R1, L1, C1). Show that V forms a vector space. Determine the dimension of the vector space V and provide an interpretation in the context of the circuit.

2	1. Explain how the Gram-Schmidt orthogonalization process can be applied to orthogonalize a set of non-orthogonal vectors. Discuss the steps involved in the process and the significance of obtaining orthogonal vectors in signal processing applications. 2. What force in the rope in Figure will hold a car of 5000 lb in equilibrium if the ramp makes an angle of 25° with the horizontal? Verify your answer using CAS 3. **Team Work**: Explore applications of orthogonal projection in different fields, such as engineering, physics, or computer science. Choose one application and explain how orthogonal projection is utilized to solve a specific problem in that field, using the CAS to demonstrate the calculations if applicable.
3	1. You are analyzing the flow of fluid in a river, and you want to understand the behavior of the velocity field. The velocity of the fluid is described by a complex function, where the real part represents the horizontal component and the imaginary part represents the vertical component. Apply the Cauchy-Riemann equations to determine the conditions under which the fluid flow is both irrotational (zero curl) and incompressible (zero divergence). 2. You are analyzing the flow of heat in a two-dimensional object, and the temperature distribution within the object is described by a harmonic function. For a particular case, let's consider a rectangular metal plate where the temperature distribution is given by $T(x, y) = sin(x)cos(y)$, where (x, y) represents the spatial coordinates. Find the harmonic

	conjugate of the temperature function $T(x,y)$ and determine the streamlines of heat flow based on the harmonic conjugate. Verify the answer using CAS 3. **Team Work:** What are the critical points and equivalent resistances of a resistor with a nonlinear resistance described by the equation $R = a\|z\|^2 + b\|z\| + c$, where 'a', 'b', and 'c' are constants and 'z' is a complex variable representing the voltage across the resistor? Use complex differentiation to analyze the behavior of the resistor and find the critical points by differentiating the resistance equation with respect to 'z' and setting it equal to zero. Finally, substitute the critical points back into the resistance equation to determine the corresponding equivalent resistances.
4	1. In the study of a particle's motion along a curve, you aim to approximate the position function $x(t) = t^3 - 2t^2 + 3t - 1$ using a Taylor series expansion. Determine the Taylor series expansion of x(t) around t = 2 and use it to approximate the position of the particle at t = 2.2 up to the second-degree term. 2. The Maclaurin series $\frac{z}{e^z - 1} = 1 + B_1 z + \frac{B_2}{2!} z^2 + \frac{B_3}{3!} z^3 + \cdots$ defines the Bernoulli numbers B_n. Using undetermined coefficients, show that $B_1 = \frac{-1}{2}, B_2 = \frac{1}{6}, B_3 = 0, B_4 = -\frac{1}{30}, B_5 = 0, B_6 = \frac{1}{42}$. Write a program for computing B_n using CAS. 3. **Team Work**: Research and find real-world applications of complex integration using the Cauchy Residue Theorem. Present your findings in a concise report or presentation, highlighting the applications and explaining how the theorem is used in each case.
5	1. How does the temperature distribution change over time in a metal rod as heat is conducted through it, and how long does it take for the rod to reach a specific temperature at a given location? 2. Verify that each u satisfies $\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} = f(x,y)$ with $f(x,y)$ as indicated using CAS (a)$u = \frac{y}{x}$ and $f = \frac{2y}{x^3}$ (b)$u = \sin(xy)$ and $f = (x^2 + y^2)\sin xy$. 3. **Team Work**: A tightly stretched string with fixed end points $x = 0$ and $x = l$ is initially in a position given by $y = y_0 \sin^3\left(\frac{\pi x}{l}\right)$. if it is released from rest, find the displacement $y(x,t)$.

24EST342	OBJECT ORIENTED PROGRAMMING AND DATA STRUCTURES	L	T	P	J	S	C	Year of Introduction
		1	0	2	0	3	2	2024

Preamble: This course provides an introduction to object-oriented programming paradigm and data structures using Java. It covers the principles of object-oriented programming and fundamental data structures algorithms. Emphasis is placed on practical implementation and problem-solving using Java.

Prerequisite:
24ESP204 Problem Solving & Programming

Course Outcomes: After the completion of the course the student will be able to

CO 1	Implement classes and objects to model real-world entities. (Understand Level)
CO 2	Apply inheritance to create class hierarchies and use polymorphism to write flexible and reusable code. (Apply Level)
CO 3	Implement interfaces and abstract classes to facilitate code reuse and achieve design flexibility. (Apply Level)
CO 4	Implement linear data structures - arrays, Linked Lists, Stacks and Queues - in JAVA. (Apply Level)
CO 5	Implement sorting algorithms **-** Selection Sort, Insertion Sort, Quick Sort, and Merge Sort. (Apply Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	✓				✓							
CO 2	✓				✓							
CO 3	✓				✓							
CO 4	✓				✓							
CO 5	✓				✓							
CO 6	✓				✓							
CO 7	✓				✓							

Assessment Pattern for Theory Component

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓		✓	✓
Understand	✓		✓	✓
Apply	✓		✓	✓
Analyse				
Evaluate				
Create				

Assessment Pattern for Lab Component

Bloom's Category	Continuous Assessment Tools	
	Class work	Test1
Remember		

Understand		✓	✓
Apply		✓	✓
Analyse			
Evaluate			
Create			
Mark Distribution of CIA			

Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Practical [P]		Total Marks
		Assignment	Test-1	Test-2	Class work	Lab Exam	
1-0-2-0	**5**	**10**	**20**	**-**	**25**	**40**	**100**

Total Marks Distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	100	-	-
SYLLABUS (14 Hours)			

MODULE I : OOP (3 Hours)

Concepts of OOP – Introduction to OOP, Principles of OOP, Benefits and applications of OOP.
Programming with JAVA – Features of Java, The Java Virtual Machine (JVM), Parts of Java program
Classes - Objects and methods, Constructors.

MODULE II : Overloading and Inheritance (3 Hours)

Method Overloading, Abstract Method and Abstract Class.
Inheritance – Multilevel Inheritance, Multiple Inheritance, Hierarchical Inheritance.

MODULE III : Exception Handling (2 Hours)

Exception Handling: Errors in Java Program, Exceptions, throws Clause, throw Clause. Overriding Methods, Multithreaded programming.

MODULE IV : Data Structure (3 Hours)

Linear arrays, Traversing linear arrays, Insertion into an array, Deletion from an array
Linked Lists, Representation of Linear Lists in memory, Traversing a Linked List, Searching a linked List, Insertion into a linked list, Deletion from linked list, Applications.

MODULE V : Stacks and Queues (3 Hours)

Stacks : Definition, Array representation of stacks, Linked representation of stacks, Insertion into a stack (PUSH), Deletion from stack (POP)
Queues : Definition, Array representation of Queues, Linked representation of Queues, Insertion into a queue, Deletion from queue

	Sorting Techniques – Selection Sort, Insertion Sort, Quick Sort, and Merge Sort.	

Text books

1. E. Balagurusamy, Object Oriented Programming with C++ and JAVA, McGrawHill
2. Samanta D., Classic Data Structures, Prentice Hall India.
3. Yashwant P. Kanetkar, Data Structures, 2/e, BPB Publications, 2003.

Reference books

1. Deitel, Harvey M., and Paul J. Deitel., Java how to program.,7th International edition." (2007): 390-420.
2. Samanta, Debasis, Object-Oriented programming with C++ and Java, PHI Learning Pvt. Ltd., 2006.
3. Tremblay J. P. and P. G. Sorenson, Introduction to Data Structures with Applications, Tata McGraw Hill.
4. https://www.coursera.org/learn/object-oriented-java

<table>
<tr><th colspan="3" align="center">COURSE CONTENTS AND LECTURE SCHEDULE</th></tr>
<tr><td>No.</td><td></td><td>No. of Hours</td></tr>
<tr><td colspan="3" align="center">MODULE 1</td></tr>
<tr><td>1.1</td><td>Concepts of OOP – Introduction to OOP, Procedural Vs. Object Oriented Programming. Overview of Java Language and environment - JVM, JDK, JRE.</td><td>1</td></tr>
<tr><td>1.2</td><td>Principles of OOP, Benefits and applications of OOP.</td><td>1</td></tr>
<tr><td>1.3</td><td>Classes, Objects and Methods, Constructors and Destructors.</td><td>1</td></tr>
<tr><td colspan="3" align="center">MODULE II</td></tr>
<tr><td>2.1</td><td>Operator Overloading – Overloading Unary and Binary Operators, Method Overloading</td><td>1</td></tr>
<tr><td>2.2</td><td>Inheritance – Multilevel Inheritance, Multiple Inheritance, Hierarchical Inheritance.</td><td>1</td></tr>
<tr><td>2.3</td><td>Inheritance – Multilevel Inheritance, Multiple Inheritance, Hierarchical Inheritance.</td><td>1</td></tr>
<tr><td colspan="3" align="center">MODULE III</td></tr>
<tr><td>3.1</td><td>Exception Handling: Errors in Java Program, Exceptions, throws Clause, throw Clause.</td><td>1</td></tr>
<tr><td>3.2</td><td>Overriding Methods, Multithreaded programming.</td><td>1</td></tr>
<tr><td colspan="3" align="center">MODULE IV</td></tr>
<tr><td>4.1</td><td>Linear arrays, Traversing linear arrays, Insertion into an array, Deletion from an array, Binary search.</td><td>1</td></tr>
<tr><td>4.2</td><td>Linked Lists, Representation of Linear Lists in memory, Traversing a Linked List, Searching a linked List</td><td>1</td></tr>
</table>

4.3	Insertion into a linked list, Deletion from linked list, Applications.	1
MODULE V		
5.1	Stacks: Definition, Array representation of stacks, Linked representation of stacks, Insertion into a stack (PUSH), Deletion from stack (POP).	1
5.2	Queues : Definition, Array representation of Queues, Linked representation of Queues, Insertion into a queue, Deletion from queue.	1
5.3	Sorting Techniques – Selection Sort, Insertion Sort, Quick Sort, and Merge Sort.	1

LESSON PLAN FOR LAB COMPONENT

No.	Topic	No. of Hours	Experiment
1	Basics Java Programming	1	Check whether a number is prime or not. Check whether a number is Armstrong or not.
		1	Methods and Recursion
2	Implementing Classes and Objects	1	Simple Program using classes and Objects
		1	Program using classes and Objects
3	Method Overloading	1	Overloading by changing the Number of Parameters
		1	Overloading by changing Data Types of the Arguments.
		1	Overloading by changing the Order of the Parameters of Methods
4	Inheritance	1	Single and Multilevel Inheritance
		1	Hierarchical Inheritance and Multiple Inheritance

		1	Hybrid Inheritance
5	Interface, Overriding	1	Abstract Class.
		1	Basic programs to override a method
6	Multithreading	1	Programs using thread and multithreading
7	Arrays	1	Insertion and Deletion
		1	Binary Search
8	Linked List	1	Implementation and Search for an element
		1	Insertion and Deletion
9	Stack and Queue	1	Implementation using Linked list
		1	Insertion and Deletion

	CO Assessment Questions
1	1. How do objects relate to classes in object-oriented programming? 2. Describe a real-world entity (e.g., a car, a bank account). How would you design a class to represent this entity?
2	1. Write an example of a superclass and a subclass relationship utilizing the concept of inheritance. Explain how it helped in code reusability.
3	1. Write an example of an abstract class in Java and explain how it can be extended and implemented. 2. Explain the concept of abstract methods and how they contribute to code reuse and flexibility.
4	1. Write a JAVA program to search an element from an array using binary search. 2. Write a JAVA program to insert and an element into linked List.
5	1. Write a JAVA program to insert and an element into a stack. 3. Write a JAVA program to insert and an element into a queue.

24ECJ303	LOGIC CIRCUIT DESIGN		L	T	P	J	S	C	Year of Introduction
			2	0	2	2	5	5	2024

Preamble: Course aims to impart the basic knowledge of logic circuits and enable students to apply it to design combinational and sequential circuits and eventually a digital system. The design can be implemented using an industry compatible hardware description language on FPGA boards.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO 1	Perform binary and hexadecimal number system conversions, arithmetic, and various binary codes. (Apply Level)
CO 2	Realize combinational logic functions using logic gates/multiplexers. (Apply Level)
CO 3	Design sequential logic circuits using flip-flops. (Apply Level)
CO 4	Design an FSM system for the given specification. (Apply Level)
CO 5	Design and implement combinational and sequential logic circuits using Verilog models and implement the same on FPGA board. (Apply Level)
CO 6	Design and implement a digital circuit for specific application and prepare a brief report. (Analyze Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	✓											
CO 2	✓	✓		✓						✓		
CO 3	✓	✓		✓						✓		
CO 4	✓	✓										
CO 5	✓	✓		✓	✓					✓		
CO 6	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓

Assessment Pattern for Theory Component

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				
Create				

Assessment Pattern for Lab Component		
Bloom's Category	**Continuous Assessment Tools**	
	Class work	**Test1**
Remember		
Understand	✓	✓
Apply	✓	✓
Analyse		
Evaluate		
Create		

Assessment Pattern for Project component			
Bloom's Category	**Continuous Assessment Tools**		
	Evaluation 1	**Evaluation 2**	**Report**
Remember			
Understand	✓	✓	
Apply	✓	✓	
Analyse	✓	✓	
Evaluate			
Create			

Mark Distribution of CIA

Course Structure [L-T-P-J]	Attendance	Theory [L- T]		Practical [P]	Project [J]			Total Marks
		Assignment	Test-2	Class work	Evaluation 1	Evalaution-2	Report	
2-0-2-2	5	10	15	10	5	10	5	**60**

Total Marks Distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
	60	40	2.5 Hours

End Semester Examination [ESE]: Pattern			
PATTERN	**PART A**	**PART B**	**ESE Marks**
PATTERN 2		2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x 8 = 40 marks) Time: 2.5 hours	40
	Total Marks: 0	Total Marks: [5x8 = 40 marks]	

SYLLABUS (24 Hours)

MODULE I: Number Systems and Codes (6 Hours)

Binary and hexadecimal number systems: Methods of base Conversions, Binary arithmetic.

Representation of signed numbers: Fixed- and floating-point numbers, Binary coded decimal codes, Gray codes, Excess 3 code. Alphanumeric codes, ASCII. (Binary, octal and hexadecimal arithmetic: to be given as assignment)

Verilog basic language elements: identifiers, data objects, scalar data types, operators.

MODULE II : Boolean Postulates and Fundamental Gates (5 Hours)

Boolean postulates and laws – De-Morgan's Theorems, Principle of Duality. Logic Functions and Gates, Minimization of Boolean expressions, Sum of Products (SOP), Product of Sums (POS). Canonical forms, Karnaugh map Minimization (up to 5 variable)

Verilog: Entity and Architecture, Gate Level Modeling: Basic gates, test bench, XOR using NAND and NOR.

MODULE III : Combinational and Arithmetic Circuits (3 Hours)

Combinatorial Logic Systems - Multiplexers, Demultiplexers, Comparators, Encoder, Decoder, Half and Full Adders, Subtractors.

Modeling combinational logic circuits in Verilog - Data Flow Modelling, Behavioral level Modeling: half adder, full adder, mux, demux, decoder, encoder.

MODULE IV : Sequential Logic Circuits (5 Hours)

Latches: SR Latch, Flip Flops: S-R, JK and Master-Slave JK, D, T Conversion of Flipflops (Conversion from JK to D Flip Flop), Excitation table and characteristic equation. Shift registers-SIPO, SISO, PISO, PIPO (Block diagram representation).

Asynchronous and Synchronous counters: Modulo N counter using D flip-flop.

Modeling of sequential logic circuits in Verilog: flip-flops, counters. Assignment on Conversion of Flip-flop, Random Sequence Generator.

MODULE V : Finite State Machines and Logic families (5 Hours)

Finite state machine: Mealy and Moore models, notations, state diagram, state transition table, excitation table, state equations.

Electrical characteristics of logic gates – logic levels and noise margins, fan -in, fan-out, propagation delay, transition time, power consumption and power- delay product.

Introduction to logic families: CMOS, LVCMOS, LVDS (Basics only) Comparison of electrical characteristics of CMOS, LVCMOS, LVDS logic families.

Text books
1. Mano M.M., Ciletti M.D., "Digital Design", Pearson India, 4th Edition. 2006
2. D.V. Hall, "Digital Circuits and Systems", Tata McGraw Hill,
3. S. Brown, Z. Vranesic, "Fundamentals of Digital Logic with Verilog Design", McGraw Hill
4. Samir Palnikar "Verilog HDL: A Guide to Digital Design and Synthesis", Sunsoft Press
5. R.P. Jain, "Modern digital Electronics", Tata McGraw Hill, 4th edition, 2009

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

No.	COURSE CONTENTS AND LECTURE SCHEDULE	No. of Hours
	MODULE I	
1.1	Introduction to number system: Binary and hexadecimal number systems; Methods of base Conversions.	1
1.2	Representation of signed numbers; Binary arithmetic	1
1.3	Fixed- and floating-point numbers	1
1.4	Binary coded decimal codes, Gray codes, Excess 3 code, Alphanumeric codes, ASCII.	1
1.5	Verilog basic language elements: identifiers, data objects	1
1.6	Verilog basic language elements: scalar data types, operators.	1
	MODULE II	
2.1	Boolean postulates and laws – Logic Functions and Gates.	1
2.2	De-Morgan's Theorems, Principle of Duality.	1
2.3	Minimization of Boolean expressions, Sum of Products (SOP).	1
2.4	Minimization of Boolean expressions, Product of Sums (POS)	1

2.5	Canonical forms, Karnaugh map Minimization	1
2.6	Verilog: Entity and Architecture, Gate Level Modeling: Basic gates, introduction to test bench.	1
2.7	Verilog implementation of XOR using NAND and NOR	1
MODULE III		
3.1	Combinatorial Logic Systems - Multiplexers, Demultiplexers.	1
3.2	Combinatorial Logic Systems - Comparators, Encoder, Decoder	1
3.3	Combinatorial Logic Systems -Half and Full Adders, Subtractors	1
3.4	Modeling combinational logic circuits in Verilog - Data Flow Modeling, Behavioral level Modeling: half adder, full adder, mux, demux, decoder, encoder.	1
3.5	Modeling combinational logic circuits in Verilog - Data Flow Modeling, Behavioral level Modeling: mux, demux, decoder, encoder.	1
MODULE IV		
4.1	Latches: SR latch, Flipflops: S-R	1
4.2	JK and Master-Slave JK FF, D & T Flipflops	1
4.3	Conversion of Flipflops, Excitation table and characteristic equation.	1
4.4	Shift registers-SIPO, SISO, PISO, PIPO.	1
4.5	Asynchronous and Synchronous counters design-Mod N counter using D flipflop.	1
4.6	Modeling of sequential logic circuits in Verilog: flipflops, counters.	1
MODULE V		
5.1	Finite state machine: Mealy and Moore models, notations, state diagram, state transition table, excitation table, state equations.	1
5.2	Finite state machine: Mealy and Moore models, notations, state diagram, state transition table, excitation table, state equations.	1
5.3	Design of Sequence Detector	1
5.4	Electrical characteristics of logic gates – logic levels and noise margins, fan -in, fan-out, propagation delay, transition time, power consumption and power-delay product.	1
5.5	Introduction to logic families: CMOS, LVCMOS, LVDS (Basics only). Comparison of electrical characteristics of CMOS, LVCMOS, LVDS logic families.	1

LESSON PLAN FOR LAB COMPONENT

No.	Topic	No. of Hours	Experiment
1	Realization of functions and Combinational circuits	5	1. Realization of functions using basic and universal gates (SOP and POS forms). 2. Realization of combinational circuits using MUX & DEMUX. 3. Random Sequence generator using LFSR.
2	Realization of sequential circuits	4	1. Synchronous and Asynchronous MOD N counter using D Flipflop 2. Realization of counters using IC's (7490, 7492, 7493).
3	Combinational circuits Implementation using verilog	3	1. Adders, Subtractors, 2. MUX and DEMUX. 3. Code converter 4. Encoder and Decoder
4	Sequential circuits Implementation using verilog	4	1. SR, JK, T and D flipflops. 2. MOD N Synchronous Counter 3. Johnson/Ring counters 4. Shift Registers
5	Familiarization of FPGAs	1	1. Familiarization of a small FPGA board and its ports and interface. 2. Create the pdf files for your FPGA board.
6	Implementation of Combinational Circuits in FPGA	3	1. Logic Gates 2. MUX and DEMUX 3. Counter/ Register

PROJECT:

The project should be a standalone one or the integration of different components pertaining to the syllabus content of the course. It can be a product or a simulation work, preferably a socially relevant or industry relevant topic. The project can be done in a group with a maximum of 4 student members. A project report has to be submitted at the end of the course.

Project Schedule

Presentation of the project proposal	4 Hours
Design verification (Evaluation I)	8 Hours
Final Presentation (Evaluation II)	8 Hours

CO Assessment Questions	
1	1. Consider the signed binary numbers A = 01000110 and B = 11010011 where B is in 2's complement form. Find the value of the following mathematical expression (i) A + B (ii) A-B 2. Perform the following operations (i)$D9CE_{16}$-$CFDA_{16}$ (ii) 6575_8-5732_8 3. Convert decimal 6,514 to both binary and hexadecimal numbers.
2	1. Design a magnitude comparator to compare two 2-bit numbers A = A_1A_0 and B = B_1B_0B 2. Simplify using K-map F(a,b,c,d) = Σ (4,5,7,8,9,11,12,13,15) 3. Explain the operation of a 8x1 multiplexer and implement the following using an 8x1 multiplexer F(A, B, C, D) = Σ m (0, 1, 3, 5, 6, 7, 8, 9, 11, 13, 14)
3	1. Design a MOD 6 asynchronous counter using JK Flip Flop. 2. Draw the logic diagram of 3 bit PIPO shift register with LOAD/SHIFT control and explain its working.
4	1. Design a mealy machine that scans sequence of input of 0 and 1 and generates output 'A' if the input string terminates in 00, output 'B' if the string terminates in 11, and output 'C' otherwise.
5	1. Realize an 8X1 MUX in Verilog and implement the same in FPGA.
6	1. Implementation of a project in the domain: Eg: Design and implementation of Vending machine

24ECT304	SEMICONDUCTOR DEVICES	L	T	P	J	S	C	Year of Introduction
		2	1	0	0	2	3	2024

Preamble: The aim of this course is to provide an insight into the physics behind semiconductor devices. The course covers topics including carrier concentration and transport in semiconductors, PN junction and MOS devices and effects of MOSFET scaling. The course will help the students to understand and analyze the operation of semiconductor devices.

Prerequisite: 24PYP102 Engineering Physics

Course Outcomes: After the completion of the course the student will be able to

CO 1	Compute carrier concentration at equilibrium and the parameters associated with generation and recombination of excess carriers. (Understand Level)
CO 2	Explain the carrier transport mechanism and compute the corresponding current densities. (Understand Level)
CO 3	Define the current components and analyze the effect of various parameters in the current of a PN junction diode and bipolar junction transistor. (Apply Level)
CO 4	Explain the physics of MOS structure and compute the current and related parameters of MOSFET. (Apply Level)
CO 5	Explain the effect of scaling in MOSFETs and the short channel effects. (Understand Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	✓	✓										
CO 2	✓	✓										
CO 3	✓	✓							✓	✓		
CO 4	✓	✓			✓							✓
CO 5	✓											

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓		✓
Understand	✓	✓		✓
Apply		✓		✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA

Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
2-1-0-0	5	15	10	10	**40**

Total Mark Distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 Hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS (33 Hours)

MODULE I : Basic semiconductor theory (7 Hours)

Basic semiconductor theory: Concept of Fermi level, Fermi level in intrinsic and extrinsic semiconductors, Equilibrium concentration of electrons and holes, Charge neutrality equation, Temperature dependence of carrier concentration

Compound semiconductors, Direct and indirect band gap semiconductors, non-equilibrium condition, Generation and recombination mechanism of excess carriers, carrier life time, quasi-Fermi level.

MODULE II : Carrier transport in semiconductors (5 Hours)

Drift current equation, conductivity, mobility, variation of mobility with temperature and doping

Diffusion current equation, Einstein relations, Poisson equations, Continuity equations, Diffusion length.

MODULE III : PN Junctions (9 Hours)
PN junction at equilibrium, Energy band diagram, Contact potential, Electrical Field, Biasing and Energy band diagrams, minority carrier distribution, Ideal diode equation, piecewise linear model of a diode. 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. High electron mobility transistor (HEMT)- structure & working.
MODULE IV : MOS Structure (6 Hours)
Ideal MOS capacitor, band diagrams at equilibrium, accumulation, depletion and inversion, threshold voltage, CV characteristics, Real MOS structure. MOSFET- structure, types, Drain current equation- linear and saturation region, Drain characteristics, transfer characteristics.
MODULE V : MOSFET scaling (6 Hours)
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. Physical operation of special diodes (LED, Solar cell, photo diode)

Text books
1. Ben G. Streetman and Sanjay Kumar Banerjee, Solid State Electronic Devices, Pearson 6/e, 2010.
2. Sung Mo Kang, CMOS Digital Integrated Circuits: Analysis and Design, McGraw-Hill, 3/e, 2002.

Reference books
1. Pierret, Semiconductor Devices Fundamentals, Pearson, 2006
2. Donald A Neaman, Semiconductor Physics and Devices, McGraw Hill, 4/e, 2012
3. Sze S.M., Semiconductor Devices: Physics and Technology, John Wiley, 3/e, 2005
4. Yannis Tsividis, Operation and Modelling of the MOS Transistor, Oxford University Press.
5. MOOC on Solid State Devices by NPTEL, https://archive.nptel.ac.in/courses/117/106/117106091/

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
MODULE 1		
1.1	Basic semiconductor theory: Concept of Fermi level, Fermi level in intrinsic and extrinsic semiconductors.	1
1.2	Equilibrium concentration of electrons and holes, Charge neutrality equation	1
1.3	Temperature dependence of carrier concentration	1
1.4	Compound semiconductors.	1
1.5	Direct and indirect band gap semiconductors, non-equilibrium condition	1
1.6	Generation and recombination mechanism of excess carriers – Types of excitations, fast and slow recombination mechanisms.	1
1.7	Carrier lifetime, Steady state carrier generation - excess carrier concentration, quasi fermi level.	1
MODULE II		
2.1	Carrier transport in semiconductors, drift current equation, conductivity and mobility.	1
2.2	Variation of mobility with temperature and doping.	1
2.3	Diffusion current equation	1
2.4	Einstein relations, Poisson equations	1
2.5	Continuity equations, Diffusion length	1
MODULE III		
3.1	PN junctions: PN junction at equilibrium, Energy band diagram,	1
3.2	PN junctions: Contact potential, Electrical Field.	1
3.3	Biasing and Energy band diagrams, minority carrier distribution	1
3.4	Ideal diode equation, piecewise linear model of a diode.	1
3.5	Metal Semiconductor contacts, Electron affinity and work function, and Rectifying Contacts,	1
3.6	Metal Semiconductor contacts: Ohmic contact, current voltage characteristics.	1
3.7	Bipolar junction transistor, current components, Transistor action, Base width modulation.	1
3.8	Terminal currents in BJT	1
3.9	High electron mobility transistor (HEMT)- structure & working.	1
MODULE IV		
4.1	Ideal MOS capacitor, band diagrams at equilibrium, accumulation, depletion and inversion, Threshold voltage	1

4.2	CV characteristics of MOS	1
4.3	Real MOS structure	1
4.4	MOSFET- structure, types	1
4.5	Drain current equation- linear and saturation region	1
4.6	Drain characteristics, transfer characteristics.	1
MODULE V		
5.1	MOSFET scaling – need for scaling, constant voltage scaling and constant field scaling.	1

5.2	Sub threshold conduction in MOS.	1
5.3	Short channel effects- Channel length modulation, Drain Induced Barrier Lowering.	1
5.4	Short channel effects- Velocity Saturation, Threshold Voltage Variations and Hot Carrier Effects.	1
5.5	Non-Planar MOSFETs: Fin FET –Structure, operation and advantages	1
5.6	Special diodes: LED, Solar cell, Photo diode	1

CO Assessment Questions	
1	Assume Si at T = 300K, doped with arsenic at N D = 1016 cm-3. Make reasonable assumptions and answer the following questions. a) Compute the density of electrons in the conduction band. b) Compute the location of the Fermi-level. c) Compute the fraction of the dopants that are ionized. d) Compute the density of holes in the valence band.
2	In an n-type semiconductor bar, there is an increase in electron concentration from left to right and an electric field pointing to the left. With a suitable sketch, indicate the directions of the electron drift and diffusion current flow and explain the reason. If we double the electron concentration everywhere, what happens to the diffusion current and the drift current? If we add a constant concentration of electrons everywhere, what happens to the drift and diffusion currents? Explain your answers with appropriate equations.

3	1. Consider the impact of changing some key BJT device parameters on some key figures of merit. For each of the 5 changes below, explain where the change increases, decreases, or has no effect on: i) the base transport factor, α_T , ii) the emitter injection efficiency , and iii) the current gain, β_{DC}
	    a) Increase the base width.
	    b) Increase the base lifetime.
	    c) Increase the base doping.
	    d) Increase the emitter doping.
	2. Perform a role play to illustrate the different current components in a

	pnp transistor.
4	1. Simulate the Drain characteristics of an NMOS. Calculate the transconductance in the linear region and saturation region. For the same NMOS, reduce the drain current by 50% by varying the length of the device. Observe the variation in the different parameters of the MOSFET and justify your observations.
5	1. Explain the effect of constant field scaling on MOSFET parameters. 2. Illustrate any two short channel effects associated with scaling down of MOSFETS.

24ECT305	NETWORK THEORY	L	T	P	J	S	C	Year of Introduction
		2	1	0	0	2	3	2024

Preamble: Network Theory is a fundamental course that explores the principles and techniques used to analyze circuits and networks. This course covers a wide range of topics, from basic circuit elements to advanced network theorems. This Course provides tools and methodologies necessary to comprehend, model, and predict the behavior of electrical networks in both the time and frequency domains.

Prerequisite: 24EST104 Fundamentals of Electrical Engineering.

Course Outcomes: After the completion of the course the student will be able to

CO 1 Apply the mesh analysis and nodal analysis of circuits with dependent and independent sources (Apply Level)

CO 2 Apply network theorems for analyzing ac and dc networks (Apply Level)

CO 3 Analyze circuits in Laplace domain (Apply Level)

CO 4 Analyze the pole zero plots for various transfer function (Apply Level)

CO 5 Determine parameters of two port network (Apply Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	✓	✓										
CO 2	✓	✓										
CO 3	✓	✓										
CO 4	✓	✓										
CO 5	✓	✓										

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓		✓
Understand	✓	✓		✓
Apply	✓	✓		✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA

Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
2-1-0-0	5	15	10	10	40

Total Mark distribution			
Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 Hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I : Mesh and Node Analysis (8 Hours)

Introduction to Network Theory: Current Division, Voltage Division, Source Conversion, Star Delta Conversion.
Mesh and node analysis of networks containing independent and dependent sources. Steady-state AC analysis using Mesh and Node analysis.

MODULE II : Network Theorems (9 Hours)

Network Theorems: Thevenin's theorem, Norton's theorem, Superposition theorem, Maximum power transfer theorem (applied to both dc and ac circuits having dependent and independent source).

MODULE III : S domain Analysis (6 Hours)

Review of Laplace Transforms and Inverse Laplace Transforms, Singularity functions, Initial value theorem & Final value theorem, Transient analysis of RL, RC, and RLC networks with impulse, step and exponential inputs. Analysis of networks with transformed impedance and dependent sources.

MODULE IV : Network functions (7 Hours)

Network functions for the single port and two port networks. Properties of driving point and transfer functions, Concept of complex frequency, 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.

MODULE V : Two port network (7 Hours)
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.

Text books
1. Ravish R., Network Analysis and Synthesis, 2/e, McGraw-Hill, 2015.
2. Valkenburg V., Network Analysis, 3/e, PHI, 2011

Reference books
1. Sudhakar A. S. P. Shyammohan, Circuits and Networks- Analysis and Synthesis, 5/e, McGrawHill, 2015.
2. Choudhary R., Networks and Systems, 2/e, New Age International, 2013.
3. Franklin F. Kuo, Network Analysis and Synthesis, 2/e, Wiley India, 2012.
4. A William Hayt, "Engineering Circuit Analysis" 8th Edition, McGraw-Hill Education
5. Ashfaq Husain, Networks and Systems, Khanna Book Publishing, 2021.
6. Edminister, Electric Circuits – Schaum's Outline Series, McGraw-Hill,2009
7. NPTEL Course on Network Analysis by Prof. Tapas Kumar Bhattacharya, IIT Kharagpur. https://onlinecourses.nptel.ac.in/noc22_ee07/preview

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
MODULE 1		
1.1	Mesh analysis of network containing dependent sources.	1
1.2	Mesh analysis of network containing independent sources	1
1.3	Node analysis of network containing dependent sources	1
1.4	Node analysis of network containing independent sources	1
1.5	Supermesh analysis	1
1.6	Supernode analysis	
1.7	Steady-state AC analysis using Mesh analysis	1
1.8	Steady-state AC analysis using Node analysis.	1
MODULE II		
2.1	Superposition theorem applied to dc circuits having dependent and independent source	
2.2	Thevenin's theorem applied to dc circuits having dependent and independent source.	1
2.3	Norton's theorem applied to dc circuits having dependent and independent source.	1
2.4	Maximum power transfer theorem applied to dc circuits having dependent and independent source.	1
2.5	Superposition theorem applied to ac circuits having dependent and independent source	1

2.6	Thevenin's theorem applied to ac circuits having independent source.	1
2.7	Thevenin's theorem applied to ac circuits having dependent source.	
2.8	Norton's theorem applied to ac circuits having dependent and independent source.	1

2.9	Maximum power transfer theorem applied to ac circuits having dependent and independent source.	1
MODULE III		
3.1	Review of Laplace Transforms and Inverse Laplace Transforms	1
3.2	Singularity functions	1
3.3	Initial value theorem & Final value theorem	1
3.4	Transient analysis of RL, RC, with impulse, step and exponential inputs.	1
3.5	Transient analysis of RLC networks with impulse, step and exponential inputs.	1
3.6	Analysis of networks with transformed impedance and dependent sources.	1
MODULE IV		
4.1	Network functions for the single port and two port networks. Properties of driving point and transfer functions.	1
4.2	Significance of Poles and Zeros of network functions	1
4.3	Concept of Complex Frequency	1
4.4	Time domain response from pole zero plot	1
4.5	Impulse Function & Response	
4.6	Network functions in the sinusoidal steady state	1
4.7	Magnitude and Phase response	1
MODULE V		
5.1	Two port Network Parameters: Impedance, Admittance,	1
5.2	Two port Network Parameters: Transmission and Hybrid parameters.	1
5.3	Calculation of Impedance, Admittance Parameters	1
5.4	Calculation of Transmission and Hybrid parameters	1
5.5	Reciprocal and Symmetrical two port network	1
5.6	Interrelationship among parameter sets	1
5.7	Series and parallel connections of two port networks	1

CO Assessment Questions

1	1. Find the node voltages V_1 and V_2 for the network shown below 2. Obtain the transient response of series RLC circuit using LT Spice
2	Find the Norton's equivalent circuit between terminals A and B
3	Calculate the sinusoidal response of an RLC Circuit.
4	Draw the pole zero diagram for the given network function I(s) and hence obtain its i(t), $$I(s) = 20s/(s+5)(s+2)$$
5	Model Bipolar Junction Transistor as a two port Network.

24HUT310	LIFE SKILLS AND PROFESSIONAL ETHICS	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: The objective of this course is to enhance the employability and maximize the potential of the students by introducing them to the principles underlying personal and professional success. It equips them with the necessary skills to apply these principles effectively in their lives and careers. This course covers essential life skills for personal and professional success, introduces creative problem-solving techniques, fosters teamwork and leadership qualities, highlights the core values of professional ethics, and explains how individuals play a crucial role in technological development while maintaining personal and legal ethical standards.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO 1	Describe different life skills required in personal and professional life (Understand Level)
CO 2	Illustrate appropriate thinking and problem-solving techniques to solve new problems creatively (Apply Level)
CO 3	Demonstrate the basics of teamwork and leadership qualities (Apply Level)
CO 4	Identify the core values that shape the ethical behavior of a professional. (Understand Level)
CO 5	Explain the role and responsibility in technological development upholding personal ethics and legal ethics (Understand Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1						✓		✓			✓	✓
CO 2	✓	✓	✓					✓	✓		✓	✓
CO 3								✓				✓
CO 4								✓				✓
CO 5						✓		✓				✓

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	**Attendance**	**Theory [L- T]**			**Total Marks**
		Assignment	**Test-1**	**Test-2**	
3-0-0-0	5	15	10	10	**40**

Total Mark Distribution			

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 Hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS (34 Hours)

MODULE I : Foundation of Life Skills (8 Hours)

Understanding Life Skills*:* Meaning and Significance of Life Skills-WHO-Identified Life Skills-Life skills for professionals
Self-awareness: Definition and Need-Tools and Techniques of Self-awareness
Stress Management: Stress, reasons and effects- stress diaries- Four A's of stress management
Coping with emotions: Identifying and managing emotions- PATH method and relaxation techniques
(Group activities for self-awareness and stress management)

MODULE II : 21st Century Skills and Problem-solving Techniques (7 Hours)

21st Century Skills*:* Creativity, Critical Thinking, Collaboration, Problem Solving, Decision Making- Lateral Thinking- Critical thinking Vs Creative thinking
Problem Solving Techniques: Six Thinking Hats- Mind Mapping- Forced

Connections- Scientific temperament and Logical thinking with case studies. (Activity based learning)

MODULE III : Group Dynamics and Leadership (7 Hours)

Group and Team Dynamics: Composition, Formation-Problem Solving in Groups-Group vs Team, Team Dynamics- Managing team performance (Activity based learning)

Leadership: Leadership Framework -Types of Leadership- VUCA Leadership- Transactional vs Transformational Leaders

MODULE IV : Human Values (6 Hours)

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.

Case study on Engineering disasters (Include study of Ethical issues in a recent disaster). Code of Conduct in Engineering profession.

MODULE V : Responsibilities & Rights (6 Hours)

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

Global ethical issues- Business ethics, Computer Ethics, Environment ethics – Role in technological development-Engineers as Managers- Consulting Engineers-Engineers as Expert witnesses and advisors.

Text books
1. Remesh S., Vishnu R.G., "Life Skills for Engineers", Ridhima Publication, First Edition 2016
2. ICT Academy of Kerala, "Life Skills for Engineers", McGraw Hill Education (India) Private Ltd., 2016
3. Mike W Martin and Roland Schinzinger, Ethics in Engineering,4th edition, Tata McGraw Hill Publishing Company Pvt. Ltd, New Delhi,2014.

Reference books
1. Shiv Khera, You Can Win, Macmillan Books, New York, 2003
2. Barun K. Mitra, "Personality Development & Soft Skills", Oxford Publishers, Third impression, 2017.
3. Shalini Verma, "Development of Life Skills and Professional Practice"; First Edition; Sultan Chand (G/L) & Company, 2014
4. Charles D Fleddermann, Engineering Ethics, Pearson Education/ Prentice Hall of India, New Jersey, 2004.
5. Charles E Harris, Michael S Protchard and Michael J Rabins, Engineering Ethics- Concepts and cases, Wadsworth Thompson Learning, United states, 2005.
6. IEEE Code of Ethics.

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
MODULE 1		
1.1	Understanding Life Skills: Meaning and Significance of Life Skills-WHO-Identified Life Skills-Life skills for professionals	1
1.2	Self-awareness: Definition and Need-Tools and Techniques of Self-awareness	1
1.3	Activity based on Self-awareness	1
1.4	Activity based on Self-awareness	1
1.5	Stress Management: Stress, reasons and effects- stress diaries-Four A's of stress management	1
1.6	Coping with emotions: Identifying and managing emotions- PATH method and relaxation techniques	1
1.7	Activity based on Stress Management	1
1.8	Activity based on Stress Management	1
MODULE II		
2.1	21st Century Skills: Creativity, Critical Thinking, Collaboration, Problem Solving	1
2.2	Decision Making- Lateral Thinking- Critical thinking Vs Creative thinking (1 hour for exercise)	1
2.3	Activity based on Lateral Thinking, Critical and Creative thinking	1
2.4	Problem Solving Techniques: Six Thinking Hats- Mind Mapping-Forced Connections (2 hours for activity)	1
2.5	Activity based on problem solving techniques	1
2.6	Activity based on problem solving techniques	1
2.7	Scientific temperament and Logical thinking with case studies	1
MODULE III		
3.1	Group and Team Dynamics: Composition, Formation-Problem Solving in Groups	1
3.2	Group vs. Team, Team Dynamics- Managing team performance (2 hours for activity)	1
3.3	Activity based on Team Dynamics	1
3.4	Activity based on Team Dynamics	1
3.5	Leadership: Leadership Framework -Types of Leadership	1
3.6	VUCA Leadership	1
3.7	Transactional vs. Transformational Leaders	1
MODULE IV		
4.1	Morals, values and Ethics – Integrity- Academic integrity	1
4.2	Work Ethics- Service Learning- Civic Virtue- Respect for others-Living peacefully	1
4.3	Honestly- courage-Cooperation commitment- Empathy	1
4.4	Self Confidence -Social Expectations.	1
4.5	Case study: Failures of electronic monitoring systems,	1

	communication breakdowns during emergencies.	

4.6	Case study: Electronic system design flaws that led to or worsened the disaster	1
4.7	Code of Conduct in Engineering profession	1
MODULE V		
5.1	Collegiality and loyalty – Managing conflict- Respect for authority	1
5.2	Collective bargaining- Confidentiality-Role of confidentiality in moral integrity	1
5.3	Conflicts of interest- Occupational crime	1
5.4	Professional rights-Employee right- IPR Discrimination	1
5.5	Global ethical issues- Business, Engineering, Environment.	1
5.6	Role in technological development-Engineers as Managers- Consulting Engineers	1
5.7	Engineers as Expert witnesses and advisors.	1

CO Assessment Questions	
1	1. List 'life skills' as identified by WHO. 2. Explain the essential life skills required by a professional.
2	1. Illustrate the creative thinking process with the help of a suitable example 2. "Imagine you are tasked with addressing a complex environmental issue, such as reducing plastic waste in a coastal community". How would you apply the Six Thinking Hats technique to explore different facets of the problem and generate potential solutions?
3	1. "A group focuses on individual contribution, while a team must focus on synergy." Explain. 2. "Imagine you are part of a diverse team tasked with addressing a complex organizational challenge in a VUCA environment. Apply your knowledge of group formation and composition to strategically assemble a team that can effectively tackle the issue.
4	1. Define integrity and point out ethical values 2. Explain the role of engineers in modern society
5	1. Distinguish between self-interest and conflicts of interest 2. Explain the role of professional ethics in technological development.

24ECT307	COMPUTER ARCHITECTURE	L	T	P	J	S	C	Year of Introduction
		2	0	0	0	0	2	2024

Preamble: The aim of this course is to provide a fundamental idea about computers, and their functioning. The course explains the basic functional units of a computer system, input/output and memory organization. It also covers the organization of processors and the operations carried out by ALU.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO 1	Explain the different functional units of a computer (Understand Level)
CO 2	Summarize the functions, structure and organization of memories (Understand Level).
CO 3	Describe the input/output organization of a computer (Understand Level).
CO 4	Explain high speed adder's algorithm for multiplication and division. (Understand Level)
CO 5	Explain data path and instruction pipelining in a computer system (Understand Level).

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	✓											
CO 2	✓											
CO 3	✓											
CO 4	✓											
CO 5	✓											

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply				
Analyse				
Evaluate				
Create				

Mark Distribution of CIA

Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
2-0-0-0	5	35	30	30	**100**

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	100	-	-

SYLLABUS
MODULE I : Introduction to Computer System (5 Hours)
Introduction to computer system, Functional units of a computer, Von Neumann and Harvard computer architectures, General internal architecture, Address bus, Data bus, control bus. Register set – status register, accumulator, program counter, stack pointer, general purpose registers. Addressing Modes, Instruction set types, instruction format, CISC vs RISC.
MODULE II: Memory Architecture (5 Hours)
Memory hierarchy, RAM -Structure of RAM cell- DRAM, SRAM, organization of a RAM cell, ROM –Structure of a ROM cell, Types, Cache memory: mapping techniques, Virtual memory – Address translation.
MODULE III: I/O Organization (4 Hours)
Accessing I/O devices, Interrupts- Enabling and disabling interrupts, Handling multiple devices, programmed I/O, interrupt driven I/O; Direct Memory Access (DMA)- Bus arbitration, distributed arbitration.
MODULE IV: Processing Unit (5 Hours)
Binary Adder/ Subtractor circuit schematic, Carry Look Ahead Adder, Booth algorithm for multiplication, algorithm for Division, Floating point arithmetic unit.
MODULE V: Processor Operation (5 Hours)
Instruction cycle - fetch, decode and execute. Datapath design - Single bus organization- Memory Read/ Write, Register transfer, Arithmetic/ Logic operation, Branch operation, instruction pipelining.

Text books
1. DA Patterson and JL Hennessy, *Computer Organization and Design*, Morgan Kaufmann Publisher, 4e, 2010
2. V Carl Hamacher, Zvonko G Varanesic and Safat G Zaky, "Computer Organization", Fifth Edition, Indian Edition, McGraw-Hill Education, 2011.

Reference books
1. J.P. Hayes, Computer Architecture and Organization, Mc Graw Hill, 2017.
2. A.S. Tanenbaum, Structured Computer Organization, PHI Publication.
3. W. Stalling, Computer Organization and Architecture, PHI Publication
4. NPTEL course on Computer Architecture and Organization by Prof. Indranil Sengupta, Prof. Kamalika Datta, IIT Kharagpur
   https://onlinecourses.nptel.ac.in/noc20_cs64/preview

	COURSE CONTENTS AND LECTURE SCHEDULE	
No.		No. of Hours
MODULE 1		
1.1	Introduction to computer system, Functional units of a computer, Von Neumann and Harvard computer architectures.	1
1.2	General internal architecture, Address bus, Data bus, control bus.	1
1.3	Register set, status register, accumulator, program counter, stack pointer, general purpose registers	1
1.4	Addressing modes.	1
1.5	Instruction set types, instruction format, CISC vs RISC.	1
MODULE II		
2.1	Memory hierarchy, Structure of RAM cell	1
2.2	DRAM, SRAM, Organization of a RAM cell	1
2.3	ROM –Structure of a ROM cell, ROM - Types	1
2.4	Cache memory: mapping techniques	1
2.5	Virtual memory – Address translation.	1
MODULE III		
3.1	Accessing IO devices.	1
3.2	Interrupts- Enabling and disabling interrupts, Handling multiple devices.	1
3.3	Programmed I/O, interrupt driven I/O.	1
3.4	Direct Memory Access (DMA)- Bus arbitration, distributed arbitration.	1
MODULE IV		
4.1	Binary Adder/ Subtractor circuit schematic.	1
4.2	Carry Look Ahead Adder.	1
4.3	Booth algorithm for multiplication.	1
4.4	Algorithm for division.	1
4.5	Floating point arithmetic unit.	1
MODULE V		
5.1	Instruction cycle - fetch, decode and execute.	1
5.2	Datapath design - Single cycle implementation	1
5.3	Memory Read/ Write, Register transfer operations	1
5.4	Arithmetic/ Logic operation, Branch operation.	1
5.5	Instruction pipelining.	1

CO Assessment Questions	
1	Outline the functional units of a computer with the help of a diagram.
2	Explain the organization of a 1K x 1 memory chip.
3	Explain the methods by which the processor handling multiple interrupts.
4	Illustrate Booth algorithm for multiplication with an example.
5	Explain the single-bus organization of the data path inside a processor.

MINOR
SYLLABUS
III SEMESTER

24ECM309	ELECTRONIC CIRCUITS	L	T	P	J	S	C	Year of Introduction
		4	0	0	0	0	4	2024

Preamble: This course aims to develop skills in designing, analyzing, and simulating diverse electronic circuits, including fundamental circuits featuring diodes, transistors, MOSFETs, and Operational Amplifier.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO1	Realize simple circuits using diodes, resistors and capacitors and simulate the same. (Understand Level)
CO2	Design amplifier and oscillator circuits. (Apply Level)
CO3	Design power supplies, D/A and A/D convertors for various application. (Apply Level)
CO4	Design and analyze circuits using operational amplifiers. (Apply Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓				✓							
CO2	✓	✓										
CO3	✓	✓										
CO4	✓	✓										

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test2	Other tools	
Remember	✓	✓		✓
Understand	✓	✓		✓
Apply	✓	✓		✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA

Course Structure [L-T-P-J]	Attendance	Theory [L- T]				Total Marks
		Assignment	Test-1	Test-2		
4-0-0-0	5	15	10	10		**40**

Total Mark Distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 Hours

End Semester Examination [ESE]: Pattern			
PATTERN	**PART A**	**PART B**	**ESE Marks**
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS (48 Hours)

MODULE I : Wave Shaping Circuits (10 Hours)

Wave shaping circuits: Sinusoidal and non-sinusoidal wave shapes, Principle and working of RC differentiating and integrating circuits, Clipping circuits - Positive, negative and biased clipper. Clamping circuits - Positive, negative and biased clamper. Transistor biasing: Introduction, operating point, concept of load line, thermal stability (derivation not required), voltage divider bias. Simulation assignment using any software should be given from the module.

MODULE II : Amplifiers (10 Hours)

MOSFET: Structure, Enhancement and Depletion types, principle of operation and characteristics. Amplifiers: RC coupled amplifier – design and working, voltage gain and frequency response, Multistage amplifiers-effect of cascading on gain and bandwidth (Analysis not required). MOSFET Amplifier: Circuit diagram, design and working of common source MOSFET amplifier.

MODULE III : Oscillators And Regulated Power Supplies (10 Hours)

Oscillators: Classification, criterion for oscillation, RC Phase Shift, Wein bridge oscillator, Hartley, Colpitts and Crystal oscillators (design equations and working of the circuits required).

Regulated power supplies: Review of simple Zener voltage regulator, series voltage regulator, 3 pin regulators-78XX and 79XX, DC to DC conversion, block diagram and working of SMPS.

MODULE IV : Operational Amplifiers (10 Hours)

Characteristics of op-amps (gain, bandwidth, slew rate, CMRR, offset voltage, offset current), comparison of ideal and practical op-amp (IC741), concept of virtual ground, Application of op-amps-scale changer, sign changer, adder/summing amplifier, subtractor, integrator, differentiator, comparator.

MODULEV: Data Converters (8 Hours)
Data Converters: D/A and A/D converters – specifications, Sample and hold circuit, R-2R ladder type D/A converters, Flash and sigma delta type A/D converters.

Text books
1. Robert Boylestad and L Nashelsky, Electronic Devices and Circuit Theory, Pearson, 2015.
2. Salivahanan S. and V. S. K. Bhaaskaran, Linear Integrated Circuits, Tata McGraw Hill, 2008.

Reference books
1. David A Bell, Electronic Devices and Circuits, Oxford University Press, 2008.
2. Neamen D., Electronic Circuits, Analysis and Design, 3/e, TMH, 2007.
3. Millman J. and C. Halkias, Integrated Electronics, 2/e, McGraw-Hill, 2010.
4. Op-Amps and Linear Integrated Circuits, Ramakant A Gayakwad, PHI, 2000.
5. K.Gopakumar, Design and Analysis of Electronic Circuits, Phasor Books,2013
6.NPTEL Course on Electronic Circuits
   https://archive.nptel.ac.in/courses/108/102/108102097/

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
MODULE I		
1.1	Wave shaping circuits: sinusoidal and non-sinusoidal wave shapes	1
1.2	Principle and working of RC differentiating circuits	1
1.3	Principle and working of RC integrating circuits	1
1.4	Clipping circuits-positive clipper	1
1.5	Clipping circuits- negative and biased clipper	1
1.6	Clamping circuits -positive and negative	1
1.7	Clamping circuit – biased clampers	1
1.8	Transistor biasing: Introduction, operating point	1
1.9	Concept of load line and thermal stability	1
1.10	Voltage divider bias	1
MODULE II		
2.1	MOSFET-structure	1
2.2	Enhancement type	1
2.3	Depletion types	1
2.4	Principle of operation and characteristics	1
2.5	Amplifiers: classification of amplifiers	1
2.6	RC coupled amplifier design and working	1
2.7	Voltage gain and frequency response	1

2.8	Multistage amplifiers-effect of cascading on gain and bandwidth	1
2.9	MOSFET Amplifier-Circuit diagram	1
2.10	Design and working of common source MOSFET amplifier	1

MODULE III		
3.1	Oscillators: criterion for oscillation	1
3.2	RC Phase Shift oscillator	1
3.3	Wein bridge oscillator	1
3.4	Hartley, Colpitts and Crystal oscillators	1
3.5	Regulated power supplies	1
3.6	Review of simple Zener voltage regulator	1
3.7	Series voltage regulator	1
3.8	3 pin regulator 78XX	1
3.9	3 pin regulator 79XX	1
3.10	DC to DC conversion	1
MODULE IV		
4.1	Block diagram of op-amp, Ideal op-amp parameters	1
4.2	Comparison of ideal and practical op-amp	1
4.3	Application of op-amps-inverting amplifier	1
4.4	Application of op-amps- non-inverting amplifier	1
4.5	Virtual Ground	1
4.6	Scale changer and sign changer	1
4.7	Summing amplifier, difference amplifier	1
4.8	Comparator	1
4.9	Integrator	1
4.10	Differentiator	1
MODULE V		
5.1	D/A converters	1
5.2	D/A - important specifications	1
5.3	A/D converters – important specifications	1
5.4	A/D - important specifications	1
5.5	Sample and hold circuit	1
5.6	R-2R ladder type D/A converters	1
5.7	Flash A/D converters	1
5.8	Sigma delta type A/D converters	1

	CO Assessment Questions
1	Design a circuit that clips the positive half cycle of input waveform at +3 volts and negative half cycle at -2 volts. Using PSpice, Proteus, or an equivalent simulation software, conduct a simulation of the previously described circuit/system.
2	Design a Hartley oscillator to generate a frequency of 150KHz
3	Explain the working of R-2R ladder type DAC. In a 10-bit DAC, reference voltage is given as 15V.Find the analog output for digital input of 1011011001
4	The difference amplifier shown in the figure have $R_1=R_2=5K\Omega$, $R_F=10K\Omega$, $R_g=1K\Omega$.Calculate the output voltage.
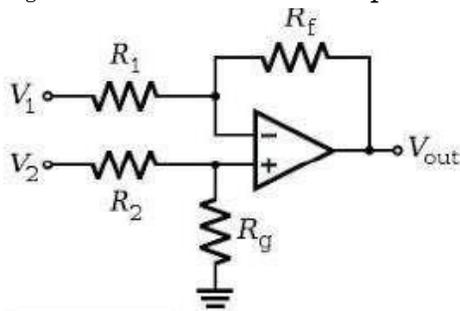
24ECM310	BASICS OF SIGNALS AND SYSTEMS	L	T	P	J	S	C	Year of Introduction
		4	0	0	0	0	4	2024

Preamble: This Course aims to lay the foundational aspects of signals and systems in both continuous time and discrete time that underpin the world of various signals and their processing.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO1	Understand and classify continuous time and discrete time signals and systems. (Understand Level)
CO2	Apply convolution to compute the time domain response of a system for the given excitation. (Apply Level)
CO3	Apply appropriate transform techniques to analyze signals in frequency domain. (Apply Level)
CO4	Apply sampling theorem to ensure proper reconstruction of sampled signal. (Apply Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓			✓							✓
CO2	✓	✓										✓
CO3	✓	✓										✓
CO4	✓	✓			✓							✓

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test2	Other tools	
Remember	✓	✓		✓
Understand	✓	✓		✓
Apply	✓	✓		✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA						
Course Structure [L-T-P-J]	Attendance	Theory [L- T]				Total Marks
		Assignment	Test-1	Test-2		
4-0-0-0	5	15	10	10		40

Total Mark distribution			
Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 Hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS (45 Hours)

MODULE I : Introduction to Continuous time signals (9 Hours)

Definition of signal. Basic continuous-time signals. Frequency and angular frequency of continuous time signals. Basic operation on signals. Classification of continuous-time signals: Periodic and Non periodic signals. Even and Odd signals, Energy and power signals. Noise and Vibration signals.

Simulation assignment: Generation of basic signals (Continuous Time) using SCILAB/MATLAB.

MODULE II : Introduction to Discrete time signals (9 Hours)

Basic discrete-time signals. Frequency and angular frequency of discrete-time signals. Classification of discrete-time signals: Periodic and Non-periodic signals. Even and Odd signals, Energy and power signals.

Simulation assignment: Generation of basic signals (Discrete Time) using SCILAB/MATLAB.

MODULE III : Introduction to Systems (9 Hours)

System definition. Continuous-time and discrete-time systems. Properties – Linearity, Time invariance, Causality, Invertibility, Stability. Representation of systems using impulse response.

Simulation assignment: Verify the properties of systems using SCILAB/MATLAB.

MODULE IV : Linear Time Invariant Systems (9 Hours)

LTI system definition. Response of a continuous-time LTI system and the Convolution Integral. Properties. Response of a discrete-time LTI system and the Convolution Sum. Properties. Correlation of discrete-time signals.

Simulation assignment: Obtain linear convolution using SCILAB/MATLAB.

MODULE V : Frequency Analysis of Signals (9 Hours)

Concept of frequency in continuous-time and discrete-time signals. Fourier transform of continuous time and discrete-time signals. Parseval's theorem. Interpretation of Spectra. The sampling theorem.

Simulation assignment: Obtain DFT and verify it's properties using SCILAB/MATLAB.

Text books
1. Alan V. Oppenheim and Alan Willsky, Signals and Systems, PHI, 2/e, 2009.
2. Simon Haykin, Signals & Systems, John Wiley, 2/e, 2003.
3. Anand Kumar, Signals and Systems, PHI, 3/e, 2013.Anders Brandt, Noise and Vibration Analysis, Wiley publication.

Reference books
1. Sanjay Sharma, Signals & Systems, S.K. Kataria & Sons, Edition : 9th 2017
2. B P. Lathi, Principles of Signal Processing & Linear systems, Oxford University Press.
3. Gurung, Signals and System, PHI.
4. Mahmood Nahvi, Signals and System, Mc Graw Hill (India), 2015.
5. P Ramakrishna Rao, Shankar Prakriya, Signals and System, MC Graw Hill Edn 2013.
6. Rodger E. Ziemer, Signals & Systems - Continuous and Discrete, Pearson, 4/e, 2013
7. MOOC course on signals and systems by Alan V Oppenheim organized by MIT.https://ocw.mit.edu/courses/res-6-007-signals-and-systems-spring-2011/ video_ galleries/video-lectures/

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
MODULE I		
1.1	Introduction to Continuous Time Signals. Definition of signal	1
1.2	Basic continuous-time signals	1
1.3	Frequency and angular frequency of continuous-time signals	1
1.4	Basic operation on signals	1
1.5	Classification of continuous-time signals-periodic c and non periodic	1
1.6	Classification of continuous-time signals-even and odd	1
1.7	Classification of continuous-time signals-energy and power signals	1
1.8	Noise and Vibration signals	1
1.9	Simulation Assignment	1
MODULE II		
2.1	Introduction to Discrete Time Signals. Definition of signal	1
2.2	Basic Discrete -time signals	1
2.3	Frequency and angular frequency of continuous-time signals	1
2.4	Basic operation on signals	1
2.5	Basic operation on signals	1
2.6	Classification of Discrete time signals-periodic and non periodic	1
2.7	Classification of Discrete time signals-even and odd	1
2.8	Classification of Discrete -time signals-energy and power signals	1
2.9	Simulation Assignment	1
MODULE III		
3.1	System definition.	1
3.2	Continuous-time and discrete-time systems.	1
3.3	Properties – Linearity	1
3.4	Time invariance	1
3.5	Causality	1
3.6	Invertibility	1
3.7	Stability.	1
3.8	Representation of systems using impulse response	1
3.9	Simulation Assignment	1
MODULE IV		
4.1	LTI system definition.	1
4.2	Response of a continuous-time LTI system and the Convolution Integral.	1
4.3	Illustration with simple examples.	1

4.4	Properties.	1
4.5	Response of a discrete-time LTI system and the Convolution Sum.	1
4.6	Illustration with simple examples.	1
4.7	Properties.	1
4.8	Correlation of discrete-time signals	1
4.9	Simulation Assignment	1
MODULE V		
5.1	Concept of frequency in continuous-time and discrete-time signals.	1
5.2	Fourier transform of continuous time signals.	1
5.3	Illustration with simple examples.	1
5.4	Fourier transform of discrete-time signals.	1
5.5	Illustration with simple examples.	1
5.6	Parseval's theorem.	1
5.7	Interpretation of Spectra.	1
5.8	The sampling theorem	1
5.9	Simulation Assignment	1

CO Assessment Questions	

1	1. Check whether the following systems are stable, causal, linear, and time-invariant
	    (a) $y[n] = x[2n]$
	    (b) (b) $y(t) = x2\ (t) + 3$
	 2. Plot the signal: a) $r(2t+3)$ b) $u(0.5t-3)$

2	Compute the output of the LTI system with input $x[n] = [1, -1, 2, -2]$ and impulse response $h[n] = [1, 2, 1]$
3	Compute the Fourier transform of a rectangular pulse with unit amplitude and width T and centered around origin. Plot the Fourier transform in the frequency domain
4	Obtain the response of an LTI system with impulse response $h(t) = \delta(t)$ with input signal $x(t) = e^{-at}u(t)$ using Fourier transform.
5	Define sampling theorem. Determine the Nyquist rate and Nyquist interval for the signal $x(t) = \cos \pi t + 3 \sin 2\pi t + \sin 4\pi t$

24ECM311	ANALOG COMMUNICATION	L	T	P	J	S	C	Year of Introduction
		4	0	0	0	0	4	2024

Preamble: This course offers an extensive exploration of the foundational principles and cutting-edge technologies essential for effective information transmission within the realm of analog communication. The course covers the basics of amplitude and frequency modulation systems. Through a comprehensive curriculum, students will gain a deep understanding of the fundamentals and contemporary advancements in analog communication systems.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO 1	Explain various amplitude modulation and demodulation schemes (Understand Level)
CO 2	Explain the generation and detection of FM (Understand Level)
CO 3	Analyze the effect of noise in AM (Apply Level)
CO 4	Explain the block diagram for AM and FM receivers (Understand Level)
CO 5	Simulate AM and FM modulation systems (Apply Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	✓	✓										
CO 2	✓	✓										
CO 3	✓	✓										
CO 4	✓	✓										
CO 5	✓			✓	✓							✓

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓		✓
Understand	✓	✓		✓
Apply		✓	✓	✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA

Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
4-0-0-0	5	15	10	10	**40**

Total Mark Distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 Hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS (48 Hours)

MODULE I: Amplitude Modulation (14 Hours)

Introduction to communication system, Need for modulation, Amplitude Modulation, Time domain and frequency domain description, single tone modulation, power relations in AM waves, Generation of AM waves, square law Modulator, Detection of AM Waves-Envelop detector, Double side band suppressed carrier modulators, Single Side Band Modulation.

MODULE II: Frequency Modulation (10 Hours)

Frequency Modulation: Expression for FM carrier, Spectrum Analysis of Sinusoidal FM Wave, Narrow band FM, Wide band FM, Transmission bandwidth of FM Wave, Generation of FM Waves, Armstrong Method, Generation of FM from Phase Modulation, Comparison of FM and AM.

MODULE III: Radio Receivers (8 Hours)

Receiver Types - Tuned radio frequency receiver, Superheterodyne receiver, RF section and Characteristics, Intermediate frequency, AGC, FM Superheterodyne Receiver, Comparison with AM Receiver, Amplitude limiting.

MODULE IV: Noise in Analog Communication System (8 Hours)

Types of Noise: Resistive (Thermal) Noise Source, Shot noise, Extraterrestrial Noise, White Noise, Narrowband Noise- In phase and quadrature phase components and its Properties, Modeling of Noise Sources, Average Noise Bandwidth, Noise Figures, Average Noise Figure of cascaded networks. Noise in AM System.

MODULE V: Simulation of AM/FM Signals (8 Hours)

Study and design of AM and modulator/demodulator. Using MATLAB generate a carrier and a modulating signal. Modulate the carrier using AM. Show the modulated

waveform in time domain and analyze its frequency spectrum. Using MATLAB generate a carrier and a modulating signal. Modulate the carrier using FM. Show the waveform in time domain and analyze its frequency spectrum. Study the waveform of FM based on the variation of parameters like β.

Text books
1. B.P. Lathi, Modern Analog and Digital communication Systems, Oxford
2. Kennedy (2005), Davis, Electronic Communication Systems, 4th Edition, Tata McGraw Hill, New Delhi. Dennis Roddy and John Coolen, Electronic Communications Systems, 4th Edition, Pearson

Reference books
1. Simon Haykin (1994), Communication Systems, 2nd edition, Wiley Eastern, India.
2. Taub and schilling (2015), Principles of Communication Systems, Tata McGraw Hill, India.
3. NPTEL Course on Analog Communication
https://archive.nptel.ac.in/courses/117/105/117105143/

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
MODULE 1		
1.1	Overview of Analog communication system,	1
1.2	Need for modulation	1
1.3	Amplitude Modulation, and frequency domain description,	1
1.4	Time domain representation of AM	1
1.5	Frequency domain representation of AM	1
1.6	Spectrum of AM, power relations in AM waves	1
1.7	Numerical examples	1
1.8	Generation of AM waves, square law Modulator	1
1.9	Detection of AM Waves: Square law detector	1
1.10	Envelop detector	1
1.11	Double side band suppressed carrier modulation	1
1.12	Single Side Band Modulation	1
1.13	Comparison of AM, DSBSC and SSB	1
1.14	Class Assessment	1
MODULE II		
2.1	Frequency Modulation,	1
2.2	Expression for FM carrier	1
2.3	Spectrum Analysis of Sinusoidal FM Wave	1
2.4	Numerical examples	1
2.5	Narrow band FM, Wide band FM	1
2.6	Transmission bandwidth of FM Wave	1

2.7	Generation of FM Waves – Armstrong Method	1
2.8	Generation of FM from Phase Modulation	1
2.9	Comparison of FM and AM	1
2.10	Class Assessment	1
MODULE III		
3.1	Receiver Types - Tuned radio frequency receiver	1
3.2	Superheterodyne receiver	1
3.3	RF section and Characteristics	1
3.4	Intermediate frequency	1
3.5	Amplitude limiting, FM Superheterodyne Receiver	1
3.6	Comparison with AM Receiver	1
3.7	Numerical examples	1
3.8	Class Assessment	1
MODULE IV		
4.1	Types of Noise: Resistive (Thermal) Noise Source, Shot noise, Extraterrestrial Noise, White Noise	1
4.2	Narrowband Noise- In phase and quadrature phase components	1
4.3	Properties of narrow band noise	1
4.4	Modeling of Noise Sources	1
4.5	Average Noise Bandwidth, Noise Figures	1
4.6	Average Noise Figure of cascaded networks	1
4.7	Noise in AM System	1
4.8	Class Assessment	1
MODULE V		
5.1	Overview of MATLAB software	1
5.2	Basic commands in MATLAB	1
5.3	Generation of sinusoidal signal in MATLAB	1
5.4	Using MATLAB generates a carrier and a modulating signal. Modulate the carrier using AM.	1
5.5	Show the modulated waveform in the time domain and analyze its frequency spectrum.	1
5.6	Using MATLAB generates a carrier and a modulating signal. Modulate the carrier using FM.	1
5.7	Show the waveform in the time domain and analyze its frequency spectrum.	1
5.8	Class Assessment	1

CO Assessment Questions	
1	1. Derive an expression for Amplitude Modulated carrier and plot the spectrum. 2. Explain the working of envelope detector.
	3. Explain the principle for the generation of DSBSC and SSB
2	1. Derive an expression for Frequency Modulated carrier and find the bandwidth of FM. 2. Explain the generation of FM signal.
3	1. Explain the working of AM superheterodyne receiver 2. Explain the working of FM superheterodyne receiver
4	1. Explain different noises encountered in analog communication systems. 2. Analyze the noise in AM systems.
5	1. Simulate AM in MATLAB. 2. Simulate FM in MATLAB.

SEMESTER - IV
SYLLABUS

24ECT401	PROBABILITY AND RANDOM PROCESSES	L	T	P	J	S	C	Year of Introduction
		2	1	0	0	2	3	2024

Preamble: This course introduces students to the modern theory of probability and statistics, covering important models of random variables, analysis of random processes using appropriate time and frequency domain tools, techniques of parameter estimation and hypothesis testing. The concepts discussed here are widely used in electronics engineering. After completing this course, students will acquire the ability to utilize the above concepts for applying to problems more efficiently.

Prerequisite: A basic course in probability theory.

Course Outcomes: After the completion of the course the student will be able to

CO1	Apply the concept and properties of discrete probability distributions in evaluating the required probabilities [Apply Level].
CO2	Apply the properties and important models of discrete and continuous random variables to analyze suitable random phenomena. [Apply Level].
CO3	Apply the concept and properties of joint probability distributions in evaluating the required probabilities [Apply Level].
CO4	Perform statistical inferences concerning characteristics of a population based on attributes of samples drawn from the population [Apply Level].
CO5	Analyse random processes using autocorrelation function and power spectral density function [Apply Level].

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	✓	✓			✓				✓			✓
CO 2	✓	✓			✓				✓			✓
CO 3	✓	✓			✓				✓			✓
CO 4	✓	✓			✓				✓			✓
CO 5	✓	✓			✓				✓			✓

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse			✓	
Evaluate				
Create				

		Mark Distribution of CIA			
Course Structure [L-T-P-J]	**Attendance**	**Theory [L- T]**			**Total Marks**
		Assignment	**Test-1**	**Test-2**	
2-1-0-0	5	15	10	10	**40**

Total Marks distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 Hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS (33 Hours)

MODULE I: Discrete Probability Distributions (6 Hours)

(Text-1: Relevant topics from sections 3.1, 3.2, 3.3, 3.4, 3.6, 3.9) Random variables, discrete random variables, probability mass function, cumulative distribution function, mean and variance, discrete probability distributions, Binomial distribution, Poisson distribution, mean and variance of Binomial and Poisson distributions.

MODULE II: Continuous Probability Distributions (6 Hours)

(Text-1: Relevant topics from sections 4.1, 4.2, 4.3, 4.4, 4.5, 4.6, 4.8) Continuous random variables, cumulative distribution function, probability density function, continuous probability distributions, uniform distribution, normal distribution, exponential distribution, mean and variance of uniform and exponential distributions.

MODULE III: Joint Probability Distributions (7 Hours)
(Text-1: Relevant topics from sections 5.1, 5.2, 5.3, 5.4, 5.5) Two dimensional random variables, joint probability mass function, marginal probability distribution, cumulative distribution function, joint probability density function, marginal density function, conditional probability function, statistical independence, functions of one random variable.
MODULE IV: Test of Hypotheses (7 Hours)
(Text-1: Relevant topics from sections 7.2,9.1, 9.2, 9.3,10.1,10.2) Population and samples, sampling distribution of the mean (for large samples only), Central limit theorem, Test of hypotheses: one sided and two-sided hypothesis, test on the mean of a normal distribution with variance known, test on the mean of a normal distribution with variance unknown, hypothesis tests on the difference in means with variance known, hypothesis tests on the difference in means with variance unknown.
MODULE V: Random Processes (7 Hours)
(Text-2: Relevant topics from sections 8.1, 8.2, 8.3, 8.5, 8.6, 8.7) Random processes – classification of random processes, characterizing a random process, mean and autocorrelation function of a random process, stationary random processes, Strict sense stationary processes, wide sense stationary processes, ergodic random processes, power spectral density.

Text books
   1. Douglas C. Montgomery, George C. Runger, Applied Statistics and Probability for Engineers, Sixth edition, Wiley 2017.
   2. Oliver C. Ibe, Fundamentals of Applied Probability and Random Processes, Elsevier,2007.

References
   1. Hossein Pishro-Nik, Introduction to Probability, Statistics and Random Processes, Kappa Research, 2014
   2. Sheldon M. Ross, Introduction to probability and statistics for engineers and scientists, 4th edition, Elsevier, 2009.
   3. T. Veera Rajan, Probability, Statistics and Random processes, Tata McGraw-Hill, 2008
   4. Prof. Somesh Kumar, Probability and Statistics, IIT Kharagpur, [NPTEL], https://nptel.ac.in/courses/111105090 (Relevant sections)
   5. Prof. Prabin K. Bora, Probability and Random Processes, IIT Guwahati, [NPTEL], https://nptel.ac.in/courses/117103067 (Relevant sections)

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours [33 hours]
MODULE I		
1.1	Random variables, Discrete random variables.	1
1.2	Probability Mass function. Cumulative distribution function,	1
1.3	Mean and variance.	1
1.4	Binomial distribution, mean and variance of Binomial distribution.	1
1.5	Poisson distribution- Poisson approximation to binomial	1
1.6	Poisson distribution- mean and variance	1
MODULE II		
2.1	Continuous random variables, Cumulative distribution function.	1
2.2	Probability density function, Continuous probability distributions.	1
2.3	Uniform distribution, mean and variance of distribution.	1
2.4	Normal distribution	1
2.5	Normal distribution(continued)	1
2.6	Exponential distribution, mean and variance of exponential distribution.	1
MODULE III		
3.1	Two dimensional random variables- Joint probability mass function	1
3.2	Marginal probability distribution	1
3.3	Cumulative distribution function	1
3.4	Joint probability density function- marginal density function.	1
3.5	Joint probability density function- marginal density function(continued).	1
3.6	Conditional probability function-Statistical Independence	1
3.7	Functions of one random variable	1
MODULE IV		
4.1	Population and samples, Sampling distribution of the mean (for large samples only)	1
4.2	Sampling distribution of mean (for large samples only) (continued)	1
4.3	Central Limit Theorem	1
4.4	Test of hypotheses: One sided and two-sided hypothesis, Test on the mean of a normal distribution variance known.	1
4.5	Test on the mean of a normal distribution variance unknown	1
4.6	Hypothesis tests on the difference in means variance known.	1
4.7	Hypothesis tests on the difference in means variance unknown.	1

MODULE V		
5.1	Random processes – classification of random processes	1
5.2	Characterizing a random process	1
5.3	Mean and autocorrelation function of a random process	1
5.4	Stationary random processes, Strict sense stationary processes, wide sense stationary processes	1
5.5	Stationary random processes, Strict sense stationary processes, wide sense stationary processes	1
5.6	Ergodic random processes.	1
5.7	Power spectral density	1

CO Assessment Questions	
1	1. A certain hospital usually admits 50 patients per day. On the average 3 patients in 100 require special facilities found in special rooms. On the morning of a certain day it is found that there are three such rooms available. Assuming that 50 patients will be admitted find the probability that more than 3 patients will require such special rooms 2. Using CAS, determine the probability of rolling a sum of 7 or 11 when rolling two fair six-sided dice? Calculate the mean and variance of the probability distribution, generate random samples, and visualize the probability mass function using CAS. 3. **Team Work:** Determine the probability of obtaining at least two heads when tossing a fair coin three times. Once the team has solved this problem, explore variations such as the probability of obtaining at least two heads when tossing the coin four times, or when using a biased coin with a 70% chance of heads and a 30% chance of tails. Explore these variations as a team and discuss the changes in probabilities
2	1. A manufacturer knows from experience that the resistance of resistors he produces is normal with mean $\mu = 150\Omega$ and standard deviations $\sigma = 5\Omega$. What percentage of the resistors will have resistance between 148 Ω and 152 Ω? Between 140 Ω and 160 Ω? 2. A spinner selects a number X randomly from the interval $[0,2\pi)$. The probability of selecting any number between 0 and x is proportional to the length of the interval $[0, x]$. Find the density function of X. What is the probability that the spinner selects a number between 2 and 3? Verify the answer using CAS. 3. **Team Work:** Calculate the probability that a normally distributed random variable with a mean of 75 and a standard deviation of 10 falls between 70 and 80? Additionally, generate random samples from this distribution and visualize the probability density function (PDF) using CAS.

| 3 | 1. Three balls are drawn at random without replacement from a box containing 2 white,3 red and 4 black balls. If X denotes the number of white balls drawn and Y denotes the number of red balls drawn, find the joint probability distribution of (X, Y)

2. Let the random variable X denote the time until a computer server connects to your machine (in milliseconds), and let Y denote the time until the server authorizes you as a valid user (in milliseconds). Each of these random variables measure the wait from a common starting time and X |

| | < Y. Assume that the joint probability density function for X and Y is
$f_{XY}(x,y) = 6*10^{-6}exp(-0.001x - 0.002y)$ for $x < y$
Using CAS calculate the probability that Y exceeds 2000 milliseconds.

3. **Team Work:** Two fair dice are rolled. Let X denote the number on the first die and Y = 0 or 1, according as 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? visualize the joint probability distribution function using CAS. |

| 4 | 1. A manufacturer of nickel-hydrogen batteries randomly selects 100 nickel plates for test cells, cycles them a specified number of times, and determines that 14 of the plates have blistered. Does this provide compelling evidence for concluding that more than 10% of all plates blister under such circumstances? State and test the approximate hypothesis using a significance level of 0.05.

2. The mean produce of a sample of 100 fields is 200 lbs per acre with standard deviation of 10 lbs. Another sample of 150 fields gives the mean of 220 lbs with a standard deviation 12 lbs. Can the two samples be considered to have been take from the same population whose standard deviation is 11 lbs? Use 5% level of significance.

3. **Team Work:** Using CAS, perform a hypothesis test to determine if there is a significant difference in the mean blood pressure between a control group and a treatment group. The datasets 'group1' and 'group2' represent the blood pressure measurements of the respective groups. Assume that the data follows a normal distribution and use a significance level of 0.05. Write CAS code to conduct the hypothesis test, calculate the test statistic, p-value, and provide a conclusion regarding the null hypothesis. Collaborate with your team members, execute the code, and interpret the results. Present your findings, discussing the hypothesis testing procedure and any notable observations made during the activity. |

5	1. Queries presented in a computer database are following a Poisson process of rate $\lambda = 6$ queries per minute. An experiment consists of monitoring the database for m minutes and recording N(m) the number of queries presented. (i) What is the probability that no queries arriving in a one-minute interval? (ii) What is the probability that less than 3 queries arriving in a half minute interval? 2. A random binary transmission process {X(t)} is a WSS process with zero mean and autocorrelation function $R(\tau) = 1 - \frac{|\tau|}{T}$ where T is a constant. Find the variance of the time average of {X(t)} and also the mean over $(0, T)$
	using CAS. Is {X(t)} mean ergodic? 3. **Team Work:** A wide sense stationary noise process N(t) has an ACF $R_{NN}(\tau) = \rho e^{-3|\tau|}$ where τ is a constant. Find its power spectrum using CAS.

24ECT402	SIGNALS AND SYSTEMS	L	T	P	J	S	C	Year of Introduction
		2	1	0	0	2	3	2024

Preamble: The course offers an extensive exploration into the fundamental principles and analytical tools essential for understanding signal processing and system behavior. Spanning five modules, it delves into topics ranging from elementary signal classification and system properties to advanced concepts in continuous and discrete Fourier transforms, Laplace transforms, and the Z-transform. Students will engage with hands-on MATLAB/Python simulation assignments, enhancing their practical skills in analyzing and interpreting signal and system characteristics in both time and frequency domains.

Prerequisite: 24ECT305 Network Theory

Course Outcomes: After the completion of the course the student will be able to

CO 1	Classify various signals and systems. (Understand Level)
CO 2	Apply convolution to compute the time domain response of a system for the given excitation (Apply Level)
CO 3	Analyze signals and systems in frequency domain using Laplace and Fourier transform (Apply Level)
CO 4	Apply sampling theorem to ensure proper reconstruction of sampled signal. (Apply Level)
CO 5	Compute the response of LTI systems to various excitations (Apply Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	✓	✓										
CO 2	✓	✓			✓							✓
CO 3	✓	✓										
CO 4	✓	✓			✓							✓
CO 5	✓	✓										

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA						
Course Structure [L-T-P-J]	Attendance	Theory [L- T]				Total Marks
		Assignment	Test-1	Test-2		
2–1–0-0	5	15	10	10		**40**

Total Mark Distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 Hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: [2x10 =20 marks]	Total Marks: [5x8 = 40 marks]	

SYLLABUS (35 Hours)

MODULE I: Introduction to Signals and System (8 Hours)

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.
Simulation Assignment I -to be performed in MATLAB/Python – Plotting of elementary signals and basic signal operations

MODULE II: Continuous Time Fourier Series and Fourier Transform (8 Hours)

Continuous time LTI systems and convolution integral, Discrete time LTI systems and linear convolution, Stability and causality of LTI systems, Correlation between signals, Signal space, Orthogonality of signals, 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.

Simulation assignment II - to be performed in MATLAB/Python – Convolution and correlation

MODULE III: Applications of Laplace and Fourier Transform (6 Hours)

Review of Laplace Transform, ROC, Properties of ROC, Stability and causality conditions, Relation between Fourier and Laplace transforms, Analysis of LTI systems using Laplace and Fourier transforms, Concept of transfer function, Magnitude and phase response.

MODULE IV: Discrete Time Fourier Series and Fourier Transform (7 Hours)

Sampling of continuous time signals, Sampling theorem for low pass signals, aliasing, effect of aliasing in the time and frequency domain.

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.

Simulation Assignment III - to be performed in MATLAB/Python – Verification of the sampling theorem

MODULE V: Z Transform (6 Hours)

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.

Text books

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

Reference books

1. Anand Kumar, Signals and Systems, PHI, 3/e, 2013.
2. B P. Lathi, Principles of Signal Processing & Linear systems, Oxford University Press.
3. Gurung, Signals and System, PHI.
4. Mahmood Nahvi, Signals and System, Mc Graw Hill (India), 2015.
5. P Ramakrishna Rao, Shankar Prakriya, Signals and System, MC Graw Hill Edn 2013.
6. Rodger E. Ziemer, Signals & Systems - Continuous and Discrete, Pearson, 4/e, 2013
7. NPTEL COURSE ON SIGNALS AND SYSTEMS by Prof. Kushal K. Shah, IISER Bhopal. https://onlinecourses.nptel.ac.in/noc21_ee28/preview
8. Video Lecture: http://www.satishkashyap.com/2012/04/iit-video-lectures-on-signals-and.html

COURSE CONTENTS AND LECTURE SCHEDULE		
No.		No. of Hours
MODULE I		
1.1	Elementary Signals	1
1.2	Classification and representation of continuous time signals	1

1.3	Classification and representation of discrete time signals	1
1.4	Signal operations	1
1.5	Continuous time systems – Classification, Properties.	1
1.6	Discrete time systems – Classification, Properties.	1
1.7	Representation of systems: Differential equation representation of continuous time systems	1
1.8	Representation of systems: Difference equation representation of discrete systems.	1
MODULE II		
2.1	Continuous time LTI systems and convolution integral.	1
2.2	Discrete time LTI systems and linear convolution.	1
2.3	Stability and causality of LTI systems.	1
2.4	Correlation between signals	1
2.5	Signal space, Orthogonality of signals, Frequency domain representation of continuous time signals	1
2.6	Continuous Time Fourier series, Convergence and Gibbs phenomenon- Properties	1
2.7	Continuous Time Fourier Transform	1
2.8	Continuous Time Fourier Transform- Properties	1
MODULE III		
3.1	Review of Laplace Transform, ROC, Properties of ROC (Laplace transform of basic signals)	1
3.2	Relation between Fourier and Laplace transforms.	1
3.3	Stability and causality conditions	1
3.4	Analysis of LTI systems using Laplace transforms	1
3.5	Concept of transfer function - Numerical Problems	1
3.6	Analysis of LTI systems using Fourier transforms. Magnitude and phase response.	1
MODULE IV		
4.1	Sampling of continuous time signals - Sampling theorem for low pass signals, aliasing	1
4.2	Effect of aliasing in the time and frequency domain.	1
4.3	Frequency domain representation of discrete time signals,	1
	Discrete time Fourier Series for discrete periodic signals - Properties	
4.4	Discrete time Fourier transform (DTFT)	1
4.5	Properties of DTFT	
4.6	Basic problems and problems with applications of properties	1
4.7	Analysis of discrete time LTI systems using DTFT. Magnitude and phase response- Numerical Problems.	1
MODULE V		
5.1	Z transform, ROC- Unilateral Z transform.	1
5.2	Properties of Z-Transform	1
5.3	Basic problems on Z-Transforms	1

5.4	Problems with applications of properties	1
5.5	Relation between DTFT and Z-Transform- Analysis of discrete time LTI systems using Z transforms, Transfer function.	1
5.6	Stability and causality using Z transform.	1

CO Assessment Questions	
1	Check whether the following systems are stable, causal, linear, and time-invariant (a) $y[n] = x[2n]$ (b) $y(t) = x^2(t) + 3$ (c) $y[n] = nx[n]$
2	Compute the output of the LTI system with input $x[n] = [1, -1, 2, -2]$ and impulse response $h[n] = [1, 2, 1]$
3	Obtain the response of an LTI system with impulse response $h(t) = \delta(t)$ with input signal $x(t) = e^{-at} u(t)$ using Fourier transform and Laplace transform
4	Define sampling theorem. Determine the Nyquist rate and Nyquist interval for the signal $x(t) = \cos \pi t + 3 \sin 2\pi t + \sin 4\pi t$
5	Obtain the response of an LTI system with impulse response $h(n) = \delta(n)$ with input signal $x(n) = e^{-an} u(n)$ using Fourier transform and Laplace transform.

24ECP403	ANALOG CIRCUITS	L	T	P	J	S	C	Year of Introduction
		2	1	2	0	4	4	2024

Preamble: This course aims to develop the skill of designing, analyzing, simulating and implementing different types of analog circuits using discrete electronic components. This course will orient learners towards the role of an analog design engineer.

Prerequisite: 24ECP304 Semiconductor Devices

Course Outcomes: After the completion of the course the student will be able to

CO 1	Design basic amplifiers using MOSFET. (Apply Level)
CO 2	Apply device models for circuit analysis. (Analyse Level)
CO 3	Analyze different feedback topologies in MOSFET amplifiers. (Analyse Level)
CO 4	Analyze differential amplifiers. (Analyze Level)
CO 5	Design different stages of an Op-amp. (Apply Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	✓	✓		✓	✓			✓	✓	✓		
CO 2	✓	✓										
CO 3	✓	✓		✓	✓			✓	✓	✓		
CO 4	✓	✓										
CO 5	✓	✓		✓	✓			✓	✓	✓		

Assessment Pattern for Theory Component

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓		✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse	✓	✓		✓
Evaluate				
Create				

Assessment Pattern for Lab Component

Bloom's Category	Continuous Assessment Tools	
	Class work	Test1
Remember		
Understand	✓	✓
Apply	✓	✓
Analyse	✓	✓
Evaluate		
Create		

Mark Distribution of CIA							
Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Practical [P]		Total Marks
		Assignment	Test-1	Test-2	Class work	Lab Exam	
2-1-2-0	5	10	12.5	12.5	10	10	**60**

Total Marks Distribution			
Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	60	40	2.5 Hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 2		2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x 8 = 40 marks) Time: 2.5 hours	40
	Total Marks: 0	Total Marks: [5x8 = 40 marks]	

SYLLABUS (30 Hours)

MODULE I: MOSFET Amplifier (8 Hours)

MOSFET amplifiers**:** Biasing of MOSFET, Need for Biasing, Operating point, DC and AC load line. Design CS MOSFET amplifier, Gain, frequency response and bandwidth. CS stage with diode-connected load.
Multistage amplifiers**:** effect of cascading on gain and bandwidth, Cascode amplifier.

MODULE II: Small Signal Analysis (5 Hours)

Small signal analysis of CS configuration using small signal hybrid-pi model for mid frequency and low frequency, (gain, input and output impedance), High frequency equivalent circuits of MOSFET, Miller effect, Analysis of high frequency response of CS amplifiers.

MODULE III: Feedback Amplifiers (7 Hours)
Feedback amplifiers**:** Effect of positive and negative feedback on gain, frequency response and distortion, The four basic feedback topologies, Analysis of discrete MOSFET circuits in voltage-series and voltage-shunt feedback topologies - voltage gain, input and output impedance. Oscillators: Classification, criterion for oscillation, RC Phase shift oscillator and Wien bridge oscillator using FET.
MODULE IV: Differential Amplifiers (5 Hours)
Current mirror: Basic topology and its variants, V-I characteristics, output resistance and minimum sustainable voltage (VON), maximum usable load. Differential amplifier: Basic structure using MOSFET and principle of operation, calculation of differential gain, common mode gain, CMRR and ICMR.
MODULE V: Design of Operational Amplifiers (5 Hours)
Block diagram of Operational amplifier. Design of differential amplifier for a given specification. Design of gain and output stages. Concept of gain margin and phase margin. Need for compensation- Miller compensation.

Text books
1. Behzad Razavi, Design of Analog CMOS Integrated Circuits, McGraw-Hill, 2nd Edition
2. Sedra A. S. and K. C. Smith, "Microelectronic Circuits", 6/e, Oxford University Press, 2013.
3. Robert Boylestad and L Nashelsky, "Electronic Devices and Circuit Theory", 11/e Pearson, 2015.
4. Tony Chan Carusone, David Johns, Kenneth Martin, "Analog Integrated Circuit Design" 2nd Edition Wiley.

Reference books
1. Razavi B., "Fundamentals of Microelectronics", Wiley, 2015
2. Neamen D., "Electronic Circuits, Analysis and Design", 3/e, TMH, 2007.
3. David A Bell, "Electronic Devices and Circuits", Oxford University Press, 2008.
4. Rashid M. H., "Microelectronic Circuits - Analysis and Design", Cengage Learning, 2/e,2011
5. Millman J. and C. Halkias, "Integrated Electronics", 2/e, McGraw-Hill, 2010.
6. Carusone, Johns, and Martin, Analog Integrated Circuit Design, 2nd edition, John Wiley, 2012
7. https://www.udemy.com/course/mosfet-foundation-course-for-analog-circuit-design
8. https://onlinecourses.nptel.ac.in/noc23_ee48/preview

No.	COURSE CONTENTS AND LECTURE SCHEDULE	No. of Hours
	MODULE I	
1.1	MOSFET output characteristics, Operating Point, Need for biasing	1
1.2	Fixed bias, self-bias – stability improvement, Drain current calculations	1
1.3	Voltage divider bias, bias stabilization	1
1.4	CS MOSFET amplifier circuit, Need of various components, AC load line	1
1.5	Design and frequency response	1
1.6	CS stage with diode-connected load	1
1.7	Effect of cascading on gain and bandwidth	1
1.8	Cascode amplifier	1
	MODULE II	
2.1	Small signal equivalent model of MOSFET, Small signal voltage gain of CS configuration	1
2.2	Small signal current gain, input and output impedance of CS configuration	1
2.3	Small signal analysis of CS amplifier without bypass capacitor	1
2.4	Miller effect, High frequency equivalent circuits of MOSFET	1
2.5	Small signal analysis of high frequency MOSFET circuit	1
	MODULE III	
3.1	Effect of positive and negative feedback on gain, frequency response and distortion	1
3.2	The four basic feedback topologies - Block level modeling	1
3.3	Voltage series feedback - voltage gain, input and output impedance	1
3.4	Voltage shunt feedback - voltage gain, input and output impedance	1
3.5	Classification of oscillators, criteria for oscillation	1
3.6	RC phase shift oscillator using MOSFET- circuit, working, frequency of oscillation	1
3.7	Wien bridge oscillator using MOSFET- circuit, working, frequency of oscillation	1
	MODULE IV	
4.1	Current mirror using MOSFET - basic topology and its variants	1
4.2	V-I characteristics, output resistance and minimum sustainable voltage (VON), maximum usable load	1

4.3	Differential amplifier: Basic structure using MOSFET and principle of operation	1
4.4	Calculation of differential gain, common mode gain	1
4.5	Calculation of CMRR and ICMR	1
MODULE V		
5.1	Introduction to Opamp	1
5.2	Design of differential amplifier for a given gain	1
5.3	Design of gain stages of Opamp	1
5.4	Design of output stages of Opamp	1
5.5	Compensation in design of Opamp	1

LESSON PLAN FOR LAB COMPONENT

No.	Topic	No. of Hours	Experiment
1	Amplifiers	2	Experiment 1: RC Coupled CE Amplifier
		2	Experiment 2: CS MOSFET Amplifier
2	Feedback Amplifiers	2	Experiment 3: Current series and Voltage Series Amplifiers using MOSFET
3	Multistage Amplifiers	2	Experiment 4: Cascade Amplifier using MOSFET
		2	Experiment 5: MOSFET Cascode Amplifier
4	Oscillators	2	Experiment 6: RC phase shift oscillator using MOSFET.
		2	Experiment 7: Weinbridge oscillator using MOSFET.
5	Circuit Simulation	1	Experiment 8: CS MOSFET Amplifier.
		1	Experiment 9: Cascode amplifier using MOSFET.
		1	Experiment 10: RC phase shift oscillator using MOSFET.
		1	Experiment 11: Design of Opamp for a given specification

CO Assessment Questions	
1	Design a CS MOSFET amplifier for any gain and verify the gain by simulating it.
2	Find the input impedance, output impedance and voltage gain for a CS MOSFET Amplifier.
3	Explain the effect of voltage shunt feedback on gain, input impedance and output impedance of a MOSFET amplifier.
4	Analyse the gain, CMRR and ICMR for the given differential amplifier.
5	Design an Op-amp for a given gain and verify the gain by simulating it.

24ECJ404	MICROPROCESSORS AND MICROCONTROLLERS	L	T	P	J	S	C	Year of Introduction
		2	0	2	2	5	5	2024

Preamble: This is a fundamental course that explores architecture of Microprocessor and Microcontroller. In this course students learn the assembly language programming and interfacing. The student will be able to incorporate these concepts into their electronic designs where control can be achieved via a microprocessor/microcontroller.

Prerequisite: 24ECJ303 Logic Circuit Design, 24ECT307 Computer Architecture

Course Outcomes: After the completion of the course the student will be able to

CO1	Illustrate the architecture and assembly language programming of 8085 microprocessors. (Apply Level)
CO2	Illustrate the architecture of 8051 Microcontroller. (Understand Level)
CO3	Describe the instruction sets in 8051 and perform Assembly/Embedded C programming. (Apply Level)
CO4	Describe timer/counter operating modes, interrupt handling mechanism and serial communication of 8051. (Apply Level)
CO5	Interface peripheral ICs with 8051 using assembly language and C program. (Apply Level).
CO6	Identify a real-world problem and propose a microcontroller-based solution for the same using modern microcontrollers. (Apply Level).

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	✓											
CO 2	✓		✓									
CO 3	✓				✓							
CO 4	✓											
CO 5	✓		✓		✓							
CO 6	✓		✓	✓	✓				✓	✓	✓	✓

Assessment Pattern for Theory Component

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember		✓	✓	✓
Understand		✓	✓	✓
Apply		✓	✓	✓
Analyse				
Evaluate				
Create				

Assessment Pattern for Lab Component		
Bloom's Category	**Continuous Assessment Tools**	
	Class work	**Test1**
Remember	✓	✓
Understand	✓	✓
Apply	✓	✓
Analyse		
Evaluate		
Create		

Assessment Pattern for Project Component			
Bloom's Category	**Continuous Assessment Tools**		
	Evaluation 1	**Evaluation 2**	**Report**
Remember			
Understand	✓	✓	
Apply	✓	✓	
Analyse	✓	✓	
Evaluate			
Create			

Mark Distribution of CIA

Course Structure	Attendance	Theory [L- T]		Practical [P]	Project [J]			Total Marks
		Assignment	Test-2	Class work	Evaluation 1	Evaluation-2	Report	
2-0-2-2	5	10	15	10	5	10	5	**60**

Total Marks Distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	60	40	2.5 Hours

PATTERN	PART A	PART B	ESE Marks
PATTERN 2		2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 subdivisions. Each question carries 8 Marks. Marks: (5x 8 = 40 Marks) Time: 2.5 hours	40
	Total Marks: 0	Total Marks: [5 x 8 = 40 Marks]	

SYLLABUS (24 Hours)
MODULE I: Architecture and Programming of 8085 Microprocessor (5 Hours)
Microprocessors: Organization of a microprocessor-based system, evolution of microprocessors, 8085 architecture and its operation, pin configuration, functions and bus organization. Machine cycles and bus timings - generation of control signals for external operations – Instruction fetch, IO/M, read/write. Addressing modes, instruction set, assembly language programming examples for 8085
MODULE II: Architecture of 8051 Microcontroller (4 Hours)
Microcontrollers: Comparison between microprocessors and microcontrollers, microcontroller families, 8051- features, architecture, pin configuration and functions, memory organization, registers, I/O ports
MODULE III: Programming of 8051 Microcontroller (5 Hours)
Addressing modes and Instruction set of 8051 - data transfer instructions, arithmetic instructions and logical instructions, branching and control instructions. Introduction to Embedded C Programming, IDE, Embedded C Programming – code conversion
MODULE IV: Interfacing of 8051 Microcontroller (5 Hours)
Timer/Counter programming: Operating modes, time delay generation, Waveform generation (Assembly Language Programming, C Programming). Interrupts in 8051: Types, interrupt source, interrupt handling. Serial communication: RS232 interface, Serial port programming, Baud rates in 8051. Serial communication: SBUF, SCON, PCON registers, Programming 8051 to transmit and receive data serially

MODULE V: Interfacing and Advanced Concepts (5 Hours)
Interfacing: Interfacing of seven segment display, alphanumeric LCD, stepper motor, ADC, and DAC modules with 8051 (block schematic and assembly language programming). Introduction to ARM – ARM family, ARM 7 register architecture. ARM programmer's model.

Text books

1. Ramesh S Goankar, 8085 Microprocessors Architecture Application and Programming. Penram International, 5/e.
2. Kenneth J Ayala, The 8051 Microcontroller, Cengage learning, 3/e
3. Muhammed Ali Mazidi, The 8051 Microcontroller and Embedded Systems, Pearson Education, 2nd edition
4. Steve Furber, ARM System - on-chip Architecture, Pearson Education

Reference books

1. B Ram, Fundamentals of Microprocessors and Microcomputers, Dhanpat Rai Publications, 2001.
2. Aditya P Mathur, Introduction to Microprocessor, 3rd edition, Tata Mc Graw – Hill, 1989.
3. Subrata Ghoshal, Computer Architecture and Organization: From 8085 to Core2Duo and beyond, Pearson, 2011.
4. I.Scott Mackenzie, Raphel C-W Phan, The 8051 microcontroller, Pearson, 4th edition, 2006.
5. Lyla B. Das, Microprocessors and Microcontrollers, Pearson Education, India, 2011.
6. Nagoorkani, Microprocessors and Microcontrollers 2e, McGraw Hill Education India, 2012.
7. Soumitra Kumar Mandal. Microprocessors and Microcontrollers Architecture, Programming & Interfacing Using 8085, 8086 and 8051, McGraw Hill Education, 2011.
8. The 8051 Microcontrollers: Architecture Programming and Applications, K Uma Rao & Andhe Pallavi, Pearson, 2011.
9. [NPTEL :: Electrical Engineering - NOC:Microprocessors And Microcontrollers](#)

COURSE CONTENTS AND LECTURE SCHEDULE		
No.		No. of Hours
MODULE 1		
1.1	Organization of a microprocessor-based system, evolution of microprocessors, 8085 architecture	1
1.2	Pin configuration, functions and bus organization	1

1.3	Machine cycles and bus timings - generation of control signals for external operations – Instruction fetch	1
1.4	Generation of control signals for external operations – IO/M, read/write, Addressing modes	1
1.5	Instruction set of 8085, Assembly language programming examples for 8085	1
MODULE II		
2.1	Comparison between microprocessors and microcontrollers, microcontroller families, architecture of 8051 microcontroller	1
2.2	Features of 8051.	1
2.3	Pin configuration and functions of 8051	1
2.4	Memory organization, registers, I/O ports of 8051	1
MODULE III		
3.1	Addressing modes and Instruction set of 8051 - data transfer instructions.	1
3.2	Instruction set and assembly language programming of 8051 - arithmetic instructions and logical instructions.	1
3.3	Instruction set and assembly language programming of 8051 - branching and control instructions	1
3.4	Introduction to Embedded C Programming, IDE.	1
3.5	Embedded C Programming – code conversion	1
MODULE IV		
4.1	Timer/Counter programming: Operating modes, time delay generation (assembly language and Embedded C).	1
4.2	Timer/Counter programming: Waveform generation (assembly language and Embedded C).	1
4.3	Interrupts in 8051: Types, interrupt source, interrupt handling.	1
4.4	Serial communication: RS 232 interface, Serial port programming, Baud rates in 8051.	1
4.5	Serial communication: SBUF, SCON, PCON registers, Programming 8051 to transmit and receive data serially.	1
MODULE V		
5.1	Interfacing of seven segment display	1
5.2	Interfacing of alphanumeric LCD, stepper motor with 8051.	1
5.3	Interfacing of ADC and DAC modules with 8051.	1
5.4	Introduction to ARM – ARM family, ARM 7 register architecture.	1
5.5	ARM programmer's model.	1

LESSON PLAN FOR LAB COMPONENT

No.	Topic	No. of Hours	Experiment
1	Data transfer/ exchange between specified memory locations using 8051.	2	1. Develop an ALP to move a block of data from one external memory location to other. 2. Develop an ALP to exchange a block of data from one internal memory location to other.
2	Addition / subtraction / multiplication / division of 8/16 bit data using 8051.	2	3. Develop an ALP to add/subtract two 8bit /16 bit numbers using 8051 microprocessor 4. Develop an ALP to multiply/divide two numbers using 8051 microprocessors
3	Sum of a series of 8 bit data using 8051.	2	5. Develop an ALP to find the sum of ten 8 bit numbers.
4	Sorting (Ascending/ Descending) of data using 8051.	2	6. Develop an ALP to sort ten 8-bit numbers in ascending order.
5	Interfacing of 8051	2	7. Develop an ALP to display characters on a seven-segment display interface. 8. Develop an ALP to make the stepper motor run in forward and reverse direction.
6	Interfacing of 8051	2	9. Generate different waveforms using DAC interface.

Project: Identify a real-world problem and propose a microcontroller-based solution for the same and implement using modern microcontrollers. The project can be done in a group with a maximum of 4 student members. A project report has to be submitted at the end of the course.

Project Schedule

Project proposal	4 Hours
Design Phase (Evaluation I)	8 Hours
Implementation Phase (Evaluation II)	12 Hours

CO Assessment Questions	
CO1	1. Describe the architecture of 8085 microprocessors with block diagram 2. Explain machine cycles and bus timings of control signals for IO/M operations. 3. Write an assembly language program using 8085 to find the largest number in a set of 10 numbers.
CO2	1. Describe the architecture of 8051 microcontroller with block diagram. 2. Explain the memory organization of microcontroller 8051.
CO3	1. Illustrate the usage of branching instructions in 8051 with an embedded C program. 2. Write a C program to move a block of data from one external memory location to other using 8051.
CO4	1. Write assembly language program in 8051 to shift data serially through port. 2. Write an ALP to incorporate a time delay of 5ms.
CO5	1. Write assembly language program in 8051 to interface ADC. 2. Write an ALP to rotate a stepper motor clockwise in 360 degrees.
CO6	1. Implement a water level indicator using microcontroller of your choice.

24HUT445	INDUSTRIAL ECONOMICS & MANAGEMENT	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: The students will be able to get a sound understanding of concepts and principles of engineering economy and management and to develop proficiency with methods for making rational decisions regarding problems likely to be encountered in professional practice.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO1	Explain the problem of scarcity of resources and consumer behavior, and to evaluate the impact of government policies on the general economic welfare. (Understand Level)
CO2	Take appropriate decisions regarding volume of output and evaluate the social cost of production. (Apply Level)
CO3	Explain the characteristics and functional areas of management. (Understand Level)
CO4	Describe the functions of management. (Understand Level)
CO5	Illustrate decision making process and project management techniques. (Apply Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓		✓									
CO2	✓	✓									✓	
CO3	✓	✓	✓				✓	✓	✓		✓	
CO4	✓	✓	✓									
CO5	✓	✓	✓		✓		✓				✓	

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				
Create				

Mark Distributions of CIA					
Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
3-0-0-0	5	15	10	10	**40**

Total Mark Distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 Hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I: Basic Concepts and Demand and Supply Analysis (7 Hours)

Basic economic problems- PPC- Scarcity and choice- Law of demand, Law of demand, elasticity of demand, Measurement of elasticity of demand and applications, Supply, law of supply and determinants of supply– Equilibrium – Changes in demand and supply and its effects –Consumer surplus and producer surplus (Concepts) – Taxation and deadweight loss.

MODULE II: Production and cost concepts (7 Hours)

Production function – law of variable proportion – economies of scale – internal and external economies – isoquants, isocost line and producer's equilibrium – expansion

path – technical progress and its implications – Cobb-Douglas production function - cost concepts – social cost: private cost and external cost – explicit and implicit cost – sunk cost - short run cost curves - long run cost curves – revenue (concepts) – shutdown point – break-even point.

MODULE III: Introduction to management (8 Hours)

Introduction to management, characteristics, Levels of management, tasks and responsibilities of professional managers, skills required for managers, functional areas of management-operations management, human resources management, marketing management, financial management, entrepreneurship, business plans, corporate social responsibility, patents and intellectual property rights.

MODULE IV: Management process (7 Hours)

Management process, management process, planning types, mission, goals, strategy, programs, procedures, organizing, principles of organization, delegation, span of control, organization structures, directing, leadership, motivation, controlling.

MODULE V: Productivity and Project Management (8 Hours)

Concept of productivity and its measurement; decision making process; decision making under certainty, risk and uncertainty; decision trees.
Project management, network construction, arrow diagram. CPM and PERT Networks, Probability of completion of project.

Textbooks
1. Gregory N Mankiw, 'Principles of Microeconomics', Cengage Publications
2. Gregory N Mankiw, 'Principles of Macro Economics', Cengage Publications
3. Management by Koontz and O'Donnell 10th Edition, Tata McGraw-Hill,
4. Management by Stephen P. Robbins and Mary Coulter 11th Edition, Pearson Education.

Reference books
1. Dwivedi D N, 'Macro Economics', Tata McGraw Hill, New Delhi.
2. Mithani D M, 'Managerial Economics', Himalaya Publishing House, Mumbai.
3. Management by James A. F. Stoner, Daniel R. Gilbert, R. Edward Freeman,6th Edition, Pearson
4. R. D. Hisrich, and M. P. Peters, Entrepreneurship: Strategy, Developing, and Managing a New Enterprise, 4th ed., McGraw-Hill Education, 1997.
5. D. J. Sumanth, Productivity Engineering and Management, McGraw-Hill Education, 1985.
6. K. Ashwathappa, 'Human Resources and Personnel Management', TMH, 3 rd edition, 2005.
7. R. B. Chase, Ravi Shankar and F. R. Jacobs, Operations and Supply Chain Management, 14th ed. McGraw Hill Education (India), 2015.
8. https://onlinecourses.swayam2.ac.in/imb23_mg38/preview

No.	COURSE CONTENTS AND LECTURE SCHEDULE	No. of Hours
MODULE 1		
1.1	Basic economic problems- PPC- Scarcity and choice.	1
1.2	Law of demand, elasticity of demand.	1
1.3	Measurement of elasticity of demand and applications.	1
1.4	Supply, law of supply and determinants of supply.	1
1.5	Equilibrium – changes in demand and supply and its effects.	1
1.6	Consumer surplus and producer surplus (Concepts).	1
1.7	Taxation and deadweight loss.	1
MODULE II		
2.1	Production function – law of variable proportion	1
2.2	Economies of scale – internal and external economies.	1
2.3	Isoquants, isocost line and producer's equilibrium -Expansion path.	1
2.4	Technical progress and its implications – Cob Douglas production function.	1
2.5	Cost concepts – social cost: private cost and external cost – Explicit and implicit cost – sunk cost.	1
2.6	Short run cost curves - long run cost curves.	1
2.7	Revenue (concepts) – shutdown point – break-even point.	1
MODULE III		
3.1	Introduction to management, characteristics, levels of management	1
3.2	Tasks and responsibilities of professional managers, Skills required for managers.	1
3.3	functional areas of management-operations management.	1
3.4	Human resources management.	1
3.5	Marketing management.	1
3.6	Financial management.	1
3.7	Entrepreneurship, business plans.	1
3.8	Corporate social responsibility, Patents and Intellectual property rights.	1
MODULE IV		
4.1	Management process.	1
4.2	Planning types.	1
4.3	Mission, goals, strategy, programs, procedures.	1
4.4	Organizing, principles of organization.	1
4.5	Delegation, span of control, organization structures.	1

4.6	Directing, leadership.	1
4.7	Motivation, controlling.	1

MODULE V		
5.1	Concept of productivity and its measurement.	1
5.2	Decision making process; decision making under certainty, risk.	1
5.3	Decision making under uncertainty.	1
5.4	Decision trees.	1
5.5	Project management, network construction, arrow diagram.	1
5.6	CPM.	1
5.7	PERT networks.	1
5.8	Probability of completion of project.	1

CO Assessment Questions	
1	1. Explain basic economy problems and how do we solve them. 2. Mention the relation between price and demand.
2	1. Imagine that XYZ company is working in a rural area. Illustrate their various external costs. 2. The total sales of a manufacturing firm are Rs 20000 this year. Its variable costs are Rs 8000 while its fixed costs are Rs 6000 for that year. Find the breakeven point of this firm.
3	1. Explain the task and responsibilities of professional managers. 2. Managerial skills are related to organizational hierarchy. Explain.
4	1. Illustrate various organization structures. 2. Define span of control. List out the factors affecting span of control.
5	1. The producer of an apple crates company produces 270 crates per 100 logs with his current equipment. He currently purchases 100 logs per day, and each log required 3 labor hours to process. He believes that he can hire a professional buyer who can buy a better-quality log at the same cost. If this is the case, he increases his production to 290 crates per 100 logs. His labor hours will increase by 8 hours per day. What will be the impact on productivity (measured in crates per labor-hour) if the buyer is hired? What is the growth in productivity in this case? 2. Differentiate between slack and float.

24MCT406	ENVIRONMENTAL SCIENCES	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	1*	2024

Preamble: Environmental Sciences is a specialized course designed to provide engineering students with a solid foundation in environmental principles and their application to engineering practice. The course aims to enhance students' understanding of the environmental challenges associated with engineering activities and equip them with the knowledge and skills to integrate environmental considerations into their future engineering work.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO 1	Identify ecosystem components and threats. (Apply Level)
CO 2	Describe the air and noise pollution problems and their sustainable solutions. (Understand Level)
CO 3	Discuss the water and waste water qualities and its treatment. (Understand Level)
CO 4	Explain the various types of solid waste and its management strategies. (Understand Level)
CO 5	Associate causes and effects of climate change and suggest climate actions. (Evaluate Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	✓	✓					✓			✓		✓
CO 2	✓					✓	✓					
CO 3	✓					✓	✓					
CO 4	✓					✓	✓					
CO 5	✓	✓		✓		✓	✓			✓		✓

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse			✓	
Evaluate			✓	
Create				

Mark Distribution of CIA

Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
3-0-0-0	5	15	10	10	40

Total Mark Distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 Hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks. Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 subdivisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS (36 Hours)

MODULE I: Environment and Ecosystem (5 Hours)

Introduction- Definition and scope of environmental science - Interdisciplinary nature of the field

Ecosystem structure and function- Biodiversity and its importance - Threats to biodiversity (habitat loss, invasive species, over exploitation) - Man and Environment – Health and Environment – Environmental Ethics.

Sustainable development – Social, economic and environmental dimensions- Need for Sustainable development, Sustainable Development Goals (SDGs).

MODULE II: Air and Noise pollution (7 Hours)
Air pollutants – classification, sources and impacts - Clean air act and national ambient air quality standards (NAAQS) - Air quality index - Emission reduction strategies - Understanding and controlling indoor air pollution. Ground level ozone and photochemical smog - Ozone layer depletion and the Montreal Protocol, Global warming, Noise Pollution: Sources and effects of noise, quantification of noise pollution (Leq, LAeq, etc.), Control and regulation rules in India
MODULE III: Water and Wastewater (9 Hours)
Sources and availability of freshwater- Water conservation strategies - Water pollution and its impacts – Water Quality Standards (IS 10500) - Water quality index, Overview of water treatment plant- Sustainable water use and conflicts over water resources. Wastewater sources and quality –wastewater disposal – Oxygen sag curve - Applicable wastewater discharge standards and typical flow schemes for sewage treatment plant-Decentralized wastewater treatment- natural methods of wastewater treatment
MODULE IV: Solid and Hazardous Waste Management (7 Hours)
Waste Management: Consumerism and our throw-away culture, Characteristics of municipal solid waste, CPHEEO guidelines for solid waste management (overview only), Waste disposal methods (landfill, incineration, recycling), Sustainable practices in waste management - Transition to zero waste lifestyle – Circular Economy, Hazardous and e-waste identification and management - Recycling and waste-to-energy technologies – regulations for hazardous waste management in India (overview only); Biomedical waste and its management
MODULE V: Climate Action (8 Hours)
Climate Change: Evidence, causes and effects, Carbon footprint, Global warming potential; Role of IPCC in the understanding of climate change; Global climate agreements – The United Nations Framework Convention on Climate Change, the Kyoto Protocol, and the Paris Agreement, Mitigation strategies – carbon capture, utilization, and storage; adapting to climate change. Renewable Energy- solar energy, Biomass, Wind energy, New Energy sources

Text books
1. Gilbert M. Masters, Wendell P. Ela, Introduction to Environmental Engineering and Science, 3rd Edition (2013), Pearson Education
2. Mark Brusseau, Ian Pepper, Charles Gerba, Environmental and Pollution Science, 3rd Edition (2019), Elsevier
3. Mackenzie L Davis, Introduction to Environmental Engineering, 5th Edition (2012), McGraw hill Education (India)

Reference books
1. Robert A Corbett, Standard Handbook of Environmental Engineering, 2nd edition (1999), McGraw Hill
2. B.C Punmia, Wastewater Engineering, 2nd edition (1998), Laxmi Publications Pvt. Ltd
3. Mackenzie Davis and Susan Masten, Principles of Environmental Engineering & Science, 4th Edition (2004), McGraw Hill

No.		No. of Hours 36
	COURSE CONTENTS AND LECTURE SCHEDULE	
	MODULE I	
1.1	Introduction- definition and scope of environmental science - Interdisciplinary nature of the field	1
1.2	Ecosystem structure and function- Biodiversity and its importance	1
1.3	Threats to biodiversity (habitat loss, invasive species, overexploitation)	1
1.4	Man and environment – health and environment – environmental ethics	1
1.5	Sustainable development – Social, economic and environmental dimensions – need for sustainable development, sustainable development goals (SDGs)	1
	MODULE II	
2.1	Air pollutants – classification, sources and impacts -	1
2.2	Clean air act and national ambient air quality standards (NAAQS) - Air quality index	1
2.3	Emission reduction strategies - Understanding and improving indoor air quality	1
2.4	Ground level ozone and photochemical smog	1
2.5	Ozone layer depletion and the montreal protocol, global warming	1
2.6	Noise Pollution: sources and effects of noise; quantification of noise pollution (Leq, LAeq, etc.)	1
2.7	Control and regulation rules in India	1
	MODULE III	
3.1	Sources and availability of freshwater- water conservation strategies.	1
3.2	Water pollution and its impacts – water quality standards (IS 10500)	1
3.3	Water quality index, overview of water treatment plant	1
3.4	Sustainable water use and conflicts over water resources	1
3.5	Wastewater sources and quality	1
3.6	Wastewater disposal – oxygen sag curve	1
3.7	Applicable wastewater discharge standards and typical flow schemes for sewage treatment plant	1
3.8	Decentralized wastewater treatment	1
3.9	Natural methods of wastewater treatment	1
	MODULE IV	

4.1	Waste Management: consumerism and our throw-away culture	1
4.2	Characteristics of municipal solid waste; CPHEEO guidelines for solid waste management (overview only);	1
4.3	Waste disposal methods (landfill, incineration, recycling)	1
4.4	Sustainable practices in waste management - transition to zero waste lifestyle – circular economy	1
4.5	Hazardous and e-waste identification and management - Recycling	1
4.6	Waste-to-energy technologies – regulations for hazardous waste management in India (overview only)	1
4.7	Biomedical waste and its management	1
MODULE V		
5.1	Climate change: evidence, causes and effects, carbon footprint, global warming potential	1
5.2	Role of IPCC in the understanding of climate change	1
5.3	Global climate agreements – The united nations framework convention on climate change, the Kyoto protocol, and the Paris agreement	1
5.4	Mitigation strategies – carbon capture, utilization and storage	1
5.5	Adapting to climate change	1
5.6	Renewable energy- solar energy	1
5.7	Biomass, wind energy	1
5.8	New energy sources	1

CO Assessment Questions	
CO1	1. Visit any wetland ecosystem and identify the major threats faced. 2. How can mangroves aid in coastal protection?
CO2	1. What are the sources and effects of CO pollution? 2. What are the main factors in indoor air quality? 3. Explain the impacts of global warming. 4. Discuss the control measures for noise pollution
CO3	1. List and explain any three water conservation strategies 2. Describe the impacts of wastewater discharge to inland water bodies. 3. With a neat layout, explain the treatment units in a conventional water treatment plant. 4. Write short note on natural methods for wastewater treatment.
CO4	1. Explain the concept of circular economy. How does it help in achieving zero waste? 2. Discuss the management strategies for biomedical waste. 3. Classify solid waste based on source. 4. Write a short note on Landfills. 5. Discuss the e-waste management regulations in India

CO5	1. Estimate the carbon footprint of a brick kiln and suggest appropriate climate action. 2. Suggest appropriate mitigation strategies for pollution from transportation sector

24ECP407	MACHINE INTELLIGENCE: METHODS AND APPLICATIONS	L	T	P	J	S	C	Year of Introduction
		1	0	2	0	3	2	2024

Preamble: In this course, students will delve into the fundamentals and advanced concepts of Machine Learning, exploring its transformative impact on Electronics and Communication Engineering. The curriculum encompasses a range of techniques from supervised and unsupervised learning to Neural Networks and Deep Learning, all tailored to applications in signal processing, communication systems and embedded solutions. Emphasizing hands-on learning, the course also addresses ethical considerations and biases, preparing students to innovatively apply Machine Learning to real-world challenges in IoT, smart grids, and robotics.

Prerequisite: 24EST302 Scientific Computing Lab

Course Outcomes: After the completion of the course the student will be able to

CO 1	Understand Machine Learning fundamentals and its applications in signal processing, communication systems and embedded solutions. (Understand Level).
CO 2	Apply supervised learning techniques like Linear Regression and SVM to signal processing tasks, including noise reduction and classification. (Apply Level)
CO 3	Apply unsupervised learning concepts like Clustering them for feature extraction in electronic signals and communication systems. (Apply Level)
CO 4	Apply Grasp Neural Networks and Deep Learning basics like CNN and RNN to signal processing tasks. (Apply Level)
CO 5	Apply advanced Machine Learning topics like Reinforcement Learning in IoT and robotics, and recognize ethical aspects. (Apply Level)

<div align="center">CO - PO MAPPING</div>

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	✓											
CO 2	✓				✓							✓
CO 3	✓				✓							✓
CO 4	✓				✓							✓
CO 5	✓		✓		✓							✓

<div align="center">Assessment Pattern for Theory component</div>

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓		✓	✓
Understand	✓		✓	✓
Apply	✓		✓	✓
Analyse				

Evaluate					
Create					

Assessment Pattern for Lab component

Bloom's Category	Continuous Assessment Tools	
	Class work	Test1
Remember		
Understand	✓	✓
Apply	✓	✓
Analyse		
Evaluate		
Create		

Mark Distribution of CIA

Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Practical [P]		Total Marks
		Assignment	Test-1	Test-2	Class work	Lab Exam	
1-0-2-0	5	10	20	-	25	40	**100**

Total Marks distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	100	-	-

SYLLABUS (12 Hours)

MODULE I: Introduction to Machine Learning and Applications (2 Hours)

Overview of Machine Learning: Definition, types and significance in Electronics and Communication Engineering. Applications in signal processing, communication systems, and embedded systems.

MODULE II: Supervised Learning Techniques and Signal Processing (3 Hours)

Understand and apply supervised learning techniques such as Linear Regression, Logistic Regression, Decision Trees, and Support Vector Machines to effectively address signal processing tasks including noise reduction, signal classification and modulation.

MODULE III: Unsupervised Learning and Feature Extraction (2 Hours)

Overview of unsupervised learning: Clustering (K-Means, Hierarchical) and Dimensionality Reduction (PCA). Feature extraction and selection in electronic signals and communication systems.

MODULE IV: Neural Networks and Deep Learning (3 Hours)
Introduction to Neural Networks and Deep Learning: Perceptrons, Multi-layer Perceptrons (MLP), Convolutional Neural Networks (CNN), and Recurrent Neural Networks (RNN). Applications in communication systems: Channel estimation, modulation recognition and image processing.
MODULE V: Advanced Topics and Real-world Applications (2 Hours)
Advanced topics: Ensemble Learning, Reinforcement Learning, and Transfer Learning. Applications in IoT, smart grids, autonomous communication systems, and robotics. Ethical considerations and biases in Machine Learning.

Text books

1. Raschka, S., & Mirjalili, V. (2019). Python Machine Learning (3rd ed.). Packt Publishing. ISBN: 978-1789955750.

Reference books

1. Bishop, C. M. (2006). *Pattern Recognition and Machine Learning*. Springer. ISBN: 978-0387310732.
2. Murphy, K. P. (2012). *Machine Learning: A Probabilistic Perspective*. The MIT Press. ISBN: 978-0262018029.
3. Goodfellow, I., Bengio, Y., & Courville, A. (2016). *Deep Learning*. The MIT Press. ISBN: 978-0262035613.
4. Hastie, T., Tibshirani, R., & Friedman, J. (2009). *The Elements of Statistical Learning: Data Mining, Inference, and Prediction* (2nd ed.). Springer. ISBN: 978-0387848570.
5. Online Course :https://onlinecourses.nptel.ac.in/noc19_cs52/preview
6. Online Course: https://nptel.ac.in/courses/106106139
7. Online Course: https://archive.nptel.ac.in/courses/106/105/106105152/

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours: 12
MODULE 1		
1.1	Definition of Machine Learning, Types of Machine Learning, Supervised, Unsupervised, Reinforcement Learning, Significance of Machine Learning in Electronics and Communication Engineering	1
1.2	Applications in Signal Processing- Noise Reduction, Signal Classification, Modulation Techniques Applications in Communication Systems-Channel Estimation, Modulation Recognition Applications in Embedded Systems-Real-time Data Processing, Predictive Maintenance	1

	MODULE II	
2.1	Overview of Supervised Learning, Introduction to Linear Regression, Concept and Mathematical Formulation, Application of Linear Regression in Signal Processing, Noise Reduction	1
2.2	Introduction to Logistic Regression, Concept and Mathematical Formulation, Introduction to Decision Trees, Concept and Algorithm, Application of Logistic Regression and Decision Trees in Signal Processing, Signal Classification	1
2.3	Introduction to Support Vector Machines (SVM), Concept and Mathematical Formulation, Application of SVM in Signal Processing, Signal Classification, Modulation Techniques	1
	MODULE III	
3.1	Overview of Unsupervised Learning, Introduction to Clustering, Concept and Significance, K-Means Clustering: Algorithm and Applications, Hierarchical Clustering: Algorithm and Applications, Application of Clustering in Electronic Signals and Communication Systems	1
3.2	Introduction to Dimensionality Reduction, Principal Component Analysis (PCA): Concept and Algorithm, Feature Extraction and Selection, Techniques for Feature Extraction in Electronic Signals, Feature Selection in Communication Systems, Application of Dimensionality Reduction and Feature Engineering in Signal Processing	1
	MODULE IV	
4.1	Overview of Neural Networks and Deep Learning, Introduction to Perceptrons, Concept and Mathematical Formulation, Introduction to Multi-layer Perceptrons (MLP), Architecture and Learning Process, Application of Perceptrons and MLP in Communication Systems, Basic Channel Estimation	1
4.2	Introduction to Convolutional Neural Networks (CNN), Concept, Architecture, and Layers (Convolution, Pooling), Application of CNN in Communication Systems and Image Processing, Modulation Recognition, Image Processing Techniques	1
4.3	Introduction to Recurrent Neural Networks (RNN), Concept, Architecture, and Applications, Long Short-Term Memory (LSTM) and Gated Recurrent Unit (GRU), Advanced Applications in Communication Systems, Advanced Channel Estimation Techniques, Modulation Recognition using RNN	1
	MODULE V	
5.1	Introduction to Ensemble Learning, Concept and Techniques (e.g., Bagging, Boosting), Overview of Reinforcement Learning	1

	Concept, Algorithm, and Applications, Applications of Ensemble and Reinforcement Learning, IoT and Smart Grids, Autonomous Communication Systems	
5.2	Introduction to Transfer Learning, Concept and Applications, Applications in Robotics, Use of Transfer Learning in Robotic Systems, Ethical Considerations and Biases in Machine Learning, Overview of Ethical Challenges, Addressing Biases in Machine Learning Models	1

LESSON PLAN FOR LAB COMPONENT

No.	Topic	No. of Hours	Experiment
1	Introduction to Machine Learning and Applications	2	Setting up the environment: Introduction to Python, Jupyter Notebook, and essential libraries (NumPy, Pandas).
		2	Basic data manipulation and visualization using Python.
2	Supervised Learning and Signal Processing	2	Implement a Linear Regression model for prediction using Python. Analyze their performances on suitable datasets, documenting your methodology and evaluation metrics.
		2	Implement a Support Vector Machine (SVM) for classification. Analyze their performances on suitable datasets, documenting your methodology and evaluation metrics.
		2	Hands-on signal processing: Noise reduction and signal classification using supervised learning.
3	Unsupervised Learning and Feature Extraction	2	Implementing clustering and PCA using Scikit-learn.
		2	Implement K-Means clustering in Python on a selected dataset.

		2	Implementing neural networks using TensorFlow and Keras.
4	Neural Networks in Signal Processing	2	Lab Task: Design and train a Multi-Layer Perceptron (MLP) in Python for a classification task using a dataset like Iris or MNIST. Detail the MLP architecture, data preprocessing, training process, and evaluate performance using metrics like accuracy, precision, and recall.
		2	Hands-on case study: Develop a Convolutional Neural Network (CNN) in Python for image classification using a basic dataset like MNIST or CIFAR-10. Describe data preprocessing, CNN design, training, and performance evaluation. Include insights on the role of CNN layers in image recognition.
5	Advanced Topics and Real-world Applications	2	Exploring case studies: Smart grids, IoT devices, and autonomous systems.
		2	Mini-project: Developing a prototype model incorporating learned techniques for a real-world application in Electronics and Communication Engineering.

	CO Assessment Questions

1	1. Definition and Types of Machine Learning:
	   a) Define Machine Learning and explain its significance in the field of Electronics and Communication Engineering.
	   b) Differentiate between Supervised, Unsupervised, and Reinforcement Learning. Provide examples of each type in the context of Electronics and Communication Engineering.
	 2. Significance in Electronics and Communication Engineering:
	   a) Discuss the role of Machine Learning in enhancing the capabilities of modern communication systems.
	   b) How has Machine Learning contributed to advancements in Electronics and Communication Engineering?
	 3. Applications in Signal Processing:
	   a) Explain how Machine Learning techniques can be applied for noise reduction in signal processing.
	   b) Describe a scenario where Machine Learning can be used for signal classification in communication systems.
	 4. Applications in Communication Systems:
	   a) How can Machine Learning be utilized for channel estimation in communication systems?
	   b) Discuss the application of Machine Learning in modulation recognition.
	 5. Applications in Embedded Systems:
	   a) Explain how Machine Learning can be integrated into embedded systems for real-time data processing.
	   b) Provide an example of a practical application of Machine Learning in embedded solutions for Electronics and Communication Engineering.
	 6. Experiment Task: Set up a Python environment in Jupyter Notebook and use NumPy and Pandas libraries to execute basic arithmetic operations (addition, subtraction, multiplication, division). Summarize your approach and findings.

2	1. Understanding Supervised Learning Techniques:
	   a) Define supervised learning and explain how it is different from other types of machine learning.
	   b) Briefly describe the working principles of Linear Regression, Logistic Regression, Decision Trees, and Support Vector Machines.
	 2. Implement a Support Vector Machine (SVM) for classification and a Linear Regression model for prediction using Python. Analyze their performances on suitable datasets, documenting your methodology and evaluation metrics.

3	1. Understanding Unsupervised Learning:
	  a) Define unsupervised learning and explain how it differs from supervised learning.
	  b) Discuss the significance of unsupervised learning in Electronics and Communication Engineering.
	2. Clustering Techniques:
	  a) Explain the K-Means clustering algorithm and describe its application in signal processing.
	  b) Lab Task: Implement K-Means clustering in Python on a selected dataset. Focus on data preprocessing, cluster formation, and the impact of different cluster numbers (k). Evaluate the clustering effectiveness and provide visualizations and insights on cluster characteristics.
	3. Dimensionality Reduction using PCA:
	  a) Define Principal Component Analysis (PCA) and explain its role in dimensionality reduction.
	  b) Use Python to apply Principal Component Analysis (PCA) for dimensionality reduction on a dataset. Describe the preprocessing, PCA application, and interpret the outcomes, focusing on the impact on data information and visualization.

4	1. Design and train a Multi-Layer Perceptron (MLP) in Python for a classification task using a suitable dataset. Detail the MLP architecture, data preprocessing, training process, and evaluate performance using metrics like accuracy, precision, and recall. 2. Develop a Convolutional Neural Network (CNN) in Python for image classification using a suitable dataset. Describe data preprocessing, CNN design, training, and performance evaluation. Include insights on the role of CNN layers in image recognition.

5	1. Create a real-world application prototype using transfer learning with ResNet50 or VGG-16. Select an application domain and dataset, adapt a pre-trained model through fine-tuning, customize the architecture, preprocess data, and implement transfer learning. Evaluate the prototype's performance and discuss its real-world applicability and limitations.
	
	2. Integrating Advanced Topics in Real-world Applications:
	  a) How can ensemble learning, reinforcement learning, and transfer learning be integrated to develop a comprehensive solution for challenges faced by autonomous communication systems?
	  b) Discuss a case study where advanced machine learning technique were used to address a real-world problem in Electronics and Communication Engineering.

MINOR

SYLLABUS

IV SEMESTER

24ECM409	DIGITAL CIRCUIT DESIGN	L	T	P	J	S	C	Year of Introduction
		4	0	0	0	0	4	2024

Preamble: Course aims to impart the basic knowledge of digital circuits. The course enables students to design combinational and sequential circuits and eventually a digital system

Prerequisite: 24EST105 Fundamentals of Electronics Engineering

Course Outcomes: After the completion of the course the student will be able to:

CO1	Perform binary and hexadecimal number system conversions and work with arithmetic operations and various binary codes. (Apply Level)
CO2	Apply Boolean algebra in logic circuit design (Apply Level)
CO3	Implement combinational logic functions using logic gates/multiplexers. (Apply Level)
CO4	Design sequential logic circuits using flip- flops (Apply Level).
CO5	Explain different logic families and compare it with respect to performance and efficiency (Understand Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	✓	✓										
CO 2	✓	✓										
CO 3	✓	✓										
CO 4	✓	✓										
CO 5	✓	✓										

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓		✓
Understand	✓	✓		✓
Apply	✓	✓		✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA

Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
4-0-0-0	5	15	10	10	**40**

Total Mark Distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 Hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS (37 Hours)

MODULE I: Number Systems and Codes (8 Hours)

Binary, octal and hexadecimal number systems; Methods of base conversions, binary, octal and hexadecimal arithmetic, Representation of signed numbers, Fixed- and floating-point numbers, Binary coded decimal, Gray codes, Excess 3 code, Error detection and correction codes - Parity check codes and Hamming Code-Alphanumeric codes: ASCII.

MODULE II: Boolean Postulates and Fundamental Gates (8 Hours)

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.

MODULE III: Combinational Circuits (7 Hours)

Combinational Logic Systems - Comparators, Multiplexers, Demultiplexers, Encoder, Decoder, Half and Full Adders, Subtractors, Serial and Parallel Adders, BCD Adder

MODULE IV: Sequential Logic Circuits (8 Hours)
Building blocks like S-R, JK and Master-Slave JK FF, Edge triggered FF. Conversion of Flipflops, Excitation table and characteristic equation. Shift registers-SIPO, SISO, PISO, PIPO. Ripple and Synchronous counters, Asynchronous and Synchronous counter design -Mod N counter, Ring counter and Johnson's counter.
MODULE V: Logic families and their characteristics (6 Hours)
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, NAND and NOR in CMOS.

Text books
1. V Carl Hamacher, Zvonko G Varanesic and Safat G Zaky, "Computer Organization",
   Fifth Edition, Indian Edition, McGraw-Hill Education, 2011
2. John P. Hayes, "Computer Architecture and Organization", Indian Edition, McGraw- Hill Education, 2017
3. DA Patterson and JL Hennessy, *Computer Organization and Design*, Morgan Kaufmann Publisher, 4e, 2010

Reference books
1. J.P. Hayes, *Computer Architecture and Organization*, Mc Graw Hill.
2. A.S. Tanenbaum, Structured Computer Organization, PHI Publication.
3. W. Stalling, Computer Organization and Architecture, PHI Publication
4. MOOC course on Digital Circuits by Prof. Santanu Chattopathayay
   IIT Kharagpur Digital Circuits - Course (nptel.ac.in)

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
MODULE 1		
1.1	Number Systems and Codes: Binary number systems: Methods of base Conversions.	1
1.2	Octal and hexadecimal number systems	1
1.3	Binary and octal arithmetic	1
1.4	Octal and hexadecimal arithmetic	1
1.5	Representation of signed numbers; Fixed- and floating-point numbers	1
1.6	Binary coded decimal codes, Gray codes, Excess 3 code.	1
1.7	Error detection and correction codes - Parity check codes and Hamming Code.	1
1.8	Alphanumeric codes: ASCII	1

MODULE II

2.1	Logic Gates AND, OR, NOT, EX-OR, Universal gates -NAND, NOR	1
2.2	Boolean postulates and laws – Logic Functions	1
2.3	De-Morgan's Theorems, Principle of Duality	1
2.4	Minimization and Implementation of Boolean expressions using Boolean Laws	1
2.5	Minimization and Implementation of Boolean expressions - Sum of Products (SOP).	1
2.6	Minimization and Implementation of Boolean expressions - Product of Sums (POS).	1
2.7	Boolean expressions -Canonical forms, Karnaugh map Minimization	1
2.8	Karnaugh map Minimization -Two, Three and four variable Karnaugh maps	1

MODULE III

3.1	Combinational Logic Systems – Comparators	1
3.2	Multiplexers, Demultiplexers	1
3.3	Encoder, Decoder	1
3.4	Half and Full Adders	1
3.5	Half and full Subtractors	1
3.6	Serial and Parallel Adders	1
3.7	BCD Adder	1

MODULE IV

4.1	Sequential Logic Circuits: S-R flip flop, JK flip-flop and Master-Slave JK FF.	1
4.2	D flip flop, T flip- flop	1
4.3	Conversion of Flip-flops with Excitation table and characteristic equation- SR to JK, JK to T, JK to D.	1
4.4	Conversion of Flipflops with Excitation table and characteristic equation- T to D	1
4.5	Shift registers- Serial in -Serial out, Serial in – Parallel out, Parallel in - Serial out Parallel in -Parallel out	1
4.6	Asynchronous counters- UP counter, Down counter, UP/Down Counter.	1
4.7	Synchronous counter- UP counter, Down counter.	1
4.8	Asynchronous and Synchronous counter design, Mod N counter.	1

MODULE V

5.1	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.	1
5.2	TTL, ECL, CMOS- Electrical characteristics of logic gates - power consumption and power-delay product.	1

5.3	TTL inverter - circuit description and operation	1
5.4	CMOS inverter - circuit description and operation	1
5.5	Structure and operations of TTL gates: NAND in TTL.	
5.6	Structure and operations of CMOS gates: NAND and NOR in CMOS.	1

CO Assessment Questions	
1	1. Convert 367.48_{10} to binary, base 5 and base 16 2. Convert AE45 .43_{16} to binary, base 10 and octal form 3. Express 674.75 in BCD and Excess-3 code
2	1. Simplify the following Boolean expressions using Boolean Simplification and draw the resultant logic circuits for each. i) Y = A'C (A'BD)' + A'BC'D' + AB'C ii) Y= AB'C + B + BD' + ABD' + AC 2. Design a magnitude comparator to compare two 2-bit numbers A = A_1A_0 and B = B_1B_0. 3. Simplify using K-map F(a,b,c,d) = Σ m (4,5,7,8,9,11,12,13,15)
3	1. Explain the operation of a 8 x 1 multiplexer and implement the following using an 8 x 1 multiplexer F(A, B, C, D) = Σ m (0, 1, 3, 5, 6, 7, 8, 9, 11, 13, 14) 2. With the help of a logic diagram and truth table explain a BCD to Decimal decoder.
4	1. Realize a D flip-flop using NAND gates and explain the operation with truth table, excitation table and characteristic equation 2. Draw the logic diagram of 3 bit PIPO shift register with LOAD/SHIFT control and explain its working
5	1. Compare TTL and MOS logic families. 2. Draw the circuit and explain the working of a TTL NAND gate.

24ECM410	INTRODUCTION TO DIGITAL SIGNAL PROCESSING	L	T	P	J	S	C	Year of Introduction
		4	0	0	0	0	4	2024

Preamble: This course aims to equip students with an understanding of the principles, algorithms, and applications of digital signal processing, preparing them for more advanced subjects in digital image processing, audio, and speech processing.

Prerequisite: 24ECM310 Basics of Signals and Systems

Course Outcomes: After the completion of the course the student will be able to

CO1	Utilize Discrete Fourier Transform techniques to analyze signals in frequency domain. (Apply Level)
CO2	Utilize Fast Fourier Transform (FFT) for efficient computation DFT. (Apply Level)
CO3	Utilize various techniques to design digital filters. (Apply Level)
CO4	Utilize appropriate techniques to realize digital filters. (Apply Level)
CO5	Explain the structure of a DSP processor. (Understand Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓										
CO2	✓	✓			✓							✓
CO3	✓	✓										
CO4	✓	✓										
CO5	✓	✓										

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA

Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
4–0–0–0	5	15	10	10	**40**

Total Mark Distribution			
Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS (37 Hours)

MODULE I: Discrete Fourier Transform (7 hours)

Basic elements of digital processing system- Review of DTFT - Discrete Fourier Transform – Properties and Application - DFT as a linear transformation - Circular convolution. Filtering of long data sequences – Overlap add and Overlap save methods.
Simulation Assignment I -to be performed in MATLAB/Python – Determination of DFT and Circular convolution operations

MODULE II: Fast Fourier Transform (8 hours)

Efficient computation of DFT- Fast Fourier Transform (FFT). Computational complexity of DFT and FFT, application. Radix-2 Decimation in Time (DIT) and Decimation in Frequency (DIF) algorithms. Circular Convolution using DFT.

MODULE III: Designing of Digital Filters (8 hours)

Digital Filters- Digital IIR Filters - Transfer function, Difference equation, Design of analogue Butterworth filters, Analog frequency transformations, Impulse invariance method. Bilinear transformation. Digital FIR Filter: Transfer function - Difference equation, Linear phase FIR filter, Concept of windowing.
Simulation assignment II - to be performed in MATLAB/Python – Simulation of IIR and FIR filters

MODULE IV: Realization of Digital Filters (8 hours)

Structure Realization of Digital filters, Direct form I and II, Cascade and parallel Structures of IIR filters. Direct form, cascade and linear phase realization of FIR filters, Multi-rate Digital Signal Processing: Decimation and Interpolation (concept only). Anti- aliasing and anti-imaging filter, Concept of fractional sampling.

	MODULE V: Digital Signal Processors (6 hours)

MODULE V: Digital Signal Processors (6 hours)

General and special purpose hardware for DSP: Computer architectures for DSP – Harvard, pipelining, MAC, special instruction, replication, on-chip cache. General purpose digital signal processors (TMS 320 family). Application of digital signal processing with real-world applications (vibration analysis, non-destructive testing, automobile engineering applications, civil engineering applications, etc.)

Textbooks
1. Proakis J. G. and Manolakis D. G., Digital Signal Processing, 4/e, Pearson Education, 2007.
2. Alan V Oppenheim, Ronald W. Schafer, Discrete-Time Signal Processing, 3rd Edition, Pearson ,2010

Reference books
1. S. K., Digital Signal Processing: A Computer Based Approach, 4/e McGraw Hill (India) 2014
2. Ifeachor E.C. and Jervis B. W., Digital Signal Processing: A Practical Approach, 2/e Pearson Education, 2009.
3. Lyons, Richard G., Understanding Digital Signal Processing, 3/e. Pearson Education India, 2004.
4. Salivahanan S, Digital Signal Processing,4e, Mc Graw –Hill Education New Delhi
5. Chassaing, Rulph., DSP applications using C and the TMS320C6x DSK. Vol. 13.
6. MOOC course on signals and systems by Alan V Oppenheim organized by MIT.https://ocw.mit.edu/courses/res-6-007-signals-and-systems-spring-2011/ video_ galleries/video-lectures/

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
MODULE 1		
1.1	Basic elements of digital processing system- Review of DTFT	1
1.2	Discrete Fourier Transform - Illustration with simple examples.	1
1.3	Properties and Application	1
1.4	Circular convolution	1
1.5	Illustration with simple examples.	1
1.6	Filtering of long data sequences – Overlap add methods	1
1.7	Filtering of long data sequences – Overlap save methods	1
MODULE II		
2.1	Efficient computation of DFT- Fast Fourier Transform (FFT).	1
2.2	Computational complexity of DFT and FFT, application.	1
2.3	Radix-2 Decimation in Time (DIT) algorithms.	1
2.4	Illustration with simple examples.	1
2.5	Radix-2 Decimation in Frequency (DIF) algorithms.	1
2.6	Illustration with simple examples.	1

2.7	Circular Convolution using DFT.	1
2.8	Illustration with simple examples.	1
MODULE III		
3.1	Digital Filters- Digital IIR Filters - Transfer function, Difference equation.	1
3.2	Design of analogue Butterworth filters - Illustration with examples.	1
3.3	Analog frequency transformations	1
3.4	Impulse invariance method - Illustration with examples.	1
3.5	Bilinear transformation	1
3.6	Illustration with examples.	1
3.7	Digital FIR Filter: Transfer function - Difference equation, Linear phase FIR filter	1
3.8	Concept of windowing - Illustration with examples.	1
MODULE IV		
4.1	Structure Realization of Digital filters	1
4.2	Direct form I and II - - Illustration with examples.	1
4.3	Cascade and parallel Structures of IIR filters - Illustration with examples.	1
4.4	Direct form realization of FIR filters.	1
4.5	Cascade and linear phase realization of FIR filters.	1
4.6	Illustration with examples.	1
4.7	Multi-rate Digital Signal Processing: Decimation and Interpolation (concept only).	1
4.8	Anti- aliasing and anti-imaging filter, Concept of fractional sampling.	1
MODULE V		
5.1	General and special purpose hardware for DSP: Computer architectures for DSP	1
5.2	Harvard, pipelining, MAC	1
5.3	Special instruction,	1
5.4	replication, on chip cache.	1
5.5	General purpose digital signal processors (TMS 320 family).	1
5.6	Architecture of TMS320XX processor	1

CO Assessment Questions	
1	Give the expression for DTFT. Compute the DTFT of the signal $x[n] = [1, -1, 1, -1]$
2	Find the DFT of the sequence $x(n) = \{1, 2, 3, 4, 4, 3, 2, 1\}$ using radix-2 DIF algorithm.
3	Design an IIR Butterworth filter for passband frequency 5 kHz and stopband frequency 10 kHz. The stop band and pass band attenuations are 0.1 respectively.

4	Obtain the direct form I and II structure realization of the IIR filter represented by the difference equation y(n)+0.75 y(n-1)+0.125 y(n-2) = x(n)+2 x(n-1)
5	a) Explain the function of the MAC unit in a DSP b) Explain the differences between Harvard and Von Neumann architecture.

24ECM411	FUNDAMENTALS OF DIGITAL COMMUNICATION	L	T	P	J	S	C	Year of Introduction
		4	0	0	0	0	4	2024

Preamble: This course explores the fundamental concepts and key principles of digital communication involved in transmitting information from source to destination. It lays a solid foundation in the models for critical components like transmitters, channels, and receivers. Furthermore, it highlights emerging trends, such as wireless ad hoc networks and their applications, to keep students at the forefront of digital communication technology.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO1	Explain various steps involved in the conversion of analog signal to digital signal (Understand Level)
CO2	Explain various modifications of PCM (Understand Level)
CO3	Explain various digital modulation schemes (Understand Level)
CO4	Illustrate the role of channel codes in transmission of information through the channel (Apply Level)
CO5	Explain the role of various layers in TCP/IP protocol stack (Understand Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓										
CO2	✓	✓										
CO3	✓	✓										
CO4	✓	✓										
CO5	✓											

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	Test 1	Test 2	
Remember	✓	✓	✓
Understand	✓	✓	✓
Apply		✓	✓
Analyse			
Evaluate			
Create			

Mark Distribution of CIA

Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
4-0-0-0	5	15	10	10	**40**

Total Mark Distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 Hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS (48 Hours)

MODULE I: Introduction to Digital Communication (8 Hours)
Elements of digital communication system, Sources, channels and receivers. Classification of communication channels, Discrete sources, Sampling theorem-Sampling and reconstruction.

MODULE II: Modifications of PCM (12 Hours)
Pulse code modulation, Sampling, quantization and encoding. Differential PCM, Delta modulator and adaptive delta modulator, Disadvantages of delta modulation, Slope overload, Comparison of different methods.

MODULE III: Digital Modulation Schemes (10 Hours)
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 (Analysis not required). QPSK transmitter and receiver. Quadrature amplitude modulation.

MODULE IV: Channel Coding (10 Hours)
Transmission through AWGN Channel. Capacity of an AWGN channel. Channel coding schemes. Repetition code. Block codes Cyclic codes.

MODULE V: Data Communication and Networks (8 Hours)
Study of OSI and TCP/IP protocol suit: The Model, Functions of each layer, TCP/IP Protocol Suites. Wireless Ad Hoc Networks: Issues and Challenges, Wireless Sensor Networks: Architecture, Data dissemination, Data gathering, MAC Protocols, Location discovery, Quality of a sensor network 6LoWPAN

Text books

1. Simon Haykin, "Communication Systems", Wiley
2. Nishanth ," Digital Communication", Cengage Learning 2018
3. Siva ram Murthy, B S Manoj- Ad Hoc Wireless Networks – Printice Hall

Reference books

1. Data Communication and Networking by Behrouz A. Forouzan (Fourth Edition), Tata McGraw Hill
2. Sklar, "Digital Communications: Fundamentals and Applications", Pearson
3. NPTEL Course on Digital Communication
   https://nptel.ac.in/courses/117101051

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
MODULE 1		
1.1	Introduction to Digital Communication	1
1.2	Elements of digital communication system. Sources, channels and receivers	1
1.3	Classification of communication channels.	1
1.4	Discrete sources.	1
1.5	Sampling	1
1.6	Sampling theorem	1
1.7	Reconstruction	1
1.8	Class Assessment	1
MODULE II		
2.1	Pulse code modulation (Block Diagrams only),	1
2.2	Overview of Sampling, quantization and encoding.	1
2.3	Quantization Noise	1
2.4	Numerical examples	1
2.5	Limitations of conventional PCM	1
2.6	Differential PCM	1
2.7	Delta modulator	1
2.8	Numerical Examples related DM	1
2.9	Adaptive delta modulator	1
2.10	Issues in delta modulation. Slope overload.	1
2.11	Comparison	1
2.12	Class Assessment	1
MODULE III		
3.1	Digital modulation schemes	1
3.2	Baseband BPSK system	1

3.3	Signal constellation of BPSK	1
3.4	BPSK transmitter and receiver	1
3.5	Plots of BER Vs SNR	1
3.6	QPSK modulation	1
3.7	Signal constellation of QPSK	1
3.8	QPSK transmitter and receiver	1
3.9	Quadrature amplitude modulation	1
3.10	Class Assessment	1
	MODULE IV	
4.1	Transmission of signal through AWGN Channel	1
4.2	Capacity of an AWGN channel- expression and its significance	1
4.3	Channel coding schemes- Repetition code	1
4.4	Block codes	1
4.5	Encoding and Decoding	1
4.6	Numerical examples	1
4.7	Cyclic codes.	1
4.8	Encoding and Decoding	1
4.9	Numerical examples	1
4.10	Class Assessment	1
	MODULE V	
5.1	Overview of layered architecture, Study of OSI and TCP/IP protocol suit	1
5.2	Functions of each layer	1
5.3	TCP/IP Protocol Suites.	1
5.4	Wireless Ad Hoc Networks: Issues and Challenges	1
5.5	Wireless Sensor Networks: Architecture, Data dissemination, Data gathering	1
5.6	MAC Protocols, Location discovery, Quality of a sensor network	1
5.7	6LoWPAN	1
5.8	Class Assessment	1

CO Assessment Questions	
1	1. State and prove sampling theorem 2. Explain various steps involved in the conversion of analog signal to digital 3. Explain the block diagram for PCM

2	1. Explain the working of DPCM transmitter
	2. Explain the working of Delta Modulator
	3. Compare the features of various modifications of PCM
3	1. Explain the block diagram for BPSK modulator and demodulator
	2. Plot the signal space representation for BPSK signals
	3. Explain the block diagram for QPSK modulator and demodulator
	4. Plot the signal space representation for QPSK signals
4	1. For a (6,3) systematic block code, the relation between parity bits and message bits are given by $P_4 = m_1 \oplus m_2$, $P_5 = m_1 \oplus m_2 \oplus m_3$, $P_6 = m_1 \oplus m_3$
	2. Determine (a) the parity check matrix (b) Generator matrix (c) All possible code words (d) dmin (e) Decode the received sequence 101101 Analyze the noise in AM systems
5	1. Explain the functions of each layer in TCP/IP protocol stack
	2. Explain various issues and challenges of Wireless Ad Hoc Networks

HONOR
SYLLABUS
IV SEMESTER

24ECH409	BIOSENSORS AND BIOELECTRONICS	L	T	P	J	S	C	Year of Introduction
		4	0	0	0	0	4	2024

Preamble: This course provides students with a comprehensive foundation to explore the fusion of electronics and biology, learning how biosensors revolutionize healthcare, diagnostics, and environmental monitoring. It empowers students with multidisciplinary skills to become a pioneer at the intersection of technology and life sciences.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO 1	Classify biosensors based on type of transduction. (Understand Level)
CO 2	Explain the principles of operation and application of various piezoelectric biosensors. (Understand Level)
CO 3	Explain the principles of operation and application of various optical biosensors. (Understand Level)
CO 4	Apply principles of biosensors in various fields. (Apply Level)
CO 5	Understand the potential developments towards a biomolecular computer. (Understand Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	✓	✓										
CO 2	✓	✓										
CO 3	✓	✓										
CO 4	✓	✓	✓									
CO 5	✓	✓										

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA

Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
4-0-0-0	5	15	10	10	40

Total Mark Distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 Hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I: Introduction to Biosensors (9 Hours)

Introduction to Biosensors: Basic Principle, Components, Classification based on transducers:-Optical, Piezoelectric, Magnetoelastic, FET Based, Electrochemical. Various components of biosensors: Biocatalysis based biosensors, Bioaffinity based biosensors & Microorganisms based biosensors, Biologically active material, and analyte. Types of membranes used in biosensor constructions.

MODULE II: Piezoelectric and Nanosized Biosensors for Medical Applications (10 Hours)

Piezoelectric biosensors for medical applications:- Introduction, Piezoelectric immunosensors, Piezoelectric genosensors, Piezoelectric biosensors with bio-mimetic receptors. Nanosized Biosensors for Medical Applications:- Introduction, Sensing modalities, Nanomaterial Properties, Biosensors on the nanoscale.

MODULE III: Optical Biosensors (8 Hours)
Principles of Optical Bio-sensing, Bio-recognition, Optical Transduction, Fluorescence Sensing, Fluorescence Energy Transfer Sensors, Molecular Beacons, Optical Geometries of Biosensing, Support for and Immobilization of Bio-recognition Elements.
MODULE IV: Application and uses of Biosensors (12 Hours)
Biosensors in clinical chemistry, medicine and health care, biosensors for veterinary, agriculture and food Low cost - biosensor for industrial processes for online monitoring, biosensors for environmental monitoring. Application of enzymes in analysis, design of enzyme electrodes and their application as biosensors in industry, healthcare, food and environment. Wearable Biosensors: Consideration and requirement of wearable sensors, Types of wearable sensors.
MODULE V: Bioelectronics (9 Hours)
Bioelectronics: Potential advantages & Developments towards a biomolecular computer, development of molecular arrays as memory stores, molecular wires and switches, Mechanisms of unit assembly. Design for a biomolecular photonic computer: Assembly of photonic biomolecular memory store; Information processing; Commercial prospects for biomolecular computing systems.

Text books

1. Biosensors for Medical Applications: Seamus Higson, Woodhead Publication series in Biomaterials,2012
2. Biosensors an Introduction, Brian R Eggins First edition, John Wiley & Sons Publishers, 1996.
3. Biosensors and Bioelectronics: Chandran Karunakaran, Kalpana Bhargava, Bosson Benjamin, Elsevier, 2015
4. Bioelectronics, Author: S. Bone, B. Zabba, Publisher: Wiley.
5. Molecular Bioelectronics, Author: Claudio Nicolini, Publisher: World Scientific

Reference books

1. Biosensors: Elizabeth A Hall, First Edition, Open University, Milton Keynes, 1990.

2. Biosensors Principles and Applications: Loic J Blum, Pierre R Coulet, First edition, Marcel Dekker, Inc, 1991.

3. Biosensors Theory and Applications: Donald G. Buerk, First Edition Technomic Publishing. Co, Inc, 1993.

4. https://nptel.ac.in/courses/102104062

No.	COURSE CONTENTS AND LECTURE SCHEDULE	No. of Hours
	MODULE 1	
1.1	Introduction to Biosensors: Basic Principle, Components of a biosensor	1
1.2	Classification based on transducers: Optical Biosensors	1
1.3	Piezoelectric Biosensors, Magnetoelastic Biosensors	1
1.4	FET Based Biosensors, Electrochemical Biosensors	1
1.5	Biocatalysis based biosensors	1
1.6	Bioaffinity based biosensors	1
1.7	Microorganisms based biosensors	1
1.8	Biologically active material and analyte	1
1.9	Types of membranes used in biosensor constructions	1
	MODULE II	
2.1	Introduction to Piezoelectric biosensors for medical applications	1
2.2	Piezoelectric immunosensors	1
2.3	Piezoelectric genosensors	1
2.4	Piezoelectric biosensors with bio-mimetic receptors.	1
2.5	Introduction to Nanosized Biosensors for Medical Applications	1
2.6	Sensing modalities	1
2.7	Nanomaterial Properties	1
2.8	Nanomaterial Properties continued	1
2.9	Biosensors on the nanoscale.	1
2.10	Review of Piezoelectric biosensors	1
	MODULE III	
3.1	Principles of Optical Bio-sensing	1
3.2	Bio-recognition	1
3.3	Optical Transduction	1
3.4	Fluorescence Sensing	1
3.5	Fluorescence Energy Transfer Sensors	1
3.6	Molecular Beacons	1
3.7	Optical Geometries of Biosensing	1
3.8	Support for and Immobilization of Bio-recognition Elements	1
	MODULE IV	
4.1	Biosensors in clinical chemistry, medicine and health care	1
4.2	Biosensors for veterinary, agriculture and food	1

4.3	Low cost - biosensor for industrial processes for online monitoring	1
4.4	Biosensors for environmental monitoring.	1
4.5	Application of enzymes in analysis	1
4.6	Design of enzyme electrodes	1
4.7	Application of enzyme electrodes as biosensors in industry	1
4.8	Application of enzyme electrodes as biosensors in, healthcare	1
4.9	Application of enzyme electrodes as biosensors in food	1
4.10	Application of enzyme electrodes as biosensors in the environment	1
4.11	Wearable Biosensors: Consideration and requirement of wearable sensors	1
4.12	Types of wearable sensors	1
MODULE V		
5.1	Bioelectronics: Potential advantages	1
5.2	Developments towards a biomolecular computer	1
5.3	Development of molecular arrays as memory stores	1
5.4	Molecular wires and switches	1
5.5	Mechanisms of unit assembly	1
5.6	Design for a biomolecular photonic computer: Assembly of photonic biomolecular memory store	1
5.7	Information processing	1
5.8	Commercial prospects for biomolecular computing systems	1
5.9	Review of Bioelectronics and its applications	1

CO Assessment Questions	
1	List the classification of biosensors based on principle of transduction and explain the principle of any two with specific applications.
2	Explain the principles of operation and application of piezoelectric biosensors with bio-mimetic receptors.
3	Explain the principles of operation and application of Fluorescence Energy Transfer Sensors
4	Design a wearable biosensor capable of monitoring vital parameters of the body.
5	Explain the design of a biomolecular photonic computer.

24ECH410	ARTIFICIAL INTELLIGENCE	L	T	P	J	S	C	Year of Introduction
		4	0	0	0	0	4	2024

Preamble: The course introduces the fundamental principles of intelligent systems. This course covers the characteristics of intelligent systems, knowledge representation schemes, logic and inference mechanisms. The course helps the learner to develop the design of self-learning systems along with some of their typical applications in the emerging scenario where the business world is being transformed by the progress made in machine learning.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO 1	Understand the concepts of intelligent systems and their architecture. (Understand Level)
CO 2	Apply the most appropriate algorithm for search and reasoning within an AI problem domain. (Apply Level)
CO 3	Represent AI domain knowledge using logic systems and use inference techniques for reasoning in intelligent systems. (Apply Level)
CO 4	Solve Constraint Satisfaction Problems using search techniques. (Apply Level)
CO 5	Understand the ethical consideration and future challenges in AI (Understand Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	✓	✓										
CO 2	✓	✓										
CO 3	✓	✓										
CO 4	✓	✓										
CO 5	✓	✓										✓

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
4-0–0-0	5	15	10	10	**40**

Total Mark Distribution			
Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	**Total Marks: [5x8 = 40 marks]**	

SYLLABUS (48 Hours)

MODULE I: Introduction (9 Hours)

Introduction – What is Artificial Intelligence (AI)? The Foundations of AI, History of AI, Applications of AI. Intelligent Agents – Agents and Environments, Good behavior: The concept of rationality, nature of Environments, Structure of Agents.

MODULE II: Problem Solving (9 Hours)

Solving Problems by Searching-Problem solving Agents, Example problems, Searching for solutions, Uninformed search strategies, Informed search strategies, Heuristic functions.

MODULE III: Search in Complex Environments (9 Hours)

Adversarial search - Games, Optimal decisions in games, The Minimax algorithm, Alpha-Beta pruning. Constraint Satisfaction Problems – Defining CSP, Constraint Propagation- inference in CSPs, Backtracking search for CSPs, Structure of CSP problems.

MODULE IV : Knowledge Representation and Reasoning (12 Hours)

Logical Agents – Knowledge based agents, Logic, Propositional Logic, Propositional Theorem proving, Agents based on Propositional Logic. First Order Predicate Logic – Syntax and Semantics of First Order Logic, Using First Order Logic, Knowledge representation in First Order Logic. Inference in First Order Logic – Propositional Vs First Order inference, Unification and Lifting, Forward chaining, Backward chaining, Resolution.

MODULE V : Ethics, Future Trends, and Challenges in AI (9 Hours)

Ethical Considerations: Bias, Fairness, Transparency, and Accountability in AI, Future of AI: Emerging trends, Opportunities and Challenges, AI Project Lifecycle: From problem definition to deployment. Research Methodologies in AI: Writing scientific papers, conducting experiments, Case Studies: Real-world examples of AI application and misapplication.

Text books
1. Russell, Stuart, and Peter Norvig. "Artificial Intelligence: A Modern Approach", 3rd Edition. Prentice Hall.
2. Goodfellow, Ian, Yoshua Bengio, and Aaron Courville. "Deep Learning."

Reference books
1. Nilsson N.J., Artificial Intelligence - A New Synthesis, Harcourt Asia Pvt. Ltd
2. Luger, George F. Artificial intelligence: structures and strategies for complex problem solving. Pearson education.
3. Patterson, Dan. Introduction to artificial intelligence and expert systems. Prentice-Hall.

Additional Resources:
1. Online platforms: Coursera, edX, Udacity for supplementary learning.
2. Research Papers and Articles for case studies and recent developments in AI.
3. https://onlinecourses.nptel.ac.in/noc22_cs56/preview
4. https://nptel.ac.in/courses/106105077

COURSE CONTENTS AND LECTURE SCHEDULE		
No.		No. of Hours
MODULE 1		
1.1	What is AI	1
1.2	History of AI	1
1.3	Applications of AI	1
1.4	Intelligent Agents – Agents	1
1.5	Intelligent Agents – Environments	1
1.6	Good Behaviour	1
1.7	The concept of Rationality	1
1.8	Nature of Environments	1
1.9	Structure of Agents	1

	MODULE II	
2.1	Solving Problems by searching	1
2.2	Problems by searching	1
2.3	Problem Solving Agents	1
2.4	Solving Agents – Problem	1
2.5	Example Problems	1
2.6	Searching for solutions	1
2.7	Uninformed search strategies	1
2.8	Informed search strategies	1
2.9	Heuristic functions	1
	MODULE III	
3.1	Adversarial search - Games	1
3.2	Optimal decisions in games	1
3.3	The Minimax algorithm	1
3.4	Alpha-Beta pruning	1
3.5	Constraint Satisfaction Problems – Defining CSP	1
3.6	Constraint Propagation	1
3.7	Inference in CSPs	1
3.8	Local Search for CSPs	1
3.9	Structure of CSP Problems	1
	MODULE IV	
4.1	Local Agents- Knowledge based agents	1
4.2	Propositional Logic	1
4.3	Propositional Theorem proving	1
4.4	Agents based on propositional Logic	1
4.5	First Order Predicate Logic – Syntax and Semantics of First Order Logic	1
4.6	Knowledge Engineering in First Order Logic	1
4.7	Inference in First Order Logic	1
4.8	Propositional Vs First Order inference	1
4.9	Unification and lifting	1
4.10	Forward chaining	1
4.11	Backward chaining	1
4.12	Resolution	1
	MODULE V	
5.1	Definition, importance, and the need for ethical considerations in AI.	1
5.2	Understanding how biases enter AI systems	1
5.3	Consequences of biased AI, and measures to reduce AI bias	1
5.4	Interpretability in machine learning models	1
5.5	The importance of clear decision-making processes.	1
5.6	Future of AI: Emerging trends, Opportunities, and Challenges	1

5.7	AI Project Lifecycle: From problem definition to deployment.	1
5.8	Research Methodologies in AI: Writing scientific papers, conducting experiments	1
5.9	Case Studies: Real-world examples of AI application and misapplication.	1

	CO Assessment Questions

1	1. Explain about the basic types of agent programs in intelligent systems.
	 2. For the following activities, give a PEAS description of the task environment and characterize it in terms of the task environment properties.
	    1. Playing soccer.
	    2. Bidding on an item at an auction.

2	1. Differentiate between uninformed and informed search strategies in intelligent systems. 2. Illustrate the working of Minimax search procedure.

3	1. Prove, or find a counter example to, the following assertion:
	    If $\alpha \models \gamma$ or $\beta \models \gamma$ (or both) then $(\alpha \wedge \beta) \models \gamma$
	 2. For each pair of atomic sentences, find the most general unifier if it exists:
	    1. P (A, B, B), P (x, y, z).
	    2. Q(y, G(A, B)), Q(G(x, x), y).

4	Solve the following crypt arithmetic problem by hand, using the strategy of backtracking with forward checking and the MRV & least-constraining-value heuristics. $$\begin{array}{r} T\ W\ O \\ +\ T\ W\ O \\ \hline F\ O\ U\ R \end{array}$$

5	Considering the ethical dimensions and future prospects of AI, please address the following:
	
	 1. Ethical Considerations:
	    Discuss the implications of bias, fairness, transparency, and accountability in AI. Provide an example of each.
	 2. Future of AI:
	    Identify and explain one emerging trend in AI, discussing its opportunities and potential challenges.
	 3. Case Studies:
	    Analyze a real-world case where AI was successfully applied and another where it led to ethical controversy or misapplication. Discuss what differentiates the two.

SEMESTER - V
SYLLABUS

24ECT501	CONTROL SYSTEMS	L	T	P	J	S	C	Year of Introduction
		2	1	0	0	2	3	2024

Preamble: Control Systems are an integral part of modern society. The concept control systems has paved the way for revolutions in automation, remote controlling and advanced communication systems. This course enables the students to develop the mathematical model of various control systems, and to perform stability analysis of systems using time domain and frequency domain approaches. This course also aims to develop a skill in state space modeling of control systems.

Prerequisite: 24ECT402 Signals and Systems

Course Outcomes: After the completion of the course the student will be able to

CO 1	Create mathematical model of control systems and compute the transfer function. (Apply Level)
CO 2	Determine transient and steady state behaviour of control systems. (Apply Level)
CO 3	Analyze the stability of control systems. (Apply Level)
CO 4	Design suitable compensator for improving system performance. (Apply Level)
CO 5	Analyze control systems using state space modeling. (Apply Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	✓	✓										
CO 2	✓	✓										
CO 3	✓	✓										
CO 4	✓	✓										
CO 5	✓	✓										

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA						
Course Structure [L-T-P-J]	Attendance	Theory [L-T]				Total Marks
		Assignment	Test-1	Test-2		
2-1-0-0	5	15	10	10		**40**

Total Mark distribution			
Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 Hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS (35 Hours)

MODULE I : Modelling of Control Systems (7 Hours)

Introduction: Basic Components of a Control System, Open-Loop Control Systems and Closed-Loop Control Systems, Typical examples

Feedback and its effects: Effects of Feedback on Overall Gain, Stability, Sensitivity and External disturbance or Noise

Types of Feedback Control Systems: Linear versus Nonlinear Control Systems, Time-Invariant versus Time-Varying Systems, and Continuous versus sampled data control systems.

Mathematical modelling of control systems: Transfer Function of Electrical Systems and Mechanical systems. Force voltage and force current Analogy, Impulse response and its relation with transfer function of linear systems.

Block Diagrams: Reduction rules, Transfer function from block diagram reduction method. Signal Flow Graphs: Determination of transfer function using Mason's Gain formula.

MODULE II : Analysis of Control Systems (7 Hours)
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, derivation of time domain specifications. Steady state error and static error coefficients. Frequency domain analysis: Frequency domain specifications, correlation between time and frequency responses.
MODULE III : Stability of Control Systems (7 Hours)
Stability of linear control systems: Concept of BIBO stability, absolute stability, Routh Hurwitz Criterion. 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. Controllers: P, PI, PD & PID controllers.
MODULE IV : Frequency domain Methods and Compensator Design (7 Hours)
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 compensator using Bode plots.
MODULE V : State space analysis (7 Hours)
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. Phase variable form and canonical form of state space representation. 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.

Text books
1. Farid Golnaraghi, Benjamin C. Kuo, Automatic Control Systems, 9/e, Wiley India.
2. I.J. Nagarath, M.Gopal: Control Systems Engineering (7th-Edition) —New Age International Pub. Co., 2007.

Reference books
1. Ogata K., Modern Control Engineering, Prentice Hall of India, 4/e, Pearson Education, 2002.
2. Norman S. Nise, Control System Engineering, 5/e, Wiley India.
3. M. Gopal, Digital Control and State Variable Method, 4/e, McGraw Hill Education India, 2012.
4. Richard C Dorf and Robert H. Bishop, Modern Control Systems, 9/e, Pearson Education, 2001.
5. MOOC Course: https://archive.nptel.ac.in/courses/107/106/107106081/

No.		No. of Hours
COURSE CONTENTS AND LECTURE SCHEDULE		
MODULE I		
1.1	Introduction: Basic Components of a Control System, Open-Loop Control Systems and Closed-Loop Control Systems, Typical examples	1
1.2	Feedback and its effects: Effects of Feedback on Overall Gain, Stability, Sensitivity and External disturbance or Noise	1
1.3	Types of Feedback Control Systems, Linear versus Nonlinear Control Systems, Time-Invariant versus Time-Varying Systems, Continuous versus sampled data control systems.	1
1.4	Mathematical modelling of control systems: Transfer Function of Electrical Systems and Mechanical systems.	1
1.5	Force voltage and force current Analogy, Impulse response and its relation with transfer function of linear systems.	1
1.6	Block Diagrams: Reduction rules, Transfer function from block diagram reduction method.	1
1.7	Signal Flow Graphs: Determination of transfer function using Mason's Gain formula	1
MODULE II		
2.1	Time Domain Analysis of Control Systems: Introduction-Standard Test signals.	1
2.2	Time response of first systems to unit step input and ramp inputs.	1
2.3	Time response of second order systems to unit step inputs.	1
2.4	Derivation of time domain specifications.	1
2.5	Steady state error and static error coefficients.	1
2.6	Frequency domain analysis: Frequency domain specifications.	1
2.7	Correlation between time and frequency responses.	1
MODULE III		
3.1	Stability of linear control systems: Concept of BIBO stability, absolute stability. Routh Hurwitz Criterion (Construction of Routh array).	1
3.2	Routh Hurwitz Criterion (Numerical Examples).	1
3.3	Root Locus Techniques: Introduction, properties.	1
3.4	Construction of root locus and its application to system stability studies.	1
3.5	Root locus: Illustration of the effects of addition of a zero and a pole.	1
3.6	Controllers: P, PI, PD controllers.	1
3.7	PID controllers, comparison of controllers.	1

	MODULE IV	
4.1	Nyquist stability criterion: Fundamentals and procedure for construction of Nyquist plot.	1
4.2	Stability analysis using Nyquist plot.	1
4.3	Relative stability: Gain margin and phase margin. Introduction to Bode plot	1
4.4	Stability analysis with Bode plot.	1
4.5	Bode plot of basic functions	1
4.6	Design of Compensators: Need of compensators, procedure for design of lag compensator.	1
4.7	Lag compensator design problems.	1
	MODULE V	
5.1	State Variable Analysis of Linear Dynamic Systems: State variables, state equations, dynamic equations, merits for higher order differential equation solution.	1
5.2	State variable representation of electrical and mechanical systems.	1
5.3	Phase variable form of state space representation.	1
5.4	Canonical form of state space representation.	1
5.5	Transfer function from State Variable Representation.	1
5.6	Solutions of the state equations, state transition matrix.	1
5.7	Concept of controllability and observability - Kalman's Test.	1

	CO Assessment Questions
1	Determine the transfer function Y2(S)/F(S) of the system shown in figure.
2	1. Determine the steady state error constants & errors of a feedback control system described as $G(s) = 50/s(s+2)(s+5)$, $H(s) = 1/s$ for a unit step input. 2. 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 input. (i) Obtain the expression for the closed loop transfer function. (ii) Determine the undamped natural frequency and the damping ratio of the system.
3	1. Determine the stability of the system having the characteristic equation $s^6+2s^5+s^4+2s^3+3s^2+4s+5=0$ with the help of Routh Hurwitz
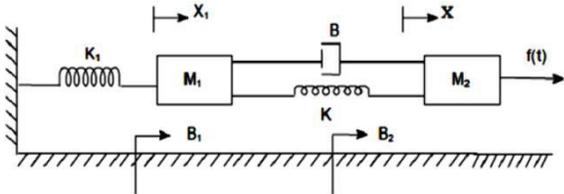
	criterion. If the system is unstable determine the number of roots of the characteristic equation on the right half of s-plane. 2. A unity feedback control system has an open loop transfer function $G(s) = K / s(s^2+4s+13)$. Sketch the root locus and analyze the stability. 3. Plot the Bode diagram for the following transfer function and obtain the gain and phase cross over frequencies. Also comment on the stability of the system. $G(S) = Ks^2 / (1+0.2s)(1+0.02)$.

4	1. Design a lag compensator for a unity feedback system with open loop transfer function $G(s) = k/s(s+1)(s+5)$ to satisfy the specifications.
	    i. $K_v \geq 50$
	    ii. Phase margin ≥ 20

5	1. Obtain the state space model of the electrical network shown in figure. 2. Obtain the state model for the given transfer function $\dfrac{Y(s)}{U(s)} = \dfrac{1}{s^2+s+1}$ 3. Obtain the state transition matrix for the following system matrix $A = [3\ 4\ 2\ 1]$.
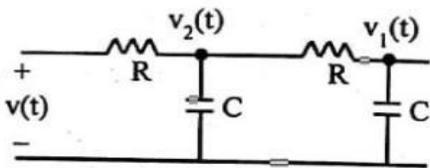
24ECJ502	DIGITAL SIGNAL PROCESSING	L	T	P	J	S	C	Year of Introduction
		2	0	2	2	5	5	2024

Preamble: This Digital Signal Processing course offers an in-depth exploration of the fundamental concepts and techniques used in the processing of digital signals. Spanning five modules, it covers the Discrete Fourier Transform, Fast Fourier Transforms, design and realization of FIR and IIR filters, and key topics in Multirate DSP, finite word length effects and Digital Signal Processors. By the end of this course, students will have gained a robust understanding of DSP methodologies, practical skills in filter design and analysis, and the ability to apply these concepts in various real-world signal processing applications.

Prerequisite: 24ECT402 Signals and Systems

Course Outcomes: After the completion of the course the student will be able to

CO 1	Analyze and manipulate digital signals using DFT, IDFT, circular convolution, and filter long duration sequences. (Analyze Level)
CO 2	Compute Fast Fourier Transform for effective signal processing in the frequency domain. (Apply Level)
CO 3	Design and implement linear phase FIR filters. (Apply Level)
CO 4	Design and implement IIR filters. (Apply Level)
CO 5	Explain the basic multi-rate DSP operations in time and frequency domains. (Understand Level)
CO 6	Design, implement, and document a signal processing system using a DSP Processor/board or an ARM-based microcontroller in groups of up to 4 members. (Apply Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	✓	✓										
CO 2	✓	✓										
CO 3	✓	✓		✓	✓							✓
CO 4	✓	✓		✓	✓							✓
CO 5	✓	✓										
CO 6	✓	✓		✓	✓			✓	✓	✓	✓	✓

Assessment Pattern for Theory component

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				
Create				

Assessment Pattern for Lab component

Bloom's Category	Continuous Assessment Tools	
	Class work	Test1
Remember	✓	
Understand	✓	✓

Bloom's Category	Continuous Assessment Tools		
	Evaluation 1	Evaluation 2	
Apply	✓	✓	
Analyse			
Evaluate			
Create			

Assessment Pattern for Project component

Bloom's Category	Continuous Assessment Tools		
	Evaluation 1	Evaluation 2	Report
Remember			
Understand	✓	✓	✓
Apply	✓	✓	✓
Analyse	✓	✓	
Evaluate		✓	
Create			

Mark Distribution of CIA

Course Structure [L-T-P-J]	Attendance	Theory [L- T]		Practical [P]	Project [J]			Total Marks
		Assignment	Test 2	Class work	Evaluation 1	Evalaution-2	Report	
2-0-2-2	5	10	15	10	5	10	5	**60**

Total Marks distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	60	40	2.5 Hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 2		2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x 8 = 40 marks) Time: 2.5 hours	40
	Total Marks: 0	Total Marks: [5x8 = 40 marks]	

SYLLABUS (36 Hours)

MODULE I : Discrete Fourier Transform (DFT) (7 Hours)

Discrete Time Fourier Transform (DTFT), Discrete Fourier Transform (DFT), Properties of DFT, Inverse DFT (IDFT), Circular Convolution, Filtering long duration sequence (Overlap add and save methods).

MODULE II : Fast Fourier Transform (FFT) (5 Hours)
Fast Fourier Transform (FFT): Radix 2 Decimation in Time, Radix 2 Decimation in Frequency, Inverse FFT (IFFT).
MODULE III : Finite Impulse Response (FIR) Filters (6 Hours)
Design of linear phase FIR filter: Fourier series method, Window method, Frequency sampling method. Realization of FIR filter: Tapped delay line structure, linear phase realization.
MODULE IV : Infinite Impulse Response (IIR) Filters (6 Hours)
Design of IIR filter: Butterworth filter, Impulse invariance transformation, Bilinear transformation. Realization of IIR filter: Direct form I, Direct form II, Cascade form.
MODULE V : Multirate DSP and DSP Processors (6 Hours)
Interpolation, Decimation, Anti-Aliasing filter and Anti imaging filter, Fractional sampling rate. Finite word length effect in DSP - Truncation, Rounding and its effects on designed systems.   Introduction to TMS320C67xx digital signal processor, Functional Block Diagram.

Text books
1. Proakis, J. G., & Manolakis, D. K. (2006). Digital Signal Processing: Principles, Algorithms, and Applications (4th ed.). Pearson/Prentice Hall.
2. Mitra, S. K. (2005). Digital Signal Processing: A Computer-Based Approach (3rd ed.). McGraw-Hill.

Reference books
1. Oppenheim, A. V., & Schafer, R. W. (2009). Discrete-Time Signal Processing (3rd ed.). Pearson. [ISBN-13: 978-0131988422]
2. Ifeachor, E. C., & Jervis, B. W. (2002). Digital Signal Processing: A Practical Approach (2nd ed.). Pearson Education. [ISBN-13: 978-0201596199]
3. Lyons, R. G. (2010). Understanding Digital Signal Processing (3rd ed.). Pearson. [ISBN-13: 978-0137027415]
4. Ingle, V. K., & Proakis, J. G. (2016). Digital Signal Processing Using MATLAB: A Problem-Solving Companion (4th ed.). Cengage Learning. [ISBN-13: 978-1305635197]
5. Oppenheim, A. V., Willsky, A. S., & Nawab, S. H. (1996). Signals and Systems (2nd ed.). Prentice Hall. [ISBN-13: 978-0138147570]
6. Schilling, R. J., & Harris, S. L. (2004). Introduction to Digital Signal Processing (1st ed.). Cengage Learning. [ISBN-13: 978-0534405090].
7. NPTEL Course: https://nptel.ac.in/courses/117102060

COURSE CONTENTS AND LECTURE SCHEDULE	
No.	**No. of Hours**
MODULE I	
1.1	Review of DTFT and Introduction to DFT	1
1.2	DFT Computation	1
1.3	Properties of DFT	1

1.4	IDFT	1
1.5	Linear and Circular convolution	1
1.6	Overlap save method	1
1.7	Overlap add method	1
MODULE II		
2.1	Introduction to FFT	1
2.2	Decimation In Time FFT Algorithm	1
2.3	Decimation In Frequency FFT Algorithm	1
2.4	Decimation In Frequency FFT Algorithm	1
2.5	IFFT	1
MODULE III		
3.1	Introduction to FIR filter. Design of FIR filter using Fourier series method.	1
3.2	Design of FIR filter using window method.	1
3.3	Gibbs phenomenon.	1
3.4	Design of FIR filter using frequency sampling method.	1
3.5	Realization of FIR filter using tapped delay line structure.	1
3.6	Realization of linear phase FIR filter.	1
MODULE IV		
4.1	Introduction to IIR filter. Types of IIR filters.	1
4.2	Design of analog Butterworth IIR filter.	1
4.3	Design of digital IIR filter using impulse invariance transformation.	1
4.4	Design of digital IIR filter using bilinear transformation.	1
4.5	Realization of IIR filter using Direct form I and Direct form II.	1
4.6	Realization of IIR filter using cascade form.	1
MODULE V		
5.1	Decimation (Time domain and frequency domain interpretation)	1
5.2	Interpolation (Time domain and frequency domain interpretation)	1
5.3	Fractional sampling rate conversion.	1
5.4	Finite word length effect in DSP - Rounding, Truncation.	1
5.5	Effect of Rounding and Truncation in filter coefficients and stability of the designed system.	1
5.6	Introduction to TMS320C67xx digital signal processor, Functional Block Diagram	1

LESSON PLAN FOR LAB COMPONENT (20 Hours)

No.	Topic	No. of Hours	Experiment
1	Introduction to Scilab and DFT	2	1. Basic Test signal generation 2. Relevance of N in computing N-DFT
2	Convolution	2	3. Linear and Circular convolution
		2	4. Overlap save method
3	FFT	2	5. Familiarization of DSP kit.
		2	6. FFT computation in DSP kit.
4	Filter Design	2	7. Design an FIR filter in Scilab.
		2	8. Implement the designed filter in DSP kit.
5	Signal Processing	2	9. Generate analog signal using DAC.
		2	10. Interface an input output device and process the input Signal.
6	Image Processing	2	11. Apply filter on an image for smoothening and sharpening.

PROJECT: (20 Hours)

The project should be any signal processing system implemented in a DSP board or in an ARM based microcontroller. The project can be done in a group with a maximum of 4 student members. A project report has to be submitted at the end of the course.

Project Schedule

Presentation of the project proposal	4 Hours
Design verification (Evaluation I)	8 Hours
Final Presentation (Evaluation II)	8 Hours

CO Assessment Questions	
1	1. Calculate the DFT of a given sequence and interpret the results. 2. Compute the IDFT of a given frequency domain sequence to retrieve

	the time-domain sequence. 3. Given a long duration sequence and a filter, apply the appropriate filtering technique and analyze the output.
2	1. Given a sequence, compute its DFT using the Radix-2 DIT FFT algorithm. 2. Calculate the IFFT of a given frequency domain sequence to obtain the time-domain sequence. 3. Compare the Radix-2 DIT FFT and Radix-2 DIF FFT in terms of their steps and computational efficiency.
3	1. Design a linear phase FIR filter for a given set of specifications using the Fourier series method. 2. Given a set of filter specifications, design a linear phase FIR filter using the Window method. 3. Given an FIR filter, determine whether it has a linear phase and justify your answer.
4	1. Design a Butterworth filter for a given set of specifications and plot its frequency response. 2. Apply the Impulse Invariance Transformation method to design an IIR filter for a given analog filter. 3. Design an IIR filter using the Bilinear Transformation method for a given set of specifications.
5	1. Design an anti-aliasing filter for a given application and analyze its performance. 2. Describe the concept of fractional sampling rate and its applications. 3. Discuss how finite word length effects, such as truncation and rounding, impact the accuracy and performance of designed DSP systems.

6	1. Design:
	  a) Describe the steps involved in designing a signal processing system for a given application. What considerations must be taken into account?
	  b) Given a specific problem statement, outline a design plan for a signal processing system using a DSP board or an ARM-based microcontroller.
	2. Implementation:
	  a) Explain how you would implement a specific signal processing algorithm on a DSP board or an ARM-based microcontroller.
	  b) Given a designed system, implement a signal processing task (e.g., filtering, modulation, etc.) and demonstrate its functionality.
	3. Documentation:
	  a) What are the key elements that should be included in the documentation of a signal processing system project?
	  b) Provide a sample documentation excerpt for a specific section (e.g., system design, implementation, results, etc.) of a signal processing project.

4. Collaboration:
   a) Describe your contribution and the contributions of your team members in the design, implementation, and documentation of the signal processing system.
   b) How did your team manage collaboration and division of tasks among up to 4 members?
5. Practical Application:
   a) Present a signal processing system that your group has designed, implemented, and documented. Explain the choices made in terms of hardware, algorithms, and optimizations.
   b) Evaluate the performance and efficiency of your implemented system. Were there any challenges faced, and how were they overcome?
6. Reflection:
   a) Reflect on the entire process of designing, implementing, and documenting the signal processing system. What would you do differently in a future project?
   b) How did working in a group contribute to the success or challenges of the project?

24ECT503	EMBEDDED SYSTEMS AND IoT	L	T	P	J	S	C	Year of Introduction
		2	1	0	0	2	3	2024

Preamble: This course provides a comprehensive understanding of embedded systems and the Internet of Things (IoT) using the RISC-V architecture. Students will delve into both theoretical concepts and practical applications, gaining insights into the design process, RISC-V processor architecture, instruction set, pipelining, and real-time operations. The course also explores the integration of IoT with embedded systems, allowing students to develop practical solutions that apply their knowledge.

Prerequisite: 23ECT307 Computer Architecture, 23ECJ404 Microprocessors and Microcontrollers

Course Outcomes: After the completion of the course the student will be able to

CO 1	Explain the fundamental principles of embedded processor design. (Understand Level)
CO 2	Explain RISC-V processor architecture. (Understand Level)
CO 3	Analyze the Hazards and Performance issues in Pipelining. (Apply Level)
CO 4	Design and develop IoT solutions integrated with embedded systems. (Apply Level)
CO 5	Create IC designs using RISC-V Instruction set Architecture (Apply Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	✓											
CO 2	✓											
CO 3	✓				✓							
CO 4	✓	✓	✓									
CO 5	✓	✓	✓		✓							✓

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	**Attendance**	**Theory [L- T]**			**Total Marks**
		Assignment	**Test-1**	**Test-2**	
2-1-0-0	5	15	10	10	**40**

Total Mark Distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 Hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS (38 Hours)

MODULE I : RISC V Processor Architecture (8 Hours)

Evolution of the RISC-V architecture, Comparison of RISC-V with MIPS and ARM architectures, open-source nature and its impact on the semiconductor industry.
Operands: Registers, Memory, and Constants. Program Flow, Logical, Shift, and Multiply Instructions, Branching, conditional statements, Loops, arrays and function calls
Assignment: Simple RISC-V assembly programs

MODULE II : Single Cycle Processor (7 Hours)

Single-Cycle Datapath, Single cycle control, Single cycle Processor operation, Performance analysis
Implementation of single cycle processor in FPGA: Controller, main decoder, ALU decoder, datapath, general building blocks

MODULE III : Pipelined Processor (7 Hours)
Architecture, Pipelined datapath, Pipelined control, hazards, Solving Data Hazards with Forwarding, Solving Data Hazards with Stalls, Solving Data Hazards with Stalls
MODULE IV : Internet of Things (8 Hours)
IoT- Definition and characteristics of IoT, IoT Functional blocks, Physical Design of IoT, Logical Design of IoT, Embedded systems development with VEGA THEJAS32 Microcontroller, The impact of IoT on business models and daily life.
MODULE V : IoT Communication protocols (8 Hours)
Functional components of IoT, IoT service-oriented architecture, IoT gateways, Data protocols: MQTT, MQTT components, MQTT methods, SMQTT. Constrained Application Protocol (CoAP), CoAP message types, CoAP request response model, Advanced Message Queuing Protocol (AMQP), AMQP features, frame types, components.

Text books
1. Rajkamal, "Embedded System: Architecture, Programming and Design", TMH3
2. David A. Patterson, John L. Hennessy, Computer Organization and Design RISC-V Edition
3. The RISC-V Reader by David A Patterson and Andrew Waterman First Edition
4. Ismail Butun, Industrial IoT Challenges, Design Principles, Applications, and Security.
5. S. Misra, A. Mukherjee, and A. Roy, 2020. *Introduction to IoT*. Cambridge University Press

Reference books
1. Steve Heath, Embedded Systems Design, Newnes – Elsevier 2ed, 2002
2. Guide to Computer Processor Architecture: A Risc-V Approach, With High-level Synthesis Goossens, Bernard
3. Georg Hager, Gerhard Wellein, Introduction to High Performance Computing for Scientists and Engineers, Chapman & Hall / CRC Computational Science series, 2011.
4. "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", by Pethuru Raj and Anupama C. Raman (CRC Press)
5. MOOC Course: https://archive.nptel.ac.in/content/storage2/106/103/106103206/MP4/mod01lec01.mp4
6. MOOC Course https://archive.nptel.ac.in/courses/106/105/106105166/

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
MODULE I		
1.1	Evolution of the RISC-V architecture	1
1.2	Comparison of RISC-V with MIPS and ARM architectures	1
1.3	Open-source nature and its impact on the semiconductor industry	1
1.4	Operands: Registers, Memory, and Constants	1
1.5	Program Flow, Logical, Shift, and Multiply Instructions	1
1.6	Branching, conditional statements	1
1.7	Loops, arrays and function calls	1
1.8	Simple RISC-V assembly programs	1
MODULE II		
2.1	Single-Cycle Datapath	1
2.2	Single cycle control	1
2.3	Single cycle Processor operation, Performance analysis	1
2.4	Introduction to Single-Cycle Processor and its implementation in FPGA	1
2.5	Implementing the Decoders (Main Decoder & ALU Decoder)	1
2.6	Implementing Datapath and Register File	1
2.7	Integration & Testing on FPGA	1
MODULE III		
3.1	Introduction to Pipelined Processor Architecture	1
3.2	Implementing the Pipelined Datapath	1
3.3	Implementing Pipelined Control	1
3.4	Identifying and Understanding Pipeline Hazards	1
3.5	Solving Data Hazards with Forwarding	1
3.6	Solving Data Hazards with Stalls (First Part)	1
3.7	Solving Control Hazards with Stalls (Second Part)	1
MODULE IV		
4.1	Introduction to IoT – Definition & Characteristics	1
4.2	IoT Functional Blocks	1
4.3	Physical Design of IoT	1
4.4	Logical Design of IoT	1
4.5	Introduction to Embedded Systems Development with VEGA THEJAS32	1
4.6	Advanced IoT Development with VEGA THEJAS32	1

4.7	The Impact of IoT on Business Models	1
4.8	The Impact of IoT on Daily Life	1
MODULE V		
5.1	Functional components of IoT, IoT service-oriented architecture IoT gateways	1
5.2	IoT gateways	1
5.3	MQTT, MQTT components	1
5.4	MQTT methods, SMQTT	1
5.5	Constrained Application Protocol (CoAP), CoAP message types	1
5.6	CoAP request response model	1
5.7	Advanced Message Queuing Protocol (AMQP), AMQP features	1
5.8	AMQP frame types and components	1

CO Assessment Questions	
1	Explain the architecture and main features of RISC-V processor.
2	1. Given a RISC V processor, outline how you would implement a program that effectively utilizes its 5-stage pipelined architecture. Consider an example where optimizing for speed is crucial. What stages would your data pass through, and how would you ensure maximum efficiency in each stage? 2. Design a scenario where an exception handling mechanism is crucial for the RISC V processor's operation. Explain how you would configure the RISC V processor to handle this exception. Include details on the types of exceptions you are planning for and the steps the processor should take to handle them efficiently.
3	Implement a single cycle RISC V processor in FPGA
4	Identify a real-world scenario and obtain an IOT based solution.
5	Consider a smart home IoT system that integrates various sensors (temperature, humidity, motion) and devices (lights, air conditioners, security cameras). The data collected by the sensors is processed and transmitted to a central hub or cloud server for monitoring and control. Using the concepts of IoT functional components, service-oriented architecture, gateways, and data protocols, complete the following tasks: a) Design and illustrate the architecture of the smart home IoT system. Clearly label and explain the functional components, including the role of IoT gateways and the service-oriented architecture used. b) Select and justify the most appropriate protocol (MQTT, CoAP, or AMQP) for the system's data communication between the sensors and the cloud.

24ECP504	DIGITAL COMMUNICATION	L	T	P	J	S	C	Year of Introduction
		2	1	2	0	4	4	2024

Preamble: Digital communication has revolutionized the way people and devices exchange information, making it faster, more efficient, and versatile in meeting the demands of modern society and technology**.** To get a better perception about digital communication, basics of Random variables and Random process, Baseband Data Transmission, Transmission over baseband channel, Signal Space Analysis and Pass Band Data Transmission were included in this subject. Digital communication has a wide range of applications in the areas of Wireless Technologies, Smart Devices and IoT, Scientific Research etc.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO 1	Explain the concept of Random Variables and Random Process. (Understand Level)
CO 2	Compare the performance of various Digital Pulse Modulation Schemes for base band transmission. (Understand Level)
CO 3	Apply the knowledge of ISI problems in Digital communication to derive Nyquist criteria for zero ISI and design an optimum receiver for baseband transmission. (Apply Level)
CO 4	Construct signal space representation of signal using Gram Schmidt Orthogonalization procedure. (Apply Level)
CO 5	Compare the error probability for different digital modulation schemes like BPSK, QPSK, BFSK etc. (Apply Level)
CO 6	Setup simple prototype circuits for waveform coding and digital modulation techniques working in a team. (Apply Level)
CO 7	Simulate the error performance of a digital communication system using standard binary and M-ary modulation schemes. (Apply Level)
CO 8	Develop hands-on skills to emulate a communication system with Software-designed-radio working in a team. (Understand Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	✓	✓			✓							
CO 2	✓	✓										
CO 3	✓	✓										
CO 4	✓	✓										
CO 5	✓	✓										
CO 6	✓	✓	✓	✓				✓	✓	✓		✓
CO 7	✓	✓	✓	✓	✓			✓		✓		
CO 8	✓	✓	✓	✓	✓			✓		✓		

Assessment Pattern for Theory component				
Bloom's Category	**Continuous Assessment Tools**			**End Semester Examination**
	Test1	**Test 2**	**Other tools**	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				
Create				

Assessment Pattern for Lab component		
Bloom's Category	**Continuous Assessment Tools**	
	Class work	**Test1**
Remember		
Understand	✓	✓
Apply	✓	✓
Analyse	✓	✓
Evaluate		
Create		

Mark Distribution of CIA

Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Practical [P]		Total Marks
		Assignment	Test-1	Test-2	Class work	Lab Exam	
2-1-2-0	5	10	12.5	12.5	10	10	**60**

Total Marks distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	60	40	2.5 Hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 2		2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x 8 = 40 marks) Time: 2.5 hours	40
	Total Marks: 0	Total Marks: [5x8 = 40 marks]	

SYLLABUS (37 Hours)

MODULE I : Overview of Random Variables and Random Process (6 Hours)

Random variables–continuous and Discrete, CDF and PDF, Stochastic processes, Stationarity, Conditions for WSS and SSS. Autocorrelation and power spectral density, Transmission of Random Process through LTI systems.

MODULE II : Baseband Data Transmission (8 Hours)

Pulse Modulation, Sampling process, Performance comparison of various sampling techniques, Aliasing, Reconstruction, Quantization, Noise in PCM system, Modifications of PCM- Delta modulation, DPCM, Performance comparison of various pulse modulation schemes, Line codes

MODULE III : Transmission over Baseband Channel (7 Hours)

Matched filter, Inter Symbol Interference (ISI), Nyquist Criteria for zero ISI, Ideal solution, Raised cosine spectrum, Eye diagram. Correlative Level Coding - Duobinary coding, precoding, Modified duobinary coding, Generalized partial response signaling.

MODULE IV : Signal Space Analysis (7 Hours)

Geometric representation of signals, Gram Schmidt procedure. Transmission Over AWGN Channel: Conversion of the continuous AWGN channel into a vector channel, Likelihood function, Maximum Likelihood Decoding, Correlation Receiver.

MODULE V : Pass Band Data Transmission (9 Hours)

Pass band transmission model, Coherent Modulation Schemes- BPSK, QPSK, BFSK. Non-Coherent orthogonal modulation schemes, Differential Phase Shift Keying (DPSK). Detection of Binary modulation schemes in the presence of noise, BER for BPSK, QPSK, BFSK.

Text books
1. John G. Proakis, Masoud Salehi, Digital Communication, McGraw Hill Education Edition, 2014.
2. Nishanth N, Digital Communication, Cengage Learning India., 2017.

3. Ramakrishna Rao, Digital communication, Tata McGraw Hill Education Pvt. Limited.
4. Simon Haykin, Communication Systems, 4/e Wiley India, 2012.

Reference books
1. Couch: Analog and Digital Communication. 8e, Pearson Education India, 2013.
2. H. Taub and Schilling Principles of Communication Systems, TMH, 2007.
3. K. Sam Shanmugham, Digital and Analog Communication Systems, John Wiley & Sons.
4. Pierre Lafrance, Fundamental Concepts in Communication, Prentice Hall India.
5. Sheldon. M. Ross, "Introduction to Probability Models", Academic Press, 7th edition.
6. Sklar: Digital Communication, 2E, Pearson Education.
7. T L Singal, Digital Communication, McGraw Hill Education (India) Pvt Ltd, 2015.
8. NPTEL Course on Digital Communication
   https://nptel.ac.in/courses/117101051

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
MODULE I		
1.1	Random variables–continuous and Discrete, CDF and PDF	1
1.2	Stochastic processes, Stationarity	1
1.3	Conditions for WSS and SSS	1
1.4	Transmission of Random Process through LTI systems	1
1.5	Autocorrelation	1
1.6	Power Spectral Density	1
MODULE II		
2.1	Pulse Modulation, Sampling process	1
2.2	Performance comparison of various sampling techniques	1
2.3	Aliasing, Reconstruction	1
2.4	Quantization	1
2.5	Noise in PCM system, Modifications of PCM- Delta modulation, DPCM	1
2.6	Modifications of PCM- DPCM	1
2.7	Delta modulation	1
2.8	Performance comparison of various pulse modulation schemes, Line codes	1
MODULE III		
3.1	Matched filter	1
3.2	Inter Symbol Interference (ISI)	1
3.3	Nyquist Criteria for zero ISI	1
3.4	Ideal solution, Raised cosine spectrum, Eye diagram	1

3.5	Correlative Level Coding - Duobinary coding, precoding	1
3.6	Modified duobinary coding,	1
3.7	Generalized partial response signaling	1
MODULE IV		
4.1	Geometric representation of signals	1
4.2	Gram Schmidt procedure	1
4.3	Transmission Over AWGN Channel	1
4.4	Conversion of the continuous AWGN channel into a vector channel	1
4.5	Likelihood function	1
4.6	Maximum Likelihood Decoding	1
4.7	Correlation Receiver.	1
MODULE V		
5.1	Pass band transmission model, Coherent Modulation Schemes-BPSK	1
5.2	Quadrature phase shift keying	1
5.3	Binary frequency shift keying	1
5.4	Non-Coherent orthogonal modulation schemes	1
5.5	Differential Phase Shift Keying (DPSK)	1
5.6	Detection of Binary modulation schemes in the presence of noise	1
5.7	Bit Error rate for BPSK	1
5.8	Bit Error rate for QPSK	1
5.9	Bit Error rate for BFSK	1

LESSON PLAN FOR LAB COMPONENT

No.	Topic	No. of Hours	Experiment
1	Delta Modulation	1	Generation of delta modulated Signal
		1	Detection of delta modulated Signal
2	Binary Phase Shift Keying	1	Generation of BPSK Signal
		1	Detection of BPSK Signal
3	Quadrature Phase Shift Keying	1	Generation of QPSK Signal
		1	Detection of QPSK Signal
		1	Generate a sinusoidal waveform with a DC offset so that it takes only positive amplitude value.

4	Performance of Waveform Coding Using PCM	1	Sample and quantize the signal using a uniform quantizer with number of representations levels L. Vary L. Represent each value using decimal to binary encoder.
		1	Compute the signal-to-noise ratio in dB. Plot the SNR versus number of bits per symbol. Observe that the SNR increases linearly.
5	Pulse Shaping and Matched Filtering	1	Generate a string of message bits. Use root raised cosine pulse p(t) as the shaping pulse, and generate the corresponding baseband signal with a fixed bit duration Tb. You may use roll-off factor as α = 0.4
		1	Simulate transmission of baseband signal via an AWGN channel
		1	Apply matched filter with frequency response $P_r(f) = P^*(f)$ to the received signal. Sample the signal at mT_b and compare it against the message sequence.
6	Eye Diagram	1	Generate a string of message bits.
		1	Use raised cosine pulse p(t) as the shaping pulse and generate the corresponding baseband signal with a fixed bit duration Tb. You may use roll-off factor as α = 0.4.
		1	Use various roll off factors and plot the eye diagram in each case for the received signal. Make a comparison study among them.
7	Error Performance of BPSK	1	Generate a string of message bits. Encode using BPSK with energy per bit E_b and represent it using points in a signal-space.
		1	Simulate transmission of the BPSK modulated signal via an AWGN channel with variance $N_0/2$.

		1	Detect using an ML decoder and plot the probability of error as a function of SNR per bit E_b/N_0.
8	Error Performance of QPSK	1	Generate a string of message bits. Encode using QPSK with energy per symbol E_s and represent it using points in a signal-space.
		1	Simulate transmission of the QPSK modulated signal via an AWGN channel with variance $N_0/2$ in both I-channel and Q-channel.
		1	Detect using an ML decoder and plot the probability of error as a function of SNR per bit E_b/N_0 where $E_s = 2E_b$.
9	Familiarization with Software Defined Radio (Hardware and Control Software)	1	Familiarize with an SDR hardware for reception and transmission of RF signal. Familiarize how it can be interfaced with computer.
		1	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.
		1	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.

CO Assessment Questions		
1	1. Calculate PSD if ACF is given as $R_X(\tau) = e^{-\alpha\tau}$ for $-\infty < \tau < \infty$. Explain the condition required for Wide Sense Stationarity. 2. Consider a WSS random process X(t) with zero mean and autocorrelation function Rxx(τ) = e-2|τ|.This random process X(t) is modulating the carrier wave cos(ωt+ø) where ø is uniformly distributed in the interval (0,2π). The resulting process is given by Y(t) =X(t)cos(ωt+ø). The carrier wave is independent of X(t). Determine whether the process Y(t) is WSS.

2	1. Derive the SQNR at the output of quantizer. 2. Explain the working of DPCM transmitter and receiver with relevant equations. 3. A television signal having a bandwidth of 4.2 MHz is transmitted by a binary PCM system having a number of quantization levels as 512. Determine (a) Codeword length; (b) Transmission bandwidth; (c) Final bit rate; and (d) Output SQNR if the input signal is assumed to be sinusoidal. 4. Explain the limitations of Delta modulation and how we can overcome these limitations with the help of relevant diagrams. 5. Explain the block diagram for Pulse Code Modulation.
3	1. Discuss the importance of raised cosine spectrum. 2. Prove Nyquist criteria for zero ISI. 3. State and prove Nyquist criteria for distortion less transmission. 4. A binary PAM is required to be transmitted over a pair of copper wire with an absolute bandwidth of 75 kHz. If the bit duration is 10 μ sec, find the roll off factor required for the raised cosine spectrum satisfying the above requirement. 5. What is raised cosine spectrum? How raised cosine filter causes increase in bandwidth when roll off factor increase.

4	1. Two functions $s_1(t)$ and $s_2(t)$ are given in Fig.
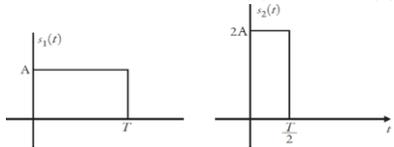	
	  (a) Using the Gram–Schmidt orthogonalization procedure, express these functions in terms of orthonormal functions.
	  (b) Sketch $\phi_1(t)$ and $\phi_2(t)$.
	2. Explain Gram–Schmidt orthogonalization procedure.

5	1. Derive the Bit Error Probability for QPSK. 2. Explain the block diagram for generation and detection of QPSK. 3. Derive the Bit Error Probability for BFSK. 4. Explain the block diagram for generation and detection of BFSK. 5. Derive the Bit Error Probability for BPSK. 6. Explain the block diagram for generation and detection of BPSK.
6	1. Design, set up and observe the output of a Delta modulation circuit. 2. Design, set up and observe the output of a Binary Phase Shift Keying (BPSK) modulator.
7	1. Plot the probability of error as a function of SNR per bit E_b/N_0 for BPSK.
8	1. Implement simple circuits using SDR.

24HUT545	ENTREPRENEURSHIP AND STARTUPS	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: The course is a dynamic exploration of the entrepreneurial journey within the electronics and communication engineering sector, designed to empower aspiring tech entrepreneurs with the tools and insights necessary to transform innovative ideas into viable businesses. Through a blend of theoretical knowledge and practical application, students will engage with the core aspects of starting a tech venture, including ideation, market validation, financial planning, product development, and strategic growth. This course aims to cultivate an entrepreneurial mindset, foster innovation, and prepare students to navigate the complexities of the startup ecosystem with confidence and ethical consideration.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO 1	Understand the role of entrepreneurship in the tech industry focusing on the mindset required for successful ventures in electronics and communication. (Understand Level)
CO 2	Understand ideation techniques, conduct market validation, and utilize intellectual property frameworks to develop and protect innovative concepts in the tech domain. (Understand Level)
CO 3	Demonstrate skill in identifying and assessing financing options, creating financial plans, and understanding legal frameworks relevant to tech startups. (Understand Level)
CO 4	Demonstrate the ability to design user-centric tech products and formulate strategic marketing plans that effectively address customer acquisition and retention. (Understand Level)
CO 5	Develop strategies for scaling tech startups and actively engage with the startup ecosystem, emphasizing ethical practices and social responsibility. (Understand Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	✓											
CO 2	✓											
CO 3	✓											
CO 4	✓											
CO 5	✓											

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓		✓
Understand	✓	✓		✓
Apply				
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
3-0-0-0	5	15	10	10	40

Total Mark Distribution			
Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 Hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS (36 Hours)
MODULE I: Foundations of Entrepreneurship (7 Hours)
Introduction to Entrepreneurship: Definition and scope, Historical context and evolution, Role in economic development. Entrepreneurial Mindset and Characteristics: Traits and skills of successful entrepreneurs, Overcoming failure and risk management. Case Studies and Inspiration: Analysis of successful tech entrepreneurs, The journey from startups to industry leaders.
MODULE II : Ideation and Conceptualization (7 Hours)
Idea Generation Techniques: Creativity in tech, Identifying market needs. Market Research and Analysis: Understanding market dynamics, Customer segmentation and targeting. Intellectual Property and Patenting: Basics of intellectual property law, Patent search and application process. Business Model Development: Introduction to the Business Model Canvas, Value proposition and revenue streams.

MODULE III : Startup Financing and Legalities (7 Hours)
Funding Strategies: Bootstrapping vs. external funding, Angel investment and venture capital. Financial Planning: Budgeting and financial forecasting, Understanding financial statements. Legal Framework for Startups: Company formation and registration, Regulatory compliance and taxation.
MODULE IV : Product Development and Marketing (8 Hours)
Product Design and Development: Prototyping and MVP, User experience and design thinking. Marketing Strategies: Branding and positioning, Digital marketing and sales channels. Customer Acquisition and Retention: Sales funnel and conversion optimization, Customer relationship management.
MODULE V : Growth, Scaling, and the Startup Ecosystem (7 Hours)
Operations and Quality Management: Supply chain and logistics, Quality standards and certifications. Scaling Up and Growth Hacking: Business expansion strategies, Leveraging data for growth, Engaging with the Startup Ecosystem: Role of incubators, accelerators, and co-working spaces, Networking and mentorship opportunities. Ethics and Social Responsibility: Ethical entrepreneurship, Corporate social responsibility and sustainability.

Text books

1. Ries, E. (2011). The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses. Crown Business.
2. Blank, S., & Dorf, B. (2012). The Startup Owner's Manual: The Step-By-Step Guide for Building a Great Company. K&S Ranch, Inc.

Reference books

1. Thiel, P., & Masters, B. (2014). *Zero to One: Notes on Startups, or How to Build the Future*. Currency.
2. Christensen, C. M. (1997). *The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail*. Harvard Business Review Press.
3. Kawasaki, G. (2015). *The Art of the Start 2.0: The Time-Tested, Battle-Hardened Guide for Anyone Starting Anything*. Portfolio.
4. Feld, B., & Mendelson, J. (2012). *Venture Deals: Be Smarter Than Your Lawyer and Venture Capitalist*. Wiley.
5. Osterwalder, A., & Pigneur, Y. (2010). *Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers*. John Wiley & Sons.
6. Aulet, B. (2013). *Disciplined Entrepreneurship: 24 Steps to a Successful Startup*. Wiley.
7. Lecture Collection Technology Entrepreneurship: https://www.youtube.com/playlist?list=PLF6C0319C607DEDC1
8. Becoming an Entrepreneur - https://www.edx.org/course/becoming-a...
9. Launching a Startup - https://www.edx.org/course/entreprene...
10. Entrepreneurship for Everyone - https://www.edx.org/course/do-your-ve...
11. Startup school (Y combinator) - https://www.startupschool.org/
12. Startup India - https://www.startupindia.gov.in/conte...

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
MODULE I		
1.1	Introduction to Entrepreneurship: Definition and Scope	1
1.2	Historical Context and Evolution	1
1.3	The Role of Entrepreneurship in Economic Development	1
1.4	Interactive Session: Discussion on current trends in tech entrepreneurship Q & A session on entrepreneurship and economic development	1
1.5	Traits and Skills of Successful Entrepreneurs	1
1.6	Overcoming Failure and Risk Management	1
1.7	Case Studies and Inspiration: Analysis of successful tech entrepreneurs. Journey from Startups to Industry Leaders	1
MODULE II		
2.1	Idea Generation Techniques: Creativity in tech, Identifying market needs	1
2.2	Market Research and Analysis: Understanding market dynamics	1
2.3	Customer segmentation and targeting	1
2.4	Intellectual Property and Patenting: Basics of intellectual property law	1
2.5	Patent search and application process	1
2.6	Business Model Development: Introduction to the Business Model Canvas	1
2.7	Value proposition and revenue streams.	1
MODULE III		
3.1	Funding Strategies: Introduction to startup funding strategies, Bootstrapping: Advantages and Challenges	1
3.2	Funding Strategies: Overview of external funding, Angel investment: Criteria and process	1
3.3	Funding Strategies: Venture capital: Stages, expectations, and securing investments Financial Planning, Basics of budgeting for startups	1
3.4	Financial Planning: Financial forecasting: Techniques and importance, Case study: Forecasting for a tech startup	1
3.5	Financial Planning: Understanding financial statements, Workshop: Analyzing financial statements	1
3.6	Legal Framework for Startups: Company formation and registration processes, Choosing the right business structure	1
3.7	Legal Framework for Startups: Regulatory compliance essentials, Taxation for startups: Basics and best practices Legal Framework for Startups, Q&A and wrap-up session	1

	MODULE IV	
4.1	Prototyping and MVP (Minimum Viable Product), Introduction to prototyping techniques, Building and testing an MVP	1
4.2	Prototyping and MVP (Minimum Viable Product), Feedback loops and iterative design	1
4.3	User Experience (UX) Fundamentals of UX in product design, Workshop on UX design principles	1
4.4	Design Thinking, Introduction to design thinking methodology, Applying design thinking to product development	1
4.5	Branding and Positioning, crafting a brand identity, Developing a positioning strategy	1
4.6	Digital Marketing and Sales Channels, Overview of digital marketing, Exploring various sales channels	1
4.7	Sales Funnel and Conversion Optimization, Building an effective sales funnel, Strategies for conversion optimization	1
4.8	Customer Relationship Management (CRM), Principles of CRM Tools and techniques for customer retention	1
	MODULE V	
5.1	Operations and Quality Management: Supply Chain and Logistics, Overview of supply chain management in tech startups	1
5.2	Operations and Quality Management: Supply Chain and Logistics, Logistics strategies for product distribution	1
5.3	Quality Standards and Certifications, Quality Management, Introduction to quality standards relevant to tech products Process of obtaining quality certifications	1
5.4	Scaling Up and Growth Hacking, Business Expansion Strategies, Strategies for scaling operations and team growth	1
5.5	Scaling Up and Growth Hacking, Leveraging Data for Growth Using data analytics to inform growth strategies	1
5.6	Engaging with the Startup Ecosystem, Role of Incubators, Accelerators, and Co-working Spaces, How these entities support startups and their benefits, Networking and Mentorship Opportunities, Building valuable connections and seeking mentorship	1
5.7	Ethics and Social Responsibility, Ethical Entrepreneurship, Corporate Social Responsibility and Sustainability Integrating CSR and sustainability into the business model	1

CO Assessment Questions	
1	1. Define entrepreneurship and discuss its scope in the context of the electronics and communication engineering sector. 2. Explain how the historical evolution of entrepreneurship has shaped the modern startup ecosystem, particularly in technology.
2	1. Describe the process of ideation and the techniques that can be used to generate innovative ideas in the field of electronics and communication. 2. How does market validation contribute to the conceptualization of a tech startup idea?
3	1. Discuss the various types of startup financing and the stages at which they are most appropriate. 2. Outline the legal steps necessary for setting up a tech startup in India.
4	1. What are the key considerations in developing a user-centric product in the electronics and communication industry? 2. Formulate a basic marketing strategy for a hypothetical tech product, including customer acquisition and retention tactics.
5	1. Propose a strategy for scaling a tech startup in the electronics and communication field. 2. Discuss the role of ethics and social responsibility in the growth of a tech startup.

24MCT506	CONSTITUTION OF INDIA	L	T	P	J	S	C	Year of Introduction
		MOOC				3	1*	2024

Preamble: To familiarize students with the key elements of the Indian Constitution.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO 1	Explain the significance of Indian Constitution as the fundamental law of the land. (Understand Level).
CO 2	Identify the importance of fundamental rights and duties. (Understand Level).
CO 3	Analyze the Indian political system, the working of the union executive, parliament and judiciary. (Understand Level).
CO 4	Evaluate the functioning of state governments in India in view of decentralization of authority and participatory governance. (Understand Level).
CO 5	Assess the effectiveness of division of power between Centre and States in India. (Understand Level).

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1						✓		✓		✓		✓
CO 2						✓		✓		✓		✓
CO 3						✓		✓		✓		✓
CO 4						✓		✓		✓		✓
CO 5						✓		✓		✓		✓

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply				
Analyse				
Evaluate				
Create				

Mark Distribution of CIA

Course Structure [L-T-P-J]	Attendance	Theory [L- T]				Total Marks
		Assignment	Test-1	Test-2		
3-0-0-0	5	15	10	10		40

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3hrs

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I : Introduction of the Indian Constitution (4 Hours)

Definition of constitution, historical background, salient features of the Indian constitution. Preamble of the constitution, union and its territory. Meaning of citizenship, types, termination of citizenship.

MODULE II : Fundamental Rights and Duties (8 Hours)

Definition of state, fundamental rights, general nature, classification, right to equality, right to freedom, right against exploitation. Right to freedom of religion, cultural and educational rights, right to constitutional remedies, Protection in respect of conviction for offences. Directive principles of state policy, classification of directives, fundamental duties.

MODULE III : Union Executive and Parliament (8 Hours)

The Union executive, The President, the Vice President, the Council of Ministers, the Prime Minister, Attorney-General, functions. The Parliament, composition, Rajya Sabha, Lok Sabha, qualification and disqualification of membership, functions of Parliament. Union judiciary, the Supreme court, jurisdiction, appeal by special leave.

MODULE IV : State Executive and State Legislature (7 Hours)

The State executive, the Governor, the Council of Ministers, the Chief Minister, advocate general, union territories. The state legislature, composition, qualification and disqualification of membership, functions. The State Judiciary, the High court, jurisdiction, writs jurisdiction. Local government- Panchayat raj system- with special reference to 73rd and 74th amendment.

MODULE V : Governance and Constitution (7 Hours)
Relations between the Union and the States, legislative relation, administrative relation, financial relations, Inter State council, finance commission. Emergency provision, freedom of trade and commerce. Comptroller and auditor general of India, public services, public service commission, administrative Tribunals. Amendment of the constitution-meaning, procedure and limitations. Election provisions and electoral process.

Text books
1. D.D. Basu, Introduction to the constitution of India, Lexis Nexis, New Delhi,25e,2021
2. P M Bhakshi, The Constitution of India, Universal Law, 14th Edition, 2017
3. M.V. Pylee, "Introduction to the Constitution of India", 4th Edition, Vikas publication, 2005.
4. K. Sharma, Introduction to the Constitution of India, Prentice Hall of India, New Delhi, 2002.

Reference books
1. Granville Austin, 2000. The Indian Constitution: cornerstone of a Nation. Melbourne: Oxford University Press.
2. Merunandan, "Multiple Choice Questions on Constitution of India", 2nd Edition, Meraga publication, 2017
3. D.C. Gupta, Indian Government and Politics, Vikas publishing House, New Delhi.

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
MODULE I		
1.1	Definition of Constitution- Historical back-ground	1
1.2	Salient features of the Constitution	1
1.3	Preamble of the Constitution-Union and its territory.	1
1.4	Meaning of Citizenship-types- termination of citizenship	1
MODULE II		
2.1	Definition of state, fundamental rights,	1
2.2	General nature, classification, right to equality.	1
2.3	Right to freedom, right against exploitation.	1
2.4	Right to freedom of religion.	1
2.5	Cultural and educational rights, right to constitutional remedies	1
2.6	Protection in respect of conviction for offences.	1
2.7	Directive principles of state policy	1
2.8	Classification of directives, fundamental duties.	1
MODULE III		

3.1	The Union executive, The President.	1
3.2	The Union executive, The Vice President.	1
3.3	The council of ministers, the Prime minister, Attorney -General, functions.	1
3.4	The Parliament, composition, Rajya Sabha, Lok Sabha.	1
3.5	Qualification and disqualification of membership,	1
3.6	Functions of parliament.	1
3.7	Union judiciary, the Supreme court.	1
3.8	Jurisdiction, appeal by special leave.	1
MODULE IV		
4.1	The state executive, the Governor, the council of ministers.	1
4.2	The Chief minister, advocate general, union territories.	1
4.3	The state Legislature, composition,	1
4.4	Qualification and disqualification of membership, functions.	1
4.5	The state judiciary, the high court	1
4.6	Jurisdiction, writ jurisdiction.	1
4.7	Local government, Panchayat raj system-with special reference to 73rd and 74th amendment.	1
MODULE V		
5.1	Relation between the union and the states, legislative relation, administrative relation.	1
5.2	Financial relations, Inter -State council, finance commission.	1
5.3	Emergency provision, freedom of trade and commerce.	1
5.4	Comptroller and Auditor General of India, public services,	1
5.5	Public service commission, administrative tribunals.	1
5.6	Amendment of the constitution-meaning, procedure and limitations.	1
5.7	Election provisions and electoral process.	1

CO Assessment Questions	
CO1	a. Examine the salient features of the Indian constitution. b. "Secularism is the foundation of democracy". Explain
CO2	"The constitution has ensured certain rights to the minorities under Article 30"- Examine.
CO3	Discuss the various ways Parliament ensures accountability of the executive.
CO4	Evaluate the impact of the 73rd and 74th constitutional amendments on the decentralization of power and the functioning of panchayats and municipalities in India.
CO5	Describe the division of powers between Central and state government in India.

24ECT507	LINEAR INTEGRATED CIRCUITS	L	T	P	J	S	C	Year of Introduction
		2	0	0	0	2	2	2024

Preamble: The aim of this course is to provide a fundamental idea about the operational amplifier and its applications. The course covers basics of operational amplifier, Op amp circuits, VCO, PLL, Data Converters. The course will inculcate the students to get an insight into applications of operational amplifier in industry.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO 1 Understand fundamental concept of operational amplifiers and its applications (Understand Level).

CO 2 Design of operational amplifier for various applications (Apply Level).

CO 3 Explain the working and the applications of VCO and PLL (Understand Level).

CO 4 Design data converters and switched capacitor circuits (Apply Level).

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	✓											
CO 2	✓	✓			✓							
CO 3	✓											
CO 4	✓	✓										

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓		
Understand	✓	✓		
Apply	✓	✓		
Analyse				
Evaluate				
Create				

Mark Distribution of CIA

Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
2-0-0-0	5	35	30	30	100

Total Mark Distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	100	-	-

SYLLABUS

MODULE I: Fundamentals of Operational Amplifier (6 Hours)

Operational Amplifiers (Opamps) : Ideal Opamp parameters, Typical parameter values for 741, Opamp Equivalent circuit, Voltage transfer curve, Frequency response curve. Opamp Applications: Inverting and non-inverting amplifiers, Summing amplifier Comparator, Schmitt trigger, Difference Amplifier, Instrumentation Amplifier

MODULE II: Op-amp Applications (5 Hours)

Precision Rectifier: Half Wave and Full Wave Precision Rectifiers. Active Filters: Low pass, high pass, band pass and band stop filters, design guidelines. (Analysis and Derivation not required)

MODULE III : Op-amp Circuits (4 Hours)

Multivibrators: Astable and Monostable multivibrators. Oscillators: RC phase shift and Wienbridge oscillators, design guidelines. (Analysis and Derivation not required)

MODULE IV : Voltage Controlled Oscillator (VCO) and Phase Locked Loop (PLL) (5 Hours)

Voltage-Controlled Oscillator: Basic concepts of VCO and application of VCO IC LM566. Phase Locked Loop:

Operation, Lock and Capture range, PLL IC 565, Applications of PLL

MODULE V : Data Converters (5 Hours)

Digital to analog converters (DACs): Specifications- Accuracy, Linearity, Monotonicity, Resolution, Settling time. Classification of DAC: R-2R ladder type, Delta Sigma DAC. Analog to digital converters (ADCs): Specifications-Resolution, Quantization error, linearity error. Classification of ADC: Flash ADC, Pipelined ADC, Successive Approximation ADC, Delta Sigma ADC.

Text books

1. Roy D.C. and S.B. Jain, Linear Integrated Circuits, New Age International,3/e,2010.
2. Gayakwad R.A. Op-Amps and Linear Integrated Circuits, PrenticeHall,4/e,2010.
3. Salivahanan S. and V.S.K. Bhaskaran, Linear Integrated Circuits, Tata McGrawHill,2008.

Reference books
1. T. R. Ganesh Babu. Linear Integrated Circuits SCITECH Publishers
2. Botkar, K.R.,Integrated Circuits,10/e, Khanna Publishers,2010
3. C.G. Clayton, Operational Amplifiers, Butterworth & Company Publ.Ltd. Elsevier,1971
4. David A.Bell, Operational Amplifiers & Linear ICs, Oxford University Press, 2nd edition,2010
5. R.F.Coughlin & Frederick Driscoll, Operational Amplifiers Linear   integrated
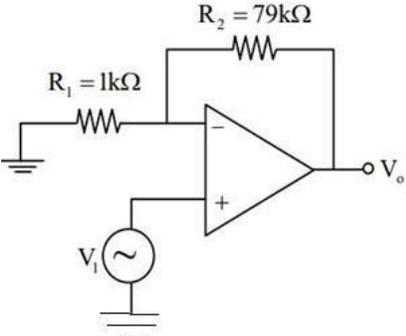
Circuits,6thEdition, PHI,2001
6. Integrated   Circuits   &   Applications,   NPTEL,   IIT   Guwahati
   www.digimat.in/nptel/courses/video/108108111/L47.html

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
MODULE I		
1.1	Operational Amplifiers (Op amps): Ideal opamp parameters, Typical parameter values for 741	1
1.2	Opamp Equivalent circuit, Voltage transfer curve	1
1.3	Frequency response curve	1
1.4	Inverting and non-inverting amplifiers, summing amplifier	1
1.5	Differentiator and integrator	1
1.6	Schmitt trigger	1
MODULE II		
2.1	Precision Rectifier: Half Wave and Full Wave Precision Rectifiers	1
2.2	Active Filters: Low pass filter	1
2.3	High pass filter and design guide lines	1
2.4	Band pass filter	1
2.5	Band stop filter and design guide lines	1
MODULE III		
3.1	Multivibrators: Astable multivibrator and design guide lines	1
3.2	Monostable multivibrators and design guide lines	1
3.3	Oscillators: RC phase shift oscillators and design guide lines	1
3.4	Wein bridge oscillators and design guide lines	1
MODULE IV		
4.1	VCO: Basic concepts of VCO	1
4.2	Application of VCO IC LM566	1
4.3	Phase locked loop: Operation, lock and capture, PLLIC 565	1
4.4	Applications of PLL	1
MODULE V		

5.1	Data Converters: Digital to analog converters, Specifications, R-2R ladder type	1
5.2	Analog to digital convertors, specifications, flash type ADC	1
5.3	Delta sigma ADC	1
5.4	Switched capacitor circuits: basic concept, practical configurations	1
5.5	Application of switched capacitor circuits in integrator	1

	CO Assessment Questions
1	1. An op amp has a slew rate of 2V/us. What is the maximum frequency of an output sinusoid of peak value 5V at which distortion sets in due to the slew rate limitation. 2. If a sinusoid of 10V peak is specified, what is the full power bandwidth
2	1. The amplifier circuit shown in the figure is implemented using a compensated operational amplifier (op-amp), and has an open-loop voltage gain, A_0 10^5 V/V and an open-loop cut-off frequency, f_C = 8 Hz. Calculate the voltage gain of the amplifier at 15 kHz. Simulate the circuit and check the voltage gain. Give reason for any difference in gain between calculated and simulated values.
3	1. Explain how a PLL can be used as an AM modulator. 2. Define voltage to frequency conversion factor of a VCO.
4	1. Determine the output voltage produced by a D/A convertor whose output range is 0 to 10V and whose input binary number is 10111100 (for a 8 bit DAC). 2. In the context of designing switched capacitor circuits for analog signal processing, how does the choice of the switching frequency influence the performance characteristics of the circuit, specifically regarding noise, signal distortion, and power consumption?

MINOR

V SEMESTER

24ECM509	EMBEDDED SYSTEMS	L	T	P	J	S	C	Year of Introduction
		4	0	0	0		4	2024

Preamble: The objective of this course is to provide a comprehensive view of the core elements of embedded systems, encompassing both theoretical and practical aspects. The focus is on understanding embedded system design process, interfacing, programming, real-time operations, security, and emerging trends, culminating in a practical application development in ARM processor that demonstrates these concepts.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO 1	Describe embedded system design process. (Understand Level)
CO 2	Explain the peripheral devices and their interfacing with the processor. (Understand Level)
CO 3	Develop embedded system program in high level language. (Apply Level)
CO 4	Describe Arm cortex M3 programming for different applications. (Apply Level)
CO 5	Explain the need of real time operating system for embedded system applications. (Understand Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	✓											
CO 2	✓	✓										
CO 3	✓	✓			✓							
CO 4	✓	✓										
CO 5	✓											

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA

Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
4-0-0-0	5	15	10	10	**40**

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 Hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS (46 Hours)

MODULE I : Introduction to embedded systems (12 Hours)
Complex Systems and Microprocessors: - Embedding Computers, Characteristics of Embedded Computing Applications, Application of Microprocessors, The Physics of Software, Challenges in Embedded Computing System, Characteristics and quality attributes of an embedded system, Performance in Embedded Computing. The Embedded System Design Process: - Requirements, Specification, Architecture Design, Designing Hardware and Software Components and System Integration. Formalisms for System Design: - Structural Description, Behavioral Description, An embedded system design example. Embedded product development cycle (EDLC), Different phases of EDLC and EDLC models.

MODULE II : Embedded system interfacing and peripherals (10 Hours)
Communication devices: - Serial Communication Standards and Devices - UART, HDLC and SPI. Serial Bus Protocols -I²C Bus, CAN Bus and USB Bus, Parallel communication standards-ISA, PCI and PCI-X Bus. Memory devices and systems: – ROM-Flash, EEPROM: RAM-SRAM, DRAM, Cache memory, memory mapping and addresses, memory management unit– DMA. I/O Device: - Interrupts, Interrupt sources, recognizing an interrupt, Interrupt Service Routine (ISR) – Device drivers for handling ISR, Shared data problem, Interrupt latency.

MODULE III : Embedded programming (8 Hours)
Embedded C programming:- Keywords & Identifiers, Data Types, Storage Class, operators, branching, looping, arrays, pointers, characters, strings, functions, function pointers, pre-processors & macros, constant declaration, volatile type qualifier, delay generation, infinite loops, bit manipulation, ISR, direct memory allocation.
MODULE IV : Arm Processor and Peripherals (8 Hours)
ARM cortex M3 processor: ARM processor – ARM cortex M3 architecture – NXP LPC214x On chip Peripherals: A/D converters, PWM, Timer/Counter, UART and its Interfacing - Real world application development using Keil IDE.
MODULE V : RTOS based embedded system design (8 Hours)
Introduction to basic concepts of RTOS- Task, process & threads, interrupt routines in RTOS, Multiprocessing and Multitasking, Preemptive and non-preemptive scheduling, Task communication shared memory, message passing-, Inter process Communication — synchronization between processes-semaphores, Mailbox, pipes, priority inversion, priority inheritance.

Text books
1. Raj Kamal, Embedded Systems Architecture, Programming and Design, TMH, 2003.
2. Wayne Wolf, Computers as Components: Principles of Embedded Computing System Design, Morgan Kaufman Publishers - Elsevier 3ed, 2008.
3. Steve Furber, ARM system-on-chip architecture, Addison Wesley, Second Edition, 2000.
4. Joseph Yiu, "The Definitive Guide to the ARM Cortex M3", Second Edition, Elsevier Inc., 2010.

Reference books
1. David E. Simon, An Embedded Software Primer, Pearson Education Asia, First Indian Reprint 2000.
2. Steve Heath, Embedded Systems Design, Newnes – Elsevier 2ed, 2002.
3. Andrew N. Sloss, Dominic Symes, Chris Wright, ARM System Developer's Guide Designing and Optimizing System Software, Morgan Kaufmann Publishers, 2004.
4. MOOC Course: Embedded Systems Design - Course (nptel.ac.in)

COURSE CONTENTS AND LECTURE SCHEDULE		
No.		No. of Hours
MODULE I		
1.1	Embedding Computers, Characteristics of Embedded Computing Applications	1
1.2	Application of Microprocessors, The Physics of Software	1

1.3	Challenges in Embedded Computing System	
1.4	Characteristics and quality attributes of an embedded system,	1
1.5	Performance in Embedded Computing	
1.6	Embedded System Design Process Requirements Specification, Architecture Design	1
1.7	Designing Hardware and Software Components and System Integration.	1

1.8	Formalisms for System Design: - Structural Description	1
1.9	Formalisms for System Design: Behavioral Description	
1.10	An embedded system design example.	1
1.11	Embedded product development cycle (EDLC)	1
1.12	Different phases of EDLC and EDLC models	1
MODULE II		
2.1	Serial Communication Standards and Devices – UART and HDLC	1
2.2	Serial Communication Standards and Devices - SPI	
2.3	Serial Bus Protocols -I²C Bus and CAN Bus	1
2.4	Serial Bus Protocols - CAN Bus and USB Bus	
2.5	Parallel communication standards-ISA, PCI and PCI-X Bus.	1
2.6	Memory devices and systems: – ROM-Flash, EEPROM: RAM-SRAM, DRAM	1
2.7	Cache memory, memory mapping and addresses	1
2.8	Memory management unit– DMA	1
2.9	I/O Device: - Interrupts, Interrupt sources, recognizing an interrupt	1
2.10	ISR – Device drivers for handling ISR, Shared data problem, Interrupt latency.	1
MODULE III		
3.1	Embedded C programming: - Keywords and Identifiers, Data Types, Storage Class	1
3.2	Characters, strings, branching, looping	1
3.3	Arrays, pointers	1
3.4	Functions, function pointers	1
3.5	Pre-processors and macros, constant declaration, volatile type qualifier	1
3.6	Delay generation, infinite loops	1
3.7	Bit manipulation, ISR	1
3.8	Direct memory allocation	

MODULE IV		
4.1	ARM cortex M3 architecture	1
4.2	NXP LPC214x On chip Peripherals: A/D converters	1
4.3	PWM	1
4.4	Timer/Counter	
4.5	UART and its Interfacing	1
4.6	Application development using Keil IDE	1
4.7	Application development using Keil IDE	1
4.8	Application development using Keil IDE	1
MODULE V		
5.1	Introduction to basic concepts of RTOS- Task, process & Threads	1
5.2	Interrupt routines in RTOS	1
5.3	Multiprocessing and Multitasking	1
5.4	Preemptive and non-preemptive scheduling,	1
5.5	Task communication shared memory, message passing	1
5.6	Inter process Communication — synchronization between processes-semaphores	1
5.7	Mailbox, pipes	1
5.8	Priority inversion, priority inheritance	1

CO Assessment Questions	
1	1. Describe the structure of an embedded system and outline the stages involved in the Embedded System Development Life Cycle (EDLC).
2	1. Compare and contrast the PCI bus and PCI-X bus. 2. Explain how the peripheral devices are connected with processors.
3	1. Write an embedded C program for sorting 64 numbers stored in memory locations and find the smallest and largest number. 2. Explain how the functions are called by using pointers in embedded 'C'? Discuss with the help of examples.
4	1. Develop an automatic number plate recognition system using ARM cortex controller.
5	1. Describe the structure of a Real Time Operating System in detail. 2. Explain in detail the synchronization tools used in Real-Time Operating Systems (RTOS).

24ECM510	MULTIMEDIA PROCESSING AND FORENSICS	L	T	P	J	S	C	Year of Introduction
		4	0	0	0		4	2024

Preamble: This course is designed to explore the various aspects of digital image processing and the application of these techniques in forensic analysis. Beginning with digital image fundamentals, including visual perception and color models, the course progresses through advanced topics such as image enhancement, segmentation, and compression, integrating practical skills in MATLAB/Python. The final module uniquely combines multimedia forensics, covering digital video standards, 3D technologies, and forensic aspects like watermarking and steganography, making it an ideal blend of technical knowledge and practical application in the evolving field of multimedia.

Prerequisite: 24ECM410 Introduction to Digital Signal Processing

Course Outcomes: After the completion of the course the student will be able to

CO 1	Understand key concepts in digital image processing, including visual perception, image acquisition, and colour models. (Understand Level)
CO 2	Develop skills in image enhancement techniques using MATLAB/Python, covering point processing, histogram, and spatial domain methods. (Apply Level)
CO 3	Explain image segmentation, edge detection, and mathematical morphology for advanced image analysis. (Understand Level)
CO 4	Understand image compression, including Huffman and arithmetic coding, and differentiate between lossless and lossy compression (Understand Level).
CO 5	Explain multimedia forensics, covering digital video standards, video quality assessment, watermarking, and steganography. (Understand Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	✓	✓										
CO 2	✓	✓			✓							
CO 3	✓	✓			✓							
CO 4	✓	✓			✓							
CO 5	✓											

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA

Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
4-0-0-0	5	15	10	10	**40**

Total Mark Distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 Hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS (48 Hours)

MODULE I : Digital image fundamentals (8 Hours)

Digital Image Fundamentals: Elements of visual perception, image sensing and acquisition, basic relationships between pixels – neighborhood, adjacency, connectivity, distance measures. Brightness, contrast, hue, saturation, mach band effect, Colour image fundamentals-RGB, CMY, HIS models. image sampling and quantization

MODULE II : Image enhancement (10 Hours)

Image Enhancement: point processing-intensity transformations, histogram processing, image subtraction, image averaging, geometric transformation. Spatial domain methods: Sharpening filters – first and second derivative, 2D-Convolution, 2D Image Transform (2D-DFT) and their properties, inverse 2D DFT, frequency domain filters – low-pass and high-pass. *(Simulation Assignment I -to be performed in MATLAB/Python – Histogram processing, 2D-DFT and Filtering operations)*

MODULE III : Image segmentation (10 Hours)	
Image segmentation: Classification of Image segmentation techniques, Thresholding – global and adaptive, region approach, and clustering techniques. Classification of edges, edge detection, Hough transform, Mathematical Morphology: Binary image processing, Structuring elements, dilation, erosion, Hit-Miss transforms.	
MODULE IV : Image compression (10 Hours)	
Image Compression- Need for compression, redundancy, classification of image compression schemes, Huffman coding, arithmetic coding. Redundancy–inter-pixel and psycho-visual; Lossless compression – predictive, entropy. Lossy compression- predictive and transform coding – DST, DCT, wavelet transform (basics only). Still image compression standards – JPEG and JPEG-2000.	
MODULE V : Forensic Aspect In Multimedia Processing (10 Hours)	
Digital Video Spatial Resolution and Frame Rate, Color, Dynamic Range, and Bit-Depth, Digital-Video Standards, 3D Video, 3D-Display Technologies, Multi-View Video, Digital-Video Applications, Video Streaming over the Internet, Computer Vision and Scene/Activity Understanding, Image and Video Quality, Visual Artifacts, Subjective/Objective Quality Assessment, Multimedia Forensics: introduction to Multimedia Forensics, Watermarking, Steganographic aspects in Multimedia.	

Text books
1. Farid Gonzalez Rafel C, Digital Image Processing, Pearson Education, 2009
2. S Jayaraman, S Esakkirajan, T Veerakumar, Digital image processing, Tata Mc Graw Hill, 2015

Reference books
1. M. Petrou, Image Processing - Fundamentals,
2. Jain Anil K, Fundamentals of digital image processing, PHI 1988
3. Kenneth R Castleman, Digital image processing, Pearson Education, 2/e, 2003
4. Pratt William K, Digital Image Processing, John Wiley,4/e, 2007.
5. https://nptel.ac.in/courses/117105079

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
MODULE I		
1.1	Introduction to Digital Image Processing: Overview of digital image fundamentals Elements of visual perception in image processing	1
1.2	Image Sensing and Acquisition Techniques and technologies in image sensing Basics of image acquisition	1

1.3	Basic Relationships Between Pixels
	    Understanding pixel neighbourhood, adjacency, and connectivity.
	    Introduction to distance measures in digital images
		1

1.4	Image Attributes - Brightness and Contrast
	    Exploring the concepts of brightness and contrast in digital images
	    Their impact on image quality and perception
		1

1.5	Understanding Color in Images - Hue and Saturation.
	    The role of hue and saturation in color images
	    Understanding the Mach band effect
		1

1.6	Color Image Fundamentals - RGB Model
	    Introduction to the RGB color model
	    Its application in digital imaging
		1

1.7	Color Models - CMY and HIS
	    Exploring the CMY and HIS color models
	    Comparison and usage scenarios in digital imaging
		1

1.8	Image Sampling and Quantization
	    Principles of image sampling and quantization
	    Their importance in digital image processing
		1

MODULE II		

2.1	Introduction to Image Enhancement
	    Overview and objectives of image enhancement
	    Point processing and intensity transformations
		1

2.2	Histogram Processing in Image Enhancement
	    Principles of histogram processing
	    Techniques for improving image contrast using histogram manipulation
		1

2.3	Advanced Histogram Processing Techniques
	    Detailed exploration of advanced histogram processing methods
	    Practical examples and applications
		1

2.4	Image Subtraction and Averaging
	    Understanding image subtraction and averaging techniques
	    Their applications in enhancing image quality
		1

2.5	Basics of Geometric Transformation in Images
	    Introduction to geometric transformations in image processing
	    Practical applications and effects on image
		1

2.6	Spatial Domain Methods - Sharpening Filters
	    Understanding the use of sharpening filters in the spatial domain
	    First and second derivative filters for image enhancement
		1

2.7	2D Convolution in Image Processing
	    Fundamentals of 2D convolution
	    Applications in image enhancement
		1

2.8	Frequency Domain Methods - Introduction to 2D-DFT
	    Principles of 2D Image Transform (2D-DFT) and their properties
	    Understanding the inverse 2D-DFT
		1

2.9	Frequency Domain Filters - Low-pass and High-pass
	    Application of low-pass and high-pass filters in the frequency domain
	    Their impact on image quality and details
		1

2.10	Practical Session (Simulation Assignment
	    Hands-on session in MATLAB/Python
	    Implementing histogram processing, 2D-DFT, and filtering operations
		1

MODULE III		

3.1	Overview of Image Segmentation
	    Introduction to image segmentation
	    Classification of image segmentation techniques
		1

3.2	Thresholding Techniques –
	    Global and Adaptive Understanding and implementing global thresholding
	    Adaptive thresholding techniques and their applications
		1

3.3	Region-Based Segmentation Techniques
	    Principles of region approach in image segmentation
	    Techniques and algorithms for region-based segmentation
		1

3.4	Clustering Techniques in Image Segmentation
	    Introduction to clustering methods in segmentation
	    Practical examples and use cases
		1

3.5	Edge Detection in Image Segmentation
	    Understanding the classification of edges
	    Techniques for edge detection in images
		1

3.6	Advanced Edge Detection and Hough Transform
	    Detailed study of advanced edge detection methods
	    Application of the Hough transform in image segmentation
		1

3.7	Introduction to Mathematical Morphology
	    Basic concepts of mathematical morphology in image processing
	    Binary image processing and its significance
		1

3.8	Structuring Elements, Dilation, and Erosion
	    Exploring structuring elements in morphology
	    Techniques and applications of dilation and erosion
		1

3.9	Hit-Miss Transforms in Mathematical Morphology
	    Understanding the hit-miss transform
	    Practical applications in image analysis
		1

3.10	Integrative Session on Image Segmentation
	    Review and discussion on key concepts
	    Problem-solving and case studies in image segmentation
		1

MODULE IV		

4.1	Introduction to Image Compression
	    Overview of image compression
	    Understanding the need for compression and types of redundancy in images
		1

4.2	Basics of Huffman Coding
	    Principles and implementation of Huffman coding
	    Practical examples in image compression
		1

4.3	Arithmetic Coding in Image Compression
	    Understanding arithmetic coding techniques
	    Comparison with Huffman coding
		1

4.4	Lossless Compression Techniques
	    Exploring predictive and entropy-based lossless compression methods
	    Applications and effectiveness in various contexts
		1

4.5	Lossy Compression - Predictive and Transform Coding.
	    Introduction to lossy compression methods
	    Basics of predictive and transform coding
		1

4.6	Understanding DST, DCT, and Wavelet Transforms
	    Detailed study of Discrete Sine Transform (DST)
	    Discrete Cosine Transform (DCT), and wavelet transforms
	    Their role in image compression
		1

4.7	Advanced Topics in Transform Coding
	    In-depth exploration of advanced concepts in transform coding
	    Practical applications in image compression
		1

4.8	Still Image Compression Standards – JPEG Understanding JPEG standard for image compression Techniques and algorithms used in JPEG	1
4.9	JPEG-2000 and Advanced Compression Standards Exploration of JPEG-2000 standards Comparison with previous standards and understanding advancements	1
4.10	Practical Session on Image Compression Hands-on experience in image compression using various techniques Implementing and comparing different compression algorithms	1
MODULE V		
5.1	Introduction to Digital Video and 3D Technologies Overview of digital video spatial resolution, frame rate, color, dynamic range, and bit-depth Introduction to 3D video and display technologies	1
5.2	Digital Video Standards and Applications Understanding various digital video standards Applications of digital video in different contexts	1
5.3	Multi-View Video and Video Streaming over the Internet Concepts and techniques in multi-view video Challenges and solutions in video streaming over the internet and activity understanding	1
5.4	Computer Vision and Scene/Activity Understanding Principles of computer vision in multimedia processing Techniques for scene understanding	1
5.5	Image and Video Quality Assessment Understanding visual artifacts in multimedia Techniques for subjective and objective quality assessment	1
5.6	Introduction to Multimedia Forensics Overview of multimedia forensics Basic principles and applications in digital investigations	1
5.7	Digital Watermarking Techniques Fundamentals of digital watermarking Applications and techniques in multimedia security	1
5.8	Steganographic Aspects in Multimedia Understanding steganography in the context of multimedia Techniques and implications of steganography in digital forensics	1

5.9	Advanced Forensic Techniques in Multimedia Exploring advanced topics in multimedia forensics Case studies and real-world applications	1
5.10	Integrative Forensic Session Review and discussion of key concepts in multimedia forensics Interactive session with problem-solving and practical examples	1

CO Assessment Questions	
1	1. Explain how elements of visual perception affect the processing and interpretation of digital images. Include a discussion on image sensing and acquisition techniques. 2. Describe the relationship between pixels in terms of neighbourhood, adjacency, connectivity, and distance measures in digital images. 3. Compare and contrast the RGB, CMY, and HIS color models in the context of digital imaging. Discuss the implications of image sampling and quantization.
2	1. Explain the various point processing techniques used in image enhancement, including intensity transformations and histogram processing. 2. Discuss spatial domain methods for image enhancement, particularly focusing on sharpening filters and 2D convolution.
	3. Describe the application of frequency domain filters, including low-pass and high-pass, in image enhancement. Practically implement these techniques in MATLAB/Python.
3	1. Discuss the different classification techniques used in image segmentation, including thresholding and region-based approaches. 2. Explain the process and application of edge detection in image segmentation, including the use of the Hough transform. 3. Describe the principles and applications of Mathematical Morphology in binary image processing, focusing on structuring elements, dilation, erosion, and Hit-Miss transforms.
4	1. Discuss the need for image compression and the types of redundancy commonly found in digital images. 2. Explain the difference between lossless and lossy compression techniques, including specific methods like predictive, entropy, and transform coding. 3. Describe the key features of still image compression standards such as JPEG and JPEG-2000. Discuss how these standards address issues in digital image compression.

5	1. Describe the key aspects and challenges in digital video processing, including spatial resolution, frame rate, color, and dynamic range.
	2. Discuss the importance and methods of subjective and objective quality assessment in multimedia, including the use of MOS and MUSHRA scores.
	3. Explain the role of watermarking and steganography in multimedia forensics. Discuss how these techniques are used to protect and verify the authenticity of digital media.

24ECM511	COMPUTER NETWORKS	L	T	P	J	S	C	Year of Introduction
		4	0	0			4	2024

Preamble: Throughout this course, the students will be able to delve into the fundamental concepts of computer networks, including network design, protocols, data transmission, security, and management. The course aims to expose students to computer networks taking a bottom-up approach of viewing from the layer of user applications and zooming into link layer protocols. The principles of various protocols used in every layer are studied in detail.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO 1	Explain the concepts and functionalities of the OSI model and the TCP/IP model including their respective layers and protocols. (Understand Level)
CO 2	Explain the way to implement data link layer technologies, to enable seamless and reliable data transmission between connected devices. (Understand Level)
CO 3	Illustrate Dijkstra's algorithm and distance-vector algorithm in the context of routing over computer networks. (Apply Level)
CO 4	Familiarize the problems pertaining to reliable data transfer, flow control and congestion over a TCP network. (Understand Level)
CO 5	Describe the protocols used in web and email applications. (Understand Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	✓	✓										
CO 2	✓	✓										
CO 3	✓	✓										
CO 4	✓	✓										
CO 5	✓											

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓		✓
Understand	✓	✓		✓
Apply	✓	✓		✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	**Attendance**	**Theory [L- T]**			**Total Marks**
		Assignment	**Test-1**	**Test-2**	
4-0-0-0	5	15	10	10	**40**

Total Mark Distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 Hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS (46 Hours)

MODULE I : Introduction to Computer Networking Concept (10 Hours)

Components of computer networks, Applications, Protocol, Protocol standardization
Introduction to computer communication: Transmission modes - serial and parallel transmission, asynchronous, synchronous, simplex, half duplex, full duplex communication.
Switching: circuit switching and packet switching.
Networks: Physical structures, network models, categories of networks, Interconnection of Networks: Internetwork. Types of delay, Packet loss
Network models: Layered tasks, OSI model, Layers in OSI model, TCP/IP protocol suite.

MODULE II : Physical and Data Link Layer (10 Hours)

Physical Layer: Transmission modes, Types of transmission media -Guided and unguided transmission media (Co-axial cable, Twisted pair cable, Fiber optic cable)

Data Link Layer: Framing, Flow and error control (stop and wait, Stop-and-Wait Automatic Repeat Request, Go-Back-N Automatic Repeat Request, Selective Repeat Automatic Repeat Request), Error detection (check sum, CRC), Bit stuffing.
Media access control: Ethernet (802.3), CSMA/CD, Wireless LAN (802.11), CSMA/CA, CAN Protocol.

MODULE III : Network Layer (9 Hours)

Networking devices: Hubs, Bridges & Switches.
Internet Protocol: Network Layer Services, Logical addressing-IPv4 & IPV6 header format.
Address Mapping: Address Resolution protocol (ARP), Reverse Address Resolution Protocol (RARP). Internet Control Message Protocol (ICMP), Dynamic Host Configuration Protocol (DHCP)
Routing and Forwarding, Static routing and Dynamic routing.
Routing Algorithms: Distance vector routing algorithm, Link state routing (Dijkstra's algorithm)
Routing Protocols: Routing Information protocol (RIP), Open Shortest Path First (OSPF), Border Gateway Protocol (BGP), MPLS.

MODULE IV : Transport Layer (8 Hours)

Services of transport layer, Process to process delivery, Transport Layer protocol – UDP-header format, operation. Protocols for reliable data transfer. Go-back-N, Selective Repeat. TCP-header format, operation. Congestion Control & Quality of Service- Traffic Descriptor, Traffic Profiles.
TCP Reno, TCP Tahoe.

MODULE V : Application Layer and Network Security (9 Hours)

Application Layer – Communication between processes. Web Applications- Hyper Text Transfer Protocol (HTTP), Domain Name System (DNS), Remote Logging (Telnet), Simple Mail Transfer Protocol (SMTP), File Transfer Protocol (FTP), World Wide Web (WWW), Post Office Protocol (POP3).
Introduction to information system security, common attacks.
Defense and countermeasures: Firewalls and their types. DMZ, Limitations of firewalls, Intrusion Detection Systems -Host based, Network based, and Hybrid IDSs.

Text books
1. Behrouz A Forouzan, Data Communications and Networking, 4/e, Tata McGraw-Hill, 2006.
2. J F Kurose and K W Ross, Computer Network A Top-down Approach Featuring the Internet, 3/e, Pearson Education, 2010.

Reference books
1. Behrouz A. Forouzan, Cryptography & Network Security, IV Edition, Tata McGraw-Hill,2008
2. Larry Peterson and Bruce S Davie: Computer Network- A System Approach, 4/e, Elsevier India, 2011.
3. S. Keshav, An Engineering Approach to Computer Networking, Pearson

Education, 2005.
4. Achyut S.Godbole, Data Communication and Networking, 2e, McGraw Hill Education New Delhi,2011
5. An online course on 'Computer Networks' by NPTEL,co-ordinated by IIT Kharagpur. Lecture -1 Emergence of Networks & Reference Models

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
MODULE I		
1.1	Introduction to Computer Networks, Components of computer networks	1
1.2	Applications, Protocol, Protocol standardization.	
1.3	Introduction to computer communication: Transmission modes - serial and parallel transmission.	1
1.4	asynchronous, synchronous, simplex, half duplex, full duplex communication.	1
1.5	Switching: circuit switching and packet switching.	1
1.6	Networks: Physical structures, network models, categories of networks.	1
1.7	Interconnection of Networks: Internetwork	1
1.8	Network models: Layered tasks	1
1.9	OSI model-Services provided by each layer	
1.10	TCP/IP protocol suite.	1
MODULE II		
2.1	Physical Layer: Transmission modes	1
2.2	Types of transmission media -Guided and unguided transmission media (Co-axial cable, Twisted pair cable, Fiber optic cable).	1
2.3	Data Link Layer: Framing-Fixed-Size Framing, Variable-Size Framing	1
2.4	Flow and error control (stop and wait, Stop-and-Wait Automatic Repeat Request)	1
2.5	Go-Back-N Automatic Repeat Request, Selective Repeat Automatic Repeat Request	1
2.6	Error detection (check sum, CRC), Bit stuffing	1
2.7	Media access control: Ethernet (802.3)-Frame format,	1
2.8	Carrier Sense Multiple Access with Collision Detection (CSMA/CD)	1
2.9	Wireless LAN (802.11), CSMA/CA.	1
2.10	CAN Protocol-Layered Architecture.	1

	MODULE III	
3.1	Networking devices: Hubs, Bridges & Switches Internet Protocol: Network Layer Services	1
3.2	Logical addressing-IPv4 & IPV6 header format.	1
3.3	Address Mapping: Address Resolution protocol (ARP)	1
3.4	Reverse Address Resolution Protocol (RARP)	1
3.5	Internet Control Message Protocol (ICMP), Dynamic Host Configuration Protocol (DHCP)	1
3.6	Routing and Forwarding, Static routing and Dynamic routing.	1
3.7	Routing Algorithms: Distance vector routing algorithm, Link state routing (Dijkstra's algorithm)	1
3.8	Routing Protocols: Routing Information protocol (RIP), Open Shortest Path First (OSPF)	1
3.9	Border Gateway Protocol (BGP), MPLS.	1
	MODULE IV	
4.1	Services of transport layer, Process to process delivery	1
4.2	Transport Layer protocol –UDP-Header format, operation.	1
4.3	Protocols for reliable data transfer- Go-back-N,	1
4.4	Selective Repeat. TCP-header format, operation	
4.5	Transport Layer protocol –TCP-header format, operation.	1
4.6	Congestion Control & Quality of Service- Traffic Descriptor, Traffic Profiles	1
4.7	TCP Reno,	1
4.8	TCP Tahoe	
	MODULE V	
5.1	Application Layer – Communication between processes. Web Applications	1
5.2	Hyper Text Transfer Protocol (HTTP)	
5.3	Domain Name System (DNS), Remote Logging (Telnet).	1
5.4	Simple Mail Transfer Protocol (SMTP)	1
5.5	File Transfer Protocol (FTP)	
5.6	World Wide Web (WWW), Post Office Protocol (POP3).	1
5.7	Introduction to information system security, common attacks	1
5.8	Defense and counter measures: Firewalls and their types. DMZ.	1
5.9	Limitations of firewalls, Intrusion Detection Systems -Host based, Network based, and Hybrid IDSs.	1

	CO Assessment Questions
1	1. List some advantages and disadvantages of combining the session, presentation, and application layer in the OSI model into one single application layer in the Internet model. 2. Dialog control and synchronization are two responsibilities of the session layer in the OSI model. Which layer do you think is responsible for these duties in the Internet model? Justify your answer.
2	1. In a CDMA/CD network with a data rate of 10 Mbps, the minimum frame size is found to be 512 bits for the correct operation of the collision detection process. What should be the minimum frame size if we increase the data rate to 100 Mbps? To1 Gbps? To 10 Gbps?
3	1. Consider the following network. Compute the shortest-path from the node D to all other nodes using Dijkstra's shortest path algorithm. (Numbers indicated show the link costs).
4	Analyze problems pertaining to reliable data transfer, flow control and congestion over a TCP network. 1. Why is it that voice and video traffic is often sent over TCP rather than UDP in today's Internet? 2. Suppose two TCP connections are present over some bottleneck link of rate R bps. Both connections have a huge file to send (in the same direction over the bottleneck link). The transmissions of the files start at the same time. What transmission rate would TCP like to give to each of the connections?

5	1. Describe the protocols used in web and email applications.
	2. Describe the HTTP message format.
	3. Compare and contrast two application layer protocols SMTP and HTTP.
	4. Explain the concept of a firewall and its role in network security. Provide examples of different types of firewalls and their respective functionalities.

HONORS
V SEMESTER

24ECH509	MEDICAL DEVICE DESIGN	L	T	P	J	S	C	Year of Introduction
		4	0	0	0		4	2024

Preamble: This course offers an in-depth exploration into the innovative field of biomedical engineering, where students will learn the critical processes of creating impactful medical devices, from conceptualization to market release. Bridging the gap between theoretical principles and practical application, the curriculum delves into user-centered design, biocompatibility, regulatory landscapes, and the integration of cutting-edge technologies. Through a blend of lectures, hands-on workshops, and case studies, students will emerge equipped to contribute to the advancement of healthcare technology and improve patient outcomes.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO 1	Understand medical device evolution, apply biomedical principles, and evaluate user-centered design for improved functionality and patient interaction. (Understand Level)
CO 2	Understand clinical assessments, develop concepts, and demonstrate proficiency in prototyping and medical device design stages (Understand Level).
CO 3	Assess biocompatibility, select sterilization methods, and ensure safety and compliance with medical device industry standards (Understand Level).
CO 4	Integrate electronics and software in medical devices, focusing on embedded systems, sensors, and data security (Understand Level).
CO 5	Comprehend medical device case studies, examine wearable and implantable technology, and predict AI and IoT impacts on future innovation (Understand Level).

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	✓	✓										
CO 2	✓	✓										
CO 3	✓	✓										
CO 4	✓	✓										
CO 5	✓	✓										✓

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓		✓
Understand	✓	✓		✓
Apply				
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	**Attendance**	Theory [L- T]			**Total Marks**
		Assignment	**Test-1**	**Test-2**	
4-0-0-0	5	15	10	10	**40**

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 Hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I : Introduction to Medical Devices (9 Hours)

Overview of Medical Devices: Categories, Importance, and Evolution. Biomedical Instrumentation: Principles and Applications. Anatomy and Physiology: Basics for Engineers. Biosignals: Characteristics, Acquisition, and Importance. User-Centered Design: Importance in Medical Devices, Stakeholder Analysis. Workshop on Biosignal Acquisition and Analysis.

MODULE II : Medical Device Design Process (10 Hours)

Identification of Clinical Needs: Market Research, User Feedback, Clinical Observations. Concept Generation: Brainstorming, Pugh Matrix, Morphological Analysis. Prototyping: Types, Methods, Rapid Prototyping Techniques. Design for Manufacturing (DFM) and Design for Assembly (DFA). Verification and Validation:

Definitions, Methods, Clinical Trials. Case Study Analysis of Successful Medical Device Design Processes.
MODULE III : Biocompatibility and Safety (10 Hours)
Introduction to Biocompatibility: Importance, Factors Influencing Response. Materials in Medical Device Design: Metals, Polymers, Ceramics, Composites. Sterilization Techniques: Autoclaving, Radiation, Ethylene Oxide. Safety Considerations: Electrical Safety, Mechanical Safety. Regulatory and Standards: FDA, CE Marking, ISO Standards. Guest Lecture on Regulatory Pathways for Medical Devices.
MODULE IV : Electronics and Software in Medical Devices (10 Hours)
Embedded Systems in Medical Devices: Microcontrollers, Digital Signal Processors. Sensor Technologies: Pressure, Flow, Temperature, Biopotential Sensors. Signal Conditioning and Data Acquisition. Wireless Communication in Medical Devices: Bluetooth, Wi-Fi, NFC. Software Development: Real-time Operating Systems, Software Validation, Cybersecurity. Practical Workshop on Software Development for Medical Devices.
MODULE V : Case Studies and Future Trends (9 Hours)
Wearable Medical Devices: Smartwatches, Fitness Trackers, Continuous Glucose Monitors. Implantable Devices: Pacemakers, Cochlear Implants, Neurostimulators. Diagnostic Equipment: Point-of-Care Devices, Imaging Equipment. Telemedicine and Remote Monitoring Devices. Future Trends: Personalized Medical Devices, Integration of AI and IoT in Medical Devices. Panel Discussion on the Future of Medical Device Technology.

Text books

1. Yock, P., Zenios, S., Makower, J., Brinton, T. J., Kumar, U. N., Watkins, F. T., ... & Krummel, T. M. (2015). *Biodesign: The Process of Innovating Medical Technologies*. Cambridge University Press.
2. Ogrodnik, P. J. (2012). *Medical Device Design: Innovation from Concept to Market*. Academic Press.
3. King, P. H., Fries, R. C., & Allen, A. P. (2012). *Design of Biomedical Devices and Systems*. CRC Press.

Reference books

1. Kucklick, T. R. (2012). *The Medical Device R&D Handbook*. CRC Press.
2. Dyro, J. (2004). *Clinical Engineering Handbook*. Academic Press.
3. Enderle, J., Blanchard, S. M., & Bronzino, J. D. (2011). *Introduction to Biomedical Engineering*. Academic Press.
4. Webster, J. G. (2009). *Medical Instrumentation: Application and Design*. Wiley.
5. Weinger, M. B., Wiklund, M. E., & Gardner-Bonneau, D. J. (Eds.). (2011). *Handbook of Human Factors in Medical Device Design*. CRC Press.
6. Togawa, T., Tamura, T., & Oberg, P. A. (2011). *Biomedical Sensors and Instruments*. CRC Press.
7. https://medicaldevicehq.com/introduction-to-design-control-course-online/

	COURSE CONTENTS AND LECTURE SCHEDULE	
No.		No. of Hours
	MODULE I	
1.1	Introduction to Medical Devices: Overview of the course and expectations, defining medical devices, importance of medical devices in healthcare	1
1.2	Categories and Evolution of Medical Devices: History of medical devices, evolution of technology in healthcare, categories of medical devices	1
1.3	Biomedical Instrumentation – Part1: Introduction to biomedical instrumentation, principles of biomedical instrumentation, commonly used instruments in medical practice	1
1.4	Biomedical Instrumentation - Part 2 Applications of biomedical instrumentation, case studies of biomedical instrumentation in clinical settings	1
1.5	Anatomy and Physiology for Engineers - Part 1: Basic human anatomy relevant to medical devices Overview of human physiology	1
1.6	Anatomy and Physiology for Engineers - Part 2: The interplay between device design and human physiology, case studies on how medical devices interact with the human body	1
1.7	Biosignals and their Importance characteristics of biosignals: The role of biosignals in diagnostics and treatment Techniques for biosignal acquisition	1
1.8	User-Centered Design in Medical Devices: Principles of user-cantered design, conducting stakeholder analysis, incorporating user feedback into device design	1
1.9	Workshop on Biosignal Acquisition and Analysis Hands-on session with biosignal acquisition equipment, analyzing and interpreting biosignal data, discussion on the implications of biosignal analysis in device design	1
	MODULE II	
2.1	Introduction to the Medical Device Design Process: Overview of the design process for medical devices, key stages and milestones in the design lifecycle, importance of a structured design process	1
2.2	Identification of Clinical Needs - Part 1: Techniques for market research in medical devices, analyzing market trends and identifying gaps	1
2.3	Identification of Clinical Needs - Part 2: Gathering user feedback and clinical observations, translating clinical needs into design requirements	1
2.4	Concept Generation - Brainstorming Techniques, introduction to brainstorming in medical device design Conducting effective brainstorming sessions, documenting and evaluating ideas	1

2.5	Concept Generation - Pugh Matrix and Morphological Analysis: Using the Pugh Matrix for concept selection, applying morphological analysis to explore design alternatives	1
2.6	Prototyping - Types and Methods: Overview of prototyping in medical device design Different types of prototypes and their purposes	1
2.7	Prototyping - Rapid Prototyping Techniques: Introduction to rapid prototyping technologies, advantages and limitations of rapid prototyping in medical device development	1
2.8	Design for Manufacturing (DFM) and Design for Assembly (DFA): Principles of DFM and DFA, Applying DFM and DFA to medical device design to optimize production	1
2.9	Verification and Validation - Part 1: Definitions and differences between verification and validation, methods and best practices for verification	1
2.10	Verification and Validation - Part 2 and Case Study Analysis Validation techniques and the role of clinical trials, case study analysis of a successful medical device design process	1
MODULE III		
3.1	Introduction to Biocompatibility: Definition and significance of biocompatibility in medical devices, overview of factors influencing biocompatibility	1
3.2	Biocompatibility Testing: Types of biocompatibility tests, interpreting test results and their implications for device design	1
3.3	Materials in Medical Device Design - Metals Properties of metals used in medical devices, Case studies of metal applications in medical devices	1
3.4	Materials in Medical Device Design - Polymers Characteristics of polymers and their role in medical devices, Advantages and challenges of using polymers	1
3.5	Materials in Medical Device Design - Ceramics and Composites Use of ceramics and composites in medical devices, comparing materials based on application requirements	1
3.6	Sterilization Techniques - Part 1: Principles of sterilization, Autoclaving process and its application in medical device sterilization	1
3.7	Sterilization Techniques - Part 2 Radiation sterilization methods Use of ethylene oxide for sterilization and its safety considerations	1
3.8	Safety Considerations in Medical Device Design Electrical safety standards and testing, Mechanical safety considerations in device design	1
3.9	Regulatory and Standards: Overview of FDA and CE marking processes, Understanding ISO standards and their application in medical device design	1

3.10	Guest Lecture on Regulatory Pathways for Medical Devices, Guest speaker from the industry or regulatory body Insights into the regulatory approval process, Q&A session with the guest speaker for practical understanding		1
MODULE IV			
4.1	Introduction to Embedded Systems in Medical Devices: Overview of embedded systems in healthcare technology Role of microcontrollers and digital signal processors in medical devices.		1
4.2	Microcontrollers in Medical Devices: Deep dive into microcontroller architecture and selection for medical applications, programming considerations and environment setup		1
4.3	Digital Signal Processors (DSPs) and Their Applications: Understanding DSPs and their advantages in medical device processing, Case studies of DSPs in action within medical devices		1
4.4	Sensor Technologies - Part 1: Pressure and Flow Sensors Types of pressure and flow sensors used in medical devices Integration of these sensors into medical device systems		1
4.5	Sensor Technologies - Part 2: Temperature and Biopotential Sensors, Overview of temperature sensors and their medical applications, Introduction to biopotential sensors and signal acquisition challenges.		1
4.6	Signal Conditioning and Data Acquisition: Fundamentals of signal conditioning for medical device sensors, Data acquisition systems and strategies		1
4.7	Wireless Communication Technologies - Part 1 Introduction to wireless communication in medical devices Detailed look at Bluetooth technology and its applications		1
4.8	Wireless Communication Technologies - Part 2 Exploring Wi-Fi and NFC in medical device contexts Security and reliability considerations for wireless medical devices.		1
4.9	Software Development for Medical Devices: Real-time operating systems (RTOS) in medical devices Software validation processes and cybersecurity in medical software		1
4.10	Practical Workshop on Software Development for Medical Devices: Hands-on session with software development tools and RTOS Implementing a simple medical device software application Discussion on the importance of software validation and cybersecurity		1
MODULE V			
5.1	Overview of Wearable Medical Devices: Introduction to wearable technology in healthcare, discussion on smartwatches and fitness trackers		1

5.2	Wearable Medical Devices for Chronic Conditions: Deep dive into continuous glucose monitors and their impact on diabetes management, Case studies on the use of wearables in chronic disease monitoring	1
5.3	Introduction to Implantable Medical Devices Overview of implantable devices and their roles, Focus on pacemakers and their technological advancements	1
5.4	Advanced Implantable Devices: Cochlear implants and their design considerations, Neurostimulators and their applications in treating neurological disorders	1
5.5	Diagnostic Equipment - Part 1: Point-of-Care Devices: The growing importance of point-of-care diagnostics Technological innovations in point-of-care devices	1
5.6	Diagnostic Equipment - Part 2: Imaging Equipment Advances in medical imaging technology, case studies on the integration of imaging equipment in medical diagnostics	1
5.7	Telemedicine and Remote Monitoring: The rise of telemedicine and its impact on healthcare delivery, remote monitoring devices and their significance in patient care	1
5.8	Future Trends in Medical Device Technology Personalized medical devices and their potential, integration of AI and IoT in medical devices and the implications for healthcare	1
5.9	Panel Discussion on the Future of Medical Device Technology Inviting industry experts and researchers for a panel discussion: Exploring the current challenges and future directions in medical device technology, Q&A session with the panel for student engagement	1

	CO Assessment Questions
1	1. Describe the evolution of medical devices and discuss how advancements in biomedical instrumentation have impacted patient care. 2. Analyze a case study where user-centered design significantly improved the functionality and user experience of a medical device. 3. Given a set of bio signals, identify their characteristics and propose a method for their acquisition and importance in patient monitoring
2	1. Conduct market research on a hypothetical clinical need and develop a concept generation matrix to address this need. 2. Design a prototype for a medical device and outline the considerations for its manufacturing and assembly, explaining how these considerations will affect the final product. 3. Explain the verification and validation processes for a medical device and how they contribute to the overall design process.
3	1. Evaluate different materials used in medical device design for their biocompatibility and select the most appropriate material for a given application. 2. Discuss various sterilization techniques and recommend a suitable method for a medical device that comes into contact with blood. 3. Identify the key regulatory considerations for medical devices and explain how they influence the design and development process.
4	1. Design a basic circuit using microcontrollers and biopotential sensors for a medical device application, explaining the choice of components. 2. Propose a data acquisition and signal conditioning solution for a wearable device that measures blood pressure continuously. 3. Discuss the importance of cybersecurity in medical devices and evaluate a real-time operating system's features for its suitability in medical device software.
5	1. Analyze the design considerations of a continuous glucose monitor and discuss how it has evolved with the integration of wearable technology. 2. Compare and contrast the use of pacemakers and neurostimulators, focusing on their design, functionality, and impact on patient health. 3. Predict how emerging technologies like AI and IoT could transform the landscape of medical device design in the next decade

24ECH510	NATURAL LANGUAGE PROCESSING	L	T	P	J	S	C	Year of Introduction
		4	0	0	0	0	4	2024

Preamble: This course enables the learners to understand the concepts of Natural Language Processing. The course covers basic pre-processing steps, language models, text classification using machine learning algorithms, information and relation extraction methods, Information Retrieval, Question Answer Systems and Machine Translation models. This course enables the students to apply techniques and methods to solve challenging real-world problems in NLP.

Prerequisite: 24ECP407 Machine Intelligence: Methods and Applications

Course Outcomes: After the completion of the course the student will be able to

CO 1	Summarize basic concepts and learning methods for NLP. (Understand Level)
CO 2	Demonstrate the relevance of pre-processing methods on text data. (Apply Level)
CO 3	Compare different language modelling techniques. (Apply Level)
CO 4	Make use of NLP techniques in Text Classification and Information Retrieval. (Apply Level)
CO 5	Explain Information Extraction, Relation Detection, QA Systems and Machine Translation. (Understand Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	✓											
CO 2	✓	✓			✓							✓
CO 3	✓				✓							
CO 4	✓				✓							
CO 5	✓											

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓		✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
4-0-0-0	5	15	10	10	**40**

Total Mark distribution			
Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 Hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS (47 Hours)

MODULE I : Introduction to natural language processing (7 Hours)

NLP Tasks and Applications, Language-Building Blocks, Challenges of NLP, Machine Learning for NLP – Naïve Bayes Classifier, Logistic Regression, Support Vector Machines, Approaches to NLP- Heuristics-Based NLP, Machine Learning-based NLP.

MODULE II : Pre-processing and Representation Models (10 Hours)

NLP System Pipeline-Steps--Data Acquisition, Text Extraction and Clean-up, Pre-processing, Feature Engineering, Modelling, Evaluation, Post-Modelling Phases.

Text Representation-Vector Space Models-Basic Vectorization Approaches--One-Hot Encoding, Bag of Words, Bag of N-Grams TF-IDF; Distributed Representations—Word Embeddings, Doc2Vec.

MODULE III : Classification and Information Extraction (12 Hours)
Text Classification--Text classification applications – Pipeline for building text classification systems, Naïve Bayes for Sentiment Classification – Naïve Bayes Classifier Training – Optimizing for Sentiment Analysis, Logistic Regression, Support Vector Machine for Text Classification Information Extraction (IE)—IE Applications – The General Pipeline for IE - Named Entity Recognition (NER), Ambiguity in Named Entity Recognition – NER as Sequence Labelling – Evaluation of NER.
MODULE IV : Relation Detection and Information Retrieval (8 Hours)
Relation Detection and Classification – Supervised Learning Approaches to Relation Analysis – Lightly Supervised Approaches to Relation Analysis – Evaluation of Relation Analysis systems. Information Retrieval – Term weighting and document scoring – Inverted Index – Evaluation of Information Retrieval Systems.
MODULE V : QA Systems and Machine Translation (10 Hours)
Question-Answering Systems – Factoid Question Answering – Question Processing – Passage Retrieval – Answer Processing – Evaluation of Factoid Answers. Machine Translation – Why Machine Translation is Hard – Classical Machine Translation – Direct Translation – Transfer – Statistical Machine Translation- The Phrase based Translation model – Alignment in MT – Training Alignment Models – Symmetrizing Alignments for Phrase-based MT – Decoding for Phrase-based Statistical MT.

Text books

1. Daniel Jurafsky, James H. Martin, "Speech and Language Processing" (2nd and 3rd editions), Pearson Prentice Hall.
   https://web.stanford.edu/~jurafsky/slp3/
2. Sowmya Vajjala, Bodhisattwa Majumder, Anuj Gupta, Harshit Surana," ractical Natural Language Processing: A Comprehensive Guide to Building Real-World NLP Systems " June 2020 Publisher(s): O'Reilly Media, Inc. ISBN: 9781492054054.

Reference books

1. James Allen, "Natural Language Understanding", Second Edn , Pearson.
2. Christopher Manning and Hinrich Schutze, Statistical Natural Language Processing, MIT Press
3. Bird, S., Klein, E., & Loper, E. (2009). *Natural Language Processing with Python.* O'Reilly Media.
4. Manning, C. D., & Schütze, H. (1999). *Foundations of Statistical Natural Language Processing.* MIT Press.
5. Goldberg, Y. (2017). *Neural Network Methods for Natural Language Processing.*

Morgan & Claypool Publishers.

6. Lane, H., Howard, C., & Hapke, H. (2019). *Natural Language Processing in Action.* Manning Publications.
7. Indurkhya, N., & Damerau, F. J. (Eds.). (2010). *Handbook of Natural Language Processing.* CRC Press.
8. Video Resources: https://onlinecourses.nptel.ac.in/noc23_cs45/preview
9. https://www.youtube.com/playlist?list=PL8P_Z6C4GcuWfAq8Pt6PBYlck4Opr HXsw

No.	**COURSE CONTENTS AND LECTURE SCHEDULE**	No. of Hours
MODULE 1	
1.1	Introduction to NLP – Tasks and Applications	1
1.2	Language – Building Blocks, Challenges of NLP.	1
1.3	Approaches to NLP - Heuristics-Based NLP, Machine Learning for NLP.	1
1.4	Machine Learning for NLP – Naïve Bayes Classifier.	1
1.5	Logistic Regression.	1
1.6	Support Vector Machines – Linearly Separable Data.	1
1.7	Support Vector Machines – Linearly Inseparable Data	
	MODULE II	
2.1	NLP System Pipeline – Stages – Overview, Data Acquisition.	1
2.2	NLP System Pipeline – Text Extraction and Cleanup.	1
2.3	NLP System Pipeline – Preprocessing - Sentence segmentation	1
2.4	Word tokenization, Stemming and lemmatization	1
2.5	Feature Engineering, Model Building	1
2.6	Evaluation – Metrices, Post-modeling phase	1
2.7	Text Representation – Vector Space Model	1
2.8	Vectorization Approaches – One hot encoding, Bag of words.	1
2.9	Bag of n-grams, TF-IDF	1
2.10	Word Embeddings – Word2Vec- CBOW, Skip Gram models	1
	MODULE III	
3.1	Text Classification--Text classification applications.	1
3.2	Pipeline for building text classification systems.	1

3.3	Sentiment Analysis using Naïve Bayes Classifier.	1
3.4	Sentiment Analysis using Logistic Regression,	1
3.5	Support Vector Machine for Text Classification	1
3.6	Information Extraction (IE) and Applications	1
3.7	IE Tasks and the IE Pipeline.	1
3.8	Named Entity Recognition (NER)	1
3.9	Ambiguity in NER	1
3.10	NER as Sequence Labeling.	1
3.11	Evaluation of NER.	1
3.12	Practical NER Systems	1
MODULE IV		
4.1	Relation Detection and Classification	1
4.2	Supervised Learning Approaches to Relation Analysis	1
4.3	Lightly Supervised Approaches to Relation Analysis	1
4.4	Evaluation of Relation Analysis systems	1
4.5	Information Retrieval	1
4.6	Term weighting and document scoring	1
4.7	Inverted Index	1
4.8	Evaluation of Information Retrieval Systems	1
MODULE V		
5.1	Question-Answering Systems, Factoid Question Answering, Question Processing	1
5.2	Passage Retrieval	1
5.3	Answer Processing- Evaluation of Factoid Answers	1
5.4	Machine Translation – Why Machine Translation is Hard	1
5.5	Classical Machine Translation, Direct Translation – Transfer	1
5.6	Statistical Machine Translation	1
5.7	The Phrase based Translation model	1
5.8	Alignment in Machine Translation	1
5.9	Training Alignment Models – Symmetrizing Alignments for Phrase-based MT	1
5.10	Decoding for Phrase-based Statistical MT	1

CO Assessment Questions

1	1. Explain the fundamental tasks that make up an NLP system. 2. Explain why NLP is considered a challenging problem domain? 3. The following table shows data about the profile of customers and whether they purchase computers or not. Given this data, use Naïve Bayes Classifier to classify the customer X (age = youth, income = medium, student = yes, credit rating = fair). RID, age, income, student, credit_rating, Class: buys_computer table below 4. Illustrate how linearly inseparable data can be made linearly separable by suitable mapping using kernel functions.
2	1. Mention two issues associated with sentence segmentation. 2. Show how is lemmatization done using Python Library. 3. Given a dataset of tweets, prepare the data for sentiment analysis by doing the following operations: conversion to lower casing, removal of punctuations, removal of stop-words, stemming, lemmatization, removal of emojis and removal of URLs. (Assignment Question).
3	1. Compare Bag-of-Words model and Bag-of-n-gram model. 2. Illustrate how TF-IDF model is used to represent text. Mention the advantage of TF- IDF over other models. 3. A corpus of data is given below: D1 Dog bites man. D2 Man bites dog. D3 Dog eats meat. D4 Man eats food. Use one hot-encoding and Bag-of-words models to represent "dog bites man". Using the toy corpus given above, represent the sentence "Dog and Man

Table for Question 1.3

RID	age	income	student	credit_rating	Class: buys_computer
1	youth	high	no	fair	no
2	youth	high	no	excellent	no
3	middle_aged	high	no	fair	yes
4	senior	medium	no	fair	yes
5	senior	low	yes	fair	yes
6	senior	low	yes	excellent	no
7	middle_aged	low	yes	excellent	yes
8	youth	medium	no	fair	no
9	youth	low	yes	fair	yes
10	senior	medium	yes	fair	yes
11	youth	medium	yes	excellent	yes
12	middle_aged	medium	no	excellent	yes
13	middle_aged	high	yes	fair	yes
14	senior	medium	no	excellent	no

		eat meat" with TF-IDF model. Use python code for Implementation. (Assignment Question)
4	1.	Given the following data about documents and contents, use tf-idf document scoring method to retrieve the document for the query "best game".
			Doc 1	The game was so exciting. The players excelled in every department of the game.				Doc 2	It was an excellent game				Doc 3	The game was not good. The moves were boring	
	2.	A corpus of data is available from a social media platform that represents review of books. How can Naïve Bayes Classifier be used for sentiment analysis of the reviews? What changes can be made to this classifier to make it tuned for sentiment analysis.
	3.	Use python library to implement sentiment analysis of review of a book, given a toy corpus data set given below.
			Document	Category				just plain boring	Negative				entirely predictable and lacks energy	Negative				no surprises and very few laughs	Negative				very powerful book	Positive				the best book of the summer	Positive	
5	1. 2.	Explain lightly supervised approaches to relational analysis. Explain a statistical algorithm for word alignment in Machine Translation.

SEMESTER VI SYLLABUS

24ECT601	APPLIED ELECTROMAGNETIC THEORY	L	T	P	J	S	C	Year of Introduction
		2	1	0	0	2	3	2024

Preamble: This course aims to impart basic knowledge on the application of circuit and field theory for electromagnetic application. This course covers the basics of Electromagnetic wave propagation through guided and unguided media. Successful completion of the course will allow students to take advanced course in Microwave and Antenna Engineering.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO1	Summarize mathematical concepts related to electromagnetic vector fields (Understand Level)
CO2	Solve Maxwell''s equations to illustrate wave propagation in various media (Apply Level)
CO3	Describe wave polarization and power transfer using EM waves (Understand Level)
CO4	Illustrate wave propagation through transmission line analytically and using Smith chart (Apply Level)
CO5	Solve field equation for a hollow rectangular wave guide (Apply Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓			✓			✓				
CO2	✓	✓										
CO3	✓											
CO4	✓	✓			✓			✓				✓
CO5	✓	✓										

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	Attendance	Theory [L-T]			Total Marks
		Assignment	Test-1	Test-2	
2-1-0-0	5	15	10	10	**40**

Total Mark distribution			
Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 Hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I: Introduction to Electromagnetics (8 Hours)

Introduction to Electromagnetics, Review of vector calculus, Significance of Unit vector, Coordinate systems: Rectangular, spherical, and cylindrical coordinate systems, coordinate conversion, Elemental displacement, area, and volume for spherical and cylindrical coordinate system. Significance of Curl, Divergence, Gradient, Derivation of capacitance and inductance of two wire transmission line and coaxial cable, Poisson and Laplace equations, Determination of E and V using Laplace equation. (Simulation Assignment: Code for coordinate conversion)

MODULE II: Propagation of Waves through Various Media (7 Hours)
Equation for continuity, Maxwell's equation from fundamental laws. Boundary condition of electric field and magnetic field, Solution of wave equation, Propagation of plane EM wave in partially conducting media, in perfect dielectric, in good conductors, attenuation, phase velocity, group velocity, skin depth.
MODULE III: Waves at Media Interface (6 Hours)
Polarization of electromagnetic waves: Linear, Circular and Elliptical Polarization. Reflection and Refraction of plane electromagnetic waves at boundaries for normal & oblique incidence, Parallel and Perpendicular Polarization –Snell"s law of refraction, Brewster angle. Electromagnetic Power transfer- Poynting Theorem.
MODULE IV: Transmission Lines (8 Hours)
Transmission line: equivalent model of two wire transmission line, voltage and current equation in transmission line, Primary and secondary constants, Input impedance derivation, Matched and unmatched line. VSWR and reflection coefficient. Application of transmission line: As circuit element (L and C), Half wave and quarter wave transformer. Development of Smith chart- Calculation input impedance, Vmax and Vmin, SWR using smith chart.
(Simulation Assignment: Smith Chart using MATLAB)
MODULE V: Waveguides (7 Hours)
Waveguides: Modes of propagation in waveguide, Basics of Parallel plate Waveguide, The hollow rectangular waveguide – modes, dominant mode, attenuation in waveguides, group velocity, phase velocity, guide wavelength.

Text books
1. Mathew N O Sadiku, Elements of Electromagnetics, Oxford University Press, 6/e, 2014.
2. William, H. Hayt, and John A. Buck. Engineering Electromagnetics. McGraw-Hill, 8/e, McGraw-Hill, 2014.
3. John D. Kraus, Electromagnetics, 5/e, TMH, 2010.
4. Edminister, "Schaum"s Outline of Electromagnetics", 4/e, McGraw-Hill, 2014.

Reference books
1. Jordan and Balmain, Electromagnetic waves and Radiating Systems, PHI, 2/e,2013.
2. Martin A Plonus, Applied Electromagnetics, McGraw Hill, 2/e,1978.
3. Nannapaneni Narayana Rao, Elements of Engineering Electromagnetics, Pearson, 6/e, 2006.
4. Umran S. Inan and Aziz S. Inan, Engineering Electromagnetics, Pearson, 2010.
5. R. K. Shevgaonkar, Electromagnetic Waves, Tata McGraw Hill India, 2005.
6. R. L. Yadav, Electromagnetic Fields and Waves, Khanna Book Publishing, 2021.
7. David Cheng, Electromagnetics, Prentice Hall.
8. MOOC on Applied Electromagnetic Theory by NPTEL, https://archive.nptel.ac.in/courses/108/104/108104087/

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
MODULE I		
1.1	Introduction to Electromagnetics, Review of vector calculus, Significance of Unit vector	1
1.2	Coordinate systems: Rectangular, spherical and cylindrical coordinate systems	1
1.3	Coordinate Conversion illustration	1
1.4	Elemental displacement, area and volume for spherical and cylindrical coordinate system	1
1.5	Significance of Curl, Divergence, Gradient	1
1.6	Derivation of capacitance and inductance of two wire transmission line and coaxial cable	1
1.7	Poisson and Laplace equations, Determination of E and V using Laplace equation	1
1.8	Illustration of Poisson and Laplace equations	1
MODULE II		
2.1	Equation for continuity	1
2.2	Maxwell"s equation from fundamental laws	1
2.3	Boundary condition of electric field and magnetic field, Solution of wave equation	1
2.4	Propagation of plane EM wave in partially conducting media	1
2.5	Propagation of plane EM wave in perfect dielectric, in good conductors	1
2.6	Attenuation, phase velocity, group velocity, skin depth	1
2.7	Illustration of Wave propagation through various media	1
MODULE III		
3.1	Polarization of electromagnetic wave: Linear, Circular and Elliptical Polarization	1
3.2	Reflection of plane electromagnetic waves at boundaries for normal incidence	1
3.3	Refraction of plane electromagnetic waves at boundaries for oblique incidence	1
3.4	Parallel and Perpendicular Polarization –Snell"s law of refraction, Brewster angle	1
3.5	Electromagnetic Power transfer- Poynting Theorem	1
3.6	Illustration of Poynting theorem	1
MODULE IV		
4.1	Transmission line: equivalent model of two wire transmission line, voltage, and current equation in transmission line	1
4.2	Primary and secondary constants, Input impedance derivation	1

4.3	Matched and unmatched line. VSWR and reflection coefficient	1
4.4	Application of transmission line: As circuit element (L and C), Half wave and quarter wave transformer	1
4.5	Development of Smith chart	1
4.6	Calculation input impedance, Vmax and Vmin	1
4.7	SWR using Smith chart	1
4.8	Illustration of Transmission Line	1
MODULE V		
5.1	Waveguides: Modes of propagation in waveguide	1
5.2	Basics of Parallel plate waveguide	1
5.3	The hollow rectangular waveguide – modes, dominant mode	1
5.4	Attenuation in waveguides	1
5.5	Group velocity, phase velocity, guide wavelength	1
5.6	Relationship between group velocity, phase velocity, guide	1

	wavelength	
5.7	Calculation of waveguide parameters	1

CO Assessment Questions	
1	1. Explain the advantages of using vector fields to model Electromagnetic field. 2. Write a code to convert a rectangular coordinate system to cylindrical/spherical coordinate system.
2	Use Maxwell"s Equations to elucidate the phenomenon of wave propagation in diverse media.
3	1. Explain time average Poynting vector. 2. Explain different types of wave polarization.
4	1. Calculate transmission line parameters using Circuit Theory and verify the results using Smith Chart. 2. Plot the Smith Chart for a given transmission line problem using MATLAB.
5	Use field theory to solve wave propagation through bounded waveguide.

24ECP602	VLSI DESIGN	L	T	P	J	S	C	Year of Introduction
		2	1	2	0	4	4	2024

Preamble: The main emphasis of the course is, on core approaches in VLSI Design, with the goal of providing a holistic grasp of a wide range of design elements and subsystems. It delves into areas including ASIC, FPGA, the design of both static and dynamic circuits, principles of pipelining for delay reduction, memory subsystems, and underscores the significance of adhering to design rules.

Prerequisite: 24ECP304 Semiconductor Devices

Course Outcomes: After the completion of the course the student will be able to

CO 1	Comprehend the architectural and design flow aspects of ASIC and FPGA. (Understand level)
CO 2	Design and implement various Static and Dynamic CMOS logic circuits. (Apply level)
CO 3	Implement combinational pipelined circuits. (Apply level)
CO 4	Design and analyse various subsystems and memory elements. (Apply level)
CO 5	Illustrate fabrication techniques and implement the layout of NAND and NOR gates. (Apply level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	✓											
CO 2	✓	✓		✓	✓			✓		✓		✓
CO 3	✓	✓		✓	✓					✓		
CO 4	✓	✓										
CO 5	✓	✓		✓	✓				✓	✓		

Assessment Pattern for Theory component

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				
Create				

Assessment Pattern for Lab component

Bloom's Category	Continuous Assessment Tools	
	Class work	Test1
Remember		
Understand	✓	✓
Apply	✓	✓
Analyse		
Evaluate		
Create		

Mark Distribution of CIA							
Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Practical [P]		Total Marks
		Assignment	Test-1	Test-2	Class work	Lab Exam	
2-1-2-0	5	10	12.5	12.5	10	10	**60**

Total Marks distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	60	40	2.5 Hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 2		2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 subdivisions. Each question carries 8 marks. Marks: (5x 8 = 40 marks) Time: 2.5 hours	40
	Total Marks: 0	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I: Introduction (5 hours)

Introduction to VLSI Design, ASIC and FPGA design flow, Top down and bottom up design Methodologies, Full custom and semi-Custom ASIC, FPGA-General Architecture, Selection of FPGA for specific application (Assignment Case study on Different FPGA architectures and specifications)

MODULE II: Static and Dynamic CMOS logic (8 hours)

MOS Transistor basics, Static CMOS logic: Complementary CMOS and Rationed logic Static CMOS Inverter: VTC, Switching Threshold, Noise Margins. Realization of logic functions with static CMOS logic, Pass transistor logic, and transmission gate logic.
Dynamic CMOS logic: Cascading issue in dynamic logic, Domino logic, Charge sharing in dynamic logic. (Assignment Effect of device variations on VTC)

MODULE III: Delay and Interconnect (7 hours)
Logical Effort, Delay in logic Gates, Identification of Critical path, Combinational blocks to Pipelined circuits, Calculation of worst case operating frequency, Delay in multistage Logic network. Interconnect modeling Resistance, capacitance
MODULE IV: Circuit and Subsystem Design (7 Hours)
Sequencing static circuits: Conventional CMOS latches and Flipflops, Pulsed Latches, Resettable Latches.   Timing analysis- Setup and hold time, Max and Min delay constraints, Sub system: SRAM, Sense Amplifiers, ALU
MODULE V: VLSI Fabrication (5 Hours)
MOSFET Fabrication techniques Twin-Tub fabrication sequence Layout and Design rules: Stick Diagram, Design rules-micron rules and Lambda rules (definitions only), layout of CMOS Inverter, two input NAND and NOR gates.   (Assignment layout of NAND gate and NOR Gate)

Text books
1. N.H.E. Weste and D.M. Harris, CMOS VLSI design: A Circuits and Systems Perspective, 4th Edition, Pearson Education India, 2011.
2. Sung –Mo Kang & Yusuf Leblebici, CMOS Digital Integrated Circuits- Analysis & Design, McGraw-Hill, Third Ed., 2003
3. S.M. SZE, VLSI Technology, 2/e, Indian Edition, McGraw-Hill,2003
4. Wayne Wolf ,Modern VLSI design, Third Edition, Pearson Education,2002.
5. https://onlinecourses.nptel.ac.in/noc22_ee44/preview
6. https://onlinecourses.nptel.ac.in/noc21_ee22/preview

Reference books
1. Jan M.Rabaey, Digital Integrated Circuits- A Design Perspective, Prentice Hall, Second Edition, 2005.
2. Neil H.E. Weste, Kamran Eshraghian, Principles of CMOS VLSI Design- A Systems Perspective, Second Edition. Pearson Publication, 2005
3. Razavi - Design of Analog CMOS Integrated Circuits,1e, McGraw Hill Education India Education, New Delhi, 2003.
4. Yuan Taur & Ning, Fundamentals of Modern VLSI Devices, Cambridge University Press, 2008

COURSE CONTENTS AND LECTURE SCHEDULE		
No.		No. of Hours
MODULE I		
1.1	Introduction to VLSI Design, ASIC and FPGA design flow	1
1.2	Top down and bottom-up design Methodologies	1
1.3	Full custom and semi-custom ASIC	1
1.4	FPGA-General Architecture	1
1.5	Selection of FPGA for specific application	1

MODULE II		
2.1	MOS Transistor basics	1
2.2	Static CMOS logic: Complementary CMOS and Rationed logic	1
2.3	Static CMOS Inverter: VTC	1
2.4	Switching Threshold, Noise Margins.	1
2.5	Static CMOS logic, Pass transistor logic, and transmission	1
2.6	Implementation of functions using Static CMOS logic, Pass transistor logic, and transmission gate logic.	1
2.7	Dynamic CMOS logic: Cascading issue in dynamic logic, Charge sharing in dynamic logic.	1
2.8	Domino logic	1
MODULE III		
3.1	Logical Effort	1
3.2	Delay in logic Gates, Identification of Critical path	1
3.3	Combinational blocks to Pipelined circuits	1
3.4	Illustration of pipeline concept in adder	1
3.5	Calculation of worst-case operating frequency,	1
3.6	Delay in multistage Logic network.	1
3.7	Interconnect modeling Resistance, capacitance	1
MODULE IV		
4.1	Sequencing static circuits: Conventional CMOS latches and Flipflops	1
4.2	Pulsed Latches, Resettable Latches	1
4.3	Timing analysis- Setup and hold time,	1
4.4	Max and Min delay constraints,	1
4.5	Illustration of Max and Min delay constraints	1
4.6	SRAM	1
4.7	Sense Amplifiers, ALU	1
MODULE V		
5.1	MOSFET Fabrication techniques Twin-Tub fabrication sequence	1
5.2	Stick Diagram and Design rules-micron rules and Lambda rules	1
5.3	Illustration of Stick diagram	1
5.4	Basics of Layout, Layout of CMOS Inverter	1
5.5	Two input NAND and NOR gates.	1

LESSON PLAN FOR LAB COMPONENT

No.	Topic	No. of Hours	Experiment
1	Inverter Design	1	1. Familiarization of simulation tools: Spice or Cadence
		2	2. Perform DC analysis of an Inverter.

		2	3. Design of Inverter Chain for a given capacitive load for lowest delay. (Spice/Cadence)
2	Design of Combinational /Sequential Circuit	1	1. Design of MUX using CMOS transistors
		2	2. Design of logic gates using CMOS transistors
		2	3. Implementation M/S FF using transistors. (SPICE/Cadence)
3	Pipelined Circuit Design	2	1. Familiarization of Delay analysis in circuits.
		2	2. Design of adder without pipelining.
		2	3. Implementation of pipelined adder. (Xilinx Vivado)
4	Layout Implementation	2	1. Obtain the VLSI layout of NAND Gate.
		2	2. Obtain the VLSI layout of NOR Gate.

CO Assessment Questions	
1	Explain full custom and semi-custom ASIC.
2	Design an inverter chain to drive a capacitive load of 500Pf.
3	Implement an adder circuit using pipelining and compare its delay with normal adder.
4	In the given circuit setup time of the flop is 6ns, the hold time of the flop is 2ns, and the clock to Q delay is given as 10ns. a. Calculate the minimum clock period required to handle the circuit by drawing a digital logic circuit for function clock frequency divided by 2. b. Also determine the status of hold time violation and give a proper reason.
5	Explain twin tub fabrication process and obtain the layout of NAND Gate.
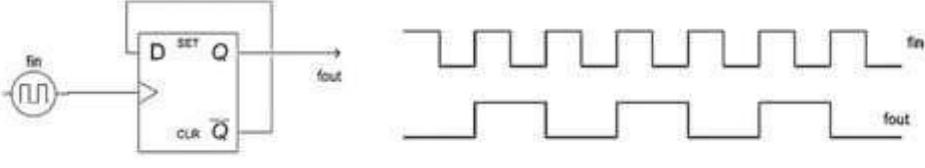
24ECP603	INSTRUMENTATION AND INDUSTRIAL AUTOMATION	L	T	P	J	S	C	Year of Introduction
		2	1	2	0	0	4	2024

Preamble: The course is intended to introduce the basic concepts of electronic measuring instruments for measuring physical variables using transducers. Various signal transmission methods used in instrumentation, the architecture and programming aspects of PLC and the application of SCADA and DCS in process industries are also included in the syllabus.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO 1	Interpret the basic concepts of measuring instruments, their classification, and selection criteria, static and dynamic characteristics. (Understand Level)
CO 2	Discuss the principle, construction, working and applications of transducers for measuring physical variables. (Understand Level)
CO 3	Describe various signal transmission methods and telemetry. (Understand Level)
CO 4	Apply PLC programming techniques to solve real life problems. (Apply Level)
CO 5	Implement SCADA based system for industrial processes control. (Apply Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	✓	✓		✓	✓			✓	✓	✓		✓
CO 2	✓	✓		✓	✓			✓	✓	✓		✓
CO 3	✓	✓										
CO 4	✓	✓										
CO 5	✓	✓										

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply		✓	✓	✓
Analyse				
Evaluate				
Create				

Assessment Pattern for Lab component		
Bloom's Category	**Continuous Assessment Tools**	
	Class work	**Test1**
Remember		
Understand	✓	✓
Apply	✓	✓
Analyse		
Evaluate		
Create		

Mark Distribution of CIA							
Course Structure [L-T-P-J]	**Attendance**	**Theory [L- T]**			**Practical [P]**		**Total Marks**
		Assignment	**Test-1**	**Test-2**	**Class work**	**Lab Exam**	
2-1-2-0	5	10	12.5	12.5	10	10	**60**

Total Marks distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	60	40	2.5 Hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 2		2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks Marks: (5x 8 = 40 marks) Time: 2.5 hours	40
	Total Marks: 0	Total Marks: [5x8 = 40 marks]	

SYLLABUS (36 Hours)

MODULE I: Introduction to Instrumentation (6 Hours)

Introduction to Measurement and Instrumentation. Static and Dynamic characteristics of instruments. Generalized configurations and Functional elements of Instrumentation systems. Need for Measurement Systems, Classification of Measuring instruments.
Errors in Measurement: Gross errors, systematic errors, random errors.

MODULE II: Sensors and Transducers (10 Hours)
Sensors and Transducers: - Definition and classification. Principle of operation and applications of Temperature Sensors: Resistance Temperature Detectors (RTDs), Thermocouples, Thermistors, semiconductor diode. Pressure Sensors: Piezoelectric, Strain Gauge, Capacitive, Load Cell. Level Sensors: Capacitive, Ultrasonic, Radar. Proximity and Displacement Sensors: Inductive, Capacitive, Optical, Linear Variable Differential Transformer (LVDT). Light Sensors: Photodiodes, Phototransistors, Light Dependent Resistor (LDR).

MODULE III: Signal Transmission and Telemetry (8 Hours)
Methods of signal transmission: Analog Signal Transmission: Current loop (4-20mA), Voltage transmission. Digital Signal Transmission: Modbus, HART, Foundation Fieldbus. Wireless Communication in Industry: Zigbee, Wi-Fi, Long Range Radio (LoRa), Wide Area Network (WAN). Optical Communication: Fiber optic sensors and transmission. Telemetry: Principles and applications in industries. IEEE – 488 interface, General Purpose Interface Bus (GPIB). Electromagnetic Interference (EMI): Types, measurement and reduction techniques, grounding and shielding.

MODULE IV: Programmable Logic Controllers (7 Hours)
Programmable Logic Controllers (PLC):   An overall view of PLCs. Architecture of PLC, Basic PLC Programming: Programming ON/OFF Inputs, Creating Ladder diagrams, Register Basics, PLC Applications using master control relay function; jump with non-return and return; data table, register and other move functions, PLC functions with Timers and Counters, PLC Arithmetic functions, Number comparison functions, Data handling Functions, Skip function and applications.

MODULE V: SCADA & DCS (5 Hours)
Introduction to SCADA: SCADA overview, SCADA Architecture – Monolithic, Distributed and Networked. SCADA Protocols- IEC 60870-5-101, DNP-3, Profibus, Modbus. SCADA Systems- Components, Architecture, and Applications. Distributed Control System- Features, hardware components of DCS; DCS software and applications. Industrial Internet of Things (IIoT): Principles, Architecture, Protocols and Applications. Cyber security in Industrial Automation: Challenges, Solutions, and Best Practices.

Text books
1. Ernest Doebelin, Dhanesh N. Manik, "Doebelin's Measurement Systems", McGraw Hill, 7th Edition, 2019.
2. John R Hackworth, Frederick D Hackworth, Jr, "Programmable Logic controllers Programming Methods and Applications", Pearson Education.
3. Michael P. Lucas, "Distributed Control System Lucas", Van Nastrant Reinhold Company.

Reference books

1. Sawhney AK, "Electrical and Electronics Measurements and Instrumentation," Dhanpat Rai and Sons.
2. John W Webb, Ronald A. Reis, "Programmable Logic Controllers- Principles and applications", PHI , ND, 2006.
3. Kalsi HS, "Electronic Instrumentation," Tata McGraw Hill, Third Edition.
4. https://www.coursera.org/courses?query=automation Online platform: coursera for supplementary learning.

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
MODULE I		
1.1	Introduction to Measurement and Instrumentation.	1
1.2	Static characteristics of instruments	1
1.3	Dynamic characteristics of instruments	1
1.4	Generalized configurations and Functional elements of Instrumentation systems.	1
1.5	Need for Measurement Systems, Classification of Measuring instruments	1
1.6	Errors in Measurement: Gross errors, systematic errors, random errors.	1
MODULE II		
2.1	Sensors and Transducers: - Definition and classification	1
2.2	Principle of operation and applications of Temperature Sensors: RTDs, Thermocouples.	1
2.3	Principle of operation and applications of Thermistors, semiconductor diodes.	1
2.4	Pressure Sensors: Piezoelectric, Strain Gauge	1
2.5	Capacitive Pressure Sensors and Load Cell	1
2.6	Level Sensors: Capacitive, Ultrasonic	1
2.7	Radar	1
2.8	Proximity and Displacement Sensors: Inductive, Capacitive	1
2.9	Proximity and Displacement Sensors: Optical and LVDT.	1
2.10	Light Sensors: Photodiodes, Phototransistors, LDR.	1

	MODULE III	
3.1	Analog Signal Transmission: Current loop (4-20mA), Voltage transmission.	1
3.2	Digital Signal Transmission: Modbus, HART	1
3.3	Foundation Fieldbus.	
3.4	Wireless Communication in Industry: Zigbee, Wi-Fi, LoRa, WAN.	
		1
3.5	Optical Communication: Fiber optic sensors and transmission.	
3.6	Telemetry: Principles and applications in industries.	1
3.7	IEEE – 488 interface, General Purpose Interface Bus (GPIB)	1
3.8	EMI: Types, measurement and reduction techniques, grounding	1
	MODULE IV	
4.1	Programmable Logic Controllers (PLC): An overall view of PLCs.	1
4.2	Architecture of PLC.	1
4.3	Basic PLC Programming: Programming ON/OFF Inputs,	1
4.4	PLC applications using master control relay function; jump with non-return and return	1
4.5	Data table, register and other move functions.	1
4.6	PLC functions with Timers and Counters,	1
4.7	PLC Arithmetic functions, Number comparison functions, Data handling Functions, Skip function and applications	1
	MODULE V	
5.1	Introduction to SCADA: SCADA overview, SCADA Architecture – Monolithic, Distributed and Networked.	1
5.2	SCADA Protocols- IEC 60870-5-101, DNP-3, Profibus, Modbus. SCADA Systems- Components, Architecture, and Applications.	1
5.3	Distributed Control System- Features, hardware components of DCS; DCS software and applications.	1
5.4	Industrial Internet of Things (IIoT): Principles, Architecture, and Applications.	1
5.5	Cyber security in Industrial Automation: Challenges, Solutions, and Best Practices.	1

LESSON PLAN FOR LAB COMPONENT

No.	Topic	No. of Hours	Experiment
	Measurement of temperature using Thermocouple	1	Measure the voltage and temperature and plot the calibration curve.

1	Measurement of temperature using RTD.	1	Measure the voltage and temperature and plot the calibration curve.	
	Measurement of temperature using Thermistor	1	Measure the voltage and temperature and plot the calibration curve.	
	Measurement of temperature using semiconductor diode.	1	Measure the voltage and Temperature and plot the calibration curve.	
2	LVDT	2	To measure the output voltage with respect to displacement of the core on the LVDT kit and plot the curve.	
3	Strain gauge	2	To measure pressure using strain gauge and obtain the gauge factor.	
4	Capacitive transducer	2	To study capacitive transducer for water level measurement	
5	Load Cell	2	To study the use of load cell for measurement and plot the load vs voltage curve.	
6	Implementation of logic gates using PLC.	2	PLC Simulation/Trainer Kit	
	Implementation of Water level control using PLC.	2	PLC Simulation/Trainer Kit	
	Implementation of Traffic light control using PLC	2	PLC Simulation/Trainer Kit	
7	Temperature control using PLC and SCADA.	2	PLC Simulation/Trainer Kit	
	Temperature control using SCADA.	2	SCADA Simulation	
8	Motor control.	2	Controlling of a motor using S7-200 Siemens with PLC and SCADA software.	

CO Assessment Questions	
1	Briefly discuss the Static and Dynamic characteristics of instruments.
2	Explain the factors influencing the choice of a transducer for an industrial instrumentation system.
3	Explain the different methods of signal transmission:
4	Design the PLC ladder diagrams to realize two input AND, OR and XOR gates. Give the significance of timers and counters in PLC.
5	Design an alarm annunciator using SCADA?

PROFESSIONAL ELECTIVE-I

24ECE614	MIXED SIGNAL VLSI DESIGN	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: The course focuses on instructing the methods required to implement Mixed Signal Systems as Integrated Circuits. It delivers comprehensive insights into the diverse blocks essential for such systems, along with their conflicting technological demands. The course imparts insights into the design aspects of critical system blocks, including Filters, ADCs, DACs, Switched Capacitor Circuits, PLL, DLL and Mixed-Signal Circuit Layout techniques.

Prerequisite: 24ECP403 Analog Circuits, 24ECT507 Linear Integrated Circuits

Course Outcomes: After the completion of the course the student will be able to

CO1	Comprehend the principles of designing filters. (Understand Level)
CO2	Design an amplifier and integrator using Switched Capacitor logic. (Apply Level)
CO3	Describe the fundamental concepts of Comparators and Data Converters. (Understand Level)
CO4	Illustrate the application of PLL. (Apply Level)
CO5	Summarize various aspects of Mixed Signal Layout. (Understand Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓										
CO2	✓	✓										
CO3	✓											
CO4	✓											
CO5	✓											

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA						
Course Structure [L-T-P-J]	**Attendance**	**Theory [L- T]**				**Total Marks**
		Assignment	**Test-1**	**Test-2**		
3-0-0-0	5	15	10	10		40

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 Hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I: Discrete Time Signals and Sampling Theory (5 Hours)

Types of Signals, Sampling Theory and Aliasing, Spectrum of Discrete time signals, Analog Continuous time and discrete time Filter Basics- Active and Passive, IIR, FIR.

MODULE II: Switched Capacitor Circuits (7 Hours)

Sampling Switches, Charge Injection, Clock Feed through, Speed consideration, Non-Overlapping clock generation, Switched Capacitor Amplifier: Basic sample and hold, Basic Gain Amplifier, Switched Capacitor Integrator.

MODULE III: Comparators and Data Converters (8 Hours)

Comparators Specifications- input offset, noise & hysteresis, Opamp as a comparator, introduction to Dynamic Comparators

Introduction to Data Converters: Data Converter Basics, Nyquist ADC: Flash ADC, SAR, Pipeline ADC, Oversampling and Noise shaping and ADC: First and second order Delta Sigma ADC, Types of DAC: R2R, Current DACs

MODULE IV: Phased Lock Loop and Delay Locked Loops (6 Hours)
Phased lock loop and Delay locked loops (PLL & DLL): Basic PLL topology, Non-idealities and jitter, Comparison of analog and digital PLL, Delay Locked loop topology, Applications: Frequency Synthesis, Frequency Multiplication, Multi phase Clock generation.

MODULE V: Mixed Signal Layout (6 Hours)
Mixed Signal Layout: Design Rules: Minimum width, Minimum spacing, Minimum enclosure, Antenna Effect, Matching and Symmetry, Dummies, Well proximity effects, Coupling, interconnects, Floor Planning, DRC, LVS.

Text books
1. CMOS: Mixed-Signal Circuit Design, Jacob Baker Wiley, 2008
2. CMOS: Circuit Design, Layout, and Simulation, Jacob Baker, 4th Edition, Wiley Publication

Reference books
1. Analog Integrated Circuit Design 2nd Edition by, Tony Chan Carusone John Wiley & Sons, Inc.
2. B. Razavi, Design of Analog CMOS Integrated Circuits, McGraw-Hill, 2001
3. P. R. Gray and R. G. Meyer, Analysis and Design of Analog Integrated Circuits, 4th Edition, 2001, Wiley.
4. D. A. Johns and K. Martin, Analog Integrated Circuit Design, Wiley, 1997
5. Nptel course on VLSI Data Conversion Circuits by Dr. Shanthi Pavan https://nptel.ac.in/courses/117106034
6. NPTEL Course on Phase Locked Loops by Prof. Saurabh Saxena https://archive.nptel.ac.in/courses/108/106/108106184/

COURSE CONTENTS AND LECTURE SCHEDULE	
No.		No. of Hours

No.		No. of Hours
MODULE I		
1.1	Types of Signals, Sampling Theory and Aliasing	1
1.2	Spectrum of Discrete time signals,	1
1.3	Analog Continuous time and discrete time Filter Basics: Active and Passive	1
1.4	IIR, FIR Filter Basics	1
1.5	Design of Filter for Given Specification	1
MODULE II		
2.1	Sampling Switches,	1
2.2	Charge Injection, Clock Feed through, Speed consideration	1
2.3	Non-Overlapping clock generation	1
2.4	Introduction to Switched capacitors	1
2.5	Switched Capacitor Amplifier: Basic sample and hold	1
2.6	Basic Gain Amplifier	1
2.7	Switched Capacitor Integrator	1

MODULE III		
3.1	Comparators Specifications- input offset, noise & hysteresis	1
3.2	Opamp as a comparator, introduction to Dynamic Comparators	1
3.3	Introduction to Data Converters: Data Converter Basics Nyquist ADC: Flash ADC	1
3.4	SAR ADC	1
3.5	Pipeline ADC	1
3.6	Oversampling and Noise shaping and ADC: First order Delta Sigma ADC	1
3.7	Second order Delta Sigma ADC	1
3.8	Types of DAC: R2R, Current DACs	1
MODULE IV		
4.1	Basic PLL topology, non-idealities and jitter	1
4.2	Comparison of analog and digital PLL	1
4.3	Delay Locked loop topology	
4.4	Application: Frequency Synthesis	1
4.5	Application: Frequency Multiplication, Multi phase Clock generation	1
4.6	Application: Multi phase Clock generation	1
MODULE V		
5.1	De Minimum width, Minimum spacing, Minimum enclosure	1
5.2	Minimum enclosure, Antenna Effect	1
5.3	Matching and Symmetry, Dummies	1
5.4	Well proximity effects, Coupling	1
5.5	Interconnects, Floor Planning	1
5.6	DRC, LVS	1

CO Assessment Questions	
1	Design an FIR low pass filter with a cut off frequency of 200 Hz.
2	Design Basic Gain Amplifier using Switched Capacitor Logic.
3	Explain the working of first and Second order Delta Sigma ADC.
4	Illustrate the use of PLL for frequency synthesis.
5	Describe design rules for Mixed Signal Layouts.

		L	T	P	J	S	C	Year of Introduction
24ECE624	**INFORMATION THEORY AND CODING**	3	0	0	0	3	3	**2024**

Preamble: Information Theory and Coding deals with the fundamental principles that govern the representation, compression, and secure transmission of data. In this course, an overview about Entropy, Channel capacity, Source codes and channel codes are discussed in a detailed manner to get a better insight for the representation and transmission of data. Digital communication has a wide range of applications in the areas of Wireless Technologies, Cyber security, Scientific Research etc.

Prerequisite: 24ECP504 Digital Communication

Course Outcomes: After the completion of the course the student will be able to

CO1	Analyze the fundamental parameters of Information theory namely Information, Entropy and Mutual information. (Apply level)
CO2	Apply Shannon's Source Coding Theorem and develop optimum source code for data representation (Apply level)
CO3	Apply the concept of Capacity of a communication channel and determine the capacity of a band limited communication channel (Apply level)
CO4	Construct efficient codes for data transmission through imperfect communication channel (Apply level)
CO5	Illustrate the convolutional coding and decoding technique (Apply level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓										
CO2	✓	✓										
CO3	✓	✓										
CO4	✓	✓										
CO5	✓	✓										

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	**Test2**	**Other tools**	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
[3-0-0-0]	5	15	10	10	**40**

Total Mark distribution			
Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 Hours

SYLLABUS (36 Marks)

MODULE I: Entropy of Sources and Source Coding (8 Hours)

Entropy, Properties of Entropy, Joint and Conditional Entropy, Mutual Information, Properties of Mutual Information. Discrete memory less sources, Uniquely decodable and prefix-free source codes. Kraft Inequality (with proof), Shannon-Fano code, Huffman code. Shannon's source coding theorem (both achievability and converse)

MODULE II: Capacity of different Channels (8 Hours)

Discrete memory less channels, Binary symmetric channels (BSC), Binary Erasure channels (BEC). Capacity of discrete memory less channels. Capacity of BSC and BEC. Shannon's channel coding theorem, Differential Entropy of Gaussian random variable, Shannon-Hartley theorem (with proof). Inferences from Shannon Hartley theorem – spectral efficiency versus SNR per bit, power-limited and bandwidth-limited regions, Shannon limit.

MODULE III: Channel Codes- Linear block Codes (7 Hours)

Introduction to Group, rings, fields, and Galois fields. Codes for error detection and correction – parity check coding – linear block codes – error detecting and correcting capabilities – generator and parity check matrices – Standard array and syndrome decoding.

MODULE IV: Channel Codes- Cyclic Codes (6 Hours)

Cyclic codes. Polynomial and matrix description. Interrelation between polynomial and matrix view points. Systematic encoding. Decoding of cyclic codes. Hamming Codes, BCH codes, Reed-Solomon Codes (Only description, no decoding algorithms).

MODULE V: Channel Codes- Convolutional Codes (7 Hours)

Convolutional Codes – encoding – time and frequency domain approaches, State Tree & Trellis diagrams – transfer function and minimum free distance – Maximum likelihood decoding of convolutional codes – The Viterbi Algorithm.

Text books
1. Concepts of Information Theory and Coding, P S Satyanarayana, MedTech,2016
2. Digital Communication Systems", Simon Haykin, Wiley.
3. Introduction to Coding Theory", Ron M Roth, Cambrdige University Press

Reference books
1. Joy A Thomas, Thomas M Cover, 'Elements of Information Theory', Wiley-Interscience.
2. Shu Lin & Daniel J. Costello. Jr., Error Control Coding: Fundamentals and Applications, 2nd Edition.
3. NPTEL Course on Information Theory and Coding: https://nptel.ac.in/courses/117101053

No.	COURSE CONTENTS AND LECTURE SCHEDULE	No. of Hours
	MODULE I	
1.1	Entropy, Properties of Entropy	1
1.2	Joint and Conditional Entropy	1
1.3	Mutual Information, Properties of Mutual Information	1
1.4	Discrete memory less sources	1
1.5	Uniquely decodable and prefix-free source codes.	1
1.6	Kraft Inequality (with proof)	1
1.7	Shannon-Fano code, Huffman code	1
1.8	Shannon's source coding theorem (both achievability and converse)	1
	MODULE II	
2.1	Discrete memory less channels, Binary symmetric channels (BSC) and Binary Erasure channels (BEC)	1
2.2	Capacity of discrete memoryless channels, Capacity of BSC and BEC	1
2.3	Shannon's channel coding theorem	1
2.4	Differential entropy	1
2.5	Differential Entropy of Gaussian random variable, Shannon Hartley theorem (with proof)	1
2.6	Inferences from Shannon Hartley theorem – spectral efficiency versus SNR per bit	1
2.7	Power-limited and bandwidth-limited regions	1
2.8	Shannon's limit	
	MODULE III	
3.1	Introduction to rings, fields, and Galois fields.	1
3.2	Codes for error detection and correction	1
3.3	Parity check coding – linear block codes	1
3.4	Error detecting and correcting capabilities	1
3.5	Generator and parity check matrices	1
3.6	Syndrome decoding	1
3.7	Standard array decoding	

MODULE IV		
4.1	Cyclic codes, polynomial and matrix description	1
4.2	Interrelation between polynomial and matrix view point	1
4.3	Systematic encoding	1
4.4	Decoding of cyclic codes	1
4.5	Encoding circuits for cyclic codes	1
4.6	Hamming Codes, BCH codes, Reed-Solomon Codes (Only description, no decoding algorithms)	1
MODULE V		
5.1	Convolutional Codes – encoding	1
5.2	Time and frequency domain approaches	1
5.3	Matrix Method	1
5.4	Graphical representation of convolution codes	1
5.5	State Tree & Trellis diagrams	1
5.6	Transfer function and minimum free distance	1
5.7	Maximum likelihood decoding of convolutional codes – The Viterbi algorithm	1

CO Assessment Questions	
1	1. Prove that H(X,Y) = H(X) + H(Y/X) 2. Consider two sources which emits messages x1,x2,x3 and y1,y2,y3 respectively with joint probability matrix given by $P(X,Y) = \begin{bmatrix} \frac{3}{40} & \frac{1}{40} & \frac{1}{40} & \frac{1}{20} & \frac{3}{20} & \frac{1}{20} & \frac{1}{8} & \frac{1}{8} & \frac{3}{8} \end{bmatrix}$. Calculate H(X), H(Y), H(X/Y) and H(Y/X).
2	1. A DMS have 9 source symbols with probabilities {0.49, 0.14, 0.14, 0.07, 0.07, 0.04, 0.02, 0.02, 0.01}. Construct the Shannon-Fano code and find the coding efficiency. 2. A DMS have 8 source symbols with probabilities {0.25, 0.2, 0.15, 0.15, 0.1, 0.05, 0.05, 0.05}. Construct the Huffman code and find the coding efficiency
3	1. Derive the capacity for BEC 2. Derive the capacity for BSC 3. Find the overall channel matrix if two binary symmetric channels with probability of error p and q respectively are connected in cascade. 4. State and prove Information Capacity Theorem 5. The terminal used to enter alphanumeric data into the computer is connected through a voice grade telephone line having a usable bandwidth of 3kHz and output SNR of 10dB. Assume that the terminal has 128 characters and data is sent in an independent manner with equal probabilities. (a) Find average information per character (b) Find capacity of the channel (c) Find the maximum rate at which data can be sent from the terminal to computer without error
4	1. A systematic (6,3) block code has the Generator matrix given below. (a) Construct the standard array (b) Determine correctable error pattern

	and their syndrome (c) Give the correct codeword if the received vector is 101110, 101101, 000110 G = $[1 0 0 1 1 0 0 1 0 0 1 1 0 0 1 1 0 1 1]$ 2. The generator polynomial for (7,4) cyclic code is $X^3 + X + 1$. Find the code word for the following message sequence (a) 1010 (b) 1111 (c) 0001 (d) 1000

5	1. A convolutional code is described by $g^1 = [100]$, $g^2 = [101]$, $g^3 = [111]$.
	
	   (a) Draw the encoder for the corresponding to this code
	
	   (b) Draw state diagram
	
	   (c) Decode the transmitted sequence 101001011110111 using viterbi algorithm
	
	2. A convolutional code is described by $g^1 = [110]$, $g^2 = [101]$, $g^3 = [111]$.
	
	   (a) Draw the encoder for the corresponding to this code
	
	   (b) State diagram
	
	   (c) Find the output sequence for m=1011 using code tree

24ECE634	DIGITAL IMAGE PROCESSING AND COMPUTER VISION	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: In Digital Image Processing and Computer Vision students embark on a comprehensive journey through the transformative techniques used to manipulate and analyze digital images for high-level understanding. The syllabus encompasses core concepts of image processing and dives into advanced computer vision topics, integrating machine learning methodologies for visual data interpretation. Upon completion, students will be proficient in applying these technologies across various domains, synthesizing innovative solutions that respect ethical standards.

Prerequisite: 24ECJ502 Digital Signal Processing

Course Outcomes: After the completion of the course the student will be able to

CO1	Understand Image Fundamentals and Transforms. (Understand Level)
CO2	Apply Advanced Image Processing Techniques. (Apply Level)
CO3	Comprehend Computer Vision Concepts and Models. (Understand Level)
CO4	Implement Deep Learning Models for Vision Tasks. (Apply Level)
CO5	Design and Analyze Vision-based Applications. (Apply Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓											
CO2	✓				✓							
CO3	✓											
CO4	✓				✓							✓
CO5	✓				✓							✓

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test2	Other tools	
Remember	✓	✓		✓
Understand	✓	✓		✓
Apply	✓	✓		✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA

Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
3-0-0-0	5	15	10	10	**40**

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 Hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: [2x10 = 20 Marks]	Total Marks: [5x8 = 40 Marks]	

SYLLABUS

MODULE I: Introduction to Digital Image Processing (6 Hours)

Basics of Digital Images: Pixel representation, colour spaces, image types. Digital Image Fundamentals: Sampling, quantization, resolution, contrast, and brightness. Image Transforms: Fourier Transform, Discrete Cosine Transform, and Wavelet Transform. Histogram Processing: Histogram equalization and specification. Basics of Spatial Filtering: Linear vs. non-linear filters, smoothing and sharpening filters.

MODULE II: Advanced Image Processing Techniques (9 Hours)

Noise Reduction and Restoration: Mean filters, median filters, Gaussian filters, Wiener filter. Edge Detection: Operators (Sobel, Prewitt, Roberts), Canny Edge detection. Segmentation: Thresholding, region-based, edge-based, and segmentation using morphological watersheds. Compression: Lossless and lossy compression, JPEG, MPEG. Colour Image Processing: Colour models, colour image enhancement.

MODULE III: Introduction to Computer Vision (8 Hours)

Fundamentals of Computer Vision: Difference between image processing and computer vision, key challenges. Camera Models and Imaging: Pinhole camera model, intrinsic and extrinsic parameters. Feature Extraction: Corner detection, blob detection, SIFT, SURF. Object Detection and Recognition: Template matching, Haar cascades, Histogram of Oriented Gradients (HOG).

MODULE IV: Deep Learning in Computer Vision (8 Hours)

Introduction to Neural Networks: Perceptron, multi-layer networks, training neural networks, backpropagation. Convolutional Neural Networks (CNNs): Architecture, convolutional layer, pooling layer, fully connected layer. Application of CNNs: Image classification, object detection (R-CNN, SSD, YOLO). Semantic Segmentation: U-Net, Mask R-CNN. Transfer Learning and Data Augmentation.

MODULE V: Advanced Topics and Applications (7 Hours)

3D Vision: Stereopsis, depth mapping, 3D reconstruction, Motion Analysis: Optical flow, background subtraction. Video Processing: Video tracking, event detection. Augmented Reality: Principles, tracking, and creating AR applications. Trends and Challenges: Current challenges in computer vision, emerging technologies.

Text books
1. Gonzalez, R. C., & Woods, R. E. (2007). Digital Image Processing (3rd ed.). Pearson Education.
2. Szeliski, R. (2010). Computer Vision: Algorithms and Applications. Springer.

Reference books
1. Sonka, M., Hlavac, V., & Boyle, R. (2014). *Image Processing, Analysis, and Machine Vision.*
2. Hartley, R., & Zisserman, A. (2003). Multiple View Geometry in Computer Vision.
3. Szeliski, R. (2010). Computer Vision: Algorithms and Applications. Springer.
4. Goodfellow, I., Bengio, Y., Courville, A., & Bengio, Y. (2016). Deep Learning. MIT press Cambridge.
5. Bradski, G., & Kaehler, A. (2008). Learning OpenCV: Computer Vision with the OpenCV Library. O'Reilly Media, Inc.
6. https://onlinecourses.nptel.ac.in/noc19_ee55/preview
7. https://onlinecourses.nptel.ac.in/noc23_ee39/preview

Note: Practical sessions/labs should be integrated throughout the course, offering students hands-on experience with image processing tools and libraries (e.g., OpenCV, MATLAB) and deep learning frameworks (e.g., TensorFlow, PyTorch). Assignments can involve small projects or problem sets that encourage students to implement and experiment with algorithms discussed in class.

COURSE CONTENTS AND LECTURE SCHEDULE		
No.		No. of Hours
MODULE I		
1.1	Basics of Digital Images: Pixel representation, colour spaces, image types.	1
1.2	Digital Image Fundamentals: Sampling, quantization, resolution, contrast, and brightness.	1
1.3	Image Transforms: Fourier Transform, Discrete Cosine Transform, and Wavelet Transform	2
1.4	Histogram Processing: Histogram equalization and specification.	1

1.5	Basics of Spatial Filtering: Linear vs. non-linear filters, smoothing and sharpening filters.	1
MODULE II		
2.1	Noise Reduction and Restoration: Mean filters, median filters, Gaussian filters, Wiener filter.	1
2.2	Noise Reduction and Restoration: Mean filters, median filters, Gaussian filters, Wiener filter.	1
2..3	Edge Detection: Operators (Sobel, Prewitt, Roberts), Canny Edge detection.	1
2.4	Edge Detection: Operators (Sobel, Prewitt, Roberts), Canny Edge detection.	1
2.5	Segmentation: Thresholding, region-based, edge-based, and segmentation using morphological watersheds.	1
2.6	Segmentation: Thresholding, region-based, edge-based, and segmentation using morphological watersheds.	1
2.7	Compression: Lossless and lossy compression, JPEG, MPEG.	2
2.8	Colour Image Processing: Colour models, colour image enhancement.	1
MODULE III		
3.1	Fundamentals of Computer Vision: Difference between image processing and computer vision, key challenges.	1
3.2	Camera Models and Imaging: Pinhole camera model	1
3.3	Intrinsic and extrinsic parameters.	1
3.4	Feature Extraction: Corner detection	1
3.5	Blob detection, SIFT, SURF	1
3.6	Blob detection, SIFT, SURF	1
3.7	Object Detection and Recognition: Template matching, Haar cascades, Histogram of Oriented Gradients (HOG).	1
3.8	Object Detection and Recognition: Template matching, Haar cascades, Histogram of Oriented Gradients (HOG).	1
MODULE IV		
4.1	Introduction to Neural Networks: Perceptron, multi-layer networks, training neural networks	1
4.2	Backpropagation.	1
4.3	Convolutional Neural Networks (CNNs): Architecture, convolutional layer, pooling layer, fully connected layer.	1
4.4	Application of CNNs: Image Classification	1
4.5	Object detection (R-CNN, SSD, YOLO)	1
4.6	Semantic Segmentation: U-Net	1
4.7	Mask R-CNN.	1
4.8	Transfer Learning and Data Augmentation.	1
MODULE V		
5.1	3D Vision: Stereopsis, depth mapping	1
5.2	3D reconstruction.	1

5.3	Motion Analysis: Optical flow, background subtraction.	1
5.4	Video Processing: Video tracking, event detection.	1
5.5	Video Processing: Video tracking, event detection.	1
5.6	Augmented Reality: Principles, tracking, and creating AR applications.	1
5.7	Trends and Challenges: Current challenges in computer vision, emerging technologies.	1
5.8	Trends and Challenges: Current challenges in computer vision, emerging technologies.	1

CO Assessment Questions	
1	Given a digital image: 1. Describe the image in terms of its pixel representation and colour space. 2. Discuss the implications of varying levels of sampling and quantization on this image. 3. Perform a Fourier Transform on a provided section of the image. Describe the significance of the resulting spectrum in terms of frequency components present in the original image segment. 4. Convert the image from its original colour space (e.g., RGB) to another (e.g., YCbCr or HSV). Discuss the advantages and disadvantages of using the new colour space for image analysis.
2	You are provided with a digital image that has been degraded by Gaussian noise and motion blur. 1. Apply a suitable noise reduction technique to minimize the Gaussian noise present in the image. Justify your choice of the technique. 2. Utilize an appropriate image restoration method to counteract the effects of motion blur. Describe the process you followed. 3. Implement edge detection on the restored image using any two methods. Compare and contrast the results obtained from both methods. 4. Using the processed image, demonstrate image segmentation to isolate specific features or objects. Explain your chosen segmentation method and the rationale behind it.
3	You are provided with a sequence of images taken by a moving camera of a static scene. 1. Differentiate between image processing and computer vision, citing specific differences and interrelations. 2. Describe the pinhole camera model. How does it relate to the formation of digital images in real-world cameras? 3. Using the provided image sequence, estimate the camera's motion between consecutive frames. Discuss the methods or algorithms you would employ. 4. Identify and describe at least two feature extraction methods suitable for detecting and recognizing objects within the image sequence. 5. Given a scenario where multiple objects are moving at different depths in the scene, explain the challenges that might arise in object tracking and potential solutions.

4	You are provided with a dataset containing images of different types of animals.
	1. Choose a suitable machine learning algorithm for classifying the images into their respective animal categories. Describe the features you would extract from the images to use as input to your classifier.
	2. Discuss the importance of training, validation, and test splits in the context of this classification task. How would you partition the dataset, and why?
	3. Implement a convolutional neural network (CNN) for the same classification task. Describe the architecture of the CNN and discuss the rationale behind your choices of layers and their parameters.
	4. Compare the performance of the machine learning algorithm and the CNN on the test split. Which method performed better, and why do you think that is the case?
	5. Describe a potential real-world application where deep learning-based image classification can make a significant impact, and discuss any ethical considerations associated with it.
5	Imagine you've been tasked to develop a computer vision system for an autonomous vehicle that can identify pedestrians and other vehicles in its path.
	1. Describe a general framework for such a system, outlining the key components and their roles within the system.
	2. Choose an image segmentation technique suitable for this application. Justify your choice and explain how it will help in identifying pedestrians and vehicles.
	3. Discuss how you would tackle the challenge of varying lighting conditions (e.g., day, night, shadows) in the images captured by the vehicle's camera.
	4. Implement a method to estimate the distance of detected pedestrians and vehicles from the autonomous vehicle using the captured images. Describe the algorithms or techniques you would employ.
	5. Highlight potential safety concerns and ethical considerations when deploying such a computer vision system in a real-world environment. How would you address these concerns?

24ECE644	MEMS	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: The course delves into the intricate world of MEMS technology, encompassing both theoretical foundations and practical applications. It emphasizes the fabrications and packaging techniques relevant to the MEMS industry and exposes the challenges the industry faces so that learners may explore various MEMS based research opportunities in their future endeavors.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO1	Describe the working principles of micro sensors and actuators (Understand Level)
CO2	Identify commonly used mechanical structures in MEMS (Understand Level)
CO3	Apply scaling laws in the design of micro systems (Apply)
CO4	Explain the principles of standard micro fabrication techniques. (Understand Level)
CO5	Describe the challenges in the design and fabrication of Micro systems. (Understand Level)

<table>
<tr><td colspan="13" align="center">CO - PO MAPPING</td></tr>
<tr><td>CO</td><td>PO1</td><td>PO2</td><td>PO3</td><td>PO4</td><td>PO5</td><td>PO6</td><td>PO7</td><td>PO8</td><td>PO9</td><td>PO10</td><td>PO11</td><td>PO12</td></tr>
<tr><td>CO1</td><td>✓</td><td>✓</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO2</td><td>✓</td><td>✓</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO3</td><td>✓</td><td>✓</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO4</td><td>✓</td><td>✓</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO5</td><td>✓</td><td>✓</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	**Test2**	**Other tools**	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure **[L-T-P-J]**	**Attendance**	**Theory [L- T]**			**Total Marks**
		Assignment	**Test-1**	**Test-2**	
3-0-0-0	5	15	10	10	**40**

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 Hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I: MEMS and Microsystems: Introduction (8 Hours)

MEMS and Microsystems: Introduction – 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

MODULE II: Mechanical Structures in MEMS (7 Hours)

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

MODULE III: Scaling laws in miniaturization (9 Hours)

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.

MODULE IV: Micro System fabrication (7 Hours)

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

MODULE V: Micro system Packaging (5 Hours)

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

Text books
1. Chang Liu, Foundations of MEMS, Pearson 2012
2. Tai-Ran Hsu, MEMS and Microsystems Design and Manufacture, TMH, 2002

Reference books
1. Chang C Y and Sze S. M., VLSI Technology, McGraw-Hill, New York, 2000
2. Julian W Gardner, Microsensors: Principles and Applications, John Wiley & Sons, 1994
3. Mark Madou, Fundamentals of Micro fabrication, CRC Press, New York, 1997
4. Stephen D. Senturia, Microsystem design, Springer (India), 2006.
5. Thomas B. Jones, Electromechanics and MEMS, Cambridge University Press, 2001
6. Gregory T.A. Kovacs, Micromachined Transducers Sourcebook, McGraw Hill, 1998NPTEL
7. Course on A brief introduction of Micro-Sensors
   https://onlinecourses.nptel.ac.in/noc20_ee52/preview
8. Course on Micro and Smart Systems
   https://nptel.ac.in/courses/112108092

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
	MODULE I	
1.1	Introduction to MEMS and Microsystems	1
1.2	Applications – multidisciplinary nature of MEMS – principles and examples of Micro sensors and micro actuators –	1
1.3	micro accelerometer, comb drives -	1
1.4	Micro grippers – micro motors,	1
1.5	micro valves, micro pumps, Shape Memory Alloys.	1
1.6	Actuation and Sensing techniques : Thermal sensors and actuators,	1
1.7	Electrostatic sensors and actuators	1
1.8	Piezoelectric sensors and actuators, magnetic actuators	1
	MODULE II	
2.1	Review of Mechanical concepts: Stress, Strain, Modulus of Elasticity,	1
2.2	Review of Mechanical concepts: yield strength, ultimate strength	1
2.3	General stress strain relations – compliance matrix.	1
2.4	Overview of commonly used mechanical structures in MEMS - Beams, Cantilevers, Plates, Diaphragms – Typical applications	1
2.5	Overview of commonly used mechanical structures in MEMS: Plates, Diaphragms – Typical applications	1
2.6	Flexural beams: Types of Beams, longitudinal strain under pure bending	1
2.7	Deflection of beams – Spring constant of cantilever, Intrinsic stresses	1
	MODULE III	
3.1	Scaling laws in miniaturization - scaling in geometry, scaling in rigid body dynamics,	1
3.2	Trimmer force scaling vector,	1
3.3	scaling in electrostatic and electromagnetic forces	1
3.4	scaling in electricity and fluidic dynamics,	1
3.5	scaling in heat conducting and heat convection	1
3.6	Materials for MEMS – Silicon – Silicon compounds- Silicon Nitride	1
3.7	Silicon Dioxide, Silicon carbide	1
3.8	Poly Silicon, GaAs, Silicon Piezo resistors	1
3.9	Polymers in MEMS – SU-8, PMMA, PDMS, Langmuir – Blodgett Film	1

MODULE IV		
4.1	Micro System fabrication, Photolithography– Ion implantation	1
4.2	Diffusion, Oxidation	1
4.3	Chemical vapour deposition, Etching	1
4.4	Overview of Micro manufacturing – Bulk micro manufacturing,	1
4.5	Surface micro machining	1
4.6	LIGA process	1
4.7	Microstereo lithography	1
MODULE V		
5.1	Micro system Packaging: general considerations in packaging design – Levels of Micro system packaging	1
5.2	Bonding techniques for MEMS: Surface bonding, Anodic bonding	1
5.3	Silicon - on - Insulator, wire bonding	1
5.4	Sealing – Assembly of micro systems	1
5.5	Overview of MEMS areas: RF MEMS, BioMEMS, MOEMS,	1

CO Assessment Questions	
1	1. Explain the principle of operation of two types of micro-accelerometers 2. Explain with relevant examples how the principle of electrostatics may be used for the design of MEMS based sensors and actuators. 3. Explain how smart materials can be used for the design of MEMS based sensors and actuators.
2	1. Explain the purpose of micro cantilevers in MEMS systems. What is the relevance of spring constant (k) of a mechanical structure in micro system design? 2. Derive the expression for the magnitude of applied bending moment with reference to pure bending of longitudinal beams.
3	1. Explain force scaling vector, what information does it provide to a MEMS designer? 2. Derive equations for acceleration a, time t and power density P/V based on the Trimmer Force Scaling Vector? 3. Explain why electrostatic actuation is preferred over electromagnetic actuation at the micro-scale
4	1. Explain the steps involved in photolithography. State the chemicals used in each of the stages along with the operating conditions. 2. Explain the criteria for choice of surface or bulk micromachining techniques in the design of micro systems. 3. Explain with block diagram the steps in LIGA process. State two advantages of LIGA process over other micro machining techniques.
5	1. Explain the challenges involved in the packaging of Microsystems as compared to microelectronic devices 2. Discuss the various fabrication challenges associated with surface micromachining.

24ECE654	REAL TIME EMBEDDED SYSTEMS	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: The aim of this course is to introduce the concept of embedded system design. It covers the basics of general and real time operating systems. It also describes the architectural and organizational implementation of ARM processors.

Prerequisite: 24ECT307 Computer Architecture, 24ECJ404 Microprocessors and Microcontrollers

Course Outcomes: After the completion of the course the student will be able to

CO1	Summarize the functions and structure of general-purpose operating systems (Understand Level).
CO2	Interpret a real time operating system along with its synchronization, communication and interrupt handling tools (Understand Level).
CO3	Illustrate real time scheduling algorithms (Apply Level).
CO4	Explain the various stages in the embedded system design process (Understand Level).
CO5	Describe the architectural and organizational implementation of ARM processor (Understand Level).

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓											
CO2	✓											
CO3	✓		✓									
CO4	✓											
CO5	✓											

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply		✓		
Analyse				
Evaluate				
Create				

Mark Distribution of CIA

Course Structure [L-T-P-J]	Attendance	Theory [L- T]				Total Marks
		Assignment	Test-1	Test-2		
3-0-0-0	5	15	10	10		**40**

Total Mark Distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 Hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS (36 Hours)

MODULE I : Operating Systems (6 Hours)

Operating system: Objective and functions, Kernel, Process - States, Process Control Block, Operations on processes. Process Scheduling: FCFS, SJF, Priority, Round-Robin, Multilevel Queue and Multilevel Feedback Queue Scheduling. Thread: Structure, User and kernel level threads, Multi-threading models

MODULE II: Task Management in Real Time Operating Systems (8 Hours)

Real Time Task: Task states, Task synchronization and communication mechanisms: semaphores, message queues, pipes, event registers, signals, Exceptions and interrupt handling. Aperiodic and periodic tasks.

MODULE III: Kernel and operations on Real Time Systems (8 Hours)

Real Time Kernel, Kernel selection criteria, Low power modes in RTOS, RTOS debugging and analysis tools, RTOS design problems- Resource classification, Deadlock, Priority inversion

MODULE IV: Concept of Embedded System Design (7 Hours)

Embedded system design process –Design example: Model train controller- Design methodologies- Design flows – Requirement Analysis – Specifications-System analysis and architecture design – Quality assurance techniques -Designing with computing platforms – Consumer electronics architecture –platform-level performance analysis.

MODULE V: ARM Microcontrollers (7 Hours)

Introduction to ARM Architecture, ARM Controller Families, ARM Microcontroller

peripherals – The Timer Unit – Pulse Width Modulation Unit – UART, Block Diagram of ARM9 and ARM Cortex M3 MCU, ARM Development tools – Keil IDE.

Embedded System Design Examples – Audio player, Engine control unit – Video accelerator.

Text books
1. Abraham Silberschatz- „Operating System Principles": Wiley India,9th edition, 2012
2. William Stallings – „Operating systems- Internals and design principles", Prentice Hall, 9th edition, 2018
3. Qing Li – „Real-Time Concepts for Embedded Systems „, CMP Books, 2021
4. Giorgio C. Buttazzo, - „Hard Real-Time Computing Systems Predictable Scheduling Algorithms and Applications", 3rd edition, Springer.
5. Raj kamal, „Embedded Systems Architecture, Programming and Design", TMH, 3rd Edition, 2017
6. 2. K.V. Shibu, Introduction to Embedded Systems, 2e, McGraw Hill Education India, 2016.
7. Colin Walls, „Embedded RTOS Design", Newnes Publications, 2020

Reference books
1. Tanenbaum 'Modern Operating Systems" ,Pearson Edition, 4/e, 2023.
2. Rajib Mall, 'Real-Time Systems: Theory and Practice', 2009.
3. David E. Simon 'An Embedded Software Primer', Pearson 2012.
4. Iyer - Embedded Real time Systems, 1e, McGraw Hill Education New Delhi.
5. Lyla B. Das, Embedded Systems: An Integrated Approach, 1/e, 2012
6. Real-Time Project for Embedded Systems (Coursera) | MOOC List (mooc-list.com) Coursera, University of Colorado Boulder

No.	COURSE CONTENTS AND LECTURE SCHEDULE	No. of Hours
	MODULE I	
1.1	Operating system: Objective and functions	1
1.2	Kernel, Process - States, Process Control Block,	1
1.3	Operations on processes.	1
1.4	Process Scheduling: FCFS, SJF and Priority	1
1.5	Process Scheduling: Round-Robin, Multilevel Queue and Multilevel Feedback Queue Scheduling.	1
1.6	Thread: Structure, User and kernel level threads, multi-threading models	1

	MODULE II	
2.1	Introduction to Real Time Operating Systems: Real time task.	1
2.2	Task: Task states	1
2.3	Task synchronization - Semaphores	1
2.4	Inter-task communication mechanisms: message queues, pipes	1
2.5	Inter-task communication mechanisms: event registers, signals	1
2.6	Exceptions and interrupt handling.	1
2.7	Task states, Aperiodic and periodic tasks,	1
2.8	Task Scheduling and prioritization	1
	MODULE III	
3.1	Real Time Kernel, Kernel selection criteria	1
3.2	Low power modes in RTOS	1
3.3	RTOS debugging and analysis tools	1
3.4	RTOS design problems- Resource classification, Deadlock	1
3.5	Deadlock – Detection, recovery	1
3.6	Deadlock - Avoidance	1
3.7	Priority inversion – Priority Inheritance Protocol, Ceiling Priority Protocol	1
3.8	Priority inversion –Ceiling Priority Protocol	1
	MODULE IV	
4.1	Embedded system design process –Design example: Model train controller	1
4.2	Design methodologies- Design flows	1
4.3	Requirement Analysis – Specifications-	1
4.4	System analysis and architecture design	1
4.5	Quality Assurance techniques -Designing with computing platforms	1
4.6	Consumer electronics architecture platform	1
4.7	Level performance analysis.	1
	MODULE V	
5.1	Introduction to ARM Architecture	1
5.2	ARM Controller Families	1
5.3	ARM Microcontroller peripherals – The Timer Unit – Pulse Width Modulation Unit	1
5.4	UART	1
5.5	Block Diagram of ARM9 and ARM Cortex M3 MCU.	1
5.6	ARM Development tools – Keil IDE.	1
5.7	Embedded System Design Examples – Audio player, Engine control unit – Video accelerator.	1

	CO Assessment Questions	
1	1. Explain the structure of a process control block in an operating system. 2. Schedule the following processes with Shortest Remaining Time First and Round Robin algorithms and compare their performances. Assume that all processes are arriving at time zero. Take a suitable time quantum for scheduling.	

Process	Burst Time	
P1	8	
P2	6	
P3	2	
P4	5	

2	1. Explain the role and types of semaphores used in process synchronization 2. Explain how exceptions and interrupts help in designing an embedded system.
3	1. Explain the methods of preventing deadlock. 2. Illustrate EDD scheduling algorithm with example.
4	1. Compare top-down and bottom-up designs of an embedded system. 2. Explain the different phases of EDLC.
5	Draw the block diagram of ARM Cortex M3 MCU and explain

PROFESSIONAL ELECTIVE-II

24ECE615	NEURAL NETWORK AND DEEP LEARNING	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: In the realm of artificial intelligence, Neural Networks and Deep Learning stand as pivotal advancements, driving innovations across sectors from healthcare to finance. This course delves into the intricacies of neural architectures, from foundational principles inspired by the human brain to sophisticated deep learning techniques that empower modern AI solutions. Through a comprehensive exploration of theory coupled with hands-on applications, students will emerge poised to harness the capabilities of these transformative technologies for cutting-edge problem solving.

Prerequisite: 24ECP407 Machine Intelligence Methods and Applications

Course Outcomes: After the completion of the course the student will be able to

CO1	Understand the foundational concepts of neural networks, including their structure, training processes, and activation functions. (Understand Level)
CO2	Acquire proficiency in designing, implementing, and optimizing deep neural network architectures, including feedforward deep networks, and be cognizant of challenges like vanishing/exploding gradients. (Apply Level)
CO3	Develop expertise in formulating convolutional neural networks (CNNs) for image-related tasks and understand the nuances of image data representation, popular architectures, and real-world applications. (Apply Level)
CO4	Comprehend the mechanics and applications of sequence models, particularly recurrent neural networks (RNNs), LSTMs, and GRUs, for tasks like time series forecasting and natural language processing. (Understand Level)
CO5	Gain exposure to advanced deep learning concepts like generative adversarial networks (GANs) and reinforcement learning, along with a holistic awareness of practical deployment challenges, ethical considerations, and emerging trends in the field. (Understand Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓			✓							
CO2	✓	✓			✓							
CO3	✓	✓			✓							
CO4	✓	✓			✓							
CO5	✓	✓			✓							

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse			✓	
Evaluate				
Create				

Mark Distribution of CIA						
Course Structure [L-T-P-J]	**Attendance**	**Theory [L- T]**				**Total Marks**
		Assignment	**Test-1**	**Test-2**		
3-0-0-0	5	15	10	10		**40**

Total Mark Distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 Hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS (36 Hours)
MODULE I: Introduction to Neural Networks (6 Hours)
Historical Perspective and Motivation, Biological Neural Networks: Structure and Function, Artificial Neurons: Models and Architectures, Activation Functions: Sigmoid, ReLU, Tanh, Leaky ReLU, etc. Basic Neural Network Architecture: Feedforward, Backpropagation, Loss Functions.
MODULE II: Advanced Neural Network Architectures (6 Hours)
Deep Feedforward Networks, Regularization Techniques: Dropout, Batch Normalization, L1/L2 Regularization, Optimization: Gradient Descent, Momentum, Adam, RMSprop, Challenges: Vanishing and Exploding Gradients, Initialization Techniques.

MODULE III: Convolutional Neural Networks (CNNs) (8 Hours)
Image Data Representation, Preprocessing, and Augmentation, Convolution Operation, Pooling, and Fully Connected Layers, CNN Architectures: LeNet-5, AlexNet, VGG, GoogLeNet, ResNet, Transfer Learning and Fine-tuning, Applications in Image Classification, Object Detection, and Segmentation.
MODULE IV: Recurrent Neural Networks (RNNs) and Sequence Models (8 Hours)
Introduction to Sequence Data and Challenges, Basic RNN Structures and Limitations, Long Short-Term Memory (LSTM) and Gated Recurrent Units (GRU), Bidirectional RNNs and Deep RNNs, Applications: Time Series Prediction, Natural Language Processing, Speech Recognition.
MODULE V: Advanced Topics and Practical Aspects of Deep Learning (8 Hours)
Generative Adversarial Networks (GANs): Architecture and Applications, Vision Transformers, Autoencoders, Reinforcement Learning: Basics and Integration with Neural Networks, Practical Aspects: Frameworks (TensorFlow, PyTorch), GPU Computing, Model Deployment, Ethics and Fairness in Deep Learning: Bias, Transparency, and Accountability, Current Trends and Future Directions in Neural Networks and Deep Learning.

Text books
1. Aggarwal, C. (2018). *Neural Networks and Deep Learning: A Textbook*. Cham, Switzerland: Springer.
2. Goodfellow, I., Bengio, Y., & Courville, A. (2016). *Deep Learning*. Cambridge, MA: MIT Press.

Reference books
1. Shanmugamani, R. (2018). *Deep Learning for Computer Vision*. Birmingham, UK: Packt Publishing.
2. Bishop, C. M. (1995). *Neural Networks for Pattern Recognition*. Oxford, UK: Oxford University Press.
3. Gibson, A., & Patterson, J. (2017). Deep Learning: A Practitioner's Approach. Sebastopol, CA: O'Reilly Media.
4. Brownlee, J. (2018). *Deep Learning for Time Series Forecasting*. Melbourne, Australia: Machine Learning Mastery.
5. Goodfellow, I., Hammerla, N. Y., & Metz, L. (2014). Generative Adversarial Networks. arXiv preprint. [This reference assumes the GAN paper, so the citation format matches a paper rather than a textbook].
6. Lapan, M. (2018). Deep Reinforcement Learning Hands-On: Apply modern RL methods. Birmingham, UK: Packt Publishing.
7. https://youtu.be/E13qqHb3J7U?si=ZYyWyKtFz_9y0QML
8. https://youtu.be/QDX-1M5Nj7s?si=j_5DVNZvM5Xqvcb3
9. https://youtu.be/MfIjxPh6Pys?si=z8vnGn1d1-N_TQpx

No.	COURSE CONTENTS AND LECTURE SCHEDULE	No. of Hours
MODULE I		
1.1	Historical Perspective and Motivation	1
1.2	Biological Neural Networks: Structure and Function	1
1.3	Artificial Neurons: Models and Architectures	1
1.4	Activation Functions: Sigmoid, ReLU, Tanh, Leaky ReLU, etc.	1
1.5	Basic Neural Network Architecture: Feedforward	1
1.6	Basic Neural Network Architecture: Backpropagation	1
MODULE II		
2.1	Deep Feedforward Networks	1
2.2	Regularization Techniques: Dropout, Batch Normalization, L1/L2 Regularization	1
2.3	Optimization: Gradient Descent, Momentum	1
2.4	Optimization: Adam, RMSprop	1
2.5	Challenges: Vanishing and Exploding Gradients	1
2.6	Challenges: Initialization Techniques	1
MODULE III		
3.1	Image Data Representation, Preprocessing, and Augmentation	1
3.2	Convolution Operation, Pooling, and Fully Connected Layers	1
3.3	CNN Architectures: LeNet-5, AlexNet	1
3.4	CNN Architectures: VGG, GoogLeNet, ResNet	1
3.5	Transfer Learning and Fine-tuning	1
3.6	Applications in Image Classification	1
3.7	Applications in Object Detection	1
3.8	Applications in Image Segmentation	1
MODULE IV		
4.1	Introduction to Sequence Data and Challenges	1
4.2	Basic RNN Structures and Limitations	1
4.3	Long Short-Term Memory (LSTM)	1
4.4	Gated Recurrent Units (GRU)	1
4.5	Bidirectional RNNs and Deep RNNs	1
4.6	Applications: Time Series Prediction	1
4.7	Applications: Natural Language Processing	1
4.8	Applications: Speech Recognition	1

	MODULE V	
5.1	Generative Adversarial Networks (GANs): Architecture and Applications	1
5.2	Reinforcement Learning: Basics and Integration with Neural Networks	1
5.3	Practical Aspects: Frameworks (TensorFlow, PyTorch)	1
5.4	Practical Aspects: GPU Computing, Model Deployment	1
5.5	Ethics and Fairness in Deep Learning: Bias, Transparency, and Accountability	1
5.6	Current Trends and Future Directions in Neural Networks and Deep Learning	1

	CO Assessment Questions
1	Consider a simple feed forward neural network with one input layer, one hidden layer, and one output layer. 1. Describe the basic structure and components of this neural network, including neurons, weights, biases, and connections. 2. Explain the concept of backpropagation and its role in training the neural network. 3. List and briefly describe three common activation functions used in neural networks, highlighting the primary advantage of each.
2	1. Design a feed forward deep neural network architecture to classify images into 10 categories. Briefly describe each layer's purpose, including input, hidden, and output layers. 2. Implement the architecture described above using a deep learning framework of your choice (e.g., TensorFlow, PyTorch). Provide the core code blocks for defining the model, specifying the loss function, and initiating training. (Note: Detailed implementation is not required, only main code blocks.) 3. Explain the phenomena of vanishing and exploding gradients. How do they affect the training of deep neural networks? 4. Propose two techniques to mitigate the challenges of vanishing/exploding gradients and justify your selections.

3	1. Describe the fundamental structure of a convolutional layer in a CNN. How does it differ from a fully connected layer, especially in the context of image processing?
	2. Explain the importance of the following elements in CNNs:
	   a. Pooling layers
	   b. Activation functions (specifically, the ReLU activation function)
	   c. Stride and Padding
	3. Implement a CNN architecture (e.g., LeNet-5, AlexNet) and explain its adaptation for a specific image classification task using transfer learning, focusing on layer adjustments.
	
	4. Implement a CNN-based object detection and segmentation system for urban traffic images, detailing architecture choice and modifications.

4	1. Create a basic RNN in Python to predict the next number in a sequence like the Fibonacci series.
	2. Use Python to build an LSTM model for classifying sentences as positive or negative.
	3. Write a Python script with a GRU model to predict the next word in a sentence.
5	1. Explain the basic architecture and principle of operation of Generative Adversarial Networks (GANs). How do the generator and discriminator components interact, and what is their ultimate objective?
	2. Implement a basic Generative Adversarial Network (GAN) in Python using TensorFlow or PyTorch. Your task is to create a simple generator and discriminator model, train the GAN on a basic dataset, and generate new data samples. Provide the code and a brief explanation of your implementation?
	3. Using Python, implement a basic version of a Vision Transformer model for image classification. Utilize a standard image dataset (like MNIST or CIFAR-10), preprocess the images, and apply the Vision Transformer model. Share your code and describe how the transformer architecture processes images differently compared to traditional CNNs.

24ECE625	OPTICAL COMMUNICATION AND NETWORKS	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: Optical communication has enabled telecommunication links to be made over much greater distances, with much lower levels of loss in the transmission medium and possibly most important of all, fiber optical communications has enabled much higher data rates to be accommodated. Getting an insight to the basics of optical communication and optical networks, analyzing optical sources and detectors is intended in this course. Fiber optic communications systems are widely employed for applications ranging from major telecommunications backbone infrastructure to Ethernet systems, broadband distribution, and general data networking. Fiber optic communication has revolutionized the telecommunication industry.

Prerequisite: 24ECP304 Basics of Semiconductor Devices

Course Outcomes: After the completion of the course the student will be able to

CO 1	Illustrate the concepts of light transmission through optical fibers and find out whether a given fiber is a single mode or multimode fiber. (Apply Level)
CO 2	Illustrate the problems of transmission characteristics and losses in optical fiber (Apply Level)
CO 3	Explain the constructional features and the characteristics of optical sources and detectors. (Understand Level)
CO 4	Explain the working of various optical amplifiers. (Understand Level)
CO 5	Describe the concepts of various optical network components (Understand Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	✓	✓										✓
CO 2	✓	✓										
CO 3	✓	✓										
CO 4	✓	✓										
CO 5	✓	✓										

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓		✓
Understand	✓	✓		✓
Apply	✓	✓		✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA						
Course Structure [L-T-P-J]	**Attendance**	**Theory [L- T]**				**Total Marks**
		Assignment	**Test-1**	**Test-2**		
3-0-0-0	5	15	10	10		**40**

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 Hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I: Ray Theory and Mode Theory Approach (8 hours)

Block Diagram and advantages of optical fiber communication, Ray theory of light, Basic Optical Laws and definition: Numerical Aperture; Optical Fiber Modes and propagation; Single Mode and Multi-Mode Fiber; Step Index and Graded Index Fibers Structures, Modes in a planar waveguide, Phase and group velocity. Fiber materials, Photonic crystal fibers: Index guiding PCF, Photonic band-gap fibers.

Assignment experiment: Find out whether a given fiber is a single mode or multimode fiber by calculating its numerical aperture, V number etc.

MODULE II: Transmission Characteristics of Optical Fibers (8 hours)
Attenuation, Material absorption losses, Linear scattering losses, Nonlinear scattering losses, Fiber bend loss, Dispersion, Chromatic dispersion, Intermodal dispersion: Multimode step index fiber. Fiber alignment and joint loss, Fiber Coupler and losses associated with the couplers.
MODULE III: Optical Sources and Detectors (8 hours)
Optical sources: LEDs and LDs, structures, characteristics, modulators using LEDs and LDs. coupling with fibers, noise in Laser diodes, Amplified Spontaneous Emission noise and effects of Laser diode noise in fiber communications. Optical detectors: Types and characteristics, structure and working of PIN and AP, noise in detectors, comparison of performance. Optical receivers, Ideal photo receiver and quantum limit of detection.
MODULE IV: Optical Amplifiers (5 hours)
Basic concept, applications, types, doped fiber amplifiers, EDFA, basic theory, structure and working, Semiconductor laser amplifier, Raman amplifiers, TDFA, amplifier configurations, performance comparison.
MODULE V: Optical Networks (7 hours)
The WDM concept, WDM standards, WDM components, Optical Network Components – Couplers, Isolators & Circulators, Optical add drop Multiplexers, Gratings & Filters, Architecture of Passive optical networks.

Text books

1. John M Senior- Optical communications, 3/e, Pearson, 2009.
2. Gerd Keiser, Optical Fiber Communications, 5/e, McGraw Hill, 2013.
3. Mishra and Ugale, Fibre optic Communication, Wiley, 2013.
4. Rajiv Ramaswami, Kumar N Sivarajan, Galen H Sasaki, Optical Networks: A practical perspective,3/e, Morgan Kauffman publishers.

Reference books

1. Chakrabarthi, Optical Fibre Communication, McGraw Hill, 2015.
2. Hebbar, Optical fibre communication, Elsevier, 2014
3. Joseph C. Palais, Fibre Optic Communications, 5/e Pearson, 2013.
4. Keiser, Optical Communication Essentials (SIE), 1/e McGraw Hill Education New Delhi, 2008.
5. NPTEL course on Fiber Optic Communication Technology by IIT Madras. https://onlinecourses.nptel.ac.in/noc20_ee79/preview

COURSE CONTENTS AND LECTURE SCHEDULE		
No.		No. of Hours
MODULE 1		
1.1	Block Diagram and advantages of optical fiber communication	1
1.2	Ray theory of light, Basic Optical Laws and definition: Numerical Aperture	1
1.3	Optical Fiber Modes and propagation; Single Mode and Multi-Mode Fiber	1
1.4	Step Index and Graded Index Fiber structures	1
1.5	Modes in a planar waveguide	1
1.6	Phase and group velocity	1
1.7	Fiber materials, Photonic crystal fibers: Index guiding PCF, Photonic band-gap fibers.	1
1.8	Find out whether a given fiber is a single mode or multimode fiber by calculating its numerical aperture, V number etc.	1
MODULE II		
2.1	Attenuation, Material absorption losses	1
2.2	Linear scattering losses	1
2.3	Nonlinear scattering losses	1
2.4	Fiber bend loss	1
2.5	Dispersion, Chromatic dispersion	1
2.6	Intermodal dispersion: Multimode step index fiber	1
2.7	Fiber alignment and joint loss	1
2.8	Fiber Coupler and losses associated with the couplers.	1
MODULE III		
3.1	Optical sources: LEDs and LDs, structures, characteristics	1
3.2	Modulators using LEDs and LDs.	1
3.3	coupling with fibers, noise in Laser diodes	1
3.4	Amplified Spontaneous Emission noise, effects of Laser diode noise in fiber communications.	1
3.5	Optical detectors**:** Types and characteristics	1
3.6	structure and working of PIN and AP	1
3.7	Noise in detectors, comparison of performance	1
3.8	Optical receivers, Ideal photo receiver and quantum limit of detection.	1
MODULE IV		
4.1	Optical amplifiers: Basic concept, applications, types	1
4.2	Doped fiber amplifiers, EDFA, basic theory, structure and working	1
4.3	Semiconductor laser amplifier	1
4.4	Raman amplifiers, TDFA	1
4.5	Amplifier configurations, performance comparison.	1

MODULE V		
5.1	The WDM concept, WDM standards, WDM components	1
5.2	Optical Network Components – Couplers	1
5.3	Isolators	1
5.4	Circulators	1
5.5	Optical add-drop Multiplexers	1
5.6	Gratings & Tunable Filters	1
5.7	Architecture of Passive optical networks.	1

CO Assessment Questions	
1	1. Consider a multimode step index optical fibre that has a core radius of 30μm, a core index of 1.49 and an index difference Δ = 0.02. What are the number of modes in the fibre at wavelength 1310 and 1550nm? 2. Derive an equation for phase velocity and group velocity for the light propagating through the optical fiber cables. 3. Determine whether a given fiber is a single mode or multimode fiber and specify the value of its numerical aperture.
2	1. 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. 2. Explain briefly about various types of linear scattering losses in the optical fiber cable. 3. Derive the equations for delay difference and rms width occurring in a multimode step index fiber.
3	1. Explain the working of a heterojunction LED with a neat sketch? 2. Explain briefly the structure and working principle of Avalanche Photodiode with a neat figure.
4	1. What are salient features of semiconductor optical amplifiers? 2. Explain the amplification mechanism with an energy level diagram in an EDFA.
5	1. Describe the principles of the WDM techniques 2. Explain the principle of diffraction gratings using a suitable figure. 3. Write a note on optical Add / Drop multiplexers

24ECE635	ASIC AND SoC	L	T	P	J	S	C	Year of Introduction 2024
		3	0	0	0	3	3	

Preamble: Upon completion of the course, students will be able to acquire proficiency in programmable ASICs, with a focus on logic cells, I/O cells, and interconnects and will develop skills in ASIC physical design, including floor planning, placement, and routing. They will possess a strong foundation in the System-on-Chip (SoC) design process and will demonstrate competence in SoC verification strategies

Prerequisite: 24ECJ303 Logic Circuit Design, 24ECP304 Semiconductor Devices

Course Outcomes: After the completion of the course the student will be able to

CO1	Describe the various types of ASICs. (Understand Level)
CO2	Illustrate the physical design of Programmable ASICs. (Apply Level)
CO3	Explain the floor planning, placement and routing of ASIC. (Apply Level)
CO4	Explain the system-level design and testing of SoC. (Apply Level)
CO5	Describe the system verification of SoC. (Apply Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓										
CO2	✓	✓	✓									
CO3	✓	✓	✓									
CO4	✓	✓	✓									
CO5	✓	✓	✓									

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA

Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	

3-0-0-0	5	15	10	10	**40**

Total Mark Distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 Hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I: Introduction (6 Hours)

VLSI Design flow - ASICs in the Sun Microsystems SPARC station 1
Types of ASICs – Standard-Cell–Based ASICs, Gate-Array–Based ASICs, Channeled Gate Array, Channelless Gate Array, Structured Gate Array
Programmable ASICs - Antifuse, SRAM, EPROM and EEPROM based Technology
Economics of ASICs

MODULE II: Programmable ASICs (6 Hours)

Programmable ASIC logic cells - Xilinx LCA, XC5200 Logic Block
Programmable I/O cells – DC and AC characteristics
Programmable interconnects - Xilinx LCA, XC5200 Interconnect

MODULE III: ASIC Physical Design (8 Hours)

ASIC floor planning - Goals and Objectives, Measurement of Delay, cell-based ASIC floor planning,
Placement - Goals and Objectives, Iterative Placement Improvement
Routing - Global Routing - Global Routing Between Blocks and inside flexible blocks, Detailed Routing - Channel routing algorithms, Multilevel Routing, Clock routing and Power routing

MODULE IV: System on Chip Design Process (7 Hours)

Canonical SoC design, SoC Design Flow, Specification requirements, System Design Process, Design for Timing Closure- Logic Design Issues and Physical Design Issues System interconnect and on-chip buses, on-chip debug structures

MODULE V: SoC Verification (7 Hours)

Design for Test: Manufacturing Test Strategies, System-Level Test Issues, Memory Test SoC Verification: System level verification, Block level verification, Hardware/software co-verification, Interface and Transaction Verification, Functional
and Gate-Level Verification

Text books
1. Michael J. S. Smith, "Application Specific Integrated Circuits", Addison-Wesley,2006
2. Michael Keating, Pierre Bricaud, "Reuse Methodology manual for System-On-A-Chip Designs", Kluwer Academic Publishers, third edition, 2002

Reference books
1. Prakash Rashinkar, Peter Paterson and Leena Singh. "SoC Verification-Methodology and Techniques", Kluwer Academic Publishers, 2001.
2. H.Gerez, "Algorithms for VLSI Design Automation", John Wiley,1999.
3. 1. J..M.Rabaey, A. Chandrakasan, and B.Nikolic, "Digital Integrated Circuit Design Perspective (2/e)", PHI2003.
4. D.A.Hodges,"Analysis and Design of Digital Integrated Circuits(3/e)",MGH2004.
5. 3. Hoi-Jun Yoo, Kangmin Leeand Jun Kyong Kim, "Low-Power NoC for High-Performance SoC Design", CRC Press,2008.
6. Pasricha and N. Dutt," On Chip Communication Architectures System on Chip Interconnect, Elsveir",2008.
7. Swayam course on VLSI Physical Design by Prof. Indranil Sengupta, IIT Kharagpur https://archive.nptel.ac.in/courses/106/105/106105161/
8. Nanohub.org ECE 695R: System-on-Chip Design https://nanohub.org/courses/ECE695R/o1a/

	COURSE CONTENTS AND LECTURE SCHEDULE	
No.		No. of Hours
	MODULE 1	
1.1	VLSI Design flow - ASICs in the Sun Microsystems SPARC station 1	1
1.2	Standard-Cell–Based ASICs, Gate-Array–Based ASICs, Channeled Gate Array	1
1.3	Channelless Gate Array, Structured Gate Array	1
1.4	Programmable ASICs – Antifuse, Metal–Metal Antifuse	1
1.5	Programmable ASICs - SRAM, EPROM and EEPROM based Technology.	1
1.6	Economics of ASICs - Product Cost, ASIC Fixed Costs, ASIC Variable Costs	1

MODULE II		
2.1	Programmable ASIC logic cells - Xilinx LCA	1
2.2	Programmable ASIC logic cells - XC5200 Logic Block	1
2.3	Programmable I/O cells – DC output and Input characteristics	1
2.4	Programmable I/O cells – AC output and Input characteristics	1
2.5	Programmable interconnects - Xilinx LCA	1
2.6	Programmable interconnects - XC5200 Interconnect	1
MODULE III		
3.1	ASIC floor planning - Goals and Objectives, Measurement of Delay	1
3.2	Floor planning a cell-based ASIC, Congestion analysis	1
3.3	Routing a T-junction between two channels in two-level metal, Channel Definition	1
3.4	Placement - Goals and Objectives, Iterative Placement Improvement	1
3.5	Routing - Global Routing - Global Routing Between Blocks and inside flexible blocks	1
3.6	Detailed Routing - Channel routing - left-edge algorithm (LEA),	1
3.7	Area-Routing Algorithms	1
3.8	Multilevel Routing, Clock routing and Power routing	1
MODULE IV		
4.1	Canonical SoC design, SoC Design Flow	1
4.2	Specification requirements, Types of Specifications	1
4.3	System Design Process	1
4.4	Design for Timing Closure - Logic Design Issues	1
4.5	Design for Timing Closure - Physical Design Issues	1
4.6	System interconnect and on-chip buses	1
4.7	On-chip debug structures	1
MODULE V		
5.1	Design for Test: Manufacturing Test Strategies	1
5.2	System-Level Test Issues	1
5.3	Memory Test	1
5.4	SoC Verification: System level verification, Block level	1
5.5	Hardware/software co-verification	1
5.6	Interface Verification and Transaction Verification	1
5.7	Functional Verification and Gate-Level Verification	1

CO Assessment Questions	
1	1. Describe the various types of gate array based ASICs. 2. Explain Standard-Cell–Based ASICs. 3. Illustrate ASIC Design flow in the Sun Microsystems SPARC station

2	1. Describe Metal–Metal Antifuse. 2. Draw the block diagram of Xilinx LCA XC5200 Logic Block, I/O block and Interconnect and explain. 3. Explain the AC output and Input characteristics of Programmable I/O cells
3	1. Explain the floor planning a cell-based ASIC. 2. Describe the left-edge algorithm (LEA) for routing. 3. Explain the Area-Routing Algorithms.
4	1. Explain the spiral SoC design flow. 2. Explain the physical design issues for timing closure. 3. Discuss the manufacturing test strategies in SoC.
5	1. Explain system level verification and block level verification. 2. Explain different stages of Interface Verification. 3. Describe Gate-Level Verification.

24ECE645	VIRTUAL INSTRUMENTATION AND LABVIEW	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: This course provides an in-depth exploration of Virtual Instrumentation, focusing on LabVIEW programming from basics to advanced applications. Students will learn to navigate the LabVIEW environment, develop programming skills, understand signal processing and analysis, and explore extensions for real-world applications. By the end, participants will be equipped to design and implement complex virtual instrumentation systems using LabVIEW to address engineering challenges.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO 1	Identify the components of Virtual Instrumentation. (Understand Level)
CO 2	Describe various types of structures used in LabVIEW. (Understand Level)
CO 3	Analyze and design different type of programs based on data acquisition. (Apply Level)
CO 4	Demonstrate the use of LabVIEW for signal processing and image processing. (Apply Level)
CO 5	Demonstrate the modular programming concept in LabVIEW using sub VI with procedure and example (Apply Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	✓	✓			✓							
CO 2	✓	✓			✓							
CO 3	✓	✓			✓							
CO 4	✓	✓			✓							
CO5	✓	✓			✓							

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA

Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
3-0-0-0	5	10	25	25	40

Total Mark distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 Hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS (36 Hours)

MODULE I: Introduction to Virtual Instrumentation (6 Hours)

Overview of Virtual Instrumentation: Evolution, Advantages, and Applications. Difference between Traditional and Virtual Instrumentation.
Components of Virtual Instrumentation System: Sensors, Signal Conditioning, DAQ Hardware. Role of Software in VI. Introduction to Graphical System Design.

MODULE II: LabVIEW Environment (8 Hours)

Introduction to LabVIEW: Features, Advantages, and Application Areas.
LabVIEW Environment: Front Panel, Block Diagram, Controls, and Indicators.
Dataflow Programming: Basics, Comparison with Sequential Programming. LabVIEW Data Types: Numeric, Boolean, String, Array, Cluster. Debugging and Tools: Highlight Execution, Breakpoints, Probes.

MODULE III: LabVIEW Programming (6 Hours)

Structures in LabVIEW: Loops (For, While), Case Structures, Sequence Structures. Data Acquisition in LabVIEW: DAQmx VIs, Analog Input/Output, Digital I/O. File I/O: Reading from and Writing to Different File Formats. SubVIs: Creating, Modifying, and Using SubVIs. Event-driven Programming: Event Handling, User Interface Events.

MODULE IV: Signal Processing and Analysis in LabVIEW (8 Hours)

Analog and Digital Signal Processing: Filters, FFT, Convolution. Control and Simulation: PID Control, System Response, Simulation Functions. Graphs and Charts: Waveform Graph, XY Graph, Intensity Graph.
Communication Protocols in LabVIEW: Serial, GPIB, TCP/IP.
Instrument Control: LabVIEW drivers, Communicating with External Instruments.

MODULE V: Advanced Applications and Extensions (8 hours)

Image Acquisition and Processing using IMAQ. LabVIEW with Databases: Connecting to Databases, Data Retrieval, Storage.
LabVIEW and Internet: Remote Monitoring and Control, Web Publishing.
Real-time and FPGA Modules: Introduction, Applications. VI Server and Connectivity Options.

Textbooks
1. Jeffrey Travis and Jim Kring, LabVIEW for Everyone: Graphical Programming Made Easy and Fun, third edition, Prentice Hall, 2006.
2. Jovitha Jerome, Virtual Instrumentation Using LabVIEW, PHI Learning publishers, 2010.
3. Rick Bitter, Taqi Mohiuddin, and Matt Nawrocki, LabVIEW: Advanced Programming Techniques, Second Edition, CRC Press, 2006.

References
1. Alan S. Morris and Reza Langari, Measurement and Instrumentation: Theory and Application, Second edition, Elsevier Science Publications, 2015.
2. Cory L. Clark, LabVIEW Digital Signal Processing and Digital Communications, First edition, McGraw Hill Publications 2005.
3. Bruce Mihura, LabVIEW for Data Acquisition, Prentice Hall Publications, 2001.
4. Rahman Jamal and Herbert Pichlik LabVIEW Applications and Solution, Prentice Hall PTR Publications 1998.
5. https://mycourses.aalto.fi/course/view.php?id=32114&section=1Online platform: MOOC course on Virtual Instrumentation and Lab View

No.		No. of Hours
	COURSE CONTENTS AND LECTURE SCHEDULE	
	MODULE 1	
1.1	Overview of Virtual Instrumentation: Evolution, Advantages, and Applications.	1
1.2	Difference between Traditional and Virtual Instrumentation. Components of Virtual Instrumentation System: Sensors	1
1.3	Signal Conditioning,	1
1.4	DAQ Hardware.	1
1.5	Role of Software in Virtual Instrumentation.	1
1.6	Introduction to Graphical System Design.	1
	MODULE II	
2.1	Introduction to LabVIEW: Features, Advantages, and Application Areas.	1
2.2	LabVIEW Environment: Front Panel, Block Diagram, Controls, and Indicators.	1
2.3	Dataflow Programming: Basics.	1
2.4	Comparison with Sequential Programming.	1
2.5	LabVIEW Data Types: Numeric, Boolean	1
2.6	String, Array, Cluster	1
2.7	Debugging and Tools: Highlight Execution	1
2.8	Breakpoints, Probes.	1
	MODULE III	
3.1	Structures in LabVIEW: Loops (For, While), Case Structures, Sequence Structures.	1
3.2	Data Acquisition in LabVIEW: DAQmx VIs, Analog Input/Output, Digital I/O.	1
3.3	File I/O: Reading from and Writing to Different File Formats.	1
3.4	SubVIs: Creating, Modifying, and Using SubVIs.	1
3.5	Event-driven Programming: Event Handling	1
3.6	User Interface Events.	1
	MODULE IV	
4.1	Analog and Digital Signal Processing: Filters, FFT	1
4.2	Convolution.	1
4.3	Control and Simulation: PID Control, System Response, Simulation Functions.	1
4.4	Graphs and Charts: Waveform Graph, XY Graph, Intensity Graph.	1 1
4.5	Communication Protocols in LabVIEW: Serial	1
4.6	GPIB, TCP/IP.	1
4.7	Instrument Control: LabVIEW drivers	1
4.8	Communicating with External Instruments.	1

MODULE V		
5.1	Image Acquisition and Processing using IMAQ.	1
5.2	LabVIEW with Databases: Connecting to Databases	1
5.3	Data Retrieval, Storage.	1
5.4	LabVIEW and Internet: Remote Monitoring and Control	1
5.5	Web Publishing.	1
5.6	Real-time and FPGA Modules: Introduction, Applications.	1
5.7	VI Server and Connectivity Options.	1

CO Assessment Questions	
1	Explain the role of different hardware's and software's in Virtual Instrumentation.
2	Discuss in detail about different structures with examples.
3	Build a VI to switch ON/OFF the LED from the front panel connected to the digital output channel of DAQ
4	Build a VI to plot temperature reading from two simulators on single uniform chart in different colors
5	Build a VI to publish live data from one VI to another.

24ECE655	VLSI TESTING AND VERIFICATION	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: The course aims to acquaint students with the latest and essential VLSI testing principles and Design-for-Test (DFT) architectures. It delves into the foundational aspects of VLSI testing, including fault models, automatic test pattern generation, designing for testability, scan design, test interfaces, boundary scanning, IDDQ testing, delay fault testing, and Built-In Self-Test (BIST) strategies for logic and memory elements. These teachings provide students with a fundamental understanding of diverse testing and verification approaches.

Prerequisite: 24ECJ303 Logic Circuit Design

Course Outcomes: After the completion of the course the student will be able to

CO1	Comprehend the causes of faults and explain fault models (Understand level)
CO2	Describe the principles of Scan based Testing (Understand level)
CO3	Implement Built-In Self-Test (BIST) on memory elements. (Apply level)
CO4	Describe the JTAG and its functionality. (Understand level)
CO5	Comprehend the modern trends in VLSI testing (Understand level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓											
CO2	✓											
CO3	✓											
CO4	✓											
CO5	✓											

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply		✓	✓	✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA						
Course Structure [L-T-P-J]	Attendance	Theory [L- T]				Total Marks
		Assignment	Test-1	Test-2		
3-0-0-0	5	15	10	10		**40**

Total Mark distribution			
Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 Hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I: Introduction to Fault Models (7 Hours)

Causes of Faults and statistical distribution of Faults- Logical Fault Models - Stuck at Faults, atspeed faults (Transition Delay Faults), Path Delay Faults, Bridging Faults, IDDQ.

MODULE II: Automatic Test Pattern Generation (ATPG) (6 Hours)

Introduction to Functional ATPG - Combinational and sequential ATPG, Introduction to Scan based design for DFT- Scan Capture, Scan Shift, Atspeed scan capture, Scan Compression, Logic BIST, ATPG Algorithms: D, PODEM

MODULE III: Memory Testing (7 Hours)

Types of memory faults and models- Memory Testing, Memory BIST, Memory Redundancy, Functional RAM Testing, High Speed Memory Testing- BIST Hardware, Memory BIST algorithms.

MODULE IV: Boundary Scan (6 Hours)

IEEE Boundary Scan Testing for VLSI systems, Boundary scan architecture, JTAG standard, TAP and TAP Controller, introduction to instruction and data registers, JTAG interface.

MODULE V: Modern Trends in Testing (6 Hours)

Low power ATPG, Low power BIST, Thermal aware techniques, Modern trends in DFT, SerDes Testing (ultra high speed interface testing), Introduction to use of AI/ML for detection of faults.

Text books
1. Digital Systems and Testable Design by M. Abramovici, M.A. Breuer and A.D. Friedman, Jaico Publishing House.
2. Essentials of Electronic Testing for Digital, Memory and Mixed-Signal VLSI Circuits by M.L. Bushnell and V.D. Agrawal, Kluwer Academic Publishers. The Boundary-Scan Handbook 4th Edition by Kenneth P. Parker, Springer

Reference books
1. Digital Circuit Testing and Testability by P.K. Lala, Academic Press.
2. Design Test for Digital IC's and Embedded Core Systems by A.L. Crouch, Prentice Hall International.
3. NPTEL Course on Digital VLSI Testing by Prof Santanu Chattopadhyay
https://archive.nptel.ac.in/courses/117/105/117105137/

<table>
<tr><th colspan="3">COURSE CONTENTS AND LECTURE SCHEDULE</th></tr>
<tr><th>No.</th><th></th><th>No. of Hours</th></tr>
<tr><td colspan="3" align="center">MODULE I</td></tr>
<tr><td>1.1</td><td>Causes of Faults</td><td>1</td></tr>
<tr><td>1.2</td><td>Statistical distribution of Faults</td><td>1</td></tr>
<tr><td>1.3</td><td>Logical Fault Models-Stuck at Faults</td><td>1</td></tr>
<tr><td>1.4</td><td>Atspeed faults (Transition Delay Faults)</td><td>1</td></tr>
<tr><td>1.5</td><td>Path Delay Faults</td><td>1</td></tr>
<tr><td>1.6</td><td>Bridging Faults</td><td>1</td></tr>
<tr><td>1.7</td><td>IDDQ</td><td>1</td></tr>
<tr><td colspan="3" align="center">MODULE II</td></tr>
<tr><td>2.1</td><td>Introduction to Functional ATPG - Combinational and sequential ATPG</td><td>1</td></tr>
<tr><td>2.2</td><td>Introduction to Scan based design for DFT- Scan Capture</td><td>1</td></tr>
<tr><td>2.3</td><td>Scan Shift, Atspeed scan capture</td><td>1</td></tr>
</table>

2.4	Scan Compression	1
2.5	Logic BIST,	1
2.6	ATPG Algorithms: D, PODEM	1
MODULE III		
3.1	Types of memory faults and models	1
3.2	Memory Testing	1
3.3	Memory BIST	
3.4	Memory Redundancy	1
3.5	Functional RAM Testing	1
3.6	High Speed Memory Testing- BIST Hardware	1
3.7	Memory BIST algorithms.	1
MODULE IV		
4.1	IEEE Boundary Scan Testing for VLSI systems	1
4.2	Boundary scan architecture	1
4.3	JTAG standard	1
4.4	TAP and TAP Controller	1
4.5	Introduction to instruction and data registers	1
4.6	IEEE Boundary Scan Testing for VLSI systems	1
MODULE V		
5.1	Low power ATPG	1
5.2	Low power BIST	1
5.3	Thermal aware techniques	1
5.4	Modern trends in DFT, SerDes Testing	1
5.5	Ultra-high speed interface testing	
5.7	Introduction to use of AI/ML for detection of faults.	1

CO Assessment Questions	
1	Explain various logical fault models
2	Describe Scan based design for DFT
3	Implement BIST algorithm for RAM testing
4	Explain boundary scan architecture
5	Describe the use of AI/ML for VLSI Testing.

24ECS606	SEMINAR	L	T	P	J	S	C	Year of Introduction
		0	0	4	0	4	2	2024

Preamble: This course is intended to enable a B.Tech student to read, understand, present and prepare report about an academic document. The learner 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. This course can help the learner to experience how a presentation can be made about a selected academic document and also empower her/him to prepare a technical report.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO 1	Identify academic documents from the literature which are related to her/his areas of interest. (Apply Level)
CO 2	Read and apprehend an academic document from the literature which is related to her/ his areas of interest. (Analyze Level)
CO 3	Prepare a presentation about an academic document. (Create Level)
CO 4	Give a presentation about an academic document. (Apply Level)
CO 5	Prepare a technical report. (Create Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	✓	✓										
CO 2	✓	✓										
CO 3	✓									✓		
CO 4	✓							✓		✓		
CO 5	✓							✓		✓		

1. **Seminar Initiation:**

   a. The Department shall form an Internal Evaluation Committee (IEC) for the seminar with academic coordinator for that program as the Chairperson/Chairman and seminar coordinator & seminar guide as members. During the seminar presentation of a -student, all members of IEC shall be present.
   b. Formation of IEC and guide allotment shall be completed within a week after the
   c. End Semester Examination (or last working day) of the previous semester.
   d. Guide shall provide required input to their students regarding the selection of topic/paper.
   e. The IEC shall approve the selected topic/paper by the second week of the semester.

2. **Student Responsibilities:**

   a. The topic for a UG seminar should be current and broad based rather than a very specific research work. It's advisable to choose a topic for the Seminar to be closely linked to the final year project area. Every member of the project team could choose or be assigned Seminar topics that covers various aspects linked to the Project area.
   b. A topic/paper relevant to the discipline shall be selected by the student during the semester break
   c. Topic/Paper shall be finalized in the first week of the semester and shall be submitted to the seminar coordinator.
   d. Accurate references from genuine peer reviewed published material to be given in the report and to be verified.

3. **Seminar Evaluation:**

   The report and the presentation shall be evaluated by a team of internal members comprising three senior faculty members based on the style of presentation, technical content, adequacy of reference, depth of knowledge and overall quality of the report.

Total Marks distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	100	--	--

Mark Distribution

   a. Attendance: 5%
   b. Guide: 25%
   c. Technical Content: 30%
   d. Presentation: 40%

24SPJ607	SOCIALLY RELEVANT PROJECT	L	T	P	J	S	C	Year of Introduction
		0	0	0	2	1	1*	2024

Preamble: This course is intended to evoke the innovation and invention skills in a student to address societal problems and developing indigenous technologies. Each student should complete a minimum of 60 hours of community service during their lower semesters (I-V).

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO 1	Identify societal challenges and propose innovative, feasible solutions using electronics and communication engineering principles. (Apply Level)
CO 2	Develop products, processes or technologies for sustainable and socially relevant applications (Apply Level).
CO 3	Plan and execute tasks utilizing available resources within timelines, following ethical and professional norms (Apply Level)
CO 4	Engage with communities for feedback and assess the social, environmental, and economic impacts of projects. (Analyze Level)
CO 5	Organize and communicate technical and scientific findings effectively in written and oral forms (Apply Level).

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	✓	✓	✓			✓	✓					✓
CO 2	✓	✓	✓	✓	✓							
CO 3								✓			✓	
CO 4						✓		✓	✓	✓		
CO 5								✓	✓	✓		

Instructions:

a. This shall be executed as a group activity where each group can have a maximum of four students.
b. Students shall be assigned a mentor to guide them through the process.
c. Students shall keep a log book of their activities, which must be signed off by their mentor or faculty member in charge.
d. The participation of students in NSS/NCC/Club activities will not be coming under the purview of socially relevant project.
e. Each team shall submit a report and make brief presentation based on the service rendered to the society, and an evaluation will be conducted by a committee constituted by the Head of the Department.

Project Evaluation:

The progress of the project is evaluated based on three reviews, two interim reviews and a final review. A report is required at the end of the semester.

Total Marks distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	100	--	--

Mark Distribution:

    a. Work assessed by the project guide – 30%
    b. Committee constituted by the Head of the Department - 50%
    c. Draft report – 5 % Final Report - 15%

24ECP608	DATA SCIENCE AND ANALYTICS	L	T	P	J	S	C	Year of Introduction
		1	0	2	0	3	2	2024

Preamble: This course covers essential aspects of the field, starting with Python IDEs and libraries like NumPy and SciPy for scientific computing. Students will learn to work with large datasets using Pandas data frames and visualize data using tools such as Matplotlib, Seaborn, and Three-dimensional plots. The course also explores statistical data analytics, including hypothesis testing and Data Analytics with R programming. By the end of the course, students will have a solid foundation in data science and the ability to extract valuable insights from data.

Prerequisite: 24EST302 Scientific Computing using Python

Course Outcomes: After the completion of the course the student will be able to

CO 1	Apply the knowledge of IDEs for Python, NumPy, and SciPy to perform operations and tasks on large datasets using Pandas' data frames. (Apply Level)
CO 2	Apply the knowledge of data visualization tools and packages like Matplotlib, Seaborn, and Three Dimension Plots to create visual representations of data. (Apply Level)
CO 3	Apply descriptive statistics and data interpretation techniques, and utilize knowledge of probability and central tendency in practical contexts. (Apply Level)
CO 4	Perform correlation analysis, hypothesis testing with t-tests, and confidence interval calculation for precise data interpretation. (Apply Level)
CO 5	Apply descriptive statistics, ANOVA, and data visualization techniques in R for both single and multiple variable analysis. (Apply Level)

<div align="center">

CO - PO MAPPING

</div>

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	✓	✓			✓							✓
CO 2	✓	✓			✓							✓
CO 3	✓	✓			✓							✓
CO 4	✓	✓			✓							✓
CO 5	✓	✓			✓							✓

<div align="center">

Assessment Pattern for Theory component

</div>

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	
Understand	✓	✓	✓	
Apply	✓	✓	✓	
Analyse				
Evaluate				
Create				

Assessment Pattern for Lab component		
Bloom's Category	**Continuous Assessment Tools**	
	Class work	**Test1**
Remember	✓	✓
Understand	✓	✓
Apply	✓	✓
Analyse		
Evaluate		
Create		

Mark Distribution of CIA							
Course Structure [L-T-P-J]	**Attendance**	**Theory [L- T]**			**Practical [P]**		**Total Marks**
		Assignment	**Test-1**	**Test-2**	**Class work**	**Lab Exam**	
1-0-2-0	5	10	20	-	25	40	**100**

Total Marks Distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	100	-	-
SYLLABUS (12 Hours)			

MODULE I: Introduction to Data Science and Basic Operations (3 Hours)

Introduction to Data Science: NumPy and SciPy Library operations. Pandas Library: Reading and writing .txt, .csv, .xlsx, and .json files. Series and Data Frames: operations, handling missing values, data preprocessing techniques, string manipulation. Use of Pivot tables, pickling of data frames in Python.

MODULE II: Data Visualization (2 Hours)

Data Visualization: Matplotlib, Seaborn, Mayavi Module, Two and Three-dimensional visualization plots, ggplot, Whisker's plot, Violin Plots, Heatmaps.

MODULE III: Statistical Data Analytics (2 Hours)

Descriptive statistics, Numerical, Tabular & Graphical methods, Measure of central tendency, Dispersion, Measure of Asymmetry – Modality, Skewness, Populations & Samples, Central limit theorem, Probability distributions, Sampling distribution of mean, Linear combination of variables.

MODULE IV: Advanced Statistical Methods (3 Hours)
Correlation analysis techniques: Covariance, Pearson, Kendall, Spearman Coefficients. Confidence Interval on Mean, Hypothesis testing of single sample, t-test, p-value, Hypothesis testing of two samples, Two sample t-test, Paired t-test, Pooled t-test, Confidence Interval on the difference in means, drawing conclusions.
MODULE V: Data Analytics using R (2 Hours)
Descriptive statistics, statistical methods for evaluation, ANOVA test. Visualization techniques using R: Exploratory Data Analytics, visualizing single variable, examining multiple variables.

Text books
1. Joel Grus, "Data Science from Scratch", O"Reilly Media, Inc., 2015
2. "Python Data Analytics" Fabio Nelli, Apress.
3. Data Analysis from Scratch with Python, Peters Morgan, AI Sciences.

Reference books
1. Cathy O'Neil and Rachel Schutt. Doing Data Science, Straight Talk from The Frontline. O'Reilly. 2014.
2. Jiawei Han, Micheline, Kamber and Jian Pei, "Data Mining: Concepts and Techniques", Third Edition. ISBN 0123814790, 2011.
3. Elegant SciPy: The Art of Scientific Python, by Juan Nunez-Iglesias, Stéfan van der Walt, Harriet Dashnow.
4. Python for Data Analysis, Wes McKinny, O, Reilly.
5. Rema Thereja, Data Science and Machine Learning with R.
6. https://www.youtube.com/playlist?list=PLEiEAq2VkUUJF3yCKuD_gksEJfOv_D4 wI

COURSE CONTENTS AND LECTURE SCHEDULE		
No.		No. of Hours
MODULE 1		
1.1	Introduction to Data Science: NumPy and SciPy Library operations, Pandas Library: Reading and writing .txt, .csv, .xlsx, and .json files.	1
1.2	Series and Data Frames: operations, handling missing values, data preparation, concatenation, string manipulation	1
1.3	Use of Pivot tables, pickling of data frames in Python.	1
MODULE II		
2.1	Data Visualization: Matplotlib, Seaborn, ggplot, Scatterplot, Histogram plot, Whisker's plot.	1
2.2	Three-dimensional visualization plots. Violin Plots, Heatmaps.	1
MODULE III		
3.1	Overview of Descriptive Statistics, Importance in Data Analysis. Presentation of Data, Types of Data Visualization,	1

	Mean, Median, Mode, Examples and Applications.	
3.2	Range, Variance, Standard Deviation, Interpretation and Relevance. Understanding Skewness, Modality in Distributions. Overview of Probability Distributions, Introduction to Central Limit Theorem and Sampling Distribution of Mean.	1
MODULE IV		
4.1	Basic Concepts and Importance of correlation analysis, Differences between Correlation and Causation. Covariance: Concept and Calculation, Pearson Correlation Coefficient, Kendall's Tau Coefficient, Spearman's Rank Correlation Coefficient, Practical Examples and Interpretation.	1
4.2	Confidence Interval on Mean, Concept and Calculation, Interpretation. Hypothesis Testing of Single Sample: Understanding the Null and Alternative Hypothesis, t-Test: Concept and Application, Calculating and Interpreting the p-value, Practical Examples.	1
4.3	Two Sample t-Test, Paired t-Test, Pooled t-Test, Deciding Which Test to Use, Practical Examples. Confidence Interval on the Difference in Means, Concept and Application. Drawing Conclusions from Statistical Analysis, Interpreting Results in Context, Understanding the Limitations, Making Informed Decisions Based on Data.	1
MODULE V		
5.1	Descriptive Statistics and Statistical Methods: Overview and Importance, Types of Data and Basic Statistical Concepts. Statistical Methods for Evaluation: Techniques for Data Analysis, Emphasis on Practical Application and Interpretation. ANOVA Test: Concept and Purpose of ANOVA, Basic Procedure and Examples, Interpreting ANOVA Results.	1
5.2	Overview of R Programming essentials, Key Functions and Data Structures in R. Fundamentals of Exploratory Data Analysis, Hands-on practice with real-world examples. Techniques for visualizing single variables, Best practices and practical demonstration. Strategies for comparing multiple variables, Gaining insights through multivariate visualization.	1

LESSON PLAN FOR LAB COMPONENT

No.	Topic	No. of Hours	Experiment
1	Reading Data & Formats	1	Expt.1: Familiarization of various data operations and data types in Python
2	Pandas & Data Frames	1	Expt.2: Familiarization of Pandas Package and data frame operations
3	Conditional Statements, Looping Statements, Functions	1	Expt.3: Familiarization of basic principles involved in Conditional Statements, Looping Statements, and Functions.
4	Data Structures: List, Tuples and Dictionaries	1	Expt.4: Demonstrate Python Programmes using List, Tuple and Dictionary operations.
5	Numpy – Basic Operations	1	Expt.5: Demonstrate Basic operations using Numpy
6	Numpy – Array and Matrix Operations	1	Expt.6: Demonstrate Array and Matrix operations using Numpy

No.	Topic	No. of Hours	Experiment
7	Data Visualization – ggplot, Scatterplot, Histogram plot	1	Expt.7: Implement and Visualize ggplot, Scatterplot, Histogram plot
8	Data Visualization – Matplotlib, Seaborn, Whiskers plot	1	Expt.8: Implement and Visualize plots using Matplotlib, Seaborn, and Whiskers plot
9	Data Preprocessing Techniques	1	Expt.9: Practice various techniques involved in handling of missing values.
10	Basic Descriptive Statistics	1	Expt.10: Load a dataset using Python's pandas, calculate mean, median, mode, variance, and standard deviation. Use describe() for a summary. Analyze and report findings, highlighting key insights and data patterns.
11	Data Visualization and Asymmetry Measurement	1	Expt.11: Create histograms and box plots of the data using matplotlib for visualization. Compute and explain the skewness of the data distribution, and provide insights into the data's symmetry.

12	Exploring Probability Distributions	2	Expt.12. Utilize numpy to create samples following a normal distribution. Employ histograms for visualization and scipy for probability calculations. Gain an understanding of probability distribution properties and their application in Python.
13	Correlation Coefficients Analysis	2	Expt.13: Calculate the Covariance, Pearson, Kendall, and Spearman correlation coefficients for a given dataset.
14	Confidence Interval Calculation	1	Expt.14: Calculate the confidence interval for the mean of a dataset using Python.
15	Single Sample Hypothesis Testing	1	Expt.15: Perform a t-test on a single sample from a given dataset to test a hypothesis. Calculate the p-value and interpret the results.
16	Two-Sample Hypothesis Testing	2	Expt.16: Conduct a two-sample t-test, paired t-test, and pooled t-test on a given dataset. Calculate the confidence interval for the difference in means.
17	Basic Descriptive Statistics	1	Expt.17: Load a dataset in R and calculate basic descriptive statistics, including mean, median, mode, variance, and standard deviation.
18	ANOVA Test Implementation	1	Expt.18: Perform an ANOVA test on a suitable dataset to analyze the differences among group means.

19	Single Variable Visualization	1	Expt. 19 Create a histogram and box plot for a single variable in your dataset using ggplot2 in R.
20	Exploratory Data Analysis	1	Expt.20: Conduct an exploratory data analysis on your dataset. Include various visualizations like scatter plots, bar charts, and line graphs to examine relationships between multiple variables.
21	Comparative Visualization	1	Expt.21: Use R to create comparative visualizations (like side-by-side box plots or overlapping histograms) for different groups or categories in your dataset.

<table>
<tr><td colspan="2" align="center">**CO Assessment Questions**</td></tr>
<tr>
<td>1</td>
<td>

The data contained in a .csv file is given below as follows. It shows the marks scored by the 10th standard students for the public examination. Write python codes to perform the following: (Maximum Mark is 50)

No	Student	AGE	ENG	MAL	MAT	PHY	CHE	BIO	SS
1	A	14	40	42	39	44	43	38	41
2	B	15	41	43	35	40	41	37	42
3	C	14	48	48	32	35	37	34	48
4	D	15	47	46	30	31	32	33	45
5	E	15	39	34	48	47	45	47	30
6	F	15	34	36	49	50	50	46	30
7	G	15	46	38	39	38	40	36	47
8	H	15	43	36	38	39	40	40	47

a) Read the .csv file using pandas
b) Find the average marks in Chemistry
c) Find the total marks for all the students
d) Save the entire marks into another .csv file.

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<td>2</td>
<td>For the given data generate various plots available in Matplotlib</td>
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1. Load a dataset using pandas and calculate measures of central tendency (mean, median, mode) and dispersion (variance, standard deviation). Also understand how to summarize data using basic statistical measures.
2. Visualize the data using histograms and box plots with matplotlib. Calculate and interpret the skewness of the distribution. Also comment on data symmetry.
3. Use numpy to generate samples from a normal distribution. Create histograms to visualize and use scipy to calculate probabilities. Also understand the properties of probability distributions and how to work with them in Python.

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1. Conduct an analysis in Python to compute Covariance, Pearson, Kendall, and Spearman correlation coefficients on a selected dataset. Also deduce the relationships among dataset variables.
2. Utilize Python to calculate the confidence interval for the mean of a provided dataset. Your goal is to apply Python's statistical tools to estimate the range within which the true population mean likely lies.
3. Perform and interpret a t-test on a single sample from your dataset, focusing on calculating and understanding the p-value.

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1. Use R to perform an ANOVA test on an appropriate dataset to examine the variance between multiple groups.
2. Conduct a multivariate exploratory data analysis on a dataset using various visualizations in R
3. Produce comparative visualizations for different categories in your dataset using R. Also, test your understanding of comparing data distributions across various groups and identifying key patterns.

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MINOR
VI SEMESTER

24ECM609	VLSI CIRCUITS	L	T	P	J	S	C	Year of Introduction
		4	0	0	0	0	4	2024

Preamble: The primary emphasis of this course is on fundamental techniques in VLSI Design, with the goal of providing a comprehensive understanding of various design components, power dissipation etc. It covers subjects such as ASIC, both static and dynamic logics, power dissipation, and layout rules. This course equips students with essential knowledge and practices commonly used in the VLSI industry

Prerequisite: NIL

Course Outcomes: After the completion of the course the student will be able to

CO 1	Explain the architectural and design flow aspects of ASIC.(Understand Level)
CO 2	Comprehend the concept of a static CMOS inverter as well as its voltage transfer characteristics (VTC) and switching behavior. (Understand Level)
CO 3	Implement functions using Static CMOS and Dynamic logic (Apply Level)
CO 4	Various sources of power dissipation in VLSI circuits (Understand Level)
CO 5	Implement the layout of NAND and NOR gates. (Apply Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	✓											
CO 2	✓											
CO 3	✓											
CO 4	✓											
CO 5	✓											

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓		✓
Understand	✓	✓		✓
Apply	✓	✓		✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA

Course Structure [L-T-P-J]	Attendance	Assignment	Theory [L- T]		Total Marks
			Test-1	Test-2	
4-0-0-0	5	15	10	10	**40**

Total Mark distribution			
Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 Hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I: Introduction to ASIC and FPGA Design Flow (6 Hours)

Introduction to VLSI Design, ASIC and FPGA design flow, Top down and bottom up design Methodologies, Full custom and semi Custom ASIC

MODULE II: CMOS Inverters (6 Hours)

MOS Transistor basics , Static CMOS logic: Complementary CMOS and Rationed logic , Static CMOS Inverter: VTC, Switching Threshold, Noise Margins.

MODULE III: Static and Dynamic Design (8 Hours)

Realization of logic functions with static CMOS logic, Pass transistor logic, and transmission gate logic.
Dynamic CMOS logic: Cascading issue in dynamic logic, Domino logic, Charge sharing in dynamic logic.

MODULE IV: Source of Power Dissipation in Circuits (7 Hours)

Dynamic Power Dissipation: Charging and Discharging capacitance power dissipation , Short Circuit Power: Short Circuit Current of Inverter , Glitching Power, Static Power Dissipation, Leakage Power Dissipation

MODULE V: Layout and Design Rules (8 Hours)

Layout 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.

Text books
1. N.H.E. Weste and D.M. Harris, CMOS VLSI design: A Circuits and Systems Perspective, 4th Edition, Pearson Education India, 2011.
2. Gray Yeap, Practical low power digital VLSI design, Springer, 1998

Reference books

1. Gray Ye Kaushik Roy, Sharat C Prasad, Low power CMOS VLSI circuit design, Wiley India, 2000
2. Sung –Mo Kang & Yusuf Leblebici, CMOS Digital Integrated Circuits- Analysis & Design, McGraw-Hill, Third Ed., 2003
3. S.M. SZE, VLSI Technology, 2/e, Indian Edition, McGraw-Hill,2003
4. Wayne Wolf ,Modern VLSI design, Third Edition, Pearson Education,2002.
5. NPTEL Course on Low Power VLSI Circuits & Systems by Prof. Ajit Pal
   https://archive.nptel.ac.in/courses/106/105/106105034/
6. NPTEL Course on CMOS Digital VLSI Design by Prof. S. Dasgupta
   https://archive.nptel.ac.in/courses/108/107/108107129/

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
MODULE I		
1.1	Introduction to VLSI Design	1
1.2	ASIC design flow	1
1.3	FPGA design flow	1
1.4	Top down and bottom-up design methodologies	1
1.5	Full custom ASIC	1
1.6	Semi-custom ASIC	1
MODULE II		
2.1	MOS Transistor basics	1
2.2	Static CMOS logic: Complementary CMOS and Rationed	1
2.3	Static CMOS Inverter	1
2.4	VTC of CMOS Inverter	1
2.5	Switching Threshold	1
2.6	Noise Margins.	1
MODULE III		
3.1	Basics of implementation of logic functions with static CMOS logic, Pass transistor logic, and transmission gate logic.	1
3.2	Realization of logic functions with static CMOS logic	1
3.3	Realization of logic functions with Pass transistor logic	1
3.4	Realization of logic functions with transmission gate logic.	1
3.5	Clocked Design: Dynamic CMOS logic: Cascading issue in dynamic logic, Domino logic, Charge sharing in dynamic logic.	1
3.6	Cascading issue in dynamic logic	1
3.7	Domino logic, Charge sharing in dynamic logic	1
3.8	Realization of logic functions with Dynamic logic	1

MODULE IV		
4.1	Dynamic Power Dissipation	1
4.2	Charging and Discharging capacitance power dissipation	1
4.3	Short Circuit Power	1
4.4	Short Circuit Current of Inverter	1
4.5	Glitching Power	1
4.6	Static Power Dissipation	1
4.7	Leakage Power Dissipation	1
MODULE V		
5.1	Layout and Design rules	1
5.2	Stick Diagram	1
5.3	Stick diagram of Basic Gates.	1
5.4	Stick diagram of given function	1
5.5	Design rules-micron rules and Lambda rules	1
5.6	layout of CMOS Inverter	1
5.7	layout of two input NAND gates	1
5.8	layout of two input NOR gates	1

CO Assessment Questions	
1	Explain full custom and semi-custom ASIC.
2	Describe the switching characteristics of Static CMOS inverter.
3	Implement universal gates using Static CMOS logic and Dynamic Logic
4	Explain the formation of Glitches and how it can be eliminated.
5	Obtain the layout of NAND Gate.

24ECM610	AUDIO AND SPEECH PROCESSING	L	T	P	J	S	C	Year of Introduction
		4	0	0	0	0	4	2024

Preamble: The Audio and Speech Processing minor course offers a comprehensive overview of the fundamental and advanced concepts in the field, tailored for students keen on exploring the intersection of technology and audio sciences. It covers a broad spectrum of topics, including the mechanics of speech production, digital signal processing, audio enhancement techniques, and the latest advancements in machine learning applications for voice technology. Through this course, students will gain valuable hands-on experience and a deep theoretical understanding, equipping them with the skills needed to innovate and excel in the rapidly evolving domain of audio and speech technologies.

Prerequisite: 24ECM410 Introduction to Digital Signal Processing

Course Outcomes: After the completion of the course the student will be able to

CO1	Understand speech production, human hearing, acoustics, and digital audio system principles. (Understand Level)
CO2	Acquire skills in audio digital signal processing and audio editing software. (Apply Level).
CO3	Learn advanced audio processing techniques with practical implementation. (Apply Level).
CO4	Understand speech signal processing fundamentals, including recognition and synthesis. (Understand Level)
CO5	Explore advanced audio and speech processing, focusing on machine learning applications. (Apply Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓											
CO2	✓				✓							✓
CO3	✓				✓							✓
CO4	✓											
CO5	✓				✓							

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyze				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
4–0–0-0	5	15	10	10	**40**

Total Mark distribution			
Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 Hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks)	60
	Total Marks: 20	Total Marks: [40 marks]	

SYLLABUS (48 Hours)

MODULE 1: Introduction to Audio and Speech Processing (9 Hours)

Introduction to speech production mechanism, Human hearing mechanism, masking, Introduction to acoustics and psychoacoustics, Basics of audio signals: Analog vs. Digital Audio, Overview of digital audio systems and perception, Applications of audio and speech processing.

MODULE II: Fundamentals Of Digital Signal Processing for Audio (13 Hours)

Stationary and non-stationary processes, STFT, Time and frequency domain representation of audio signals, Fourier transform and its applications in audio processing, Digital filters and their applications in audio processing, Hands-on session: Working with audio editing software.

MODULE III: Audio Processing Techniques (9 Hours)
Audio signal enhancement and noise reduction, Echo and reverberation, Audio compression techniques and standards (e.g., MP3, AAC), Spatial audio processing: Basics of 3D sound and surround sound technologies, Hands-on session: Implementing audio effects and understanding audio codecs.

MODULE IV: Speech Signal Processing (9 Hours)
Vocal tract model of speech production, Pitch, formant, time domain and frequency domain analysis, spectrogram, Feature extraction from speech (e.g., MFCC, LPC), Basics of speech coding, transform coding, Introduction to Automatic Speech Recognition (ASR), Text-to-Speech (TTS) systems, Hands-on session: Building a simple speech recognition and synthesis system.

MODULE V: Advanced Topics and Applications (8 Hours)
Overview of machine learning in audio and speech processing, Speech enhancement and separation techniques, Biometric authentication using voice recognition, Voice-enabled technology and intelligent assistants.

Text books

1. Gold, B., Morgan, N., & Ellis, D. (2005). *Speech and Audio Signal Processing: Processing and Perception of Speech and Music*. Wiley-Interscience.
2. Quatieri, T. F. (2002). *Discrete-Time Speech Signal Processing: Principles and Practice*. Prentice Hall.

Reference books

1. Proakis, J. G., & Manolakis, D. K. (2006). *Digital Signal Processing: Principles, Algorithms, and Applications* (4th ed.). Prentice-Hall.
2. Smith, S. W. (1997). *The Scientist and Engineer's Guide to Digital Signal Processing*. California Technical Publishing.
3. Rabiner, L., & Juang, B. H. (1993). *Fundamentals of Speech Recognition*. Prentice Hall.
4. Spanias, A., Painter, T., & Atti, V. (2007). *Audio Signal Processing and Coding*. Wiley-Interscience.
5. Camastra, F., & Vinciarelli, A. (2008). *Machine Learning for Audio, Image and Video Analysis: Theory and Applications*. Springer.
6. Zamparas, V. (2019). *Hands-On Signal Processing with Python: Perform Digital Signal Processing and Signal Analysis with Python*. Packt Publishing.
7. Speech and Audio Processing by Prof. Ambikairajah UNSW eLearning https://www.youtube.com/playlist?list=PLA480D1979B10D8F5
8. Speech Processing (2/2020, KMUTT) https://www.youtube.com/playlist?list=PLASRwO_UDeJUQhA6dbymIEMvhlBm7Fzuk

No.	COURSE CONTENTS AND LECTURE SCHEDULE	No. of Hours
	MODULE 1	
1.1	Introduction to the Module and Speech Production Mechanism-Overview of the module, Basic concepts of speech production mechanism	1
1.2	Human Hearing Mechanism-Anatomy and function of the human auditory system, Basic principles of hearing	1
1.3	Masking in Audio and Speech-Concept of auditory masking, Its relevance in audio processing	1
1.4	Introduction to Acoustics- Fundamental concepts of acoustics, The science of sound and its propagation	1
1.5	Introduction to Psychoacoustics - Psychoacoustics and human perception of sound, The psychological interpretation of audio	1
1.6	Basics of Audio Signals: Analog Audio - Understanding analog audio signals, Characteristics and processing of analog audio	1
1.7	Basics of Audio Signals: Digital Audio-Transition from analog to digital audio, Digital audio signal processing fundamentals	1
1.8	Overview of Digital Audio Systems and Perception-Components and functioning of digital audio systems, Perception of digital audio	1
1.9	Applications of Audio and Speech Processing-Exploring various applications in the field, Current trends and future prospects in audio and speech processing	1
	MODULE II	
2.1	Introduction to Digital Signal Processing for Audio-Overview of digital signal processing in audio, Distinction between analog and digital processing	1
2.2	Stationary Processes in Audio-Understanding stationary processes, Applications in audio signal processing	1
2.3	Non-Stationary Processes in Audio-Exploring non-stationary processes, Their relevance in dynamic audio environments	1
2.4	Introduction to the Short-Time Fourier Transform (STFT)-Basic principles of STFT, Its importance in audio analysis	1
2.5	Advanced Concepts in STFT-Practical applications and examples of STFT in audio processing	1
2.6	Time Domain Representation of Audio Signals-Analyzing audio signals in the time domain, Techniques and tools for time domain analysis	1

2.7	Frequency Domain Representation of Audio Signals-Understanding frequency domain analysis, Tools and applications in audio processing	1
2.8	Introduction to Fourier Transform in Audio-Basics of Fourier Transform, Theoretical concepts and mathematical foundations	1
2.9	Applications of Fourier Transform in Audio Processing-Practical examples and case studies in audio processing using Fourier Transform	1
2.10	Basics of Digital Filters-Introduction to digital filters in audio, Types and characteristics of digital filters	1
2.11	Applications of Digital Filters in Audio Processing, Implementing digital filters in practical audio processing scenarios	1
2.12	Hands-on Session with Audio Editing Software (Part 1)-Introduction to audio editing software, Basic operations and tools.	1
2.13	Hands-on Session with Audio Editing Software (Part 2)-Advanced techniques in audio editing, Practical exercises and projects	1
MODULE III		
3.1	Introduction to Audio Signal Enhancement-Overview of audio signal enhancement techniques, Basic principles and applications	1
3.2	Noise Reduction Techniques in Audio Processing-Understanding different noise reduction strategies, Practical examples and use-cases	1
3.3	Fundamentals of Echo and Reverberation in Audio, Theoretical concepts of echo and reverberation, Their impact on sound quality	1
3.4	Advanced Echo and Reverberation Techniques-Practical techniques for managing echo and reverberation in audio processing	1
3.5	Introduction to Audio Compression Techniques-Understanding the need for audio compression, Basic techniques and methodologies	1
3.6	Standards in Audio Compression (e.g., MP3, AAC)-Overview of popular audio compression standard, Comparative analysis and usage scenarios	1
3.7	Basics of Spatial Audio Processing-Introduction to 3D sound and surround sound technologies, Concepts and principles of spatial audio	1

3.8	Advanced Spatial Audio Processing Techniques-In-depth exploration of spatial audio processing methods, Practical applications and current trends	1
3.9	Hands-on Session: Implementing Audio Effects and Understanding Audio Codecs-Practical implementation of audio effects, Working with different audio codecs, Interactive session	1
MODULE IV		
4.1	Introduction to Vocal Tract Modelling in Speech Production- Basic principles of the vocal tract model, how it relates to speech production	1
4.2	Understanding Pitch in Speech Processing-Concepts of pitch in speech, Techniques for pitch analysis	1
4.3	Formant Analysis in Speech Processing-Introduction to formants in speech, Methods for formant analysis and its significance	1
4.4	Time Domain Analysis of Speech-Exploring speech signal in the time domain, Techniques and tools for analysis	1
4.5	Frequency Domain Analysis and Spectrograms-Understanding speech signals in the frequency domain, Use of spectrograms in speech analysis	1
4.6	Feature Extraction from Speech (MFCC, LPC)-Introduction to key features in speech like MFCC and LPC, Methods and applications of feature extraction	1
4.7	Basics of Speech Coding and Transform Coding-Understanding the principles of speech coding, Introduction to transform coding techniques	1
4.8	Introduction to Automatic Speech Recognition (ASR) and Text-to-Speech (TTS) System-Basic concepts and technologies in ASR and TTS, Overview of system architectures and applications	1
4.9	Hands-on Session: Building a Simple Speech Recognition and Synthesis System-Practical implementation of speech recognition and synthesis, Step-by-step guidance to build a	1
MODULE V		
5.1	Introduction to Machine Learning in Audio and Speech Processing-Overview of the role of machine learning in audio and speech processing, Basic principles and applications	1
5.2	Advanced Machine Learning Techniques in Audio Processing-Exploring specific machine learning algorithms and their applications in audio enhancement	1
5.3	Machine Learning in Speech Processing-Application of machine learning for speech signal analysis and processing	1

5.4	Speech Enhancement Techniques-Understanding various techniques for speech signal enhancement, Real-world applications and case studies	1
5.5	Speech Separation Techniques-Techniques and algorithms for separating speech from noise, Challenges and solutions in speech separation	1
5.6	Biometric Authentication Using Voice Recognition-Fundamentals of voice biometrics, Implementing voice recognition for authentication purposes	1
5.7	Introduction to Voice-Enabled Technology-Exploring the development and use of voice-enabled technologies, Current trends and future directions	1
5.8	Intelligent Assistants and Advanced Applications-The role of intelligent assistants in audio and speech processing, Discussion on emerging technologies and future applications in field	1

CO Assessment Questions	
1	1. Describe the basic mechanism of speech production and explain how the human hearing system processes these sounds. 2. Discuss the role of the vocal tract and auditory nerves in this process. 3. Explain the fundamental principles of acoustics and psychoacoustics. 4. How do these principles relate to the perception of sound, and what are their implications for audio signal processing? 5. Compare and contrast analog and digital audio systems. Provide examples of applications in audio and speech processing where the transition from analog to digital has significantly impacted the field. Include a discussion on the perception of digital audio in your response.
2	Write a Python program to demonstrate the concepts of stationary and non-stationary processes, Fourier Transform, and digital filtering in audio signal processing. Your program should: 1. Load two audio samples: one representing a stationary process (like a constant tone) and another representing a non-stationary process (like a speech recording). Visualize their waveforms. 2. Perform and display the Fourier Transform of both audio samples to illustrate the frequency domain representation. 3. Apply a digital filter (e.g., low-pass, high-pass, band-pass, or band-stop) to one of the audio samples. Choose a filter based on the sample's characteristics and explain your choice. Visualize the audio signal before and after filtering, and discuss the effect of the filter on the audio signal.

3	Implement a Python project that demonstrates key concepts in audio processing: signal enhancement and audio compression. Your project should include: Audio Signal Enhancement and Noise Reduction: 1. Load an audio file with noticeable noise. 2. Implement and apply noise reduction techniques to enhance the audio quality. 3. Visualize and play both the original and enhanced audio files. Discuss how the enhancement technique improved the audio quality. Audio Compression: 1. Load a high-quality audio file. 2. Compress the audio using techniques similar to MP3 or AAC standards (you may use available libraries). 3. Compare the file size and quality of the original and compressed audio. Discuss the trade-offs in terms of file size reduction and perceived audio quality.
4	1. Explain the vocal tract model of speech production and its significance in speech signal processing. How do pitch, formant, and spectrogram analyses assist in understanding and processing speech signals? 2. Discuss the importance of feature extraction in speech processing, focusing on methods like Mel-Frequency Cepstral Coefficients (MFCC) and Linear Predictive Coding (LPC). Provide an example of how these features are used in a practical application, such as in speech recognition or speaker verification. 3. Describe the fundamental principles behind Automatic Speech Recognition (ASR) and Text-to-Speech (TTS) systems. What are the key challenges in developing these systems, and how do they impact their performance in real-world applications?
5.	Develop a speaker recognition system in Python using machine learning algorithms.

24ECM611	RADAR & NAVIGATION	L	T	P	J	S	C	Year of Introduction
		4	0	0	0	0	4	2024

Preamble: This course provides comprehensive understanding of the principles, technologies and applications of radar system and navigation techniques. Students will explore the various fields of radar and its types, signal detection and information extraction, signal analysis and navigation applications. The Radar and Navigation course offers an in depth exploration of the principles, technologies and applications of Radar system and Navigation techniques.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO1	Familiarize the fundamentals and principle of operation of radar. (Understand level)
CO2	Illustrate the working of different types of radar systems. (Apply level)
CO3	Illustrate detection of radar signal, information extraction and estimation. (Apply level)
CO4	Explain the various processes involved in radar signal processing. (Understand level)
CO5	Identify the various fields of application of radar. (Understand level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓										
CO2	✓	✓										
CO3	✓	✓										
CO4	✓	✓										
CO5	✓	✓										

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test2	Other tools	
Remember	✓	✓		✓
Understand	✓	✓		✓
Apply	✓	✓		✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA						
Course Structure [L-T-P-J]	Attendance	Theory [L- T]				Total Marks
		Assignment	Test-1	Test-2		
4-0-0-0	5	15	10	10		**40**

Total Mark Distribution			
Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 Hours

End Semester Examination [ESE]: Pattern

SYLLABUS (48 Hours)

MODULE I: Radar Fundamentals (10 Hours)

Radar fundamentals and operation: Introduction, principles, types of radar, pulse and moving target indication radar, transmitter functions, wave form spectra, receiver functions, signal processing, Radar range equation, Radar cross section, Doppler Effect, Display methods, Instrument Landing System – Ground Controlled Approach System.

MODULE II: Radar Systems (10 Hours)

Radar Systems: Pulse, CW, FM-CW, MTI, Doppler and multimode techniques, Tracking Radar: Tracking Radar: Types of Tracking Radar Systems, Monopulse Tracking – Amplitude Comparison Monopulse (One and Two Coordinates) Tracking system parameters, Conical Scan, amplitude comparison DTOA and phase interferometry. Range and velocity tracking, Tracking accuracy, types of antennas used in radar systems.

MODULE III : Signal Detection & Information Extraction (10 Hours)

Detection of Radar Signals and information extraction and estimation: Detection introduction, threshold detection, Signal integration, Binary integrators, CFAR, Theoretical accuracy of radar measurements, ambiguity function and radar waveform design, correlation detection and matched filter receiver.

MODULE IV : Signal Analysis (9 Hours)

Radar signal processing: Spatial resolution, Sampling Theory, Correlation, Signal integration, spectrum analysis, windowing and resolution, MTI -principles and methods, De staggering and processing, Moving Radars and moving clutter, Doppler processing.

MODULE V : Applications (9 Hours)	
Radar Applications: Direction finders, instrument landing systems, Radar beacons, high resolution radar, range and Doppler resolution, Radio navigation systems, Hyperbolic navigation systems, Satellite Navigation systems.	

Text books

1. Skolnik M.M.; Introduction to Radar systems, McGraw Hill, (Second Edition) 1981.

2. Mark A. Richards, William A. Holm, James A. Scheer, Principles of Modern Radar: Volume 1: Basic principles (Radar, Sonar and Navigation), 2010.
3. J. C. Toomay, Paul Hannen "Radar Principles for the Non-Specialist", SolTech Pub. 2004.

4. Clive Alabaster, Pulse Doppler Radar: Principles, Technology, Applications

Reference books

1. Byron Edde: Radar: principles, technology, and applications Pearson Education Inc., 1995.

2. D Curtis Scheleher: Introduction to Electronic Warfare Artech House Inc.,1986.

3. Wheeler G.J: Radar Fundamentals; Prentice Hall Inc. NJ 1967.

4. Samuel M. Sherman, David K. Barton, Monopulse Principles and Techniques.

5. William L. Melvin, James A. Scheer, Principles of Modern radar: Advanced Techniques.
   Online Resources:
6. NPTEL course on Principles and techniques of Modern Radar Systems by IIT Kharagpur - https://archive.nptel.ac.in/courses/108/105/108105154/

COURSE CONTENTS AND LECTURE SCHEDULE	

No.		No. of Hours
MODULE 1		
1.1	Radar Fundamentals and Operation: Introduction, Basic Radar System – Detection and Ranging	1
1.2	Applications - Radar Bands and Usage	1
1.3	Types of radar – Pulse Radar – Basic Pulsed Radar System – Block Diagram	1
1.4	Moving Target Indication Radar – Doppler Effect – Time Delay Ranging	1
1.5	Transmitter Functions, Wave Form Spectra	1
1.6	Receiver Functions, Signal Processing	1
1.7	Radar range equation (Qualitative Treatment only)	1
1.8	Factors Influencing Maximum Range - Radar cross section	1

1.9	Display Methods – Radar A - Scope, Plan Position Indicator display	1
1.10	Instrument Landing System – Ground Controlled Approach System	1
MODULE II		
2.1	Radar Systems: Pulse Radar, Continuous Wave Radar – Unmodulated Continuous Wave Radar and Frequency Modulated Continuous Wave Radar	1
2.2	Moving Target Indication Radar - Doppler and multimode techniques	1
2.3	Tracking Radar: Types of Tracking Radar Systems, Monopulse Tracking	1
2.4	Amplitude Comparison Monopulse (One and Two Coordinates)	1
2.5	Tracking system parameters, Conical Scan Tracking	1
2.6	Conical Scan Tracking – Block Diagram of Conical Scan Tracking Radar	1
2.7	Differential Time of Arrival and phase interferometry	1
2.8	Solving questions based on DTOA	1
2.9	Range and velocity tracking, Tracking accuracy	1
2.10	Types of antennas used in radar systems	1
MODULE III		
3.1	Detection of Radar Signals – Introduction, Matched Filter Receiver	1
3.2	Matched Filter Receiver – Response Characteristics and Derivation	1
3.3	Correlation Function and Cross- Correlation Receiver,	1
3.4	Efficiency of Non-Matched Filters, Threshold detection,	1
3.5	Signal integration, Binary integrators	1
3.6	Constant False Alarm Rate – Principle, Cell Averaging CFAR	1
3.7	Theoretical accuracy of radar measurements	1
3.8	Ambiguity function and radar waveform design	1
3.9	Solving tutorial questions	1
3.10	Radar Receivers – Noise Figure and Noise Temperature	1
MODULE IV		
4.1	Radar signal processing: Spatial resolution	1
4.2	Sampling Theory, Correlation methods	1
4.3	Interference suppression, Imaging, Detection	1
4.4	Signal integration, spectrum analysis	1
4.5	Spectrum analysis: Windowing and resolution	1
4.6	Moving Target Indication Radar -principles and methods	1
4.7	De staggering and processing methods	1

4.8	Moving Radars and moving clutter	1
4.9	Doppler effect, Doppler processing	1

MODULE V		
5.1	Radar Applications: Methods of Navigation, Direction finders, Loop Antenna	1
5.2	Instrument landing systems (ILS) – Elements, Localizer, Glide Slope	1
5.3	Radar beacons, Lighting Systems, Operation, Limitation	1
5.4	Radio Navigation Systems – Radio Compass Automatic Direction Finder, Types	1
5.5	Hyperbolic Navigation Systems – Basic Principle, LORAN (Long Range Navigation)	1
5.6	Radio Ranges – VOR – Ground Equipment	1
5.7	VOR Receiver –Doppler VOR	1
5.8	Satellite Navigation Systems – Global Positioning System,	1
5.9	Differential Global Positioning System (Concept only)	1

CO Assessment Questions	
1	Describe the simplified version of radar range equation and explain how this equation does not adequately describe the performance of practical radar?
2	Explain the working of a pulsed radar and moving target indication radar.
3	How the interference from other radars is reduced in pulse radar? Describe how threshold level for detection is decided in the presence of receiver noise for a specified probability of occurrence of false alarms.
4	What is Doppler frequency shift? Establish a relation between Doppler frequency shift and radial velocity of a moving target.
5	Define blind speed and explain how it can be overcome practically in a radar system.
6	Describe the simplified version of radar range equation and explain how this equation does not adequately describe the performance of practical radar?

HONORS
VI SEMESTER

24ECH609	BIOMEDICAL SIGNAL PROCESSING	L	T	P	J	S	C	Year of Introduction
		4	0	0	0	0	4	2024

Preamble: Biomedical Signal Processing bridges the gap between engineering and medicine, translating intricate physiological signals into actionable medical information. This course guides students through foundational concepts, signal enhancement, advanced analysis techniques, and emerging trends such as AI integration and wearable devices. Upon completion, students will be adept at handling and interpreting complex biomedical data, poised to drive innovations in healthcare and advanced research.

Prerequisite: 24ECT402 Signals and Systems, 24ECJ502 Digital Signal Processing

Course Outcomes: After the completion of the course the student will be able to

CO 1	Understand and Interpret Biomedical Signals. (Understand Level)
CO 2	Perform Signal Enhancement and Noise Reduction. (Apply Level)
CO 3	Extract Relevant Features and Employ Pattern Recognition. (Apply Level)
CO 4	Implement Advanced Analysis Techniques on Biomedical Signals. (Apply Level)
CO 5	Recognize and Forecast Trends in Biomedical Signal Processing. (Understand Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	✓	✓			✓							✓
CO 2	✓		✓		✓							
CO 3	✓	✓		✓	✓							
CO 4	✓		✓		✓							
CO 5	✓					✓	✓					

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
4-0-0-0	5	15	10	10	**40**

Total Mark Distribution			
Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I: Introduction to Biomedical Signals (8 Hours)

Overview of Biomedical Signals and Devices: Introduction to Biomedical Devices, Origin, Characteristics, Importance. Types of Biomedical Signals: Electrocardiogram (ECG), Electroencephalogram (EEG), Electromyogram (EMG), etc. Time and Frequency Domain Representations. Noise and Artifacts in Biomedical Signals. Basic Equipment for Biomedical Signal Acquisition.
(Practical Session on Signal Acquisition and Analysis.)

MODULE II: Signal Enhancement and Filtering (10 Hours)

Basics of Signal Processing: Convolution, Correlation, Fourier Transforms, Noise in Biomedical Signals: Origins and Types. Filters: Basics, IIR, FIR, Adaptive Filters. Applications: Baseline Wander Removal, Power Line Interference Removal. Wavelet Transforms: Basics, Applications in Denoising and Feature Extraction. Design and Implementation of Digital Filters for Biomedical Applications.

(Workshop on Noise Reduction and Signal Enhancement Techniques).

MODULE III: Feature Extraction and Pattern Recognition (10 Hours)

Importance of Feature Extraction: Characteristics and Patterns, Techniques: Time-domain Analysis, Frequency-domain Analysis, Time-frequency Representations. Introduction to Pattern Recognition: Classifiers, Training and Testing Data. Common Algorithms: K-Nearest Neighbors (KNN), Decision Trees, Support Vector Machines (SVM), Deep Learning, Applications: Arrhythmia Detection, Sleep Stage Classification. Case Studies on Pattern Recognition in Biomedical Signals. (Hands-on Machine Learning Workshop for Biomedical Data).

MODULE IV: Advanced Biomedical Signal Analysis (12 Hours)

Nonlinear Dynamics: Chaos, Lyapunov Exponents, Fractals, Entropy-based Measures: Applications in EEG Analysis. Source Separation: Independent Component Analysis (ICA), Blind Source Separation (BSS). Parametric Modeling: Autoregressive (AR) Models, Moving Average (MA) Models. Advanced Techniques: Empirical Mode Decomposition (EMD), Hilbert-Huang Transform. Deep Dive into Advanced Signal Processing Techniques, Interactive Lab Session on Parametric and Non-parametric Modeling.

MODULE V: Applications and Trends in Biomedical Signal Processing (9 Hours)

Telemedicine and Remote Monitoring, Wearable Devices and Continuous Monitoring, Brain-Computer Interfaces (BCI): Principles, Techniques, Applications, Biometrics: ECG-based Authentication, Voice Recognition, Future Trends: Integration of AI and Deep Learning in Biomedical Signal Analysis.
Guest Lecture Series on Current Research and Innovations in Biomedical Signal Processing.

Text books

1. Bruce, Eugene N. "Biomedical signal processing and signal modeling." Wiley Student Edition, 2007
2. Reddy, D. C. "Biomedical signal processing: principles and techniques." (2005).
3. Rangaraj M. Rangayyan, Biomedical Signal Analysis: A Case–Study Approach, Wiley Student Edition, 2010

Reference books

1. Cerutti, Sergio, and Carlo Marchesi, eds. Advanced methods of biomedical signal processing. Vol. 27. John Wiley & Sons, 2011.
2. Shiavi, Richard. Introduction to applied statistical signal analysis: Guide to biomedical and electrical engineering applications. Elsevier, 2010.
3. Bishop, C.M. and Nasrabadi, N.M., 2006. Pattern recognition and machine learning (Vol. 4, No. 4, p. 738). New York: springer.

4. Schneider, M. "Brain-Computer Interfaces: Principles and Practice, eds JR Wolpaw and EW Wolpaw." (2012).
5. Zhou, S. Kevin, Hayit Greenspan, and Dinggang Shen, eds. Deep learning for medical image analysis. Academic Press, 2017.
6. NPTEL Videos: https://archive.nptel.ac.in/courses/108/105/108105101/

Assignments/Practical Work

1. Hands-on sessions for signal acquisition, preprocessing, feature extraction, and classification using MATLAB, Python, or any relevant software.
2. Analysis of real or simulated biomedical signals like ECG, EEG, and EMG.
3. Implementation of various signal processing techniques and validation of their efficiency.

Project Work:
Students should take on a project that deals with real-world biomedical signal data, such as developing an arrhythmia detection system or a sleep stage classifier. The project should cover signal preprocessing, feature extraction, and classification.

No.	COURSE CONTENTS AND LECTURE SCHEDULE	No. of Hours
MODULE 1		
1.1	Overview of Biomedical Signals: Origin, Characteristics and Importance.	1
1.2	Types of Biomedical Signals: Electrocardiogram (ECG) Electroencephalogram (EEG), Electromyogram (EMG)	1
1.3	Time and Frequency Domain Representations	1
1.4	Noise and Artifacts in Biomedical Signals	1
1.5	Basic Equipment for Biomedical Signal Acquisition	1
1.6	Practical Session on Signal Acquisition and Analysis	1
1.7	Practical Session on Signal Acquisition and Analysis	1
MODULE II		
2.1	Basics of Signal Processing: Convolution, Correlation, Fourier Transforms	1
2.2	Basics of Signal Processing: Convolution, Correlation, Fourier Transforms	1
2.3	Noise in Biomedical Signals: Origins and Types	1
2.4	Filters: Basics, IIR, FIR, Adaptive Filters	1
2.5	Filters: Basics, IIR, FIR, Adaptive Filters	1
2.6	Applications: Baseline Wander Removal, Power Line Interference Removal	1

2.7	Wavelet Transforms: Basics, Applications in Denoising and Feature Extraction	1
2.8	Wavelet Transforms: Basics, Applications in Denoising and Feature Extraction	1
2.9	Implementation of Digital Filters for Biomedical Applications	1
2.10	Workshop on Noise Reduction and Signal Enhancement Techniques	1
MODULE III		
3.1	Importance of Feature Extraction: Characteristics and Patterns	1
3.2	Techniques: Time-domain Analysis, Frequency-domain Analysis, Time-frequency Representations	1
3.3	Introduction to Pattern Recognition: Classifiers, Training and Testing Data	1
3.4	Common Algorithms: K-Nearest Neighbors (KNN), Decision Trees, Support Vector Machines (SVM)	1
3.5	Common Algorithms: K-Nearest Neighbors (KNN), Decision Trees, Support Vector Machines (SVM)	1
3.6	Common Algorithms: K-Nearest Neighbors (KNN), Decision Trees, Support Vector Machines (SVM)	1
3.7	Applications: Arrhythmia Detection, Sleep Stage Classification	1
3.8	Case Studies on Pattern Recognition in Biomedical Signals	1
3.9	Hands-on Machine Learning Workshop for Biomedical Data	1
3.10	Hands-on Machine Learning Workshop for Biomedical Data	1
MODULE IV		
4.1	Introduction to Advanced Biomedical Signal Analysis-Overview of advanced techniques, Importance in biomedical applications	1
4.2	Non-linear Dynamics in Biomedical Signals-Introduction to chaos theory, Relevance to biomedical signal processing	1
4.3	Understanding Lyapunov Exponents-Definition and mathematical background, Practical computation of Lyapunov exponents	1
4.4	Fractals in Biomedical Signal Analysis-Fractal geometry in biological systems, Fractal dimension and its calculation	1
4.5	Entropy-based Measures for EEG Analysis-Entropy as a measure of complexity, Applications in analyzing EEG signals	1
4.6	Source Separation Techniques - Part 1-Introduction to Independent Component Analysis (ICA), Use cases in biomedical signal separation	1
4.7	Source Separation Techniques - Part 2-Introduction to Blind Source Separation (BSS), Differentiating BSS from ICA with examples	1

4.8	Parametric Modeling with AR Models-Fundamentals of Autoregressive Models, Fitting AR models to biomedical signals	1
4.9	Moving Average (MA) Models in Signal Processing-Theory behind MA models, Application in smoothing biomedical data	1
4.10	Empirical Mode Decomposition (EMD)-Introduction to EMD, Application in non-stationary signal analysis	1
4.11	Hilbert-Huang Transform for Biomedical Applications-Combining EMD with Hilbert Spectral Analysis, Case studies in biomedical signal processing	1
4.12	Interactive Lab Session-Hands-on practice with parametric and non-parametric modeling, Implementing advanced signal processing techniques on real biomedical data	1
MODULE V		
5.1	Telemedicine and Remote Monitoring.	1
5.2	Wearable Devices and Continuous Monitoring	1
5.3	Brain-Computer Interfaces (BCI): Principles, Techniques, Applications	1
5.4	Biometrics: ECG-based Authentication,	1
5.5	Voice Recognition	1
5.6	Future Trends: Integration of AI and Deep Learning in Biomedical Signal Analysis.	1
5.7	Future Trends: Integration of AI and Deep Learning in Biomedical Signal Analysis.	1
5.8	Guest Lecture Series on Current Research and Innovations in Biomedical Signal Processing.	1
5.9	Guest Lecture Series on Current Research and Innovations in Biomedical Signal Processing.	1

CO Assessment Questions	
1	Given a raw biomedical signal: 1. Identify and label the signal type (e.g., ECG, EEG, EMG). 2. Describe the origin and physiological significance of the chosen signal. 3. Represent the signal in the frequency domain using MATLAB/Python and provide an analysis of its primary components. 4. Highlight any potential noise or artifacts visible in the signal and explain their probable sources. 5. Describe the equipment typically used for the acquisition of this signal type and their primary roles in the acquisition process.
2	You are presented with an ECG signal contaminated with baseline wander and power line interference. 1. Describe the sources and characteristics of the noises present.

	2. Choose a suitable filtering technique (IIR, FIR, or adaptive filter) to mitigate each type of noise. Justify your choice. 3. Explain the basic principles behind the chosen filtering techniques. 4. Given the opportunity to use wavelet transform, describe how it could assist in denoising the signal. 5. After applying the chosen filters, compare and analyze the original and filtered signals in both time and frequency domains.
3	You are provided with a set of EEG signals from different sleep stages. 1. Employ time-domain analysis to extract relevant features from the EEG signals. Detail the features you've chosen and their significance. 2. Transform the signal to the frequency domain and identify key spectral components associated with different sleep stages. 3. Choose a pattern recognition algorithm (K-Nearest Neighbors, Decision Trees, or Support Vector Machines) suitable for classifying the EEG signals into their respective sleep stages. Justify your choice. 4. Discuss how you would partition the data into training and testing sets, ensuring a robust classification. 5. Describe potential challenges and limitations in using the chosen pattern recognition method for this application.
4	You are given an EEG signal that exhibits non-linear characteristics associated with a specific neurological condition. 1. Explain the concept of non-linear dynamics and its relevance to biomedical signal analysis. 2. Utilizing the principles of entropy-based measures, assess the complexity of the EEG signal provided and interpret the results in the context of the neurological condition. 3. Describe the application of Independent Component Analysis (ICA) in biomedical signals and illustrate how it could be used to segregate source signals in this EEG data. 4. Propose a suitable parametric model (AR or MA) to analyze the EEG signal and justify your choice based on the characteristics of the signal. 5. Discuss the advantages and limitations of using Empirical Mode Decomposition (EMD) in processing and analyzing EEG signals like the one provided. (Note: For this assessment question, a suitable EEG signal displaying non-linear characteristics should be provided to the students.)
5	You are working for a healthcare technology company that aims to develop a wearable device for continuous health monitoring, integrating Brain-Computer Interfaces (BCI) and biometric authentication. 1. Discuss the importance of telemedicine and remote monitoring in the context of your device and its potential impact on healthcare. 2. Describe the fundamental principles of Brain-Computer Interfaces

(BCI) and how they can be integrated into your wearable device.

3. Explain how continuous monitoring using wearable devices can leverage advanced biomedical signal processing techniques for more accurate and timely health insights.

4. Propose an ECG-based biometric authentication system for the device, detailing its advantages over other authentication methods.

5. Highlight and discuss potential future trends or advancements that could enhance or redefine the capabilities of your proposed wearable device.

(Note: This assessment question is designed to be open-ended, encouraging students to integrate multiple aspects of the syllabus and think creatively about applications and trends in biomedical signal processing.)

24ECH610	ROBOTICS AND ARTIFICIAL INTELLIGENCE	L	T	P	J	S	C	Year of Introduction
		4	0	0	0	0	4	2024

Preamble: This comprehensive course in Robotics and Artificial Intelligence offers an in-depth exploration of the integration of cutting-edge AI technologies with advanced robotic systems. Covering five key modules, the course delves into the history and components of robotics, robot kinematics and dynamics, trajectory planning, and advanced AI applications in robotics, including deep learning and swarm robotics. Students will emerge with a profound understanding of both theoretical and practical aspects of robotics and AI, equipped with the skills necessary for innovative problem-solving and advancement in the rapidly evolving field of robotics.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO1	Understand the history and types of robotics, and effectively choose and use sensors, actuators, and end effectors for various robots. (Understand Level)
CO2	Master robot kinematics, including forward and inverse analyses, coordinate systems, and manipulator Jacobian applications. (Understand Level)
CO3	Effectively model and analyze robotic manipulator dynamics using Lagrange and Newton-Euler equations. (Analyze Level)
CO4	Skilled in robotic trajectory planning and will apply their knowledge in a practical workshop to build a line-following robot. (Apply Level)
CO5	Equipped to apply AI techniques such as deep learning and reinforcement learning in various robotics scenarios, including object detection and human-robot interaction. (Apply Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓											
CO2	✓											
CO3	✓	✓										
CO4	✓				✓							✓
CO5	✓				✓							✓

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test2	Other tools	
Remember	✓	✓		✓
Understand	✓	✓		✓
Apply	✓	✓	✓	✓
Analyse			✓	
Evaluate				
Create				

Mark Distribution of CIA						
Course Structure [L-T-P-J]	**Attendance**	**Theory [L- T]**				**Total Marks**
		Assignment	**Test-1**	**Test-2**		
4-0-0-0	5	15	10	10		**40**

Total Mark Distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 Hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS (48 Hours)

MODULE I: Introduction to Robotics (9 Hours)

Robotics: History, Evolution, and Categories (Manipulators, Mobile Robots, Aerial Robots), Basic Components of Robots: Actuators, Sensors, End Effectors.

Sensor Types: Choosing the right sensor: Acoustic sensors, optic, vision, pneumatic, force/torque sensors, optical encoder.

Actuators and Grippers: Electric, Hydraulic, Pneumatic, Selection of Motors, Grippers.

MODULE II: Robot Kinematics (10 Hours)
Kinematics: Forward and Inverse position analysis – Robot specifications, Work envelope of different robots, Classification of Robots. Robot Coordinate Systems- Fundamental and composite rotations, homogeneous co-ordinates and transformations, Kinematic parameters. The Arm Equation-Kinematic analysis of a typical robot. The inverse kinematics problem- general properties of solutions, Inverse kinematics of typical manipulator Robot. Linear and angular velocities of a rigid body; Manipulator Jacobian.
MODULE III: Robot Dynamics (10 Hours)
Manipulator Dynamics- Lagrange equations, Dynamics of two link planar robot, Newton-Euler equations of rigid body, Dynamic model of a robot using Lagrange's Equation, 1 DOF and 2 DOF manipulator dynamic modelling.
MODULE IV: Trajectory Planning (10 Hours)
Definition and Planning Task, Steps in Trajectory Planning, Joint Space Techniques, Cartesian Space Techniques, Join Space versus Cartesian space trajectory planning. (Workshop: Design and development of line following Robot).
MODULE V: Advanced Topics in AI for Robotics (9 Hours)
Applications of AI in Robotics: Perception, Decision Making, Control. Reinforcement Learning, Deep Learning for Vision: Convolutional Neural Networks (CNNs) in Object Detection, Semantic Segmentation. Robot Learning from Demonstration: Imitation Learning, Transfer Learning. Recurrent Neural Networks (RNNs) for Sequence Predictions in Robotics. Generative Models. Multi-Robot Systems: Cooperative behaviors, Swarm robotics. Human-Robot Interaction.

Text books
1. S. K. Saha, Introduction to Robotics, McGraw Hill Education India.
2. R. K. Mittal, and I J Nagrath, Robotics and Control, McGraw Hill Education India.
3. Russell, S., & Norvig, P. (2020). *Artificial Intelligence: A Modern Approach* (4th ed.), Pearson.

Reference books
1. Murphy, R. R. (2019). *Introduction to AI Robotics* (2nd ed.). The MIT Press.
2. Siciliano, B., Khatib, O., Groover, M. P., & Sciavicco, L. (2016). *Springer Handbook of Robotics.* Springer International Publishing.
3. Thrun, S., Burgard, W., & Fox, D. (2005). *Probabilistic Robotics.* The MIT Press.
4. Goodfellow, I., Bengio, Y., & Courville, A. (2016). *Deep Learning.* The MIT Press.
5. Arkin, R. C. (1998). *Behavior-Based Robotics.* The MIT Press.
6. Spong, M. W., Hutchinson, S., & Vidyasagar, M. (2006). *Robot Modeling and Control.* John Wiley & Sons.
7. Siegwart, R., Nourbakhsh, I. R., & Scaramuzza, D. (2011). *Introduction to Autonomous Mobile Robots* (2nd ed.). The MIT Press.
8. https://www.youtube.com/playlist?list=PL65CC0384A1798ADF
9. https://onlinecourses.nptel.ac.in/noc21_ge20/preview
10. https://omscs.gatech.edu/cs-7638-robotics-ai-techniques
11. https://www.classcentral.com/course/udacity-artificial-intelligence-for- robotics-319

COURSE CONTENTS AND LECTURE SCHEDULE		
No.		No. of Hours
MODULE 1		
1.1	Overview of Robotics, History and Evolution of Robotics	1
1.2	Introduction to Manipulators, Mobile Robots, and Aerial Robots	1
1.3	Overview of Robot Components, Detailed study of Actuators	1
1.4	In-depth discussion on Sensors in Robotics	1
1.5	Understanding End Effectors	1
1.6	Introduction to Sensor Types, Detailed study of Acoustic and Optic Sensors	1
1.7	Vision Sensors and Pneumatic Sensors	1
1.8	Force/Torque Sensors and Optical Encoders, Choosing the Right Sensor	1
1.9	Types of Actuators: Electric, Hydraulic, Pneumatic, Selection of Motors and Grippers	1
MODULE II		
2.1	Overview of Kinematics in Robotics, Basic Concepts and Definitions	1
2.2	Introduction to Forward Kinematics, Robot Specifications and Work Envelope	1
2.3	Classification of Robots, Forward Position Analysis of Different Robots	1
2.4	Fundamentals of Robot Coordinate Systems, Composite Rotations	1
2.5	Homogeneous Coordinates and Transformations	1
2.6	Kinematic Parameters in Robotics, Introduction to The Arm Equation	1
2.7	Kinematic Analysis of a Typical Robot: Detailed Analysis Using the Arm Equation	1
2.8	Introduction to Inverse Kinematics, General Properties of Solutions	1
2.9	Inverse Kinematics of Typical Manipulator Robots	1
2.10	Understanding Linear and Angular Velocities of a Rigid Body, Application and Computation of Manipulator Jacobian	1

	MODULE III	
3.1	Overview of Dynamics in Robotics, Basic Principles of Manipulator Dynamics.	1
3.2	Fundamentals of Lagrange Equations, Their Application in Robotics.	1
3.3	Advanced Concepts and Problem-Solving using Lagrange Equations	1
3.4	Introduction and Basic Dynamics, Analyzing Forces and Movements	1
3.5	Complex Dynamics and Real-world Applications	1
3.6	Basics of Newton-Euler Equations, Application in Robotic Dynamics	1
3.7	Complex Problem Solving with Newton-Euler Equations	1
3.8	Application of Lagrange's Equation in Dynamic Modelling	1
3.9	Concepts and Techniques in Single Degree of Freedom Modelling	1
3.10	Approaches and Challenges in Two Degrees of Freedom Modelling	1
	MODULE IV	
4.1	Overview and Definition of Trajectory Planning in Robotics, Introduction to the Planning Task	1
4.2	Detailed Steps Involved in Trajectory Planning, Key Considerations and Strategies	1
4.3	Introduction to Joint Space Techniques, Basic Concepts and Applications	1
4.4	Advanced Concepts and Problem-Solving in Joint Space	1
4.5	Fundamentals of Cartesian Space Techniques, Applications and Advantages	1
4.6	Complex Problem-Solving in Cartesian Space	1
4.7	Analysis of Joint Space versus Cartesian Space, Situational Advantages and Use Cases	1
4.8	Introduction to the Workshop on Line Following Robot, Overview of Design and Development Process	1
4.9	Detailed Design Steps for the Line Following Robot, Hands-on Session on Robot Design	1

4.10	Construction and Programming of the Line Following Robot, Testing and Troubleshooting	1
	MODULE V	
5.1	Introduction to the Role of AI in Robotics, AI for Perception, Decision Making, and Control in Robotics	1
5.2	Fundamentals of Reinforcement Learning, Applications in Robotic Scenarios	1
5.3	Introduction to Deep Learning in Robotics, Basics of Convolutional Neural Networks (CNNs)	1
5.4	CNNs in Object Detection and Semantic Segmentation	1
5.5	Concepts of Imitation Learning and Transfer Learning, Applications in Robotics	1
5.6	Basics of RNNs, Sequence Predictions in Robotics	1
5.7	Introduction to Generative Models, Applications and Use Cases in Robotics	1
5.8	Cooperative Behaviors in Robotics, Introduction to Swarm Robotics	1
5.9	Concepts and Challenges in Human-Robot Interaction, Future Trends and Applications	1

CO Assessment Questions	
1	1. Outline the key milestones in the history of robotics and discuss how these have influenced current trends in AI integration with robotic systems. 2. Compare and contrast the roles of actuators, sensors, and end effectors in robotic systems, providing examples of each in industrial robots.
2	1. Explain the difference between forward and inverse kinematics in robotics. How do these concepts relate to the specifications and work envelope of different types of robots (e.g., manipulators, mobile robots)? Additionally, classify these robots based on their kinematic structures. 2. Describe the role of robot coordinate systems in kinematics, focusing on fundamental and composite rotations, and homogeneous coordinates. How do these systems aid in understanding the kinematic parameters and transformations of a robot? Provide an example to illustrate your explanation. 3. Discuss the significance of the Arm Equation in the kinematic analysis of a typical robot. What are the general properties of solutions to the

		inverse kinematics problem, and how do they apply to a typical manipulator robot? Also, describe the importance of linear and angular velocities, and the role of the manipulator Jacobian in kinematics.
3		1. Compare and contrast the use of Lagrange equations with the Newton-Euler equations in the context of robotic manipulator dynamics. Analyze the advantages and limitations of each method when applied to the dynamics of a two-link planar robot. Provide specific examples to support your analysis.
		2. Critically evaluate a dynamic model of a robot that you have developed using Lagrange's Equation. Analyze the model's effectiveness in representing the dynamics of a 1 Degree of Freedom (DOF) manipulator. Discuss any discrepancies or limitations you observe and suggest potential improvements.
		3. Perform a detailed comparative analysis of the dynamic modeling processes for 1 DOF and 2 DOF manipulators. Focus on the complexities introduced when moving from a single DOF to two DOFs. How do these changes impact the application of Lagrange's or Newton-Euler equations in dynamic modelling? Use specific examples to illustrate your points.
4		1. Given a specific task for a robotic arm, outline a comprehensive trajectory plan. Include steps for both joint space and Cartesian space techniques. Explain your choice of technique for each step and how it optimally achieves the task objectives.
		2. Consider a scenario where a robot needs to navigate through a complex environment with obstacles. Develop a trajectory planning strategy for this scenario using both joint space and Cartesian space techniques. Compare the effectiveness of each approach in this context, detailing the advantages and challenges of each method.
		3. Describe the process you would follow to design and develop a line following robot, as part of the workshop. Detail the steps in trajectory planning for this specific robot, explaining how you would apply joint space or Cartesian space techniques in your design. Additionally, discuss any unique challenges you might face in this project and how you plan to address them.
5		1. Create a design for a robotic system for a chosen application, integrating AI for perception, decision-making, and control. Focus on applying reinforcement learning and CNNs for object detection.
		2. Outline a programming approach for a robot to learn a complex task through demonstration. Detail the use of imitation learning, transfer learning, and RNNs for action sequence prediction.
		3. Propose a multi-robot system design for a collaborative task, emphasizing cooperative behaviors and swarm robotics. Describe the integration of AI techniques for effective human-robot interaction and robot coordination.

SEMESTER VII
SYLLABUS

24ECP701	MICROWAVE AND ANTENNAS	L	T	P	J	S	C	Year of Introduction
		2	1	2	0	4	4	2024

Preamble: This course aims to impart knowledge on fundamental concepts of antenna theory and microwave engineering. The course covers topics including antenna parameters, antenna arrays, broadband antennas, microwave sources, hybrid circuits and microwave semiconductor devices. This course will lay the foundation for further exploring the vast area of antenna analysis and design along with RF and microwave engineering.

Prerequisite: 24ECT601 Applied Electromagnetic Theory

Course Outcomes: After the completion of the course the student will be able to

CO 1	Comprehend the basic concepts of antenna parameters (Understand Level)
CO 2	Calculate the far field pattern of short dipole and half wave dipole antenna (Apply Level)
CO 3	Design and analyze broadband antenna and antenna arrays (Apply Level)
CO 4	Illustrate the principle of operation of various microwave sources and amplifiers (Apply Level)
CO 5	Determine the scattering matrix of various microwave hybrid components (Understand Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	✓	✓			✓							
CO 2	✓	✓										
CO 3	✓	✓			✓			✓	✓	✓		✓
CO 4	✓	✓										
CO 5	✓	✓						✓	✓	✓		

Assessment Pattern for Theory component

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				
Create				

Assessment Pattern for Lab component

Bloom's Category	Continuous Assessment Tools	
	Class work	Test1
Remember		
Understand	✓	✓
Apply	✓	✓
Analyse	✓	✓

Evaluate							
Create							

Mark Distribution of CIA

Course Structure [L-T-P-J]	Attendance	Theory [L-T]			Practical [P]		Total Marks
		Assignment	Test-1	Test-2	Class work	Lab Exam	
2-1-2-0	5	10	12.5	12.5	10	10	60

Total Marks distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	60	40	2.5 Hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 2		2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x 8 = 40 marks) Time: 2.5 hours	40
	Total Marks: 0	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I : Basic Antenna Parameters (8 Hours)

Basic antenna parameters: Radiation pattern, beam width, antenna field zones, gain, directivity, radiation resistance, radiation efficiency, effective aperture calculations, effective height, wave polarization. Principles of reciprocity, Field, directivity and radiation resistance of a short dipole and half wave dipole (far field derivation).

MODULE II : Array of Point Sources (6 Hours)

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 arrays. Concept of Phase array.

MODULE III :Broadband Antenna (6 Hours)

Broadband antenna: Principles of Horn, Parabolic dish antenna (expression for E, H and Gain without derivation), Helical antenna: types and design. Principle of Log periodic antenna array and design, Design of Microstrip Rectangular Patch antennas and feeding methods. Mobile phone antenna – Inverted F

antenna.

MODULE IV : Microwave Oscillators and Amplifiers (6 Hours)

Introduction to Microwaves, Cavity Resonators- Derivation of resonance frequency of rectangular cavity resonator. Single cavity klystron-Reflex Klystron Oscillators: Derivation of velocity modulation. Bunching parameter, power output, efficiency (no derivation). Introduction to Magnetron oscillators(basic concepts, no derivation) Travelling Wave Tube: Slow wave structures-Helix TWT, Amplification process, Derivation of convection current, axial electric field and
wave modes. Power gain in TWT (derivation not required).

MODULE V : Microwave Hybrid Circuits and Devices (6 Hours)

Microwave Hybrid circuits: Scattering parameters, S-matrix and properties. Introduction to waveguide tees. Formulation of S-matrix - Magic tee, two-hole directional couplers. Isolators and circulators. Microwave Semiconductor Devices: Gunn diodes - Different modes, Principle of operation of Gunn Diode Oscillators. Assignment – Formulation of S matrix of E and H plane tee.

Text books
1. Balanis, Antenna Theory and Design, 3/e, Wiley Publications.
2. John D. Krauss, Antennas for all Applications, 3/e, TMH.
3. K D Prasad, Antenna and Wave Propagation, Satyaprakash Publications.
4. Samuel Y. Liao, Microwave Devices and Circuits, 3/e, Pearson Education, 2003.
5. Robert E. Collin, Foundation of Microwave Engineering, 2/e, Wiley India, 2012.

Reference books
1. Collin R.E, Antennas & Radio Wave Propagation, McGraw Hill. 1985.
2. Jordan E.C. & K. G. Balmain, Electromagnetic Waves & Radiating Systems, 2/e, PHI.
3. Raju G.S.N., Antenna and Wave Propagation, Pearson, 2013.
4. Sisir K. Das & Annapurna Das, Antenna and Wave Propagation, McGraw Hill,2012.
5. Thomas A. Milligan, Modern Antenna Design, IEEE PRESS, 2/e, Wiley Interscience.
6. Das, Microwave Engineering, 3/e, McGraw Hill Education India Education, 2014.
7. David M. Pozar, Microwave Engineering,4/e, Wiley India, 2012.
8. NPTEL Course on Antenna by Prof. Girish Kumar, https://nptel.ac.in/courses/108101092
9. NPTEL Course on Microwave Theory and Techniques by Prof. Girish Kumar, https://nptel.ac.in/courses/108101112

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
MODULE 1		
1.1	Basic antenna parameters: Radiation pattern, beam width	1
1.2	Antenna field zones, gain, directivity, radiation resistance, radiation efficiency	1
1.3	Effective aperture calculations, effective height, wave polarization	1
1.4	Principles of reciprocity	1
1.5	Field of a short dipole	1
1.6	Directivity and radiation resistance of a short dipole	1
1.7	Field of a half wave dipole	1
1.8	Directivity and radiation resistance of a half wave dipole	1
MODULE II		
2.1	Arrays of point sources, field of two isotropic point sources	1
2.2	Principle of pattern multiplication	1
2.3	Linear arrays of 'n' isotropic point sources, Array factor, Grating Lobes	1
2.4	Design of Broadside array	1
2.5	Design of End fire arrays	1
2.6	Concept of Phase array	1
MODULE III		
3.1	Broadband antenna: Principles of Horn, Parabolic dish antenna (expression for E, Hand Gain without derivation)	1
3.2	Helical antenna: types and design	1
3.3	Principle of Log periodic antenna array and design	1
3.4	Design of Micro strip Rectangular Patch antennas	1
3.5	Feeding methods	1
3.6	Mobile phone antenna – Inverted F antenna	1
MODULE IV		
4.1	Introduction to Microwaves, Cavity Resonators- Derivation of resonance frequency of rectangular cavity resonator	1
4.2	Single cavity klystron – Working of Reflex Klystron Oscillators, Derivation of velocity modulation	1
4.3	Bunching parameter, Power output and efficiency of reflex klystron (derivation not required), Introduction to magnetron oscillators	1
4.4	Travelling Wave Tube: Slow wave structures, Helix TWT, Amplification process	1
4.5	Derivation of convection current and axial electric field	1
4.6	Derivation of wave modes. Power gain (derivation not required)	1

	MODULE V	
5.1	Microwave Hybrid circuits - Scattering parameters, Scattering matrix and properties	1
5.2	Waveguide tees– Formulation of S-matrix – Magic Tee	1
5.3	Two hole directional couplers - Formulation of S-matrix	1
5.4	Circulators and Isolators	1
5.5	Microwave Semiconductor Devices: Gunn diodes - Different modes	1
5.6	Principle of operation of Gunn Diode Oscillators	1

LESSON PLAN FOR LAB COMPONENT

No.	Topic	No. of Hours	Experiment
1	Basic Antenna Parameters	1	Exp 1: Familiarization of antenna parameters (Hardware/Software)
		2	Exp 2: Simulation of dipole antenna
2	Broadband Antenna	1	Exp 3: Radiation pattern of horn antenna
		2	Exp 4: Simulation of patch antenna
		1	Exp 5: Familiarization of Vector Network Analyzer
3	Reflex Klystron	2	Exp 6: Reflex Klystron Mode Characteristics
		1	Exp 7: Verify the relation between guide wavelength, free space wavelength and cut off wavelength for rectangular waveguide
		2	Exp 8: VSWR Measurement
4	Microwave Hybrid Circuits	1	Exp 9: Study of Microwave Hybrid Components
		2	Exp 10: Directional Coupler Characteristics
5	Microwave Semiconductor Devices - Gunn Diode	1	Exp 11: Gunn Diode Characteristics

	CO Assessment Questions
1	1. List and explain any three important parameters associated with an antenna. 2. Design a dipole antenna for a given frequency and obtain different parameters.
2	1. Derive expressions for far field components of a short dipole and half wave dipole antenna applying vector potential concepts.
3	1. Design a broadband antenna for the given specifications and plot its radiation pattern. 2. Plot and measure the radiation characteristics of horn antenna. 3. Design a rectangular patch antenna for a given resonant frequency.
4	1. Explain the working of any one microwave generator and a microwave amplifier. 2. Plot the klystron mode characteristics.
5	1. Identify a given microwave hybrid component and obtain its simplified scattering matrix under given considerations. 2. Determine the following parameters of a directional coupler: Coupling factor, insertion loss, isolation, directivity.

		L	T	P	J	S	C	Year of Introduction
24ECP702	**COMPUTER NETWORKS AND SECURITY**	2	1	2	0	4	4	**2024**

Preamble: This course aims to equip students with a solid foundation in the fundamental concepts, protocols, and technologies that underpin modern computer networks. Topics include networking principles, Transmission Control Protocol/Internet Protocol, naming and addressing (Domain Name System), link layer protocols, routing protocols, transport layer services, congestion control, quality of service, network services and security in computer networks. This course teaches the design and implementation techniques essential for engineering robust networks.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO 1	Familiarize the fundamental concepts, terminology, components and layering in computer networks. (Understand Level)
CO 2	Explain the principles and operation of various Medium Access Control protocols. (Understand Level)
CO 3	Evaluate various LAN (Local Area Network) technologies and understand their implementation and operation at the data link layer. (Apply Level)
CO 4	Develop the skills necessary to apply and manage different routing algorithms, including distance vector, link-state routing algorithms. (Apply Level)
CO 5	Develop the skills necessary to implement and manage TCP congestion control algorithms, to ensure fair and efficient network resource utilization and prevent network congestion. (Apply Level)
CO 6	Understand the fundamental concepts, principles, and best practices in network security, including threats, vulnerabilities, and security mechanisms. (Understand Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO 12
CO 1	✓	✓										
CO 2	✓	✓										
CO 3	✓	✓	✓	✓	✓							
CO 4	✓	✓		✓	✓				✓			
CO 5	✓	✓	✓	✓	✓				✓			
CO 6	✓	✓	✓	✓	✓				✓			

Assessment Pattern for Theory Component				
Bloom's Category	**Continuous Assessment Tools**			**End Semester Examination**
	Test1	**Test 2**	**Other tools**	
Remember	✔	✔	✔	✔
Understand	✔	✔	✔	✔
Apply		✔	✔	✔
Analyse			✔	
Evaluate			✔	
Create				

Assessment Pattern for Lab Component		
Bloom's Category	**Continuous Assessment Tools**	
	Class work	**Test1**
Remember		
Understand	✔	✔
Apply	✔	✔
Analyse	✔	✔
Evaluate		
Create		

Mark Distribution of CIA							
Course Structure [L-T-P-J]	**Attendance**	**Assignment**	**Theory [L- T]**		**Practical [P]**		**Total Marks**
			Test-1	**Test-2**	**Class work**	**Lab Exam**	
2-1-2-0	5	10	12.5	12.5	10	10	60

Total Marks Distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	60	40	2.5 Hours

End Semester Examination [ESE]: Pattern			
PATTERN	PART A	PART B	ESE
PATTERN 2		2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 subdivisions. Each question carries 8 marks. Marks: (5x 8 = 40 marks) Time: 2.5 hours	40
		Total Marks: [5x8 = 40 marks	

SYLLABUS

MODULE I : Introduction to Data Communication (5 Hours)

Introduction – Data Communication, Networks, Internet, Intranet, Protocols, OSI & TCP/IP Models and addressing. Classification of networks: Local Area Network (LAN), Wide Area Network (WAN), and Metropolitan Area Network (MAN). Network Architecture-Peer to Peer, Client Server network.

Physical Layer-Transmission modes, Communication media, Guided and Unguided media, Circuit Switched Network, Packet Switched Network.

MODULE II : Data Link Layer (7 Hours)

Data Link Layer: Framing, Flow and error control (stop and wait, Stop-and-Wait Automatic Repeat Request, Go-Back-N Automatic Repeat Request, Selective Repeat Automatic Repeat Request), Error detection (check sum, CRC). Media access control: Carrier Sense Multiple Access (CSMA), CSMA/ Collision Detection (CD), CSMA/ Collision Avoidance (CA), Ethernet (802.3), Logical link control, Wireless LAN (802.11), Controller Area Network (CAN) Protocol.

MODULE III : Network Layer (8 Hours)

Network Layer: Datagram versus virtual-circuit network service, Router architecture. IPv4 addressing, header format, address assignment -manual and Dynamic Host Configuration Protocol (DHCP), Internet Control Message Protocol (ICMP). IPv6 header format, IPv4 to IPv6 transition.

Address Resolution protocols: Address Resolution protocol (ARP), Reverse Address Resolution Protocol (RARP).

Routing: Routing and Forwarding, Static routing and Dynamic routing

Routing Algorithms: Distance vector routing algorithm, Link state routing (Dijkstra's algorithm)

Routing Protocols: Routing Information protocol (RIP), Open Shortest Path First (OSPF), Border Gateway Protocol (BGP).

MODULE IV : Transport and Application Layer (6 Hours)
Transport Layer – User Datagram Protocol (UDP), Transmission Control Protocol (TCP) (header format) Congestion Control & Quality of Service– Data traffic, Congestion, Congestion Control, QoS and Flow Characteristics, Resource Reservation Protocol (RSVP). Application Layer Communication between processes, Domain Name System (DNS), Remote Logging (Telnet), Simple Mail Transfer Protocol (SMTP), File Transfer Protocol (FTP), World Wide Web (WWW), Hyper Text Transfer Protocol (HTTP), Post Office Protocol (POP3).
MODULE V: Network Security (5 Hours)
Overview of Network Security: Elements of Network Security, Classification of Network Attacks, Security Methods. Principles of Cryptography- Symmetric-Key Cryptography, common attacks. Defense and counter measures: Firewalls and their types. Demilitarized Zone (DMZ), Limitations of firewalls, Intrusion Detection Systems -Host based, Network based, and Hybrid Intrusion Detection Systems (IDSs).

Text books
  1. Behrouz A. Forouzan, Cryptography & Network Security, IV Edition, Tata McGraw-Hill,2008
  2. J F Kurose and K W Ross, Computer Network A Top-down Approach Featuring the Internet, 6/e, Pearson Education,2012

Reference books
  1. Larry Peterson and Bruce S Davie: Computer Network- A System Approach, 4/e, Elsevier India, 2011.
  2. S. Keshav, An Engineering Approach to Computer Networking, Pearson Education, 2005.
  3. Achyut S.Godbole, Data Communication and Networking, 2e, McGraw Hill Education New Delhi,2011
  4. NPTEL Course on Computer Networks and Internet Protocol, by Soumya K Ghosh and Sandip Chakraborty IIT Kharagpur https://nptel.ac.in/courses/106105183.

COURSE CONTENTS AND LECTURE SCHEDULE		
No.		No. of Hours
MODULE I		
1.1	Introduction – Data Communication, Networks, Internet, Intranet, Protocols	1
1.2	OSI & TCP/IP Models and addressing.	1
1.3	Classification of networks: LAN, WAN, MAN. Network Architecture-Peer to Peer, Client Server network.	1
1.4	Physical Layer-Transmission modes, Communication Media-Guided and Unguided media.	1

1.5	Circuit Switched Network, Packet Switched Network.	1
MODULE II		
2.1	Data Link Layer: Error Detection and Correction, Types of error.	1
2.2	Framing, Flow and error control, Stop and wait protocol.	1
2.3	Stop-and-Wait Automatic Repeat Request, Go-Back-N Automatic Repeat Request	1
2.4	Error detection (check sum, CRC)	1
2.5	Media access control: CSMA, CSMA/CD	1
2.6	CSMA/CA, Ethernet-MAC Frame format	1
2.7	Wireless LAN-MAC sublayer, frame format, CAN Protocol.	1
MODULE III		
3.1	Network Layer: Datagram versus virtual-circuit network service, Router architecture.	1
3.2	IPv4 addressing, header format	1
3.3	Address assignment -manual and DHCP. ICMP.	1
3.4	IPv6 header format, IPv4 to IPv6 transition.	1
3.5	Address Resolution protocols: Address Resolution protocol (ARP), Reverse Address Resolution Protocol (RARP).	1
3.6	Routing: Routing and Forwarding, Static routing and Dynamic routing	1
3.7	Routing Algorithms: Distance vector routing algorithm, Link state routing (Dijkstra's algorithm)	1
3.8	Routing Protocols: Routing Information protocol (RIP), Open Shortest Path First (OSPF), Border Gateway Protocol (BGP).	1
MODULE IV		
4.1	Transport Layer –UDP, TCP (header format)	1
4.2	Congestion Control & Quality of Service– Data traffic, Congestion, Congestion Control.	1
4.3	QoS and Flow Characteristics, RSVP	1
4.4	Application Layer Communication between processes, Domain Name System (DNS)	1
4.5	Remote Logging (Telnet), Simple Mail Transfer Protocol (SMTP), File Transfer Protocol (FTP).	1
4.6	World Wide Web (WWW), Hyper Text Transfer Protocol (HTTP), Post Office Protocol (POP3).	1
MODULE V		
5.1	Overview of Network Security: Elements of Network Security, Classification of Network Attacks, Security Methods.	1
5.2	Principles of Cryptography- Symmetric-Key Cryptography, common attacks.	1

5.3	Defense and countermeasures: Firewalls and their types.	1
5.4	DMZ, Limitations of firewalls,	1
5.5	Intrusion Detection Systems Host based, Network based, and Hybrid IDSs.	1

LESSON PLAN FOR LAB COMPONENT

No.	Topic	No. of Hours	Experiment
1	Study of Network Devices and Network IP	2	Experiment 1: Familiarization of network devices such as • Repeater • Hub • Switch • Bridge • Router • Gate Way Experiment 2: Study of network IP • Classification of IP address • Sub netting • Super netting
2	Study of Network Configuration.	2	Experiment 3: Connect the computers in Local Area Network.
			Experiment 4: Study of basic network command and Network configuration commands.
3	Introduction to NetSim	2	Experiment 5: Introduction to network simulation with NetSim, NetSim feature list and NetSim Simulation environment.
		2	Experiment 6: Understand Measures of Network Performance: Throughput and Delay

4	IP Forwarding and Routing	2	Experiment 7: Understand working of ARP, and IP Forwarding within a LAN and across a router.
		2	Experiment 8: Implementation of Distance Vector Routing algorithm. Experiment 9: Implementation of Link state routing algorithm
5	Transmission Control Protocol	2	Experiment 10: Understand the working of "Connection Establishment" in TCP.
		2	Experiment 11: Understand the working of Slow start and Congestion Avoidance (Old Tahoe), Fast Retransmit (Tahoe) and Fast Recovery (Reno) Congestion Control Algorithms in TCP.
6	Network Security	2	Experiment 12: Implementation of data encryption and Decryption Experiment 13: Transfer of files from PC to PC using Windows/ UNIX socket processing.

CO Assessment Questions	
1	Give some advantages and disadvantages of combining the session, presentation, and application layer in the OSI model into one single application layer in the Internet model.
2	Discuss the challenges and solutions related to managing collisions in the data link layer. Explain how protocols like CSMA/CD (Carrier Sense Multiple Access with Collision Detection) and CSMA/CA (Carrier Sense Multiple Access with Collision Avoidance) help mitigate collision-related issues.
3	Suppose nodes A and B are on the same 10 Mbps broadcast channel, and the propagation delay between the two nodes is 325 bit times. Suppose CSMA/CD and Ethernet packets are used for this broadcast channel. Suppose node A begins transmitting a frame and, before it finishes, node B begins transmitting a frame. Can A finish transmitting before it detects that B has transmitted? Why or why not? Justify your answer.

4	Consider the following network. Compute the shortest-path from the node D to all other nodes using Dijkstra's shortest path algorithm. (Numbers indicated shows the link costs).
5	Explain the TCP three-way handshake process used for establishing a connection between two hosts, and explain the four-way handshake process involved in connection termination in TCP. Elaborate on the roles of the FIN (Finish) and ACK (Acknowledgment) flags during the connection closing process.
6	Explain how network address translation (NAT) is used in firewalls to improve network security and manage IP addresses.
7	How can application-layer protocols, such as HTTP, DNS, and SIP, be targeted in a DoS attack, and what measures can be implemented to mitigate these risks?
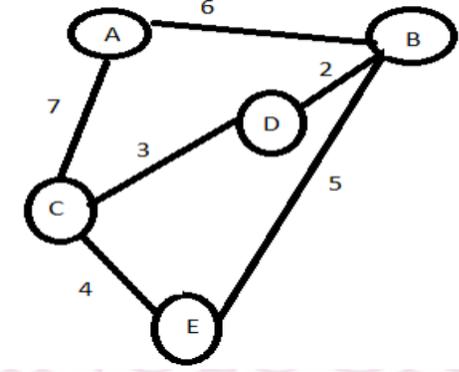
PROFESSIONAL ELECTIVE III SEVENTH SEMESTER

24ECE713	ADVANCED MICROCONTROLLERS	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: The primary focus of this course is on analyzing tasks performed by different units in a microprocessor system. The course emphasize on implementing various RISC V instruction set using Verilog HDL.

Prerequisite: 24ECJ303 Logic Circuit Design, 24ECT307 Computer Architecture, 24ECJ404 Microprocessors and Microcontrollers, 24ECT503 Embedded System and IoT

Course Outcomes: After the completion of the course the student will be able to

CO 1	Comprehend Reduced Instruction Set Computer (RISC) V architecture and simulate various subsystems (Apply Level)
CO 2	Describe data path, multicycle implementation of RISC V and simulate memory interfacing. (Apply Level)
CO 3	Design and implement Pipeline architecture in RISC V (Apply Level)
CO 4	Describe the architectural features and power saving modes in MSP430 (Understand Level)
CO 5	Understand the interfacing of the various peripherals with MSP430 microcontroller. (Understand Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	✓				✓							
CO 2	✓											
CO 3	✓											
CO 4	✓											
CO 5	✓				✓							✓

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply				
Analyse				
Evaluate				
Create				

Mark Distribution of CIA						
Course Structure [L-T-P-J]	**Attendance**	**Theory [L- T]**				**Total Marks**
		Assignment	**Test-1**	**Test-2**		
3-0-0-0	5	15	10	10		40

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 Hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS (36 Hours)

MODULE I: RISC-V Architecture and Simulation (7 Hours)

RISC-V Software Simulation, RISC-V Assembly (Assignment), Memory Layout and Addressing, ALU Design Alternatives, RISC-V ALU and Register File, Verilog Simulation, Coding Guidelines for Synthesis.

MODULE II: RISC V Processor Performance analysis and optimization (7 Hours)

CPU Memory Interface, Instruction Memory, Data Memory, Branching, RISC-V Branch Instructions, Single Cycle Datapath, Number representations, Floating Point, Compilation and Optimization, Multicycle CPU, CPU Performance Equation, The Assembly Line, Input/Output, Multicycle peripherals and Buses.

MODULE III: Interrupts and Hazards in RISC-V (7 Hours)
Interrupts and Exceptions, Pipelined CPU, Pipelined Datapath, Pipeline Control, Pipeline Forwarding, Load Hazards and Pipeline Stalling, Control Hazards, Memory Technology, Cache, Virtualization
MODULE IV: MSP430 (7 Hours)
MSP430 Architecture, CPU Registers, Instruction Set, addressing modes, Low Power Modes in MSP430, Introduction to MSP430 Timer Module and it's Modes of Operation. Programming Methods for MSP430. Introduction to Lunchbox Platform.
MODULE V: MSP430 and Peripherals (8 Hours)
Fundamentals of Physical Interfacing, Connecting Input Devices: Switches, Keyboard and Output devices: LEDs, Seven Segment Displays (SSD), Handling Interrupts in MSP430, Writing efficient Interrupt Service Routine (ISR), Serial Communication Protocols: UART, SPI, and I^{2}C. Interfacing Universal Serial Communication Interface (USCI)

Text books

1. "Computer Organization and Design: The Hardware/Software Interface - RISC-V edition", D. A. Patterson and J. L. Hennessy, Morgan-Kaufmann publishers
2. Chris Nagy, Embedded Systems Design using TI MSP430 Series, Newnes Publications, Elsevier, 2003.
3. Online resource on advanced microcontrollers:
   https://www.youtube.com/playlist?list=PLco7dux9L7g2GM-rwKf0DPrHItgsVWxiH

Reference books

1. Guide to Computer Processor Architecture: A Risc-V Approach, With High-level
2. Synthesis Goossens, Bernard
3. MSP430 Microcontroller Basics. John H. Davies. Elsevier. ISBN-10: 9789380501857
4. MSP430, Reference manual, Texas Instruments.

COURSE CONTENTS AND LECTURE SCHEDULE		
No.		No. of Hours
MODULE I		
1.1	RISC-V Software Simulation	1
1.2	RISC-V Assembly (Assignment)	1
1.3	Memory Layout and Addressing	1
1.4	ALU Design Alternatives	1
1.5	RISC-V ALU and Register File	1
1.6	Verilog Simulation	1
1.7	Coding Guidelines for Synthesis.	1
MODULE II		
2.1	CPU Memory Interface	1

2.2	Instruction Memory, Data Memory	1
2.3	Branching, RISC-V Branch Instructions, Single Cycle Datapath	1
2.4	Number representations, Floating Point	1
2.5	Compilation and Optimization	1
2.6	Multicycle CPU, CPU Performance Equation, The Assembly Line	1
2.7	Input/Output, Multicycle peripherals and Buses.	1
MODULE III		
3.1	Interrupts and Exceptions	1
3.2	Pipelined CPU	1
3.3	Pipelined Datapath, Pipeline Control	1
3.4	Pipeline Forwarding	1
3.5	Load Hazards and Pipeline Stalling	1
3.6	Control Hazards	1
3.7	Memory Technology, Cache, Virtualization	1
MODULE IV		
4.1	MSP430 Architecture	1
4.2	CPU Registers, Instruction Set	1
4.3	Instruction Set, addressing modes	1
4.4	Low Power Modes in MSP430	1
4.5	Introduction to MSP430 Timer Module and it's Modes of Operation	1
4.6	Programming Methods for MSP430	1
4.7	Introduction to Lunchbox Platform.	1
MODULE V		
5.1	Fundamentals of Physical Interfacing.	1
5.2	Connecting Input Devices: Switches, Keyboard	1
5.3	Output devices: LEDs, Seven Segment Displays (SSD)	1
5.4	Handling Interrupts in MSP430	1
5.5	Writing efficient Interrupt Service Routine (ISR)	1
5.6	Communication Protocols: UART, SPI, I2C	1
5.7	Communication Protocols: UART, SPI, I2C	1
5.8	Universal Serial Communication Interface (USCI)	1

CO Assessment Questions	
1	1. Explain the key design principles behind the RISC-V architecture. 2. Perform the Verilog implementation of ALU.
2	1. Compare and contrast the pipeline and multicycle implementations in RISC-V processors. 2. Perform the Verilog implementation of memory interfacing in RISC-V
3	1. Describe the advantages and challenges of pipelining in RISC-V processors. 2. Implement pipeline hazard control in RISC-V using Verilog.

4	Describe the role and features of the Unified Clock System in MSP430
5	Explain the process of interfacing a seven-segment display with an MSP430 microcontroller. Include in your explanation the necessary steps to configure the MSP430 ports for output, the method used to drive the segments of the display, and how to display a hexadecimal digit. Additionally, discuss any potential challenges that might arise during the interfacing process and how they can be overcome.

24ECE723	WIRELESS COMMUNICATION AND 5G NETWORKS	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: 5G delivers high bandwidth and speeds of up to 10 gigabytes per second to enable ultra-high-definition video and data volumes. To understand the underlying principles of 5 G it is essential to understand basic theory and principles of wireless communication systems and cellular systems. This course provides the knowledge on mobile radio propagation, channel fading, different Access and diversity techniques and an understanding of 5G networks.

Prerequisite: 24ECP504 Digital Communication

Course Outcomes: After the completion of the course the student will be able to

CO 1	Illustrate the fundamental design aspects of cellular communication. (Apply Level)
CO 2	Illustrate the various types of wireless channel models. (Apply Level).
CO 3	Explain the various diversity techniques and multiple-access techniques in wireless communication (Understand Level)
CO 4	Highlight the concept of multicarrier modulation techniques. (Understand Level)
CO 5	Explain the concepts of 5G networks. (Understand Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓										
CO2	✓	✓										
CO3	✓	✓										
CO4	✓	✓										
CO5	✓	✓										

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓		✓
Understand	✓	✓		✓
Apply	✓	✓		✓
Analyze				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
3-0-0-0	5	15	10	10	40

Total Mark Distribution			
Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 hours

End Semester Examination [ESE]: Pattern			
PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks

Marks: (2x10 =20 marks) | 2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions.

Each question carries 8 marks.

Marks: (5x8 = 40 marks)

Time: 3 hours | 60 |
| | Total Marks: 20 | Total Marks: [5x8 = 40 marks] | |

SYLLABUS (36 Hours)

MODULE I: Cellular System Design Fundamentals (7 Hours)

Frequency Reuse, channel assignment strategies, Handoff strategies, Interference and system capacity, Trunking and grade off service, improving coverage and capacity – cell splitting, sectoring, microcells. Global System for Mobile (GSM)- GSM services and features, GSM system architecture, GSM radio subsystem, Frame structure for GSM.

MODULE II: Wireless Channel and Modelling (9 Hours)

Free space path loss model, Two-Ray model, Shadowing model, Knife -edge Diffraction Model, path loss prediction in hilly terrain, 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.

MODULE III: Multiple Access Techniques and Diversity Techniques (8 Hours)
Multiple Access Techniques: Introduction to Multiple Access Techniques, Uplink and downlink multiuser systems, Frequency Division Multiple Access, Time Division multiple access, Spread spectrum Multiple Access-Frequency Hopped Multiple Access, Code Division Multiple Access, Orthogonal Frequency division multiple access   **Diversity Techniques:** Diversity Techniques- Derivation of Selection Diversity Improvement, Derivation of Maximum ratio combining Improvement, Practical space Diversity considerations, Transmitter diversity – Alamouti scheme for 2x2 MIMO.
MODULE IV: Multicarrier Modulation and OFDM (5 Hours)
Data transmission using multicarrier modulation for frequency-selective fading channels. Overlapping subchannels, Mitigation of Subcarrier Fading, Discrete Implementation of multicarrier modulation– OFDM. Cyclic prefix, Peak-to average-power-ratio.
MODULE V: 5G Broadband Wireless Communications and wireless Propagation Channels (7 Hours)
Evolution of mobile technologies 1G to 4G (LTE, LTEA, LTEA Pro), Extension of 4G D2D standardization to 5G, LTE architecture, An Overview of 5G requirements, Channel modeling requirements, propagation scenarios and challenges in the 5G modeling, Channel Models for mm Wave MIMO Systems.

Text books
1. Andrea Goldsmith, Wireless Communications, Cambridge University Press, 2005
2. Theodore S. Rappaport, Wireless communication: Principles and Practice, 2/e, Pearson Education, 1990
3. Aditya Jagannatham, Principles of Modern Wireless Communication Systems, Mc Graw Hill, 2017.
4. Martin Sauter "From GSM From GSM to LTE–Advanced Pro and 5G: An Introduction to Mobile Networks and Mobile Broadband", Wiley-Blackwell.
5. Theodore S.Rappaport, Robert W.Heath, Robert C.Danials, James N.Murdock "Millimeter Wave Wireless Communications", Prentice Hall Communications.

Reference books
1. David Tse and Pramod Viswanath, Fundamentals of Wireless Communication, Cambridge University Press, 2005
2. Jochen Schiller, Mobile Communications, Pearson, 2008
3. Andreas F Molish , Wireless Communications, 2nd Edition , Wiley India Publications, 2013
4. W. C. Y. Lee, Mobile Cellular Telecommunication, McGraw Hill,
5. Jonathan Rodriguez, "Fundamentals of 5G Mobile Networks", John Wiley & Sons.
6. Amitabha Ghosh and Rapeepat Ratasuk "Essentials of LTE and LTE-A", Cambridge University Press.
7. NPTEL course on Wireless Communication by Dr. Ranjan Bose IIT Delhi. https://archive.nptel.ac.in/courses/117/102/117102062/#

No.	COURSE CONTENTS AND LECTURE SCHEDULE	No. of Hours
	MODULE I	
1.1	Frequency Reuse, channel assignment strategies	1
1.2	Handoff strategies	1
1.3	Interference and system capacity	1
1.4	Trunking and grade off service	1
1.5	Improving coverage and capacity – cell splitting, sectoring, microcells	1
1.6	Global System for Mobile (GSM)- GSM Services and features, GSM System Architecture	1
1.7	GSM Radio Subsystem, Frame Structure for GSM.	1
	MODULE II	
2.1	Free space path loss model	1
2.2	Two-Ray model	1
2.3	Shadowing model	1
2.4	Knife -edge Diffraction Model	1
2.5	Path loss prediction in hilly terrain	1
2.6	Time-varying channel impulse response	1
2.7	Narrowband fading, Wideband fading models	1
2.8	Delay spread and Coherence bandwidth, Doppler spread and Coherence time, Flat fading versus frequency selective fading, Slow fading versus fast fading	1
2.9	Discrete-time model.	1
	MODULE III	
3.1	Introduction to Multiple Access Techniques, Uplink and downlink multiuser systems	1
3.2	Frequency Division Multiple Access, Time Division multiple access	1
3.3	Spread spectrum Multiple Access-Frequency Hopped Multiple Access, Code Division Multiple Access	1
3.4	Orthogonal Frequency division multiple access	1
3.5	Diversity Techniques- Derivation of Selection Diversity Improvement	1
3.6	Derivation of Maximum ratio combining Improvement	1
3.7	Practical space Diversity considerations	1
3.8	Transmitter diversity – Alamouti scheme for 2x2 MIMO.	1
	MODULE IV	
4.1	Data transmission using multicarrier modulation for frequency-selective fading channels	1
4.2	Overlapping subchannels	1

4.3	Mitigation of Subcarrier Fading	1
4.4	Discrete Implementation of multicarrier modulation– OFDM.	1
4.5	Cyclic prefix, Peak-to average-power-ratio.	1
MODULE V		
5.1	Evaluation of mobile technologies 1G to 4G (LTE, LTEA, LTEA Pro)	1
5.2	Extension of 4G D2D standardization to 5G,	1
5.3	LTE architecture	1
5.4	An Overview of 5G requirements	1
5.5	Channel modeling requirements	1
5.6	Propagation scenarios and challenges in the 5G modeling	1
5.7	Channel Models for mmWave MIMO Systems.	1

CO Assessment Questions	
1	1. Locate the co-channels cells in a cellular system given cluster size is (a)7 (b)12 2. A total of 33MHz of bandwidth is allocated to an FDD cellular system which uses two 25kHz simplex channels to provide full-duplex voice & control channels. Compute the number of channels available per cell if the system uses 7-cell reuse.
2	1. Derive an equation for the received power using a ground reflection model. 2. Illustrate the concepts of a time varying impulse response channel with the help of suitable examples.
3	1. Compare multiple-access schemes TDMA, FDMA and CDMA 2. Find the outage probability of BPSK modulation at Pb = 10^{-3} for a Rayleigh fading channel with SC diversity for M = 1 (no diversity) M = Assume equal branch SNRs of 15 dB.
4	1. Explain the significance of cyclic prefix in the discrete implementation of multicarrier modulation. 2. Describe various methods of mitigating the subcarrier fading.
5	1. Explain about the channel modelling required to support 5G networks. 2. Explain the evolution of mobile technology from 1G to 5G.

24ECE733	SPEECH AND AUDIO SIGNAL PROCESSING	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: This course is a designed to provide a deep understanding of the technical aspects of speech and audio processing. It starts with the acoustic theory of speech production, vocal tract modeling, and moves through advanced topics like frequency domain analysis, including Short Time Fourier Transform (STFT) and cepstral analysis. The course further delves into practical applications in speech processing, audio perception, and audio compression, culminating in a detailed study of audio quality analysis techniques, equipping students with both theoretical knowledge and practical skills in the field.

Prerequisite: 24ECJ502 Digital Signal Processing

Course Outcomes: After the completion of the course the student will be able to

CO 1	Understand acoustic speech production theory and analyze speech using vocal tract models, formants, and short-time analysis methods. (Understand Level)
CO 2	Gain proficiency in speech frequency domain analysis, including filter banks, STFT, spectrogram, and Linear Predictive Coding (LPC) techniques. (Apply Level)
CO 3	Apply advanced techniques in speech processing like speaker and speech recognition, synthesis, and enhancement, focusing on deep neural networks. (Apply Level)
CO 4	Develop an understanding of audio perception, covering the anatomy of the hearing system and psycho-acoustic analysis. (Understand Level).
CO 5	Master audio compression principles and techniques, including coding standards and audio quality assessment methods. (Understand Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	✓											
CO 2	✓				✓							
CO 3	✓				✓							
CO 4	✓											
CO 5	✓											

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test2	Other tools	
Remember	✓	✓		✓
Understand	✓	✓		✓
Apply	✓	✓		✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA

| Course Structure | Attendance | Theory [L- T] | | | Total Marks |
		Assignment	Test-1	Test-2	
[L-T-P-J]					
3-0-0-0	5	15	10	10	40

Total Mark Distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 Hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS (38 Hours)

MODULE I: Speech Production and Short Time Speech Analysis (6 Hours)

Acoustic Theory of Speech Production, Vocal Tract Model for Speech Analysis, Formants, Pitch, Articulatory phonetics, Acoustic phonetics, Time domain analysis: Short time energy, short time zero crossing rate, Autocorrelation function.

MODULE II: Frequency Domain Analysis (8 Hours)

Frequency Domain Analysis: Filter Banks, STFT, Spectrogram- Wide band and Narrow band, Formant Estimation and analysis, Cepstral Analysis: Mel-Frequency Cepstral Coefficients (MFCC), AR Model, ARMA model, LPC Modelling, Autocorrelation method, Levinson Durbin Algorithm.

MODULE III: Speech Processing Applications (8 Hours)

(Block diagram approaches) Fundamentals of Speaker Recognition- Speaker

Identification/Verification, Advanced Techniques using Deep Neural Networks, Speech Recognition, Recent Trends in Speech Recognition. Speech Synthesis, Speech Enhancement, Speech coding- Time domain coding, Transform domain coding, Language identification.

MODULE IV: Audio Perception (8 Hours)

Signal Processing Models of Audio Perception: Basic anatomy of hearing System: Outer ear, middle ear and inner ear, Cochlea and signal processing in cochlea, Auditory Filter Banks, Gamma-tone filters, Bark Scale, Mel frequency scale, Psycho- acoustic analysis: Critical Band Structure, Simultaneous Masking, Temporal Masking

MODULE V: Audio Compression and Quality Analysis (8 Hours)

Audio compression methods: Sampling rate and bandwidth requirement for digital audio, Redundancy removal and perceptual irrelevancy removal, Loss less coding, sub-band coding, sinusoidal coding, Transform coding of digital audio:MPEG2-AAC coding standard, MDCT and its properties, Pre-echo and pre-echo suppression.

Audio Quality Analysis: Objective analysis methods- PEAQ, Subjective analysis methods - MOS score, MUSHRA score

Text books
1. Speech Communications: Human and Machine, Douglas O'Shaughnessy
2. Discrete-Time Speech Signal Processing: Principles and Practice" by Thomas F. Quatieri
3. Speech and Audio Signal Processing: Processing and Perception of Speech and Music by Ben Gold, Nelson Morgan, and Dan Ellis

Reference books
1. Theory and Applications of Digital Speech Processing by Lawrence R. Rabiner and Ronald W. Schafer
2. Audio Signal Processing and Coding by Andreas Spanias, Ted Painter, and Venkatraman Atti
3. Spatial Audio Processing: MPEG Surround and Other Applications" by Jeroen Breebaart and Christof Faller
4. Coursera and edX for supplementary online courses and materials:
   https://onlinecourses.nptel.ac.in/noc22_ee117/preview

COURSE CONTENTS AND LECTURE SCHEDULE		
No.		No. of Hours
MODULE I		
1.1	Introduction to Acoustic Theory of Speech Production-Overview of the course content and objectives, Basic principles of the acoustic theory of speech production	1
1.2	Vocal Tract Model for Speech Analysis-Understanding the vocal tract model, Its application in speech signal analysis	1
1.3	Exploring Formants and Pitch in Speech-Introduction to formants in speech analysis, Basics of pitch and its significance in speech processing	1

1.4	Fundamentals of Articulatory and Acoustic Phonetics-Differentiating between articulatory and acoustic phonetics, Their roles and applications in speech analysis	1
1.5	Time Domain Analysis - Short Time Energy and Zero Crossing Rate-Introduction to time domain analysis in speech, Concepts of short time energy and zero crossing rate	1
1.6	Autocorrelation Function in Speech Analysis-Understanding the autocorrelation function, Its application and importance in speech signal processing	1
MODULE II		
2.1	Introduction to Frequency Domain Analysis in Speech Processing-Overview of frequency domain analysis, Basic principles and significance in speech processing	1
2.2	Filter Banks in Speech Analysis-Understanding the role of filter banks, Types and applications in speech signal processing	1
2.3	Short-Time Fourier Transform (STFT) and Its Applications-Fundamentals of STFT, Practical applications in speech processing	1
2.4	Spectrogram Analysis - Wideband and Narrowband, Differences between wideband and narrowband spectrograms, Analysis techniques and their specific uses	1
2.5	Formant Estimation and Analysis-Techniques for formant estimation, The role of formant analysis in understanding speech characteristics	1
2.6	Cepstral Analysis and Mel-Frequency Cepstral Coefficients (MFCC)-Introduction to cepstral analysis, Understanding MFCC and its applications in speech processing	1
2.7	Linear Predictive Coding (LPC) and Autoregressive (AR) Models-Basics of LPC modelling, Introduction to AR and ARMA models in speech analysis	1
2.8	Advanced Modelling Techniques - Autocorrelation Method and Levinson Durbin Algorithm-Understanding the autocorrelation method in speech signal analysis, Detailed study of the Levinson Durbin Algorithm and its applications	1
MODULE III		
3.1	Overview of Speech Processing Applications-Introduction to the module, Basic understanding of block diagram approaches in speech processing	1
3.2	Fundamentals of Speaker Recognition- Concepts of speaker identification and verification, Techniques and challenges in speaker recognition	1

3.3	Advanced Techniques in Speaker Recognition using Deep Neural Networks-Introduction to deep learning in speech processing, Application of deep neural networks in speaker recognition	1
3.4	Fundamentals of Speech Recognition-Basic principles and methodologies in speech recognition, Overview of speech recognition systems	1
3.5	Recent Trends in Speech Recognition- Exploration of the latest advancements and trends in speech recognition, Discussion on emerging technologies and their implications	1
3.6	Speech Synthesis Techniques- Understanding the principles of speech synthesis, Techniques and applications in creating synthesized speech	1
3.7	Speech Enhancement and Coding- Introduction to speech enhancement techniques, Overview of speech coding methods, including time domain and transform domain coding	1
3.8	Language Identification in Speech Processing- Concepts and techniques in language identification, Application and significance in multi-lingual speech processing environments	1
MODULE IV		
4.1	Introduction to Audio Perception and Hearing System Anatomy-Overview of audio perception, Basic anatomy of the hearing system, including the outer, middle, and inner ear	1
4.2	Cochlea and Signal Processing in the Cochlea-Understanding the function of the cochlea in audio perception, Signal processing mechanisms within the cochlea	1
4.3	Auditory Filter Banks and Their Role-Introduction to auditory filter banks, Understanding their significance in audio signal processing	1
4.4	Gamma-tone Filters in Auditory Processing-Explaining gamma-tone filters, Their application and importance in auditory signal processing	1
4.5	Bark Scale and Mel Frequency Scale-Introduction to Bark Scale, Understanding the Mel frequency scale and its applications	1
4.6	Basics of Psycho-acoustic Analysis-Introduction to psycho-acoustics, Exploring critical band structure in auditory perception	1
4.7	Simultaneous Masking in Psycho-acoustics-Understanding simultaneous masking, Its implications and applications in audio signal processing	1
4.8	Temporal Masking in Audio Perception-Exploring the concept of temporal masking, Its relevance and effects in the perception of sound	1
MODULE V		
5.1	Introduction to Audio Compression-Overview of audio compression, Understanding sampling rate and bandwidth requirements for digital audio and its removal	1

5.2	Redundancy and Perceptual Irrelevancy in Audio Compression-Techniques for redundancy removal in audio signals, Concepts of perceptual irrelevancy	1
5.3	Lossless Coding Techniques-Principles of lossless audio compression, Different methods and applications of lossless coding	1
5.4	Sub-band and Sinusoidal Coding-Introduction to sub-band coding in audio compression, Understanding sinusoidal coding and its applications	1
5.5	Transform Coding and MPEG2-AAC Coding Standard-Basics of transform coding in digital audio, Detailed study of the MPEG2-AAC coding standard	1
5.6	MDCT and Its Properties in Audio Compression-Exploring the Modified Discrete Cosine Transform (MDCT), Its role and properties in audio compression	1
5.7	Pre-echo and Pre-echo Suppression in Audio Compression-Understanding the phenomenon of pre-echo, Techniques for pre-echo suppression	1
5.8	Audio Quality Analysis - Objective and Subjective Methods-Overview of objective analysis methods like PEAQ, Introduction to subjective analysis methods including MOS and MUSHRA scores.	1

	CO Assessment Questions

1	1. Describe the acoustic theory of speech production. How does this theory explain the generation of speech sounds from a physiological perspective, and what are the implications of this theory for speech signal processing?
	2. Explain the vocal tract model used in speech analysis. Discuss how the model contributes to our understanding of speech production and its relevance in analyzing different speech characteristics such as formants and pitch.
	3. Using Matlab or Python, write code to calculate the short-time energy, short-time zero crossing rate, and the autocorrelation function of a given speech signal. Provide a detailed commentary on the following:
	
	Implementation of Techniques:
	
	    a. Explain how you implemented the short-time energy and illustrate its use in identifying segments of a speech signal with high energy (like vowels) versus low energy (like pauses).
	    b. Describe your implementation of the short-time zero crossing rate. Discuss how this measure helps in differentiating voiced and unvoiced parts of speech.
	    c. Implement the autocorrelation function and explain how it can be used to estimate the pitch of the speech signal.
	
	1. Analysis of Speech Signals:
	
	    a. Apply these techniques to analyze a provided speech signal. Use visualizations (like plots) to demonstrate the variations in energy, zero crossing rate, and autocorrelation across different segments of the speech signal.
	    b. Discuss your observations and insights gained from this analysis. How do these time-domain techniques contribute to understanding the characteristics of the speech signal?
	
	2. Modern Tool Utilization:
	
	    a. Reflect on your experience using Matlab or Python for this analysis. Discuss the advantages and limitations of using these tools for speech signal analysis, specifically in the context of time-domain analysis techniques.

2	1. Explain the role of filter banks in frequency domain analysis of speech signals. How do filter banks help in decomposing a speech signal, and what are their applications in speech processing?
	2. Describe how the Short-Time Fourier Transform (STFT) is used in speech signal analysis. Discuss the difference between wideband and narrowband spectrograms and their respective uses in analyzing speech signals.
	3. Using Matlab or Python, write a script to extract Mel Frequency Cepstral Coefficients (MFCC) from a given speech sample. Your task will include the following steps and requirements:
	
	    1. Preprocessing the Speech Signal:
	
	    a. Load the provided speech sample into your Matlab or Python environment.
	    b. Perform necessary preprocessing steps such as framing, windowing, and pre-emphasis. Explain the purpose of each of these steps in the context of MFCC extraction.
	
	    2. MFCC Feature Extraction:
	
	    a. Implement the process of MFCC feature extraction. This should include computing the Mel-scaled filterbank energies and then applying the discrete cosine transform to obtain the cepstral coefficients.
	    b. Discuss the reason for using the Mel scale in MFCC feature extraction and how it relates to human auditory perception.
	
	    3. Analyzing the Extracted Features:
	
	    a. Visualize the MFCCs for the speech sample. You can use plots to show the variation of these coefficients over time.
	    b. Provide a brief analysis of the MFCC features extracted. Discuss any patterns or characteristics observed and what they might indicate about the speech sample.
	
	    4. Reflection on the Implementation:
	
	    a. Reflect on your experience of implementing the MFCC extraction process in Matlab or Python. Discuss the challenges faced, if any, and how you overcame them.
	    b. Evaluate the effectiveness of Matlab/Python as a tool for speech feature extraction and its importance in speech processing applications.

3	1. Describe the key principles of speaker recognition, including both speaker identification and verification. Discuss how these systems differentiate between speakers and the challenges involved in accurately recognizing a speaker's identity. 2. Using Matlab or Python, develop a speech or speaker recognition system that employs Deep Neural Networks (DNNs). Your task will encompass the following components: System Development: Design and implement a speech or speaker recognition system using DNNs. This should include data preprocessing, feature extraction (e.g., MFCCs), and the use of a suitable neural network architecture (e.g., CNN, RNN, LSTM). Train your model on a provided dataset and test its performance on a separate set of speech samples. 3. Discuss the process and applications of speech synthesis and speech enhancement. Include in your answer how speech coding, including time-domain and transform-domain coding, contributes to the effectiveness of these processes.
4	1. Describe the basic anatomy of the human hearing system, including the outer, middle, and inner ear, and the cochlea. Explain how each part contributes to the process of hearing and the perception of sound. 2. Discuss the role of the cochlea in signal processing and the concept of auditory filter banks. How do these filter banks, including Gamma-tone filters, influence our perception of sound? 3. Explain the principles of psycho-acoustic analysis, focusing on critical band structure, simultaneous masking, and temporal masking. How do these concepts help in understanding the human perception of sound and in designing audio processing systems?
5	1. Describe the various methods used in audio compression, including sampling rate considerations, redundancy removal, and perceptual irrelevancy removal. How do these methods contribute to effective audio compression, and what are the trade-offs involved, particularly in lossless versus lossy compression? 2. Explain the concept of transform coding in digital audio compression, with a focus on the MPEG2-AAC coding standard. Discuss the role of the Modified Discrete Cosine Transform (MDCT) and its properties, including how it is used to suppress pre-echo in audio signals. 3. Discuss the methods used for audio quality analysis, both objective (like PEAQ) and subjective (such as MOS and MUSHRA scores). How are these methods applied to evaluate the quality of compressed audio, and what are their limitations?

24ECE743	ROBOTICS	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: The objective of this course is to introduce students the emerging field of robotics by imparting the fundamental knowledge on the design and control of robots, their multi-disciplinary engineering aspects and applications.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO 1	Attain a thorough understanding of different types of Robots and their applications. (Understand Level)
CO 2	Select appropriate sensors and actuators based on the robotic applications (Understand Level)
CO 3	Perform kinematic and dynamic analyses for robots. (Apply Level)
CO 4	Carry out the design and control of a simple robot. (Apply Level)
CO 5	Integrate mechanical and electrical hardware for making a robotic device. (Apply Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	✓	✓										
CO 2	✓	✓										
CO 3	✓	✓			✓							
CO 4	✓	✓			✓							
CO 5	✓	✓										✓

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA

Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
3-0-0-0	5	15	10	10	40

Total Mark Distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 Hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS
MODULE I: Introduction to Robotics (6 Hours)
Introduction to Robotics: Definition and Origin of Robotics. Robot Anatomy. Robot Specifications. Robot Characteristics – Accuracy, Precision, and Repeatability. Classification of Robots. Robot Structure - Types of Joints and End Effectors, Mechanisms and Manipulators. Common Kinematic Arrangements. Degree of Freedom. Robot Coordinates. Reference Frames. Robot Workspace. Areas of Application for Robots.
MODULE II Introduction to Sensors and Actuation Systems for Robots (8 Hours)
Introduction to Sensors and Actuation Systems for Robots: <u>Actuators:</u> Types of Robotic Drive Systems and Actuators: Hydraulic, Pneumatic and Electric drives. Parameters for selection of actuators. Specification. Areas of Application for: Stepper Motor, Servo Motor and Brushless DC Motor. Microprocessor Control of Motors. Speed Control using PWM and Direction Control using H- Bridge. Sensors: Types and Applications of Sensors in Robotics: Position, Displacement and Velocity Sensors. Tactile Sensors for Contact and Proximity Assessment. Strain Gauge based Force and Torque Sensors. Robotic Vision Systems- Introduction to Cameras, Imaging, Sensing and Digitization. Vision Applications in Robotics.

MODULE III: Introduction to Robot Kinematics (8 Hours)

Introduction to Robot Kinematics**:** Position and Orientation of Objects. Rotation. Euler Angles. Rigid Motion Representation using Homogenous Transformation Matrix. Kinematic Modeling: Translation and Rotation Representation, Coordinate Transformation, Forward and Inverse Kinematics. *Forward Kinematics*-Link Coordinates, Denavit-Hartenberg Representation, Application of DH Convention to Different Serial Kinematic Arrangements. *Inverse Kinematics* – General Properties of Solutions, Kinematic Decoupling

MODULE IV: Velocity Kinematics (9 Hours)

Velocity Kinematics **–** Derivation of the Jacobian, Application of Velocity Kinematics for Serial Manipulators, Importance of Singularities. Introduction to Dynamic Modelling: *Forward and Inverse Dynamics-* Equations of Motion using Euler- Lagrange formulation, Newton Euler Formulation.

Introduction to Robot Programming – Programming Methods, Robot Language Classification, Robot Language Structure, Elements and its Functions. Motion, End-Effecter and Sensor Commands in VAL Programming Language. Simple Programs.

MODULE V: Recent Developments in Robotics (6 Hours)

Recent Developments in Robotics: Mobile Robots- Mobile Robot Kinematics, Navigation. Humanoid Robotics: Biped Locomotion, Imitation Learning. Collaborative Robots: Collaborative Robot, Collaborative Operation, Applications. Artificial Intelligence in Robotics: Applications in Unmanned Systems, Defense, Medical, Industries, etc. Industrial Applications of Robots in Material Handling and Assembly. Robotics and Automation for Industry 4.0., Robot Ethics, Robot Safety. Social Robotics.

Text books

1. S.K. Saha, Introduction to Robotics, Tata McGraw Hill, 2nd Edition, 2014
2. Saeed B. Niku, Introduction to Robotics: Analysis, Systems, Applications, John Wiley & Sons, 2nd Edition, 2011.
3. Spong and Vidyasagar, Robot Dynamics and Control, John Wiley & Sons, 1990.
4. Mikell P. Groover, et al., Industrial Robotics – Technology, Programming and Applications, McGraw Hill, 2nd Edition, 2012

Reference books

1. John. J.Craig, Introduction to Robotics: Mechanics and Control, PHI, 2005.
2. Ashitava Ghosal, Robotics, Fundamental concepts and analysis, OXFORD University Press, 2006
3. Fu, K.S, Gonzalez, R.C, Lee, C.S.G., Robotics, Control, Sensing, Vision and Intelligence, McGraw-Hill, 1987.
4. Asada, H., and J. J. Slotine. *Robot Analysis and Control.* New York, NY: Wiley, 1986.
5. Robert J. Schilling, Fundamentals of Robotics: Analysis & Control, Pearson Education, 2000
6. Klafter, R.D., Chmielewski, T.A, Negin, M, Robotic Engineering An Integrated Approach, PHI, 2007

7. S. R. Deb, Robotics Technology and Flexible Automation, Tata McGraw Hill, New Delhi, 1994.
8. NPTELCourse on Robotics by Prof. D K Pratihar, IIT Kharagpur, https://onlinecourses.nptel.ac.in/noc19_me74/preview

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
MODULE I		
1.1	Introduction to Robotics: Definition and Origin of Robotics. Robot Anatomy. Robot Specifications.	1
1.2	Robot Characteristics – Accuracy, Precision, and Repeatability.	1
1.3	Classification of Robots. Advantages and Disadvantages of Robots.	1
1.4	Robot Structure - Types of Joints and End Effectors, Mechanisms and Manipulators. Common Kinematic Arrangements.	1
1.5	Degree of Freedom. Robot Coordinates. Reference Frames.	1
1.6	Robot Workspace. Areas of Application for Robots.	1
MODULE II		
2.1	Introduction to Sensors and Actuation Systems for Robots: Actuators: Types of Robotic Drive Systems and Actuators: Hydraulic, Pneumatic and Electric drives.	1
2.2	Transmission: Gears, Timing Belts and Bearings. Parameters for selection of actuators. Specification	1
2.3	Areas of Application for: Stepper Motor, Servo Motor and Brushless DC Motor.	1
2.4	Microprocessor Control of Motors. Speed Control using PWM and Direction Control using H- Bridge.	1
2.5	Sensors: Types and Applications of Sensors in Robotics: Position, Displacement and Velocity Sensors.	1
2.6	Tactile Sensors for Contact and Proximity Assessment. Strain Gauge based Force and Torque Sensors. Tachometers, etc	1
2.7	Robotic Vision Systems- Introduction to Cameras, Imaging.	1
2.8	Sensing and Digitization, Vision Applications in Robotics	1
MODULE III		
3.1	Introduction to Robot Kinematics: Position and Orientation of Objects, Rotation, Euler Angles.	1
3.2	Rigid Motion Representation using Homogenous Transformation Matrix.	1

3.3	Kinematic Modelling: Translation and Rotation Representation, Coordinate Transformation,	1
3.4	*Forward Kinematics*-Link Coordinates,	1
3.5	Denavit-Hartenberg Representation	1
3.6	Application of DH Convention to Different Serial Kinematic Arrangements.	1
3.7	*Inverse Kinematics* – General Properties of Solutions	1
3.8	Kinematic Decoupling	1
MODULE IV		
4.1	*Velocity Kinematics* – Derivation of the Jacobian	1
4.2	Application of Velocity Kinematics for Serial Manipulators	1
4.3	Importance of Singularities.	1
4.4	Introduction to Dynamic Modelling: *Forward and Inverse Dynamics*- Equations of Motion using Euler-Lagrange formulation	1
4.5	Equations of motion using Newton Euler Formulation.	1
4.6	Introduction to Position and force control of robotic manipulators Robot actuation and control using PID Controllers.	1
4.7	Introduction to Position and force control of robotic manipulators Robot actuation and control using PID Controllers.	1
4.8	Introduction to Robot Programming – Programming Methods, Robot Language Classification, Robot Language Structure, Elements and its Functions	1
4.9	Motion, End-Effecter and Sensor Commands in VAL Programming Language. Simple Programs.	1
MODULE V		
5.1	Recent Developments in Robotics. Mobile Robots: Mobile Robot Kinematics, Navigation.	1
5.2	Humanoid Robotics: Biped Locomotion, Imitation Learning.	1
5.3	Collaborative Robots: Collaborative Robot, Collaborative Operation,	1
5.4	Applications. Artificial Intelligence in Robotics: Applications in Unmanned Systems, Defense, Medical, Industries, etc	1
5.5	Industrial Applications of Robots in Material Handling and Assembly.	1
5.6	Robotics and Automation for Industry 4.0., Robot ethics, Robot Safety. Social Robotics.	1

	CO Assessment Questions
1	Identify five different applications of non-industrial robots.
2	Explain the functions of a robotic vision system? List two applications where vision systems can be employed in robots.
3	An object in space executes the following sequence of motions: i. Rotation of 30^0 about the world z-axis ii. Translation of 3 unit along current y-axis iii. Rotation of 45^0 about world x-axis iv. Translation of 6 units along current x-axis. Establish the relationship between the world frame and the resultant object frame. Also determine the coordinates of a point in the world frame, if it is described by $[1\ 5\ 2]^T$ in the object frame.
4	Design a cylindrical manipulator using D-H convention.
5	Create a working prototype of a simple manipulator configuration and demonstrate its workspace and the motion of End Effector in the workspace.

24ECE753	LOW POWER VLSI DESIGN	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: The main emphasis of the course is on core approaches in Low power VLSI Design, with the goal of providing a holistic grasp of various methodologies in low power circuit design. It delves into areas including short channel effects, various sources of power dissipation, power reduction techniques and Adiabatic logic etc. This course equips students with essential knowledge and practices commonly used for Low Power VLSI design.

Prerequisite: 24ECP602 VLSI Design

Course Outcomes: After the completion of the course the student will be able to

CO 1	Comprehend various short channel effect in MOSFET. (Understand Level)
CO 2	Describe various sources of power dissipation in MOSFET. (Understand Level)
CO 3	Identify various power reduction techniques that can be applied for low power design. (Understand Level)
CO 4	Realize functions in clocked and non-clocked design styles. (Apply Level)
CO 5	Explain Adiabatic and Reversible logic circuits. (Apply Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	✓											
CO 2	✓											
CO 3	✓											
CO 4	✓											
CO 5	✓											

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA

Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
3-0-0-0	5	15	10	10	40

Total Mark distribution			
Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 Hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS (34 Hours)

MODULE I : Physics of power dissipation in MOSFET devices (7 Hours)

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.

MODULE II : Sources of power dissipation in CMOS (6 Hours)

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 power dissipation of gate level circuit

MODULE III : Power Reduction Techniques (7 Hours)

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.

MODULE IV : Circuit design style (7 Hours)

Clocked design- 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)

MODULE V : Adiabatic switching (7 Hours)

Adiabatic charging, adiabatic amplification, One stage and two stage adiabatic

buffer, Adiabatic logic gates, pulsed power supplies, Reversible logic basic concepts.

Text books
1. Gray Yeap, Practical low power digital VLSI design, Springer, 1998
2. Kaushik Roy, Sharat C Prasad, Low power CMOS VLSI circuit design, Wiley India, 2000

Reference books
1. Abdellatif Bellaouar, Mohamed I Elmasry, Low power digital VLSI design, Kluwer Academic, 1995
2. Anatha P Chandrakasan, Robert W Brodersen, Low power digital CMOS Design, Kluwer Academic, 1995
3. Christian Piguet, Low power CMOS circuits, Taylor & Francis, 2006
4. Kiat Seng Yeo, Kaushik Roy, Low voltage, low power VLSI sub systems, Tata McGraw Hill, 2004
5. https://archive.nptel.ac.in/courses/106/105/106105034/

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
MODULE 1		
1.1	Need for low power circuit design	1
1.2	MIS Structure	1
1.3	MIS Structure Band diagram	1
1.4	Short channel effects-surface scattering, punch through	1
1.5	Velocity saturation, impact ionization	1
1.6	Hot electron effects, Drain Induced Barrier Lowering	1
1.7	Deep submicron transistor design issues	1
MODULE II		
2.1	Dynamic Power Dissipation	1
2.2	Dynamic Power Dissipation: Charging and Discharging capacitance power dissipation.	1
2.3	Short Circuit Power: Short Circuit Current of Inverter	1
2.4	Short circuit current dependency with input and output load	1
2.5	Glitching Power Dissipation	1
2.6	Gate level power analysis: Capacitive power dissipation of gate level circuit	1
MODULE III		
3.1	Supply voltage Scaling Approaches**:** Multi VDD and Dynamic VDD.	1
3.2	Leakage power reduction Techniques – Transistor stacking.	1
3.3	VTCMOS, MTCMOS	1
3.4	DTCMOS	1
3.5	Power gating	1

3.6	Clock gating for Dynamic power dissipation	1
3.7	Transistor and Gate Sizing for Dynamic and Leakage Power Reduction.	1
MODULE IV		
4.1	Clocked design - Basic concept	1
4.2	Domino logic (domino NAND gate)	1
4.3	Differential Current Switch Logic.	1
4.4	Non clocked circuit design style-fully complementary logic.	1
4.5	NMOS and pseudo –NMOS logic	1
4.6	Differential Cascade voltage switch logic (DCVS)	1
4.7	Implementation of DCVS	
MODULE V		
5.1	Adiabatic charging	1
5.2	Adiabatic amplification	1
5.3	One stage and two stage adiabatic buffer	1
5.4	Adiabatic logic gates	1
5.5	Implementation of Adiabatic Logic gates	1
5.5	Pulsed power supplies	1
5.6	Reversible logic basic concepts	1

CO Assessment Questions	
1	Explain impact ionization and Hot electron effect.
2	Derive the expression of switching power in static CMOS circuit.
3	Describe supply voltage scaling method for power reduction.
4	Implement the function F= [AB+CD] in DCVS
5	Implement Y=AB using adiabatic logic

SEMESTER VII
OPEN ELECTIVE I

		L	T	P	J	S	C	Year of Introduction
24ECO714	**WIRELESS Ad-Hoc AND SENSOR NETWORK**	3	0	0	0	3	3	**2024**

Preamble: This course will provide students with an understanding of wireless Ad-Hoc and sensor networks enable them to recognize the wide range of applicability of these networks and provide them with an understanding of the major design issues such as protocol mechanisms and resource constraints. Wireless Sensor Network (WSN) system also incorporates a gateway that provides wireless connectivity back to the wired world and distributed nodes. This course offers an in-depth exploration of the architecture and routing algorithm for wireless network.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO 1	Explain the fundamental concepts of wireless Ad-Hoc network and the design of Media Access Control (MAC) layer protocols for Ad-Hoc networks. (Understand Level)
CO 2	Describe routing protocols for Ad-Hoc wireless networks and its design issues. (Understand Level)
CO 3	Describe transport layer protocols and secure routing mechanisms for Ad-Hoc wireless networks. (Understand Level)
CO 4	Explain the concepts of network architecture and MAC layer protocol for wireless sensor network. (Understand Level)
CO 5	Analyze the security challenges and routing issues in wireless sensor network. (Apply Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓										
CO2	✓	✓										
CO3	✓	✓										
CO4	✓	✓										
CO5	✓	✓										

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			**End Semester Examination**
	Test1	**Test 2**	**Other tools**	
Remember	✓	✓		✓
Understand	✓	✓		✓
Apply		✓		✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
4-0-0-0	5	15	10	10	40

Total Mark Distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 Hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I: Ad hoc wireless networks and MAC protocols (7 Hours)

Introduction, Issues and challenges in Ad-Hoc wireless networks –Medium Access scheme, Routing, Multicasting, Transport layer protocols, Pricing scheme Quality of Service, Self-Organization, Security, Addressing and Service Discovery, Energy Management, Scalability, Deployment Considerations. Design goals of a MAC Protocol - MAC layer protocols for wireless ad hoc networks– Contention Based Protocols - MAC protocols using Directional antennas - Multichannel MAC protocol -
Power control MAC protocol - Design Issues.

MODULE II : Routing protocols for ad hoc wireless networks (7 Hours)

Introduction, Issues in designing a Routing protocol, Routing protocols for ad hoc

wireless networks - Table Driven Routing Protocol, On-Demand Routing Protocol, Hybrid Routing Protocol, Routing Protocols with Efficient Flooding mechanisms, Hierarchical Routing Protocol, Power Aware Routing Protocol.

MODULE III : Transport layer and security protocols (7 Hours)

Issues in designing a Transport Layer protocol, Transport Layer protocols for ad hoc wireless networks, Security in Ad Hoc Wireless networks - Network Security attacks – Network layer attacks, Transport layer attacks, Application layer attacks - Key management – Symmetric Key algorithms, Asymmetric Key algorithms, Secure routing in Ad-Hoc wireless networks – Security –Aware AODV protocol.

MODULE IV : Wireless sensor network (7 Hours)

Introduction, Applications of Sensor networks, Issues and challenges in designing sensor network, Sensor Network Architecture – Layered and Clustered Architectures, Data Dissemination, Data Gathering, Self Organizing MAC protocols for Sensor networks, Hybrid TDMA/FDMA, CSMA based MAC protocols, Quality of a sensor network – Coverage, Exposure.

MODULE V: Security in ad hoc and sensor networks (7 Hours)

Security Attacks – Key Distribution and Management – Intrusion Detection – Software based Anti-tamper techniques – Water marking techniques – Defense against routing attacks - Secure Ad hoc routing protocols – Broadcast authentication
WSN protocols – TESLA – Biba – Sensor Network Security Protocols – SPINS.

Text books

1. C. Siva Ram Murthy and B. S. Manoj, — Ad-Hoc Wireless Networks – Architectures and Protocols, Pearson Education, 2006.
2. Holger Karl, Andreas Willing, —Protocols and Architectures for Wireless Sensor Networks‖, John Wiley & Sons, Inc., 2005.
3. Labiod. H, 'Wireless ad-hoc and Sensor network', Wiley,2008.
4. Carlos De Morais Cordeiro, Dharma Prakash Agrawal" Ad Hoc & Sensor Networks: Theory and Applications", World Scientific Publishing Company, 2nd edition, 2011.

Reference books

1. Subir Kumar Sarkar, T G Basavaraju, C Puttamadappa, —Ad Hoc Mobile Wireless Networks‖, Auerbach Publications, 2008.
2. Waltenegus Dargie, Christian Poellabauer, —Fundamentals of Wireless Sensor Networks Theory and Practice‖, John Wiley and Sons, 2010
3. Xiang-Yang Li "Wireless Ad Hoc and Sensor Networks: Theory and Applications, Cambridge university Press,2008.
4. NPTEL course on Principles and techniques of Wireless Ad Hoc and Sensor Network by IIT Kharagpur - https://archive.nptel.ac.in/courses/106/105/106105160/

COURSE CONTENTS AND LECTURE SCHEDULE	
No.	No. of Hours

	MODULE I	
1.1	Introduction: Cellular and Ad Hoc Wireless Networks, Applications	1
1.2	Issues and challenges in AD Hoc wireless networks –Medium Access scheme, Routing, Multicasting, Transport layer protocols	1
1.3	Pricing scheme, Quality of Service, Self-Organization, Security	1
1.4	Addressing and Service Discovery, Energy Management, Scalability, Deployment Considerations.	1
1.5	Design goals of a MAC Protocol - MAC layer protocols for wireless ad hoc networks	1
1.6	Contention Based Protocols - Contention – Based Protocols with Reservation Mechanisms, Contention – Based Protocols with Scheduling Mechanisms	1
1.7	MAC protocols using Directional antennas - Multichannel MAC protocol - Power control MAC protocol - Design Issues.	1
	MODULE II	
2.1	Introduction, Issues in designing a Routing protocol: Mobility, bandwidth constraint, resource constraints.	1
2.2	Routing protocols for ad hoc wireless networks – Based on routing information update mechanism and routing topology.	1
2.3	Table Driven Routing Protocol – Destination Sequenced Distance Vector Routing Protocol - Wireless Routing Protocol	1
2.4	On-Demand Routing Protocol – Dynamic Source Routing Protocol – Ad-Hoc On-Demand Distance Vector Routing Protocol	1
2.5	Hybrid Routing Protocol - Zone Routing Protocol	1
2.6	Routing Protocols with Efficient Flooding mechanisms	1
2.7	Hierarchical Routing Protocol, Power Aware Routing Protocol	1
	MODULE III	
3.1	Issues in designing a Transport Layer protocol	1
3.2	Transport Layer protocols for ad hoc wireless networks,	1
3.3	Security in Ad Hoc Wireless networks - Network Security attacks	1
3.4	Network layer attacks, Transport layer attacks, Application layer attacks	1
3.5	Key management – Symmetric Key algorithms	1
3.6	Asymmetric Key algorithms	1
3.7	Secure routing in Ad Hoc wireless networks – Security –Aware AODV protocol	1
	MODULE IV	

4.1	Introduction, Applications of Sensor networks	1
4.2	Issues and challenges in designing sensor network	1
4.3	Sensor Network Architecture – Layered and Clustered Architectures	1
4.4	Data Dissemination, Data Gathering	1
4.5	Self-Organizing MAC protocols for Sensor networks	1
4.6	Hybrid TDMA/FDMA, CSMA based MAC protocols	1
4.7	Quality of a sensor network – Coverage, Exposure.	1
MODULE V		
5.1	Security Attacks – Key Distribution and Management	1
5.2	Intrusion Detection – Software based Anti-tamper techniques	1
5.3	Water marking techniques – Defense against routing attacks	1
5.4	Secure Ad hoc routing protocols	1
5.5	Broadcast authentication WSN protocols – TESLA – Biba	1
5.6	Sensor Network Security Protocols – SPINS	1
5.7	Applications of wireless sensor networks	1

CO Assessment Questions	
1	Justify the significance of power management in wireless ad-hoc networks with the help of a relevant example.
2	Analyze and justify the applicability of a table-driven routing protocol in a high mobility environment.
3	Compare and contrast the security provisioning in adhoc networks with that in infrastructure-based network.
4	Illustrate the advantages of clustered architecture over a layered architecture in a sensor network.
5	Consider the third iteration of LEACH protocol. If the desired number of nodes per cluster is ten, compute the threshold for a node during it's random number generation.

24ECO724	MECHATRONICS	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: This course introduces students to the rapidly emerging, multi- disciplinary, and exciting field of Mechatronics. The students would be exposed to modern tools and technologies such as Programmable Logic Controllers (PLCs), (Microelectromechanical systems) MEMS and Robotic systems.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO 1	Understand the working principles of various sensors and actuators in Mechatronics systems and be able to choose the suitable one for real world applications. (Understand Level)
CO 2	Formulate and simulate models of mechatronics systems (Apply Level).
CO 3	Explain the implementation of PLC in mechatronics applications. (Understand Level)
CO 4	Explain the standard fabrication techniques and principle of operation of MEMS devices**.** (Understand Level)
CO 5	Design and Analysis of commonly encountered mechatronics systems for real time applications. (Apply Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	✓	✓										
CO 2	✓	✓										
CO 3	✓	✓										
CO 4	✓	✓										
CO 5	✓	✓			✓							

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	**Attendance**	Theory [L- T]			**Total Marks**
		Assignment	**Test-1**	**Test-2**	
3-0-0-0	5	15	10	10	40

Total Mark Distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 Hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I : Introduction to Mechatronics (7 Hours)

Introduction to Mechatronics: Structure of Mechatronics system. Comparison between traditional and mechatronics approach. Sensors - Characteristics - Temperature, flow, pressure sensors. Displacement, position and proximity sensing by magnetic, optical, ultrasonic, inductive, capacitive and eddy current methods. Encoders: incremental and absolute. Resolvers and synchros. Piezoelectric sensors. Acoustic Emission sensors. vibration sensors. Force and tactile sensors. Range
finders: ultrasonic and light-based range finders

MODULE II : Actuators (7 Hours)
Actuators: Hydraulic and Pneumatic actuators - Directional control valves, pressure control valves, process control valves. Rotary actuators. Development of simple hydraulic and pneumatic circuits using standard Symbols. Electrical drives: DC, AC, brushless, servo and stepper motors. Harmonic drive. Magnetostrictive actuators and piezoelectric actuators.
MODULE III : System Modeling and PLC (7 Hours)
System modeling - Mathematical models and basic building blocks of general mechanical, electrical, fluid and thermal systems. Typical elements of open and closed loop control systems. Adaptive controllers for machine tools. Programmable Logic Controllers (PLC) –Basic structure, input/ output processing. Programming: Timers, Internal Relays, Counters and Shift registers. Development of simple ladder programs for specific purposes.
MODULE IV : MEMS (7 Hours)
Micro Electro Mechanical Systems (MEMS): Fabrication: Deposition, Lithography, Micromachining methods for MEMS -Surface and Bulk, Deep Reactive Ion Etching (DRIE) and LIGA processes. Principle, fabrication and working of MEMS based pressure sensor, accelerometer and gyroscope.
MODULE V : Mechatronics in Robotics (8 Hours)
Mechatronics in Robotics- choice of Sensors and Actuators. Robotic vision system - Image acquisition: Vidicon, charge coupled device (CCD) and charge injection device (CID) cameras. Image processing techniques: histogram processing: sliding, stretching, equalization and thresholding. Case studies of Mechatronics systems: Automatic camera, bar code reader, simple weighing machine, pick and place robot, automatic car park barrier system, automobile engine management system.
Text books 1. Bolton W., Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering, Person Education Limited, New Delhi, 2007 2. Ramachandran K. P., G. K. Vijayaraghavan, M. S. Balasundaram, Mechatronics: Integrated Mechanical Electronic Systems, Wiley India Pvt. Ltd., New Delhi, 2008. 3. Saeed B. Niku, Introduction to Robotics: Analysis, Systems, Applications, Person Education ,Inc., New Delhi, 2006. 4. Devdas Shetty, Richard A. Kolk, "Mechatronics System Design", Thomson Learning Publishing Company, Vikas publishing house, Second edition, 2001. 5. NPTEL Course on Mechatronics by Prof. Pushparaj Mani Pathak, IIT Roorkee https://onlinecourses.nptel.ac.in/noc21_me27/preview

Reference books

1. David G. Aldatore, Michael B. Histand, Introduction to Mechatronics and Measurement Systems, McGraw-Hill Inc., USA, 2003.
2. Gordon M. Mair, Industrial Robotics, Prentice Hall International, UK, 1998.
3. HMT, Mechatronics, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2004.
4. Vijay K. Varadan, K. J. Vinoy, S. Gopalakrishnan, Smart Material Systems and MEMS: Design and Development Methodologies, John Wiley & Sons Ltd., England, 2006.
5. Bishop, Robert H. The Mechatronics Handbook-2 Volume Set. CRC press, 2002.

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
MODULE I		
1.1	Introduction to Mechatronics: Structure of Mechatronics system	1
1.2	Comparison between traditional and mechatronics approach	1
1.3	Sensors - Characteristics -Temperature, flow, pressure sensors	1
1.4	Displacement, position and proximity sensing by magnetic, optical, ultrasonic, inductive, capacitive and eddy current methods	1
1.5	Encoders: incremental and absolute. Resolvers and synchros	1
1.6	Piezoelectric sensors. Acoustic Emission sensors. vibration sensors	1
1.7	Force and tactile sensors, Range finders: ultrasonic and light based range finders	1
MODULE II		
2.1	Actuators: Hydraulic and Pneumatic actuators - Directional control valves	1
2.2	pressure control valves, process control valves	1
2.3	Rotary actuators.	1
2.4	Development of simple hydraulic and pneumatic circuits using standard Symbols	1
2.5	Electrical drives: DC, and AC	1
2.6	Brushless, servo motors	1
2.7	Stepper motors. Harmonic drive	1
MODULE III		
3.1	System modeling - Mathematical models and basic building blocks of general mechanical, electrical, fluid and thermal systems	1

3.2	System modeling - Mathematical models and basic building blocks of general mechanical, electrical, fluid and thermal systems	1
3.3	Typical elements of open and closed loop control systems.	1
3.4	Adaptive controllers for machine tools	1
3.5	Programmable Logic Controllers (PLC) –Basic structure, input/ output processing	1
3.6	Programming: Timers, Internal Relays, Counters and Shift registers	1
3.7	Development of simple ladder programs for specific purposes	1
MODULE IV		
4.1	Micro Electro Mechanical Systems (MEMS): Fabrication: Deposition, Lithography	1
4.2	Micromachining methods for MEMS -Surface micromachining	1
4.3	Micromachining methods for MEMS – Bulk micromachining	1
4.4	Deep Reactive Ion Etching (DRIE) and LIGA processes	1
4.5	Principle, fabrication and working of MEMS based pressure sensor	1
4.6	Principle, fabrication and working of MEMS based pressure accelerometer	1
4.7	Principle, fabrication and working of MEMS based pressure gyroscope	1
MODULE V		
5.1	Mechatronics in Robotics- choice of Sensors and Actuators	1
5.2	Robotic vision system - Image acquisition: Vidicon, charge coupled device (CCD)	1
5.3	Robotic vision system - charge injection device (CID) cameras.	1
5.4	Image processing techniques: histogram processing: sliding, stretching, equalization and thresholding	1
5.5	Image processing techniques: histogram processing: sliding, stretching, equalization and thresholding	1
5.6	Case studies of Mechatronics systems: Automatic camera, bar code reader, simple weighing machine, picks and place robot	1
5.7	Case studies of Mechatronics systems: Automatic camera, bar code reader, simple weighing machine, picks and place robot	1
5.8	automatic car park barrier system, automobile engine management system	1

	CO Assessment Questions
1	1. Illustrate the working of a strain gauged load cell 2. Explain the working of any one non-contact temperature measurement system.
	3. With neat sketches explain the working of a double acting hydraulic actuator. 4. Design a hydraulic circuit to operate a winch fitted with a hydraulic motor. The motor should be run clockwise, counter clockwise and stopped. Use a manually operated valve. 5. Explain any two situations when pneumatic actuators are preferred over hydraulic ones.
2	1. Derive the mathematical model of a general electrical system and draw its analogy with a mechanical system. 2. Explain the working of a mechanical device using closed loop control system with the help of a suitable example.
3	1. Explain 'latching' in PLC logic with an example. 2. Illustrate the significance of Internal Relays in PLC program 3. Consider a pneumatic system with single-solenoid controlled valves and involving two cylinders A and B, with limit switches a–, a+, b–, b+ detecting the limits of the piston rod movements. Design a ladder programme with the requirement being when the start switch is triggered, the sequence A+, B+, A–, 10s time delay, B– occurs and stop at that point until the start switch is triggered again.
4	1. Explain the steps involved in photolithography. State the chemicals used in each of the stages along with the operating conditions. 2. Explain the criteria for choice of surface or bulk micromachining techniques in the design of micro systems. 3. Explain with block diagram the steps in LIGA process. State two advantages of LIGA process over other micro machining techniques
5	1. With the help of a neat sketch design the different mechatronics modules used in automatic car park barrier system 2. Explain with a neat sketch the mechatronic implementation of a household weighing machine and analyse its performance. 3. With a neat sketch, design the physical system and working of a pick and place robot.

24ECO734	BIOMEDICAL INSTRUMENTATION	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: This course will introduce aspects of biomedical instrumentation as applied to biological systems described using engineering principles and the use of modern diagnostic and therapeutic equipment. The course covers major diagnostic, therapeutic and different imaging systems. After the completion of course the students are able to understand the principles, techniques, and applications that bridge the gap between engineering innovation and healthcare advancement.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO 1	Explain a Biomedical Instrumentation System and origin of Bioelectric potentials. (Understand Level)
CO 2	Describe a cardiovascular system and cardiovascular measurements. (Understand Level)
CO 3	Illustrate the function of Diagnostic Equipments. (Understand Level)
CO 4	Illustrate the function of Therapeutic Equipments. (Understand Level)
CO 5	Explain the different Imaging System used in medical diagnosis. (Understand Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	✓											
CO 2	✓											
CO 3	✓											
CO 4	✓											
CO 5	✓											

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply				
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	**Attendance**	**Theory [L- T]**			**Total Marks**
		Assignment	**Test-1**	**Test-2**	
3-0-0-0	**5**	**15**	**10**	**10**	**40**

Total Mark Distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 Hours

End Semester Examination [ESE]: Pattern			
PATTERN	**PART A**	**PART B**	**ESE Marks**
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS (35 Hours)

MODULE I: Human Physiological System and Bio-Potentials (8 Hours)

Physiological systems of the body (Brief discussion on Heart and cardio vascular system, Anatomy of nervous system, Physiology of respiratory system). Sources of bioelectric potentials – resting and action potentials -propagation of action potentials. Bio electric potentials. Bio potential electrodes- Nernst relation- skin surface electrodes, needle electrodes, microelectrodes. Transducers for Biomedical Applications-Strain gauge, LVDT, variable capacitor, Piezoelectric transducers.

MODULE II: Measurement of Biopotentials (7 Hours)

Electro conduction system of the heart, ECG waveform–electrodes and leads – Einthoven triangle, ECG read out devices, ECG machine – block diagram. Electro encephalogram –neuronal communication-brain waves – EEGmeasurement-10-20 electrode system, recording and analysis. Electromyogram (EMG) –Electromyogram measurements and its applications.

MODULE III: Diagnostic Equipments (7 Hours)	
Measurement of blood pressure – Direct and Indirect measurement (Oscillo metric measurement, ultrasonic method), Measurement of blood flow-Electromagnetic blood flow meter and ultrasonic blood flow meter, cardiac output. Oxy meter, pH meter. Respiratory parameters – Spiro meter.	
MODULE IV: Therapeutic Equipments and Biotelemetry (7 Hours)	
Principles of Therapeutic equipments – block diagram schematics of - Cardiac pacemakers – internal and external pacemakers, cardiac defibrillators. Ventilators, heart lung machine, hemodialysis, surgical diathermy equipment. Biomedical Telemetry system Components of biotelemetry system, application of telemetry in medicine. Single channel telemetry system for ECG.	
MODULE V: Medical Imaging Systems and Electrical Safety (6 Hours)	
Advances in Radiological Imaging: X-rays- principles of generation, uses of X-rays. Basic principle of computed tomography, magnetic resonance imaging system. Ultrasonic imaging system - introduction and basic principle. Electrical safety: Physiological effects of electric current –shock hazards from electrical equipment-Micro shock and Macro shock hazards –method of accident prevention.	

Text books

1. L. Cromwell, F. J. Weibell and L. A. Pfeiffer, Biomedical Instrumentation Measurements, Pearson education, Delhi, 2nd Edition.
2. R. S. Khandpur, Handbook of Biomedical Instrumentation, Tata Mc Graw Hill
3. J. J. Carr and J. M. Brown, Introduction to Biomedical Equipment Technology, Pearson Education

Reference books

1. J. G. Webster, Medical Instrumentation, Application and Design, 4th Edition, John Wiley and Sons
2. John Enderele , Susan Blanchard, Joseph Bronzino, Introduction to Biomedical Engg,Academic Press
3. Welkovitz, Biomedical Instruments, Theory and Design,Elselvier.
4. MOOC Course on Biomedical Instrumentation & Sensors by Dr. Piyush Lotia and Mr. Thaneshwar Kumar Sahu, Chhattisgarh Swami Vivekanand Technical University, Bhilai https://onlinecourses.swayam2.ac.in/nou23_bt05/preview.

	COURSE CONTENTS AND LECTURE SCHEDULE	
No.		No. of Hours
	MODULE I	
1.1	Physiological systems of the body (brief discussion on Heart and cardio vascular system)	1
1.2	Anatomy of nervous system, Physiology of respiratory system	1
1.3	Sources of bioelectric potentials – resting and action potentials - propagation of action potentials – bio electric potentials example (ECG, EEG, EMG, ERG, EOG, EGG etc.)	1
1.4	Bio potential electrodes– Theory – Nernst relation	1
1.5	Skin surface electrodes	1

1.6	Needle electrodes, Microelectrodes	1
1.7	Transducers for Biomedical Applications-Strain gauge, LVDT	1
1.8	Variable capacitor, Piezoelectric transducers	
MODULE II		
2.1	Electro conduction system of the heart	1
2.2	ECG waveform–electrodes and leads – Einthoven triangle	1
2.3	ECG read out devices, ECG machine – block diagram	1
2.4	Electro encephalogram –neuronal communication-brain waves	1
2.5	EEG measurement-10-20 electrode system	1
2.6	Recording and analysis of EEG	1
2.7	Electromyogram Measurements and its applications	1
MODULE III		
3.1	Measurement of blood pressure – direct measurement	1
3.2	Indirect measurements– oscillometric measurement	1
3.3	Indirect measurements- ultrasonic method	1
3.4	Measurement of blood flow-Electromagnetic blood flow meter	1
3.5	Measurement of blood flow-Ultrasonic Blood flow meter, Cardiac output	1
3.6	Oxy meter, pH meter	1
3.7	Respiratory parameters – Spiro meter	1
MODULE IV		
4.1	Principles of Therapeutic equipments– Block diagram schematics of - Cardiac pacemakers – internal and external pacemakers	1
4.2	Cardiac defibrillators	1
4.3	Ventilators	1
4.4	Heart lung machine	1
4.5	Hemodialysis	1
4.6	Surgical diathermy equipment	1
4.7	Components of biotelemetry system, application of telemetry in medicine. Single channel telemetry system for ECG	1
MODULE V		
5.1	X-rays- principles of generation, uses of X-rays	1
5.2	Basic principle of computed tomography	1
5.3	Magnetic resonance imaging system	1
5.4	Ultrasonic imaging system - introduction and basic principle	1
5.5	Electrical safety– physiological effects of electric current –shock hazards from electrical equipment	1
5.6	Micro shock and Macro shock hazards –method of accident prevention	1
CO Assessment Questions		
1	Explain the formation of resting potential and action potential in human body.	

2	Illustrate the electro conduction system of a human heart with PQRS waveform of the ECG.
3	Describe the working of ultrasonic blood flow meter.
4	Explain the working of ventilator.
5	Describe the working of CT with schematic diagram.

24ECO744	COMPUTER ARCHITECTURE AND EMBEDDED SYSTEMS	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: The aim of this course is to introduce the concept of embedded system design. It covers the basics of real time operating systems The course explains the basic functional units of a computer system, input/ output and memory organization.

Prerequisite: 24EST105 Fundamentals of Electronics Engineering

Course Outcomes: After the completion of the course the student will be able to

CO1	Explain the different functional units of a computer. (Understand Level)
CO2	Summarize the functions, structure and organization of memories and to describe the input/output organization of a computer. (Understand Level)
CO3	Describe Embedded system design process. (Understand Level)
CO4	Describe Reduced Instruction Set Computer (RISC)-V architecture and basic instruction sets. (Understand Level)
CO5	Interpret a Real Time Operating System along with its synchronization and communication. (Understand level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓											
CO2	✓											
CO3	✓											
CO4	✓											
CO5	✓											

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test 1	Test 2	Other tools	
Remember	✓	✓		✓
Understand	✓	✓		✓
Apply				
Analyse				
Evaluate				
Create				

Mark Distribution of CIA

Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
3-0-0-0	5	15	10	10	**40**

Total Mark Distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 Hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS (36 Hours)

MODULE I: Introduction to Computer System (5 Hours)

Introduction to computer system, Functional units of a computer, VonNeumann and Harvard computer architectures, General internal architecture, Address bus, Data bus, control bus. Register set – status register, accumulator, program counter, stack pointer, general purpose registers. Addressing Modes, Instruction set types, Instruction format.

MODULE II: Memory Architecture and I/O Organization (8 Hours)

Memory hierarchy, RAM -Structure of RAM cell- DRAM, SRAM, Organization of a RAM cell, ROM – Structure of a ROM cell, Types, Cache memory: mapping techniques, Virtual memory – Address translation. Accessing IO devices, Interrupts- Enabling and disabling interrupts, Handling multiple devices, programmed IO, interrupt driven IO; Direct Memory Access (DMA)- Bus arbitration, distributed arbitration.

MODULE III: Introduction to Embedded Systems (8 Hours)
Complex Systems and Microprocessors: - Embedding Computers, Characteristics of Embedded Computing Applications, Application of Microprocessors, Challenges in Embedded Computing System, Characteristics and quality attributes of an embedded system, Performance in Embedded Computing. Embedded product development cycle (EDLC): - Different phases of EDLC, EDLC models.

MODULE IV: Embedded System Interfacing and RISC (9 Hours)
Communication devices: - Serial Communication Standards and Devices - UART, HDLC and SPI. Serial Bus Protocols – I²C Bus, CAN Bus and USB Bus. Parallel communication standards ISA, PCI and PCI-X Bus. RISC V Processor: - RISC and CISC architectures, Computer arithmetic – Comparison of RISC and CISC architectures, Introduction to RISC-V, RISC-V instruction set architecture (ISA), execution model and basic concepts, Basic instructions and addressing modes, Control flow instructions, Data transfer and manipulation instructions.

MODULE V: Real Time Operating Systems (6 Hours)
Introduction to Real Time Operating Systems, Task: Task states, Task synchronization and communication mechanisms: semaphores, message queues, pipes, event registers, signals, Task states, Aperiodic and periodic tasks.

Text books

1. DA Patterson and JL Hennessy, *Computer Organization and Design*, Morgan Kaufmann Publisher, 4e, 2010
2. Rajkamal, "Embedded System: Architecture, Programming and Design", TMH3
3. Qing Li – 'Real-Time Concepts for Embedded Systems ', CMP Books, 2021
4. Raj kamal, 'Embedded Systems Architecture, Programming and Design', TMH, 3rd Edition, 2017
5. 2. K.V. Shibu, Introduction to Embedded Systems, 2e, McGraw Hill Education India, 2016.
6. V Carl Hamacher, Zvonko G Varanesic and Safat G Zaky, "Computer Organization", Fifth Edition, Indian Edition, McGraw-Hill Education, 2011
7. John P. Hayes, "Computer Architecture and Organization", Indian Edition, McGraw-Hill Education, 2017

Reference books

1. DA Patterson and JL Hennessy, *Computer Organization and Design*, Morgan Kaufmann Publisher, 4e, 2010
2. Rajkamal, "Embedded System: Architecture, Programming and Design", TMH3
3. Qing Li – 'Real-Time Concepts for Embedded Systems ', CMP Books, 2021
4. Raj Kamal, 'Embedded Systems Architecture, Programming and Design', TMH, 3rd Edition, 2017
5. 2. K.V. Shibu, Introduction to Embedded Systems, 2e, McGraw Hill Education India, 2016.
6. V Carl Hamacher, Zvonko G Varanesic and Safat G Zaky, "Computer

Organization", Fifth Edition, Indian Edition, McGraw-Hill Education, 2011

7. John P. Hayes, "Computer Architecture and Organization", Indian Edition, McGraw-Hill Education, 2017

8. NPTEL course on Computer Architecture and Organization by Prof. Indranil Sengupta, Prof. Kamalika Datta   IIT Kharagpur
Computer architecture and organization - Course (nptel.ac.in)

9. NPTEL course on Enbedded System Design by By Prof. Dhananjay V. Gadre, Prof. Badri Subudhi, Netaji Subhas University of Technology, IIT Jammu
Introduction to Embedded System Design - Course (nptel.ac.in)

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
MODULE I		
1.1	Introduction to computer system, Functional units of a computer, VonNeumann and Harvard computer architectures	1
1.2	General internal architecture, Address bus, Data bus, control bus	1
1.3	Register set – status register, accumulator, program counter, stack pointer, general purpose registers	1
1.4	Addressing Modes	1
1.5	Instruction set types, Instruction format	1
MODULE II		
2.2	Memory hierarchy, RAM -Structure of RAM cell- DRAM	1
2.2	SRAM, Organization of a RAM cell	1
2.3	ROM – Structure of a ROM cell, ROM - Types	1
2.4	Cache memory: mapping techniques	1
2.5	Virtual memory – Address translation	1
2.6	Accessing IO devices, Interrupts- Enabling and disabling interrupts, Handling multiple devices	1
2.7	Programmed IO, interrupt driven IO	1
2.8	Direct Memory Access (DMA)- Bus arbitration, distributed arbitration	1
MODULE III		
3.1	Embedding Computers, Characteristics of Embedded Computing Applications	1
3.2	Application of Microprocessors	1
3.3	Challenges in Embedded Computing System	1
3.4	Characteristics and quality attributes of an embedded system	1
3.5	Performance in Embedded Computing	1
3.6	Introduction to Embedded product development cycle (EDLC)	1
3.7	Embedded product development cycle (EDLC)	1

3.8	Different phases of EDLC and EDLC models	1
MODULE IV		
4.1	Serial Communication Standards: UART	1
4.2	Serial Communication Standards: HDLC and SPI	1
4.3	Serial Bus Protocols – I^{2}C Bus, CAN Bus and USB Bus	1
4.4	Parallel communication standards ISA, PCI and PCI-X Bus	1
4.5	RISC and CISC architectures	1
4.6	Computer arithmetic – Comparison of RISC and CISC architectures	1
4.7	Introduction to RISC-V, RISC-V instruction set architecture (ISA), execution model and basic concepts	1
4.8	Basic instructions and addressing modes, Control flow	1
4.9	Data transfer and manipulation instruction	1
MODULE V		
5.1	Introduction to Real Time Operating Systems	1
5.2	Task: Task states, Task synchronization - Semaphores	1
5.3	Inter-task communication mechanisms - Message queues pipes	1
5.4	Inter-task communication mechanisms - Event registers, signals	1
5.5	Task states, Aperiodic and periodic tasks	1
5.6	Aperiodic and periodic tasks	1

CO Assessment Questions	
1	Outline the functional units of a computer with the help of a diagram.
2	Explain the organization of a 1K x 1 memory chip.
3	Give the structural description of embedded system and explain the phases of EDLC.
4	Explain the architecture and main features of RISC-V processor.
5	Explain the role and types of semaphores used in process synchronization.

24ECR705	MAJOR PROJECT	L	T	P	J	S	C	Year of Introduction
		0	0	14	0	14	7	2024

Preamble: This course focuses on strengthening the understanding of student's fundamental concepts through the application of theoretical concepts and to boost their skills and widen the horizon of their thinking in research by implementing/working a recent research paper in the domain of study. The research-based project in the seventh semester shall be continued as the project in the eighth semester.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO 1	Identify technology/research gaps in the area of Electronics and Communication Engineering or allied stream and propose innovative/creative solutions by considering societal or sustainable aspects. (Analyze Level)
CO 2	Model and solve real world problems by applying knowledge across domains. (Apply Level)
CO 3	Develop products, processes or technologies for sustainable and socially relevant applications. (Apply Level)
CO 4	Plan and execute tasks utilizing available resources within timelines, following ethical and professional norms. (Apply Level)
CO 5	Organize and communicate technical and scientific findings effectively in written and oral forms. (Apply Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓			✓	✓					✓
CO2	✓	✓	✓									✓
CO3	✓	✓	✓	✓	✓							
CO4								✓			✓	
CO5								✓	✓	✓		

1. **Project Initiation:**
   a. This shall be executed as a group activity where each group can have a maximum of four students.
   b. Consult with the Mini Project Coordinator of the courses to identify a project topic of interest.
   c. The research-based project in the seventh semester shall be continued as the project in the eighth semester.
   d. Finalize the project area by first week of the 7th semester in consultation with Project Coordinator.
   e. The research based mini project shall be carried out under the guidance of a faculty member assigned by the Head of the Department (HoD) and project coordinators.

f. Finalize the project topic before the mid of the second week after discussion with the project guide.

2. Student Responsibilities:

a. Choose a project that aligns with the thrust areas of the respective engineering stream or as interdisciplinary projects.
b. The research based mini project can involve implementing or working on a recent research paper, or developing an innovative product.
c. Emphasize innovation, creativity, and the practical application of theoretical knowledge.
d. Clearly define the scope and objectives of the project.
e. Adhere to all instructions and guidelines issued for the project.
f. Regularly update the mentor/supervisor on the progress of work.
g. Ensure the timely submission of all required documents through the designated portal.

3. Learning Outcomes:
Upon completion of this course, students are expected to demonstrate the following capabilities:

a. **Design and Development:** Proficiently design and develop sustainable solutions within the specialization domain, addressing and meeting societal needs.
b. **Ethical Awareness:** Exhibit a comprehensive understanding of ethical principles and showcase a strong commitment to professional ethics and responsibilities.
c. **Collaborative Skills:** Effectively collaborate both as an individual and as a team member in diverse multidisciplinary settings, leveraging collective strengths for optimal results.
d. **Communication Mastery:** Communicate proficiently on intricate environmental problems and concerns with the community and society at large. This includes the ability to comprehend, articulate, and translate effective solutions into comprehensive reports and documentation.

4. Project Evaluation:

The progress of the project is evaluated based on three reviews, two interim reviews and a final review. A report is required at the end of the semester.

Total Marks Distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	100	--	--

Mark Distribution

   a. Work assessed by the project guide –25%

   b. Three-member Continuous Internal Evaluation Committee –25% (Guide shall be one member in the CIE committee)

   c. Draft report – 5 % Final Report - 10%

   d. Final Evaluation by a three-member Committee comprising of the department project coordinator, guide and a member nominated by Head of the Department. - 35%

24ECM709/ 24ECM710/ 24ECM711	PROJECT IN MINOR	L	T	P	J	S	C	Year of Introduction
		0	0	0	4	2	4	2024

Preamble: The Project in Minor is an integral component of the course requirements, mandated for the attainment of a minor degree. In the 7th semester, students are tasked with undertaking an innovative project that applies the knowledge acquired throughout their minor specialization courses. This project could involve implementing or working on a recent research paper, or alternatively, developing a novel product. The primary objective is to enhance students' skills and broaden their understanding in the specific domain of their minor specialization.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO1	Identify technology/research gaps and propose innovative/creative solutions by considering societal or sustainable aspects. (Analyze Level).
CO2	Model and solve real world problems by applying knowledge across domains (Apply Level).
CO3	Develop products, processes or technologies for sustainable and socially relevant applications (Apply Level).
CO4	Plan and execute tasks utilizing available resources within timelines, following ethical and professional norms (Apply Level)
CO5	Organize and communicate technical and scientific findings effectively in written and oral forms (Apply Level).

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓			✓	✓					✓
CO2	✓	✓	✓									✓
CO3	✓	✓	✓	✓	✓							
CO4								✓			✓	
CO5								✓	✓	✓		

2. **Project Initiation:**

   a. This project is to be conducted as a group activity, with each group comprising a maximum of four students.
   b. Students are required to collaborate with the Project Coordinator of the minor courses within the department offering minor course, identifying a topic of interest.
   c. The initiation of the project is expected by the first week of the 7th semester.
   d. The topic selection should occur in consultation with the Project Coordinator and be finalized during the second week of the 7th semester.
   e. The project will be guided by a faculty member assigned by the Head of the Department [offering department] and the Project Coordinator of the minor courses.

2. Student Responsibilities:

   a. Choose a project that aligns with the specialized areas of the minor stream.
   b. The project can involve implementing or working on a recent research paper, or developing an innovative product.
   c. Emphasize innovation, creativity, and the practical application of theoretical knowledge.
   d. Clearly define the scope and objectives of the project.
   e. Adhere to all instructions and guidelines issued for the minor project.
   f. Regularly update the mentor/supervisor on the progress of work.
   g. Ensure the timely submission of all required documents through the designated portal.

3. Learning Outcomes:

Upon completion of this course, students are expected to demonstrate the following capabilities:
   a. **Design and Development:** Proficiently design and develop sustainable solutions within the specialization domain, addressing and meeting societal needs.
   b. **Ethical Awareness:** Exhibit a comprehensive understanding of ethical principles and showcase a strong commitment to professional ethics and responsibilities.
   c. **Collaborative Skills:** Effectively collaborate both as an individual and as a team member in diverse multidisciplinary settings, leveraging collective strengths for optimal results.
   d. **Communication Mastery:** Communicate proficiently on intricate environmental problems and concerns with the community and society at large. This includes the ability to comprehend, articulate, and translate effective solutions into comprehensive reports and documentation.

4. Project Evaluation:

   a. The evaluation process for the Minor Project comprises three key stages: two interim reviews and a final review.
   b. For interim reviews, a committee, comprising of three members shall be formed to assess the minor project. This committee consists of a faculty member experienced in handling courses within the minor basket, the Project Coordinator of the minor courses and the project guide.
   c. For final review, a four-member Committee, formed by the department, will be responsible. This committee is composed of the minor project guide, the Project Coordinator of the minor courses, an internal expert and a faculty member experienced in handling courses within the minor basket. During the evaluation sessions, students are expected to present their work,

followed by a question-and-answer session.

d. The timeline for evaluations is as follows: the first interim review shall be scheduled within the third week of the commencement of 7th-semester classes.

e. The second interim evaluation shall be conducted, three weeks after the first series test, and the final evaluation is supposed to be scheduled immediately after the conclusion of the 7th-semester End Semester Examination (ESE).

Total Marks distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	100	--	--

Mark Distribution

First interim evaluation:
  a. Presentation: 5%
  b. Question & Answer session: 5%
Second interim evaluation:
  a. Presentation: 10%
  b. Question & Answer session: 10%
Draft report submitted at the time of second evaluation: 5%
Work assessed by the project guide:
After the
  a. First assessment   - 5%
  b. Second assessment - 10%
  c. Third assessment   -10%
Final evaluation:
  a. Presentation: 15%
  b. Question & Answer session: 10%
Final Report: 15%

24ECH709	MEDICAL IMAGING SYSTEMS	L	T	P	J	S	C	Year of Introduction
		4	0	0	0	3	4	2024

Preamble: The course offers a comprehensive exploration of the principles, technologies, and applications of various medical imaging modalities, from traditional X-rays and CT scans to advanced techniques like MRI and hybrid imaging systems. Through this course, students will gain proficiency in understanding image production, quality assessment, digital image processing, and the ethical considerations and emerging trends in the field. By delving into the integration of AI and novel imaging modalities, students will be well-equipped to contribute to the evolving landscape of healthcare diagnostics and personalized medicine.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO1	Gain a foundational understanding of the evolution, significance, and categories of medical imaging, along with an appreciation for relevant biophysical phenomena and image quality parameters. (Understand Level)
CO2	Acquire knowledge of X-ray production, interaction mechanisms, and digital radiography, while also understanding the principles, techniques, and safety considerations of Computed Tomography (CT). (Understand Level)
CO3	Develop a comprehensive understanding of the principles and components of Magnetic Resonance Imaging (MRI) and Ultrasound, including image formation and basic ultrasound physics. (Understand Level)
CO4	Understand the concepts of radioactive decay, radiopharmaceuticals, and nuclear imaging techniques, and become familiar with hybrid and novel imaging modalities. (Understand Level)
CO5	Gain proficiency in digital image processing, 3D medical imaging, Computer-Aided Diagnosis (CAD), and recognize the integration of AI and emerging trends in medical imaging. (Understand Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓										✓
CO2	✓	✓										
CO3	✓	✓										
CO4	✓	✓										
CO5	✓	✓										✓

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓		✓
Understand	✓	✓		✓
Apply				
Analyse				

Evaluate				
Create				

Mark Distribution of CIA

Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
4-0-0-0	5	15	10	10	40

Total Mark Distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 Hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I: Introduction to Medical Imaging (6 Hrs)

Overview of Medical Imaging: Significance, Evolution, and Categories. Basic Principles of Medical Imaging Modalities. Biophysical Phenomena: Magnetic Resonance, Ultrasound Waves, X-rays, Nuclear emissions. Anatomy for Engineers: Basic overview of human anatomy as relevant for imaging. Image Quality: Resolution, Contrast, Noise, and Artifacts.

MODULE II: Radiological Imaging and Computed Tomography (CT) (10 Hrs)

Basics of X-ray Production and Interaction with Matter. X-ray Imaging Systems: Components, Image Formation, Digital Radiography. Principles of Computed Tomography (CT): Image Reconstruction, Filtered Back Projection. Modern CT Systems: Spiral CT, Multislice CT. Radiation Dose Issues and Reduction Techniques.

MODULE III: Magnetic Resonance Imaging (MRI) and Ultrasound (10 Hrs)
Basics of Nuclear Magnetic Resonance (NMR). Components of MRI Systems: Magnets, Gradient Coils, RF Coils. Image Formation in MRI: Pulse Sequences, Spatial Encoding. Basics of Ultrasound Physics: Wave Propagation, Reflection, and Scattering. Ultrasound Imaging Systems: Transducers, Beam Formers, Doppler Imaging.
MODULE IV: Nuclear Medicine and Advanced Imaging Techniques (8 Hrs)
Basics of Radioactive Decay and Radiopharmaceuticals. Gamma Cameras and Single Photon Emission Computed Tomography (SPECT). Positron Emission Tomography (PET): Physics, Image Reconstruction. Hybrid Imaging Systems: PET/CT, SPECT/CT, PET/MRI. Novel Imaging Modalities: Optical Coherence Tomography (OCT), Thermography.
MODULE V: Image Processing and Trends in Medical Imaging (10 Hrs)
Digital Image Processing: Enhancement, Restoration, Registration, Segmentation. 3D Medical Imaging: Volume Rendering, Surface Rendering. Computer-Aided Diagnosis (CAD): Principles, Techniques, Applications. Integration of AI in Medical Imaging: Deep Learning for Detection, Segmentation, and Classification. Future Trends: Quantitative Imaging, Molecular Imaging, Personalized Medicine. (Field Trip for witnessing the working of different biomedical imaging devices is recommended).

Text books

Hashemi, R., Bradley, W., & Lisanti, C. (2012). *Biomedical Imaging: Principles and Applications*. Wiley-Blackwell. ISBN-13: 978-0470544204.

Reference books

1. Gonzalez, R. C., & Woods, R. E. (2017). *Digital Image Processing* (4th ed.). Pearson. ISBN-13: 978-0133356724.
2. Bushberg, J. T., Seibert, J. A., Leidholdt, E. M., & Boone, J. M. (2011). *The Essential Physics of Medical Imaging* (3rd ed.). Lippincott Williams & Wilkins. ISBN-13: 978-0781780575.
3. Haacke, E. M., Brown, R. W., Thompson, M. R., & Venkatesan, R. (1999). *Magnetic Resonance Imaging: Physical Principles and Sequence Design*. Wiley-Liss. ISBN-13: 978-0471351283.
4. Cherry, S. R., Sorenson, J. A., & Phelps, M. E. (2012). *Physics in Nuclear Medicine* (4th ed.). Saunders. ISBN-13: 978-1416051985.
5. Proakis, J. G., & Manolakis, D. G. (2013). *Digital Signal Processing: Principles, Algorithms, and Applications* (4th ed.). Pearson. ISBN-13: 978-0131873742.
6. https://onlinecourses.nptel.ac.in/noc22_bt34/preview

COURSE CONTENTS AND LECTURE SCHEDULE		
No.		No. of Hours
MODULE 1		

1.1	Introduction to Medical Imaging
	    Overview of Medical Imaging: Significance and Evolution
	    Categories of Medical Imaging Modalities
	    Introduction to Biophysical Phenomena
		1

1.2	Biophysical Phenomena - Part 1
	    Detailed exploration of Magnetic Resonance
	    Understanding Ultrasound Waves
		1

1.3	Biophysical Phenomena - Part 2
	    Understanding X-rays
	    Overview of Nuclear Emissions
	    Discussion on how different phenomena is used in imaging
		1

1.4	Anatomy for Engineers
	    Basic Overview of Human Anatomy as relevant for imaging
	    Relevance of Anatomy in different Imaging Modalities
		1

1.5	Image Quality
	    Understanding Image Quality: Resolution
	    Contrast in Medical Imaging
	    Noise and Artifacts in Medical Images
		1

MODULE II		

2.1	Introduction to X-ray Production
	    Basics of X-ray Production
	    Interaction of X-rays with Matter
		1

2.2	X-ray Imaging Systems - Part 1
	    Components of X-ray Imaging Systems
	    Introduction to Image Formation
		1

2.3	X-ray Imaging Systems - Part 2
	    Detailed exploration of Image Formation
	    Introduction to Digital Radiography
		1

2.4	Digital Radiography
	    Advantages and Applications of Digital Radiography
	    Transition from traditional to digital systems
		1

2.5	Principles of Computed Tomography (CT) - Part 1
	    Introduction to CT and its significance
	    Image Reconstruction in CT
		1

2.6	Principles of Computed Tomography (CT) - Part 2
	    Filtered Back Projection in CT
	    Comparison with other reconstruction techniques
		1

2.7	Modern CT Systems
	    Introduction to Spiral CT and its advantages
	    Multislice CT and its applications
		1

2.8	Radiation Dose Issues
	    Understanding Radiation Dose in CT
	    Reduction Techniques and Safety Protocols
		1

MODULE III		

3.1	Introduction to Nuclear Magnetic Resonance (NMR) Basics of NMR	1
3.2	Components of MRI Systems - Part 1 Introduction to Magnets in MRI Systems	1
3.3	Components of MRI Systems - Part 2 Gradient Coils and RF Coils in MRI Systems	1
3.4	Image Formation in MRI - Part 1 Overview of Pulse Sequences	1
3.5	Image Formation in MRI - Part 2 Spatial Encoding in MRI	1
3.6	Basics of Ultrasound Physics Wave Propagation, Reflection, and Scattering	1
3.7	Ultrasound Imaging Systems - Part 1 Introduction to Transducers and Beam Formers	1
3.8	Ultrasound Imaging Systems - Part 2 Doppler Imaging in Ultrasound Systems	1
MODULE IV		

4.1	Introduction to Radioactive Decay and Radiopharmaceuticals
	    Basics of Radioactive Decay
	    Overview of Radiopharmaceuticals
		1

4.2	Gamma Cameras and SPECT - Part 1
	    Introduction to Gamma Cameras
	    Basics of Single Photon Emission Computed Tomography (SPECT)
		1

4.3	Gamma Cameras and SPECT - Part 2 Detailed exploration of SPECT	1
4.4	Positron Emission Tomography (PET) - Part 1 Physics of PET	1
4.5	Positron Emission Tomography (PET) - Part 2 Image Reconstruction in PET	1
4.6	Hybrid Imaging Systems Overview of PET/CT, SPECT/CT, and PET/MRI	1
4.7	Novel Imaging Modalities - Part 1 Introduction to Optical Coherence Tomography (OCT)	1
4.8	Novel Imaging Modalities - Part 2 Overview of Thermography	1
MODULE V		

5.1	Digital Image Processing - Part 1
	    Introduction to Digital Image Processing
	    Image Enhancement Techniques
		1

5.2	Digital Image Processing - Part 2 Image Restoration and Registration	1
5.3	Digital Image Processing - Part 3 Image Segmentation Techniques	1

5.4	3D Medical Imaging Volume Rendering and Surface Rendering in 3D Medical Imaging.	1
5.5	Computer-Aided Diagnosis (CAD) Principles, Techniques, and Applications of CAD.	1
5.6	Integration of AI in Medical Imaging Deep learning for Detection, Segmentation, and Classification in Medical Imaging.	1
5.7	Future Trends in Medical Imaging Quantitative Imaging, Molecular Imaging, and Personalized Medicine.	1

CO Assessment Questions	
1	1. Briefly describe the evolution of medical imaging and its significance in modern healthcare. 2. Explain the different categories of medical imaging modalities. 3. Discuss the biophysical phenomena associated with Magnetic Resonance Imaging (MRI) and X-rays. 4. How do resolution, contrast, noise, and artifacts contribute to image quality in medical imaging?
2	1. Explain the process of X-ray production and how X-rays interact with matter. 2. Describe the components and functioning of an X-ray imaging system. 3. Discuss the principles of image reconstruction in Computed Tomography (CT). 4. What are the radiation dose issues in CT and how can they be mitigated?
3	1. Explain the basic principles of Nuclear Magnetic Resonance (NMR) and how it is utilized in MRI. 2. Describe the components of an MRI system and how image formation occurs. 3. Discuss the basics of ultrasound physics, including wave propagation, reflection, and scattering. 4. How do ultrasound imaging systems form images using transducers and Doppler imaging?
4	1. Explain the concept of radioactive decay and how radiopharmaceuticals are used in nuclear medicine. 2. Describe the functioning of Gamma Cameras and Single Photon Emission Computed Tomography (SPECT). 3. Discuss the principles of Positron Emission Tomography (PET) and its image reconstruction techniques. 4. What are hybrid imaging systems and how do novel imaging modalities like Optical Coherence Tomography (OCT) work?
5	1. Describe the key techniques used in digital image processing for medical images.

2. Explain the concepts of volume rendering and surface rendering in 3D medical imaging.
3. Discuss the principles and applications of Computer-Aided Diagnosis (CAD) in medical imaging.
4. How is Artificial Intelligence integrated into medical imaging and what are some future trends in this field?

			L	T	P	J	S	C	Year of Introduction
24ECH710		**DEEP LEARNING**	4	0	0	0	0	4	**2024**

Preamble: This course delves into the fundamental principles of Deep Learning, highlighting recent advancements. Topics encompass Neural Network optimization, Regularization, Convolutional and Recurrent Neural Networks, Word Embedding, and Transformers. Students will learn to apply these techniques to practical real-world scenarios.

Prerequisite: 24ECP407 Machine Intelligence Methods and Applications, 24ECP608 Data Science and Analytics

Course Outcomes: After the completion of the course the student will be able to

CO 1	Implement forward and backward propagation in Deep Neural Networks (DNNs), use suitable optimizers, and enhance model performance through hyperparameter tuning. (Apply Level)
CO 2	Implement and analyze Convolutional Neural Networks (CNNs), understand layer dynamics, apply transfer learning, and study architectures like LeNet, AlexNet, and ResNet. (Apply Level)
CO 3	Apply generative models like Autoencoders and Generative Adversarial Networks (GANs) for data generation and reconstruction. (Apply Level)
CO 4	Design and optimize Recurrent Neural Networks (RNNs), including Long Short-Term Memory (LSTM), Gated Recurrent Unit (GRU), and Attention Models, for temporal data processing. (Apply Level)
CO 5	Understand and apply object detection models such as Region-based Convolutional Neural Networks (RCNN) and You Only Look Once (YOLO) for instance and semantic segmentation. (Apply Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	✓				✓							
CO 2	✓				✓							
CO 3	✓				✓							
CO 4	✓		✓		✓							✓
CO 5	✓				✓							✓

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA						
Course Structure [L-T-P-J]	Attendance	Theory [L- T]				Total Marks
		Assignment	Test-1	Test-2		
4 – 0 – 0 - 0	5	15	10	10		**40**

Total Mark Distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 subdivisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I : Deep Neural Networks, Optimizers and Regularizers (9 Hours)

Forward and Backward Propagation in DNN, Gradient Descent, Overview - SGD, SGD with momentum, Minibatch GD, NAG, ADAGrad, RMSProp, Adam, Regularizers: L1, L2, Dropout, adding noise, Hyperparameter tuning, Data Augmentation.

MODULE II : Convolutional Neural Networks (CNNs) Techniques (10 Hours)

Convolution/Pooling/FC Layers, Relation between input size, output size and filter size.

Case studies: LeNet, AlexNet, VGG, ResNet, Inception. Transfer Learning. Advanced CNN

Architectures: DenseNet, EfficientNet, Capsule Networks, CNN Visualization Techniques:

Feature Maps, CAM, Grad-CAM.

MODULE III: Auto Encoders and Generative Adversarial Network (GAN) (8 Hours)
Autoencoder, Stacked Denoising Autoencoder, Variational AutoEncoder, Introduction to GAN, Vanilla GAN. Advanced GAN Models: Conditional GANs, Cycle GAN, Style GAN. Applications of GANs: Image-to-Image Translation, Data Generation, Style Transfer. Workshops on GANs: Building and training various GAN architectures.
MODULE IV: Time Series Models (10 Hours)
Recurrent Neural Network, Backpropagation through time, Vanishing and exploding gradients with RNNs, Different types of RNNs-overview, Long Short-Term Memory (LSTM), Gated Recurrent Unit (GRU), Attention Model, Transformer Models, Time Series Forecasting examples, Sequence-to-Sequence Models: Applications in Machine Translation and Summarization.
MODULE V: Segmentation Techniques (8 Hours)
Instance Segmentation v/s Semantic Segmentation, Object Detection: RCNN, RCNN, Fast RCNN, Faster RCNN, YOLO, Vision Transformers, Case study/Projects using the learned models for different engineering applications using deep learning hardware architecture (Jetson Nano Board). Advanced Segmentation Models: U-Net, DeepLab.

Text books

Ian Goodfellow, Yoshua Bengio, Aaron Courville, "Deep Learning (Adaptive Computation and Machine Learning Series)", MIT Press, 2016.

Reference books

1. Andrew Glassner, "Deep Learning from Basics to Practice", Vol. 1 and Vol. 2, The Imaginary Institute, Seattle, WA, 2018
2. Nikhil Buduma, "Fundamentals of Deep Learning: Designing Next-Generation Machine Intelligence Algorithms", 1st Edition, O'Reilly Media, 2017.
3. Christopher M. Bishop, "Neural Networks for Pattern Recognition", Oxford University press, 1995.
4. https://www.youtube.com/playlist?list=PLtBw6njQRU-rwp5__7C0oIVt26ZgjG9NI

Additional Resources:

- Online platforms: Coursera, edX, Udacity for supplementary learning.
- Research Papers and Articles for case studies and recent developments in AI.

Software/Tool Requirement:

- Python
- Jupyter Notebook
- TensorFlow/Keras
- Scikit-learn

No.		No. of Hours
COURSE CONTENTS AND LECTURE SCHEDULE		
	MODULE 1	
1.1	Forward Propagation in DNN	1
1.2	Backward Propagation in DNN - Gradient Descent	
1.3	Overview - SGD, SGD with momentum	1
1.4	Minibatch GD, NAG, ADAGrad, RMSProp, Adam	1
1.5	Regularizers: L1, L2, Dropout, Adding noise.	1
1.6	Hyperparameter tuning	1
1.7	Data Augmentation	1
1.8	Practical Workshops: Implementing DNNs with different optimizers and regularizers	1
1.9	Practical Workshops: Implementing DNNs with different optimizers and regularizers	1
	MODULE II	
2.1	Convolution/Pooling/FC Layers	1
2.2	Relation between input size, output size and filter size	1
2.3	Project: CNN, Case studies: LeNet	1
2.4	AlexNet	1
2.5	VGG	
2.6	ResNet,	1
2.7	Inception	
2.8	Transfer Learning	1
2.9	Advanced CNN Architectures: DenseNet, EfficientNet, Capsule Networks	1
2.10	CNN Visualization Techniques: Feature Maps, CAM, Grad-CAM	1
	MODULE III	
3.1	Autoencoder	1
3.2	Stacked Denoising Autoencoder	1
3.3	Variational Auto Encoder	1
3.4	Introduction to GAN	1
3.5	Vanilla GAN	1

3.6	Advanced GAN Models: Conditional GANs, CycleGAN, StyleGAN	1
3.7	Applications of GANs: Image-to-Image Translation, Data Generation, Style Transfer	1
3.8	Workshops on GANs: Building and training various GAN architectures	1
MODULE IV		
4.1	Recurrent Neural Network	1
4.2	Backpropagation through time	1
4.3	Vanishing and exploding gradients with RNNs	1
4.4	Different types of RNNs-overview	1
4.5	Long Short-Term Memory (LSTM)	1
4.6	Gated Recurrent Unit (GRU)	1
4.7	Attention Model	1
4.8	Transformer Model	1
4.9	Time Series Forecasting: Using RNNs for prediction in finance, weather, and more	1
4.10	Sequence-to-Sequence Models: Applications in Machine Translation and Summarization	1
MODULE V		
5.1	Instance Segmentation v/s Semantic Segmentation	1
5.2	Object Detection: RCNN	1
5.3	Fast RCNN, Faster RCNN	1
5.4	YOLO	1
5.5	Case studies/Project: YOLO, Mask RCNN	1
5.6	Advanced Segmentation Models: U-Net, DeepLab	1
5.7	Real-time Segmentation: Techniques for video and live data	1
5.8	Segmentation in Medical Imaging: Specialized techniques for MRI, CT scans, etc	1

CO Assessment Questions	
1	Provide a Python script to build and train a DNN, including both forward and backward propagation? The script should utilize a common optimizer like Adam or SGD for optimization and demonstrate hyperparameter tuning to improve performance. Use a standard dataset like MNIST for an example.

2	1. Transfer Learning:
	    1. Explain the concept of transfer learning and its benefits in computer vision tasks.
	    2. Implement a computer vision solution using transfer learning with a pre-trained model (e.g., VGG or ResNet) and evaluate its performance.
	 2. Practical Application:
	    1. Design and implement a deep neural network system to address a specific computer vision challenge, explaining your choice of architecture, layers, and parameters.
	    2. Evaluate and discuss the performance of your implemented system, including any challenges faced and optimizations made.
	 3. Reflection:
	    1. Reflect on the process of designing and implementing deep neural network systems for computer vision. What insights have you gained, and what would you explore further?
	    2. How did the case studies and transfer learning techniques influence your approach to solving computer vision challenges?

3	1. Application and Comparison:
	    1. Compare the effectiveness of Autoencoders, Stacked Denoising Autoencoders, VAEs, and GANs in handling and generating sequential data.
	    2. Given a specific problem involving temporal data, identify the most suitable sequential learning model and justify your choice.
	 2. Practical Implementation:
	    1. Implement a sequential learning model (e.g., VAE or GAN) for a real-world application involving temporal data and discuss the results and challenges faced.
	    2. Reflect on the process of applying sequential learning models to temporal data and discuss potential improvements or alternative approaches.

4	1. Recurrent Neural Network (RNN):
	     1. Explain the architecture and working principle of Recurrent Neural Networks (RNNs) in handling sequential data.
	     2. Implement a simple RNN for a given sequential data task and analyze its performance.
	 2. Long Short-Term Memory (LSTM) and Gated Recurrent Unit (GRU):
	     1. Describe the architecture and working of LSTM and GRU networks.
	     2. Implement an LSTM or GRU for a given sequential data task and evaluate its performance against a basic RNN.
	 3. Attention Model:
	     1. Explain the concept of attention mechanisms in deep learning models.
	     2. Illustrate how attention models can be integrated with RNNs, LSTMs, or GRUs for sequence-to-sequence tasks.
	 4. Application and Comparison:
	     1. Compare the effectiveness of RNNs, LSTMs, GRUs, and attention models in handling sequential data.
	     2. Given a specific problem involving sequential data, identify the most suitable DL model and justify your choice.

5	1. Practical Implementation:
	     1. Implement an object detection model using Faster RCNN or YOLO for a given dataset and evaluate its performance.
	     2. Discuss the challenges faced during the implementation and how they were addressed.
	 2. Case Studies and Projects:
	     1. Describe a real-world application where instance segmentation (e.g., using Mask RCNN) would be beneficial. Justify your choice.
	     2. Present a case study or project where you applied YOLO for object detection. Discuss the results and any improvements made.
	 3. Comparative Analysis:
	     1. Compare the performance of YOLO and Mask RCNN on a similar task. Discuss the trade-offs involved in choosing one over the other.

SEMESTER – VIII
SYLLABUS

PROJECT

24ECD804	PROJECT	L	T	P	J	S	C	Year of Introduction
		0	0	14	0	14	7	2024

Preamble: The course 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 prototype or simulation. The research-based project in the seventh semester shall be continued as the project in the eighth 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.

Prerequisite: 24ECR705 Major Project

Course Outcomes: After the completion of the course the student will be able to

CO 1	Identify technology/research gaps and propose innovative/creative solutions considering societal/sustainable aspects. (Analyze).
CO 2	Model and solve real world problems by applying knowledge across domains (Apply).
CO 3	Develop products, processes or technologies for sustainable and socially relevant applications (Apply).
CO 4	Plan and execute tasks utilizing available resources within timelines, following ethical and professional norms (Apply)
CO 5	Perform as team player and organize and communicate technical and scientific findings effectively in written and oral forms (Apply).

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	✓	✓	✓			✓	✓					✓
CO 2	✓	✓	✓									✓
CO 3	✓	✓	✓	✓	✓							
CO 4								✓			✓	
CO 5								✓	✓	✓		

1. **Project Initiation:**

   a. This shall be executed as a group activity where each group can have a maximum of four students.
   b. Consult with the Project Coordinator of the courses to identify a project topic of interest.
   c. The research-based project in the seventh semester shall be continued as the project in the eighth semester.
   d. Finalize the project area by first week of the 8th semester in consultation with Project Coordinator.
   e. The project shall be carried out under the guidance of a faculty member assigned by the Head of the Department (HoD) and project coordinators.

    f. Finalize the project topic before the mid of the second week after discussion with the project guide.

2. Student Responsibilities:

    a. Choose a project that aligns with the thrust areas of the respective engineering stream or as interdisciplinary projects.
    b. The project can involve implementing or working on a recent research paper, or developing an innovative product.
    c. Emphasize innovation, creativity, and the practical application of theoretical knowledge.
    d. Clearly define the scope and objectives of the project.
    e. Adhere to all instructions and guidelines issued for the project.
    f. Regularly update the mentor/supervisor on the progress of work.
    g. Ensure the timely submission of all required documents through the designated portal.

3. Learning Outcomes:

Upon completion of this course, students are expected to demonstrate the following capabilities:

    a. **Design and Development:** Proficiently design and develop sustainable solutions within the specialization domain, addressing and meeting societal needs.
    b. **Ethical Awareness:** Exhibit a comprehensive understanding of ethical principles and showcase a strong commitment to professional ethics and responsibilities.
    c. **Collaborative Skills:** Effectively collaborate both as an individual and as a team member in diverse multidisciplinary settings, leveraging collective strengths for optimal results.
    d. **Communication Mastery:** Communicate proficiently on intricate environmental problems and concerns with the community and society at large. This includes the ability to comprehend, articulate, and translate effective solutions into comprehensive reports and documentation.

4. Project Evaluation:

    a. The progress of the project is evaluated based on three reviews, two interim reviews and a final review. A report is required at the end of the semester.

    b. All students doing a project in the eighth semester, shall prepare a Poster as part of their project highlighting their work. The poster carries 5% weightage of the total marks of the project course and to be prepared based on the guidelines issued time to time.

Total Marks distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	100	--	--

Mark Distribution

a. Work assessed by the project guide – 25%
b. Three-member Continuous Internal Evaluation Committee - 20% (Guide shall be one member in the CIE committee)
c. Final Evaluation by a three-member Committee comprising of the department project coordinator, guide and an external expert. The external expert shall be an academician or from industry. The industry expert is preferred: 30%
d. Draft report – 5 % Final Report - 15%
e. Preparing and presenting poster -5%
f. One third of the project shall be completed in VII semester and two third in VIII semester.

PROFESSIONAL ELECTIVE - 4

24ECE811	BIOMEDICAL ENGINEERING	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: This course will introduce aspects of biomedical engineering as applied to biological systems described using engineering principles and the use of modern diagnostic and therapeutic equipment. The course covers major diagnostic, therapeutic and different imaging systems. After the completion of course the students are able to understand the principles, techniques, and applications that bridge the gap between engineering innovation and healthcare advancement.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO 1	Design bio potential signal conditioning amplifiers (Apply Level)
CO 2	Describe a cardiovascular system and cardiovascular measurements. (Understand Level)
CO 3	Illustrate the function of diagnostic equipments. (Understand Level)
CO 4	Illustrate the function of therapeutic equipments. (Understand Level)
CO 5	Explain the different imaging system used in medical diagnosis. (Understand Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	✓											
CO 2	✓											
CO 3	✓											
CO 4	✓											
CO 5	✓											

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply				
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
3 – 0 – 0 - 0	5	15	10	10	**40**

Total Mark Distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS (36 Hours)

MODULE I : Human Physiological System and Bio-Potentials (9 Hours)

Physiological systems of the body (Brief discussion on Heart and cardio vascular system, Anatomy of nervous system, Physiology of respiratory system). Sources of bioelectric potentials – resting and action potentials -propagation of action potentials. Bio electric potentials. Bio potential electrodes- Nernst relation- skin surface electrodes, needle electrodes, microelectrodes. Bio-potential signal conditioning amplifiers-instrumentation amplifiers, Carrier amplifiers, isolation amplifiers, chopper amplifiers.

MODULE II : Measurement of Biopotentials (7 Hours)

Electro conduction system of the heart, ECG waveform–electrodes and leads – Einthoven triangle, ECG read out devices, ECG machine – block diagram. Electro encephalogram –neuronal communication-brain waves – EEGmeasurement-10-20 electrode system, recording and analysis. Electromyogram (EMG) – Nerve

Conduction velocity measurements- Electromyogram measurements and its applications.

MODULE III : Diagnostic Equipments (7 Hours)

Measurement of blood pressure – Direct and Indirect measurement (Oscillometric measurement, ultrasonic method), Measurement of blood flow- Electromagnetic blood flow meter and ultrasonic blood flow meter, cardiac output. Measurement of heart sounds –phonocardiography, Oxy meter, pH meter. Respiratory parameters – Spiro meter.

MODULE IV : Therapeutic Equipments and Brain Computer Interface (7 Hours)

Principles of Therapeutic equipments – block diagram schematics of - Cardiac pacemakers – internal and external pacemakers, cardiac defibrillators. Ventilators, heart lung machine, hemodialysis, surgical diathermy equipment. Brain Computer Interface: Fundamentals of BCI – Structure of BCI system – Classification of BCI – Invasive, Non-invasive and Partially invasive BCI – Applications.

MODULE V : Medical Imaging Systems and Electrical Safety (6 Hours)

Advances in Radiological Imaging: X-rays- principles of generation, uses of X-rays. Basic principle of computed tomography, magnetic resonance imaging system. Ultrasonic imaging system, - introduction and basic principle.
Electrical safety: Physiological effects of electric current –shock hazards from electrical equipment-Micro shock and Macro shock hazards –method of accident prevention.

Text books
1. L. Cromwell, F. J. Weibell and L. A. Pfeiffer, Biomedical Instrumentation Measurements, Pearson education, Delhi, 2nd Edition.
2. R. S. Khandpur, Handbook of Biomedical Instrumentation, Tata Mc Graw Hill
3. J. J. Carr and J. M. Brown, Introduction to Biomedical Equipment Technology, Pearson Education

Reference books
1. J. G. Webster, Medical Instrumentation, Application and Design, 4th Edition, John Wiley and Sons
2. John Enderele, Susan Blanchard, Joseph Bronzino, Introduction to Biomedical Engg, Academic Press
3. Welkovitz, Biomedical Instruments, Theory and Design, Elselvier
4. https://onlinecourses.swayam2.ac.in/nou23_bt05/preview.

No.	COURSE CONTENTS AND LECTURE SCHEDULE	No. of Hours
	MODULE 1	
1.1	Physiological systems of the body (brief discussion on Heart and cardio vascular system)	1
1.2	Anatomy of nervous system, Physiology of respiratory system	1
1.3	Sources of bioelectric potentials – resting and action potentials - propagation of action potentials	1
1.4	Bio electric potentials example (ECG, EEG, EMG, ERG, EOG, EGG etc.)	1
1.5	Bio potential electrodes– Theory – Nernst relation	1
1.6	Skin surface electrodes	1
1.7	Needle electrodes, Microelectrodes	1
1.8	Bio-potential signal conditioning amplifiers-instrumentation amplifiers, Carrier amplifiers	1
1.9	Isolation amplifiers, Chopper amplifiers	1
	MODULE II	
2.1	Electro conduction system of the heart	1
2.2	ECG waveform–electrodes and leads – Einthoven triangle	1
2.3	ECG read out devices, ECG machine – block diagram	1
2.4	Electro encephalogram –neuronal communication-brain waves	1
2.5	EEG measurement-10-20 electrode system, recording and analysis	1
2.6	Electromyogram (EMG) – Nerve Conduction velocity measurements	1
2.7	Electromyogram Measurements and its applications	1
	MODULE III	
3.1	Measurement of blood pressure – direct measurement	1
3.2	Indirect measurements– oscillometric measurement –ultrasonic method	1
3.3	Measurement of blood flow-Electromagnetic blood flow meter	1
3.4	Measurement of blood flow- Ultrasonic Blood flow meter, Cardiac output	1
3.5	Measurement of heart sounds –phonocardiography	1
3.6	Oxy meter, pH meter	1
3.7	Respiratory parameters – Spiro meter	1
	MODULE IV	
4.1	Principles of Therapeutic equipments– Block diagram schematics of - Cardiac pacemakers – internal and external pacemakers	1
4.2	Cardiac defibrillators, Ventilators	1
4.3	Heart lung machine	1

4.4	Hemodialysis	1
4.5	Surgical diathermy equipment	1
4.6	Fundamentals of BCI – Structure of BCI system	1
4.7	Classification of BCI – Invasive, Non-invasive and Partially invasive BCI – Applications	1
MODULE V		
5.1	Advances in Radiological Imaging: X-rays- principles of generation, uses of X-rays	1
5.2	Basic principle of computed tomography	1
5.3	Magnetic resonance imaging system	1
5.4	Ultrasonic imaging system - introduction and basic principle	1
5.5	Electrical safety– physiological effects of electric current –shock hazards from electrical equipment	1
5.6	Micro shock and Macro shock hazards –method of accident prevention	1

CO Assessment Questions	
1	Design a preamplifier for EMG signal acquisition with a gain of 1000 using an instrumentation amplifier.
2	Explain the electro conduction system of a human heart with PQRS waveform of the ECG.
3	Describe the working of ultrasonic blood flow meter.
4	Explain the working of ventilator.
5	Describe the working of CT with schematic diagram.

24ECE821	THEORY OF ERROR CONTROL CODING	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: Theory of Error Control Coding deals with the fundamental principles that govern the secure transmission of data. In this course, an overview about the Mathematical Foundation for Coding Schemes, Block Codes, Cyclic Codes, Convolutional Codes and Turbo Codes are discussed in a detailed manner to get a better insight for the transmission of data. Theory of Error Control Coding has a wide range of applications in the areas of Wireless Technologies, Cyber security, Scientific Research etc.

Prerequisite: 24ECP504 Digital Communication

Course Outcomes: After the completion of the course the student will be able to

CO 1	Explain the fundamentals of Abstract algebra for designing efficient channel codes (Understand Level)
CO 2	Analyze the encoding and decoding of Linear Block codes (Apply Level)
CO 3	Explain the encoding and decoding of Cyclic codes (Understand Level)
CO 4	Illustrate the Convolutional coding and decoding technique (Apply Level)
CO 5	Illustrate the concept of Turbo codes (Apply Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	✓	✓										
CO 2	✓	✓										
CO 3	✓	✓										
CO 4	✓	✓										
CO 5	✓	✓										

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
3 – 0 – 0 - 0	5	15	10	10	**40**

Total Mark Distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I: Mathematical Foundation for Coding Schemes (6 Hours)

Overview of Groups, Rings, Finite Fields, Construction of Finite Fields from Polynomial rings, Vector spaces. Error Control Coding – Relevance of error control codes in Communication System, concepts of Code rate, Hamming Distance, Minimum Distance, Error detecting and correcting capability.

MODULE II: Linear Block Codes (6 Hours)

Linear Block Codes - Generator matrix, Parity Check Matrix. Dual Codes, Error Detection and Correction over hard output channels, Standard Array and Syndrome decoding.

MODULE III: Cyclic Codes (9 Hours)

Basic theory of Cyclic codes- Generator and Parity check matrices Cyclic encoders- Polynomial and matrix description. Interrelation between polynomial and matrix view point. Systematic encoding. Error detection &

correction- decoding of cyclic codes- Cyclic Hamming codes- Binary Golay codes- BCH codes, Reed-Solomon Codes (Only description, no decoding algorithms).

MODULE IV: Convolutional Codes (6 Hours)

Convolution Codes - Generator matrices and encoding state diagram, code tree and trellis diagram. Transfer function, Free distance, Maximum Likelihood decoding- Viterbi Algorithm

MODULE V: Turbo Codes (9 Hours)

Turbo codes- Turbo decoding, Turbo Coding: Turbo Encoder, Interleaving, High rate turbo codes. Performance upper bound on turbo codes, Interleaving performance gain, Effective free distance, Turbo codes performance evaluation, Turbo code design, Applications of turbo codes

Text books

1. P S Satyanarayana, 'Concepts of Information Theory and Coding', MedTech, 2016
2. Simon Haykin, 'Digital Communication Systems', Wiley.
3. Ron M Roth, 'Introduction to Coding Theory', Cambrdige University Press

Reference books

1. Joy A Thomas, Thomas M Cover, 'Elements of Information Theory', Wiley- Intercedence.
2. Shu Lin & Daniel J. Costello. Jr., 'Error Control Coding: Fundamentals and Applications', 2nd Edition.
3. NPTEL Course on Information Theory and Coding: https://nptel.ac.in/courses/117101053

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
MODULE 1		
1.1	Overview of Groups	1
1.2	Rings, Finite Fields	1
1.3	Construction of Finite Fields from Polynomial rings, Vector spaces	1
1.4	Error Control Coding - Relevance of error control codes in Communication System	
1.5	Concepts of Code rate, Hamming Distance, Minimum Distance	
1.6	Error detecting and correcting capability	
MODULE II		
2.1	Linear Block Codes - Generator matrix	1
2.2	Parity Check Matrix	1
2.3	Dual Codes, Standard Array	1
2.4	Error Detection and Correction over hard output channels.	1
2.5	Standard Array	1

2.6	Syndrome decoding	1
MODULE III		
3.1	Basic theory of Cyclic codes	1
3.2	Generator and Parity check matrices	1
3.3	Cyclic encoders	1
3.4	Polynomial and matrix description. Interrelation between polynomial and matrix view point	1
3.5	Systematic encoding	1
3.6	Error detection & correction	1
3.7	Decoding of cyclic codes	1
3.8	Cyclic Hamming codes	1
3.9	Binary Golay codes- BCH codes, Reed-Solomon Codes (Only description, no decoding algorithms)	1
MODULE IV		
4.1	Convolution Codes	1
4.2	Generator matrices and encoding state diagram	1
4.3	Code tree and trellis diagram	1
4.4	Transfer function	1
4.5	Free distance	1
4.6	Maximum Likelihood decoding- Viterbi Algorithm	1
MODULE V		
5.1	Turbo codes- Turbo decoding	1
5.2	Turbo Encoder	1
5.3	Interleaving, High-rate turbo codes	1
5.4	Performance upper bound on turbo codes	1
5.5	Interleaving performance gain	1
5.6	Effective free distance	1
5.7	Turbo codes performance evaluation	1
5.8	Turbo code design	1
5.9	Applications of turbo codes	1

CO Assessment Questions	
1	1. Check whether the set of integers form an Abelian group under multiplication 2. Check whether $Z6$ is an Integral domain. Justify 3. Distinguish between integral domain and Division ring with the help of an example

2	Given a (7,4) linear block code whose generator matrix is given by $$G = \begin{bmatrix} 1 & 0 & 0 & 0 & 1 & 0 & 1 \\ 0 & 1 & 0 & 0 & 1 & 1 & 1 \\ 0 & 0 & 1 & 0 & 1 & 1 & 0 \\ 0 & 0 & 0 & 1 & 0 & 1 & 1 \end{bmatrix}$$ a. Find the parity check matrix b. Find all possible code words c. Find d_{min}

3	The generator polynomial for (7,4) cyclic code is X^3+X+1. Construct encoder and determine the code word for the following message sequence (i) 1010 (ii) 1111 (iii) 0001 (iv) 1000
4	A Convolutional code is described by $g^1 = [100]$, $g^2=[101]$, $g^3=[111]$. a. Draw the encoder corresponding to this code b. Draw the state diagram c. Decode the transmitted sequence 101001011110111 using Viterbi algorithm
5	1. Illustrate how turbo codes are decoded with the help of suitable block diagrams 2. Enumerate the different types of interleaves used in the turbo encoder and illustrate their significance on an encoding perspective.

24ECE831	EMBEDDED SYSTEM DESIGN FOR AUTOMOTIVE APPLICATIONS	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: The objective of the course is to provide broad introduction to automotive embedded systems. The emphasis is on comprehending the automotive systems, vehicle dynamics, electrical and electronic systems used in automobiles. This course develops the ability to conceptualize automotive electronic technologies for future.

Prerequisite: 24ECT503 Embedded Systems and IoT

Course Outcomes: After the completion of the course the student will be able to

CO 1	Explain the basic concepts of embedded systems (Understand Level)
CO 2	Describe vehicle dynamics, electrical and electronic systems used in automobiles. (Understand Level)
CO 3	Explain Automotive Sensory and Actuator Systems (Understand Level)
CO 4	Describe the control systems used for various vehicular modules (Understand Level)
CO 5	Develop an Automotive Subsystem using HCS12XDT512 controller (Apply Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	✓	✓										
CO 2	✓											
CO 3	✓											
CO 4	✓											
CO 5	✓				✓							✓

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply				
Analyse				
Evaluate				
Create				

Mark Distribution of CIA						
Course Structure [L-T-P-J]	Attendance	Theory [L- T]				Total Marks
		Assignment	Test-1	Test-2		
3 – 0 – 0 – 0	5	15	10	10		**40**

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I: Introduction to Embedded Systems (6 Hours)

Introduction to functional building blocks of embedded systems – Register, memory devices, ports, timer, interrupt controllers using circuit block diagram representation for each category –Devices & buses for devices network - serial communication using I2C, CAN, USB buses – parallel communication using ISA, PCI - device drivers in a system – Serial port & Parallel port

MODULE II: Automotive Systems (8 Hours)

Automotive Systems Overview: Automotive Vehicle Technology, Overview of Vehicle Categories, Various Vehicle Sub Systems like Chassis, Body, Driveline, Engine technology, Fueling technology, vehicle Emission, Brakes, Suspension, Emission, Doors, Dashboard instruments, Wiring Harness, Safety & Security, Comfort &Infotainment, Communication & Lighting, Future Trends in Automotive
Embedded Systems: Hybrid Vehicles, Electric Vehicles.

MODULE III: Sensors and Actuators in Automotive Systems (6 Hours)
Sensors and Actuators in Automotive Systems: - sensors used in automobiles temperature, pressure, proximity, Carbon Dioxide (CO2), Carbon Monoxide (CO), Oxygen (O2), Engine Speed sensor, Throttle Position Sensor, Pressure Sensors, Knock Sensor & Mass Flow Sensor. Actuators used in automotive control systems (motors, valves, solenoids, etc...) Interfacing sensors and actuators with microcontrollers.
MODULE IV: Automotive Control System (9 Hours)
Control systems, Power storage and generation, starting motor systems, HVAC, engine cooling, vehicle security, driver comfort and assistance, signaling and vision. Cruise control and adaptive cruise control systems – ABS, ESP, TCS, Active Suspension System, Automatic transmission, X–by–wire systems. Automotive alarm systems: - Vehicle immobilization & deactivation, Driver information systems, Parking systems. Central locking system and electric windows, Occupants and driver safety systems: Seat belt lighteners and air–bags, Fault tolerant schemes
MODULE V: Embedded Communications (7 Hours)
Automotive Protocols: - CAN (Controller Area Network), LIN (Local Interconnect Network), Flex Ray Protocol, Test, Calibration and Diagnostics tools for networking of electronic systems like ECU Software and Testing Tools, ECU Calibration Tools. Introduction to HCS12XDT512 Student learning kit & PBMCU (Project board), Introduction to code warrior IDE.

Text books

1. William B. Ribbens, 'Understanding Automotive Electronics-An Engineering Perspective', Seventh edition, Butterworth-Heinemann Publications.
2. Tom H. Denton, 'Automobile electrical and electronic systems', Routledge, 2017.
3. Ronald K. Jurgen, "Automotive Electronics Handbook", Mc-Graw Hill

Reference books

1. Automotive Electrical and Electronic Systems by John F. Kershaw, James D. Halderman / Pearson Education
2. Robert Bosch," Automotive Hand Book", Fifth edition, SAE Publications.
3. Automotive Embedded System Handbook by Nicolas Navet/CRC PRESS
4. Automotive Embedded Systems Course | Online Course with Certification (easycourses.in)

No.		No. of Hours
	COURSE CONTENTS AND LECTURE SCHEDULE	
	MODULE 1	
1.1	Introduction to functional building blocks of embedded systems	1
1.2	Register, Memory devices	1
1.3	Ports, Timer, Interrupt controllers	1
1.4	Devices & buses for devices network - serial communication using I2C, CAN, USB buses	1
1.5	Parallel communication using ISA	1
1.6	PCI - device drivers in a system – Serial port & Parallel port	1
	MODULE II	
2.1	Automotive Vehicle Technology, Overview of Vehicle Categories	1
2.2	Various Vehicle Sub Systems:- Chassis, Body, Driveline	1
2.3	Engine technology	1
2.4	Fueling technology, vehicle Emission	1
2.5	Brakes, Suspension, Emission	1
2.6	Doors, Dashboard instruments, Wiring Harness	1
2.7	Safety & Security, Comfort &Infotainment, Communication & Lighting	1
2.8	Future Trends in Automotive Embedded Systems: Hybrid Vehicles, Electric Vehicles	1
	MODULE III	
3.1	Sensors used in automobiles: - temperature, pressure, proximity	1
3.2	Carbon Dioxide (CO_2), Carbon Monoxide (CO), Oxygen (O_2)	1
3.3	Engine Speed sensor, Throttle Position Sensor	1
3.4	Pressure Sensors, Knock Sensor & Mass Flow Sensor.	1
3.5	Actuators used in automotive control systems (motors, valves, solenoids, etc...)	1
3.6	Interfacing sensors and actuators with microcontrollers.	1
	MODULE IV	
4.1	Control systems, Power storage and generation	1
4.2	Starting motor systems, HVAC	1
4.3	Engine cooling, Vehicle security	1
4.4	Driver comfort and assistance, Signaling and vision	1
4.5	Cruise control and adaptive cruise control systems – ABS, ESP, TCS	1
4.6	Active Suspension System, Automatic transmission, X–by–wire systems.	1
4.7	Automotive alarm systems: - Vehicle immobilization & deactivation, Driver information systems, Parking systems.	1
4.8	Central locking system and electric windows	1

4.9	Occupants and driver safety systems: Seat belt lighteners and air–bags, Fault tolerant schemes	1
MODULE V		
5.1	Automotive Protocols: - CAN (Controller Area Network)	1
5.2	LIN (Local Interconnect Network), Flex Ray Protocol	1
5.3	ECU Software and Testing Tools	1
5.4	ECU Calibration Tools	1
5.5	Introduction to HCS12XDT512 Student learning kit	1
5.6	Introduction to PBMCU (Project board)	1
5.7	Introduction to code warrior IDE	1

CO Assessment Questions	
1	Describe the hardware architecture of the embedded system
2	Explain in detail about the development of electronics in automobiles.
3	Explain how the embedded system integrates sensors and actuators within the vehicle?
4	Explain the vehicle power supply controller system with a neat layout.
5	Design and implement a smart parking system using HCS12XDT512 controller for efficient and automated parking space management.

24ECE841	MODERN COMMUNICATION SYSTEMS	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: This course provides a comprehensive study of contemporary communication technologies and systems that form the backbone of our interconnected world. Students will explore the principles and applications of a diverse range of communication systems, such as wireless communication, satellite communication, IoT technology, Vehicular Technology and Software Defined Radio enabling them to develop a solid foundation in this rapidly evolving field. This course is designed to equip students with a deep understanding of various modern communication methodologies, protocols, and technologies that are integral to the functioning of global communication networks.

Prerequisite: 24ECP702 Computer Networks and Security

Course Outcomes: After the completion of the course the student will be able to

CO 1	Familiarize with the basic concepts, principles, and components of current wireless communication technologies. (Understand Level)
CO 2	Explain various networking technologies used in IoT, including wireless protocols, and their application in IoT device communication. (Understand Level)
CO 3	Describe the architecture of satellite communication systems, including the roles of ground stations, satellite transponders, and user terminals. (Understand Level)
CO 4	Understand the various communication standards for connected autonomous Vehicles. (Understand Level)
CO 5	Illustrate the architecture and application of software defined radio and cognitive Radio. (Apply Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	✓											
CO 2	✓											
CO 3	✓	✓										
CO 4	✓	✓										
CO 5	✓	✓			✓							

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply			✓	
Analyse				
Evaluate				
Create				

Mark Distribution of CIA						
Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
3 – 0 – 0 – 0	5	15	10	10	**40**

Total Mark Distribution			
Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS (37 Hours)

MODULE I: Wireless Communication System (9 hours)

Introduction to current wireless technologies, background and current scenario, future wireless network requirements, IEEE 802.11 (Wi-Fi standards and applications), 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.

MODULE II: IoT System (8 hours)

Introduction to IoT Systems, Evolution of IoT, IoT Networking Components, characteristics, physical and logical design of IoT, IoT architectures and protocols.

IoT Connectivity Technologies – Zigbee, Wireless HART, RFID, NFC, WiFi, Bluetooth. IoT Enabling and Communication Technologies – Infrastructure Protocols IPv6, 6LoWPAN. Case Studies and Future Trends – Agricultural IoT, Vehicular IoT, Healthcare IoT.

MODULE III: Satellite Communication (6 hours)

Introduction to satellite communication, Evolution, Kepler's law, Satellite orbits, Geosynchronous satellites. Satellite Classifications, Spacing and Frequency Allocation, Active and Passive satellite, Satellite system Link Models-Uplink, Transponder and user terminal. Satellite Link Equations.

MODULE IV: Intelligent Transport System (8 hours)

Introduction to Intelligent Transport system – Evolution, Vehicular Networks and ITS, Vehicular Communication Standards-Wireless Access for Vehicular Environments (WAVE) and Its Migration Towards IEEE 802.11p – DSRC, IEEE 1609, LED-Enabled Visible Light Communications (IEEE TG 802.15.7), 4G/5G-Device to Device (D2D), Operational Scenario – Collision Avoidance. Automated Route Guidance for Emergency Response Vehicles. 6G for Vehicle-to-Everything (V2X) Communications: Enabling Technologies, Challenges, and Opportunities.

MODULE V: Software Defined Radio System (6 hours)

Software radio concepts, Operating frequency bands, Transmitter and Receiver specifications of SDR, Architecture of SDR, Introduction to cognitive radio, significance of cognitive radio and spectrum subleasing, spectrum sharing in cognitive radio, Cognitive radio network architecture. Applications. Implementation of cognitive radio, Cognitive process.

Text books
1. Andrea Goldsmith, Wireless Communications, Cambridge University Press, 2005
2. Aditya Jagannatham, Principles of Modern Wireless Communication Systems, Mc Graw Hill, 2017.
3. Wayne Tomasi, Advanced Electronic Communication Systems, Pearson New International Edition,6 Ed ,2014.
4. Sudip Misra, Anandarup Mukherjee & Arijit Roy. "Introduction to IoT". Cambridge University Press. 2021.
5. George J. Dimitrakopoulos. "Current Technologies in Vehicular Communication", Springer International Publishing, 2017.
6. Noor-A-Rahim, Zilong Liu, Haeyoung Lee, Mohammad Omar Khyam, Jianhua He, Dirk Pesch. "6G for Vehicle-to-Everything (V2X) Communications: Enabling Technologies, Challenges, and Opportunities.
7. Walter Tuttlebee, "SDR Enabling Technologies", John Wiley
8. Huseyin Arslan, "Cognitive Radio, SDR and Adaptive Wireless System" Springer, 2007

Reference books

1. Dipankar Raychaudhuri, Mario Gerla, "Emerging Wireless Technologies and the Future Mobile Internet", Cambridge University Press, 2011.
2. Arshdeep Bahga, A., & Vijay Madisetti V. "Internet of Things: A hands-on Approach". Vpt., 2014.
3. Paul, A., Chilamkurti, N., Daniel, A. and Rho, S. "Intelligent vehicular networks and communications: fundamentals, architectures and solutions". Elsevier, 2016.
4. Peter B. Kenington, 'RF and baseband techniques for software defined radio", Artech House Mobile Communication, 2005.
5. NPTEL course on 'Introduction to Internet of Things by By Prof. Sudip Misra IIT Kharagpur. https://onlinecourses.nptel.ac.in/noc22_cs53/preview
6. MOOC (NPTEL) on Nanoelectronics: Devices & Materials: https://nptel.ac.in/courses/117108047

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
MODULE 1		
1.1	Introduction to current wireless technologies, background and current scenario, future wireless network requirements.	1
1.2	IEEE 802.11 (Wi-Fi) standards and applications)	1
1.3	HiperLAN technology	1
1.4	WPAN (IEEE 802.15.1, IEEE 802.15.3 & IEEE 802.15.4)	1
1.5	WMAN (IEEE 802.16a - WiMAX)	1
1.6	Space time wireless standards, IEEE 802.16 (Wi-Max standard)	1
1.7	3GPP-LTE standard, Millimeter wave characteristics, Channel performance at 60 GHz	1
1.8	Development of millimeter wave standards, Indoor and outdoor applications for millimeter wave communications.	1
1.9	6G Networks – Use Cases and Technologies.	1
MODULE II		
2.1	Introduction to IoT Systems, Evolution of IoT, IoT Networking Components	1
2.2	Characteristics, physical and logical design of IoT.	1
2.3	IoT architectures and protocols.	1
2.4	IoT Connectivity Technologies – Zigbee, Wireless HART	1
2.5	RFID, NFC, WiFi, Bluetooth.	1
2.6	IoT Enabling and Communication Technologies	1
2.7	Infrastructure Protocols IPv6, 6LoWPAN	1

2.8	Case Studies and Future Trends – Agricultural IoT, Vehicular IoT, Healthcare IoT.	1

MODULE III		
3.1	Introduction to satellite communication, Evolution	1
3.2	Keppler's law	1
3.3	Satellite orbits, Geosynchronous satellites	1
3.4	Classifications, Spacing, and Frequency Allocation, Active and Passive satellite.	1
3.5	Satellite system Link Models-Uplink, Downlink, Transponder	1
3.6	Satellite Link Equations	1
MODULE IV		
4.1	Introduction to Intelligent Transport system – Evolution, Vehicular Networks and ITS	1
4.2	Vehicular Communication Standards-Wireless Access for Vehicular Environments (WAVE) and Its Migration Towards IEEE 802.11p	1
4.3	DSRC, IEEE 1609	1
4.4	LED-Enabled Visible Light Communications (IEEE TG 802.15.7).	1
4.5	4G/5G-Device to Device (D2D).	1
4.6	Operational Scenario – Collision Avoidance. Automated Route Guidance for Emergency Response Vehicles.	1
4.7	Case Study: 6G for Vehicle-to-Everything (V2X) Communications: Enabling Technologies, Challenges, and Opportunities	1
4.8	Literature Review on 6G and connected autonomous vehicular networks.	1
MODULE V		
5.1	Software radio concepts, Operating frequency bands, Transmitter and Receiver specifications of SDR.	1
5.2	Architecture of SDR	1
5.3	Introduction of cognitive radio, significance of cognitive radio and spectrum subleasing	1
5.4	Spectrum sharing in cognitive radio, Cognitive radio network architecture.	1
5.5	Applications. Implementation of cognitive radio Implementation.	1
5.6	Cognitive process	1

CO Assessment Questions	
1	Discuss the differences between HIPERLAN Type 1 and HIPERLAN Type 2 standards.
2	Propose an innovative use case for IoT in a domain not commonly associated with IoT, outlining the potential benefits and challenges.
3	Design a satellite communication system for a remote sensing application, specifying the satellite orbit, frequency bands, and ground infrastructure
4	Conduct a literature review 6G and connected autonomous vehicular networks.
5	1. Receive digitized FM signal (for the clearest channel in the lab) using the SDR board. 2. Familiarize with an SDR hardware for reception and transmission of RF signal. 3. Identify and describe the essential elements that make up the architecture of a cognitive radio system

24ECE851	NANOELECTRONICS	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: The course is designed to give a basic idea about the physics behind mesoscopic systems. Topics like quantum effects in nano structures, working of nano electronic devices like single electron transistor, fabrication and characterization techniques are covered in the course. The students will get an insight on the quantum mechanical effects on low dimension structures and devices.

Prerequisite: 24PYP102 Engineering Physics

Course Outcomes: After the completion of the course the student will be able to

CO 1	Explain the basic concepts of quantum mechanics behind low dimensional structures. (Understand Level)
CO 2	Explain the behaviour of two-dimensional nanostructures and superlattice. (Understand Level)
CO 3	Explain the mechanism of transport of charge carriers in nanostructures subjected to electric and magnetic fields. (Understand Level)
CO 4	Illustrate the operating principles of nano electronic devices. (Understand Level)
CO 5	Explain special techniques for fabricating nano materials and the characterizing tools. (Understand Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	✓	✓										
CO 2	✓											
CO 3	✓											
CO 4	✓									✓		✓
CO 5	✓											

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply				
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	**Attendance**	**Theory [L- T]**			**Total Marks**
		Assignment	**Test-1**	**Test-2**	
3 – 0 – 0 – 0	5	15	10	10	**40**

Total Mark Distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 Hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I: Physics of Mesoscopic Structures (6 Hours)

Introduction to nanotechnology, Mesoscopic physics, characteristic lengths in mesoscopic systems, Quantum mechanical coherence. Classification of Nano structures: Quantum wells, wires and dots, Quantum confinement and density of states in 0-D (zero-dimensional), 1-D (one-dimensional), and 2-D (two-dimensional) materials, square quantum wells of finite depth, parabolic and triangular quantum wells, Quantum wires and quantum dots.

MODULE II: Quantum Nanostructures and Superlattices (6 Hours)

Two-dimensional electronic system: two-dimensional behaviour, MOSFET structures, Heterojunctions: Modulation-doped heterojunctions, SiGe strained heterostructures. Quantum wells: Modulation-doped quantum well, Multiple quantum wells (MQW) SiGe strained heterostructures. Superlattices: The concept of a superlattice, Kronig–Penney model of a superlattice. Zone folding, Tight binding approximation of a superlattice.

MODULE III: Charge Transport in Nanostructures (7 Hours)
Transport in electric field: Parallel Transport - Electron scattering mechanisms, hot electrons in parallel transport. Perpendicular Transport – Resonant tunnelling. Quantum Transport: Quantized conductance. Landauer formula. Transport in Magnetic Fields: Low-dimensional systems in magnetic fields, Density of states of a 2D system in a magnetic field, The Aharonov–Bohm effect, The Shubnikov–de Haas effect. The quantum Hall effect: Elementary theory of the integer quantum Hall effect (IQHE)
MODULE IV: Electronic Devices Based on Nanostructures (6 Hours)
MODFETs, Heterojunction bipolar transistors, Resonant tunnel diodes, Hot electron transistors, Single electron transistors. Carbon Nanotube Devices: Structure and Technology, Carbon Nanotube Transistors.
MODULE V: Fabrication and Characterization Techniques (9 Hours)
Fabrication of nanolayers: Physical vapour deposition – Resistive method, Sputtering, Chemical vapour deposition, Molecular beam epitaxy, Formation of Silicon Dioxide- dry and wet oxidation methods. Formation of nanoparticles: Reduction method, Laser ablation method, Sol Gel process, Self-assembly. Characterization Techniques: Comparison of optical and electron microscopy techniques. Principle of probe microscopy: Scanning Tunnelling Microscope, Atomic Force Microscope. Principles of Electron Microscopy: Scanning Electron Microscope, Specimen interaction, Transmission Electron Microscope. X-Ray Diffraction analysis.

Text books

1. J.M. Martinez-Duart, R.J. Martin Palma, F. Agulle Rueda Nanotechnology for Microelectronics and optoelectronics, Elsevier, 2006.
2. W.R. Fahrner, Nanotechnology and Nanoelectronics, Springer, 2005.
3. George W. Hanson, Fundamentals of Nanoelectronics, Pearson Education, 2009.

Reference books

1. Chattopadhyay, Banerjee, Introduction to Nanoscience & Technology, PHI, 2012.
2. K. Goser, P. Glosekotter, J. Dienstuhl, Nanoelectronics and nanosystems, Springer 2004.
3. Murty, Shankar, Text book of Nanoscience and Nanotechnology, Universities Press, 2012.
4. Poole, Introduction to Nanotechnology, John Wiley, 2006.
5. Gregory L. Timp, Nanotechnology, 2012, 3rd edition, Springer, New York.
6. MOOC (NPTEL) on Nanoelectronics: Devices & Materials
   https://nptel.ac.in/courses/117108047

No.	COURSE CONTENTS AND LECTURE SCHEDULE	No. of Hours
	MODULE 1	
1.1	Introduction to nanotechnology, Mesoscopic physics	1
1.2	Characteristic lengths in mesoscopic systems, Quantum mechanical coherence	1
1.3	Classification of Nano structures: Quantum wells, wires and dots, Quantum confinement and density of states in 2-D materials	1
1.4	Quantum confinement and density of states in 1-D and 0-D materials	1
1.5	Square quantum wells of finite depth	1
1.6	Parabolic and triangular quantum wells, Quantum wires and quantum dots	1
	MODULE II	
2.1	Two-dimensional electronic system: two-dimensional behaviour	1
2.2	MOSFET structures	1
2.3	Heterojunctions: Modulation-doped heterojunctions, SiGe strained heterostructures	1
2.4	Quantum wells: Modulation-doped quantum well, Multiple quantum wells (MQW), Superlattices: The concept of a superlattice	1
2.5	Kronig–Penney model of a superlattice	1
2.6	Zone folding, Tight binding approximation of a superlattice	1
	MODULE III	
3.1	Transport in electric field: Parallel Transport – Electron scattering mechanisms	1
3.2	Hot electrons in parallel transport	1
3.3	Perpendicular Transport – Resonant tunnelling	1
3.4	Quantum Transport: Quantized conductance, Landauer formula	1
3.5	Transport in Magnetic Fields: Low-dimensional systems in magnetic fields, Density of states of a 2D system in a magnetic field	1
3.6	The Aharonov–Bohm effect, The Shubnikov–de Haas effect	1
3.7	The quantum Hall effect: Elementary theory of the integer quantum Hall effect (IQHE)	1
	MODULE IV	
4.1	MODFETs	1
4.2	Heterojunction bipolar transistors	1
4.3	Resonant tunnel diodes, Hot electron transistors	1
4.4	Single electron transistors	1

4.5	Carbon Nanotube Devices: Structure and Technology	1
4.6	Carbon Nanotube Transistors	1
MODULE V		
5.1	Fabrication of nanolayers: Physical vapour deposition – Resistive method, Sputtering	1
5.2	Chemical vapour deposition, Molecular beam epitaxy	1
5.3	Formation of Silicon Dioxide- dry and wet oxidation methods, Formation of nanoparticles: Reduction method, Laser ablation method	1
5.4	Sol Gel process, Self-assembly	1
5.5	Characterization Techniques: Comparison of optical and electron microscopy techniques. Principle of probe microscopy: Scanning Tunnelling Microscope	1
5.6	Atomic Force Microscope	1
5.7	Principles of Electron Microscopy: Specimen interaction	1
5.8	Scanning Electron microscope	1
5.9	Transmission Electron Microscope. X-Ray Diffraction analysis	1

CO Assessment Questions	
1	Consider an electron having kinetic energy 5eV and effective mass $0.511 m_0$. Calculate its De-Broglie wavelength. If the size of the measoscopic structure having this electron is in the range of 2×10^{-14} m, will it fall in the category of nanostructures?
2	Explain Kronig Penney model of superlattice and the concept of zone folding
3	Explain the formation of Landau levels and degeneracy associated with these levels
4	1. With the aid of energy band diagram, explain why MODFETs are high electron mobility transistors. 2. Present a seminar on the latest advancements in the field of nano electronic devices and submit a brief report on the same.
5	Explain the different emission and interaction processes between electron beam and the sample in a Scanning Electron Microscope.

OPEN ELECTIVE - II

24EC0812	INTRODUCTION TO MEMS	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: The course delves into the intricate world of MEMS technology, encompassing both theoretical foundations and practical applications. It emphasizes the fabrications and packaging techniques relevant to the MEMS industry and exposes the challenges the industry faces so that learners may explore various MEMS based research opportunities in their future endeavors.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO 1	Describe the working principles of micro sensors and actuators (Understand Level)
CO 2	Identify commonly used mechanical structures in MEMS (Understand Level)
CO 3	Apply scaling laws in the design of micro systems (Apply Level)
CO 4	Identify the typical materials used for fabrication of microsystems (Understand Level)
CO 5	Explain the principles of standard micro fabrication techniques (Understand Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	✓	✓										
CO 2	✓	✓										
CO 3	✓	✓										
CO 4	✓	✓										
CO 5	✓	✓										

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA

Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
3-0-0-0	5	15	10	10	**40**

Total Mark Distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 Hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I: MEMS and Microsystems: Introduction (8 Hours)

MEMS and Microsystems: Introduction – 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.

MODULE II: Mechanical Structures in MEMS (7 Hours)

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

MODULE III: Scaling laws in Miniaturization (9 Hours)

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.

MODULE IV : Microsystem Fabrication (7 Hours)

Microsystem Fabrication – Photolithography – Ion implantation- Diffusion – Oxidation – Chemical vapour deposition – Etching

Overview of Micro manufacturing – Bulk micro manufacturing, Surface micro machining, LIGA process –Micro stereo lithography.

MODULE V : Micro System Packaging (5 Hours)

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

Text books

1. Chang Liu, Foundations of MEMS, Pearson, 2012.
2. Tai-Ran Hsu, MEMS and Microsystems Design and Manufacture, TMH, 2002.

Reference books

1. Chang C Y and Sze S. M., VLSI Technology, McGraw-Hill, New York, 2000
2. Julian W Gardner, Microsensors: Principles and Applications, John Wiley & Sons, 1994
3. Mark Madou, Fundamentals of Micro fabrication, CRC Press, New York, 1997
4. Stephen D. Senturia, Microsystem design, Springer (India), 2006.
5. Thomas B. Jones, Electromechanics and MEMS, Cambridge University Press, 2001
6. Gregory T.A. Kovacs, Micromachined Transducers Sourcebook, McGraw Hill, 1998.
7. NPTEL Course on A brief introduction of Micro-Sensors https://onlinecourses.nptel.ac.in/noc20_ee52/preview
8. Course on Micro and Smart Systems https://nptel.ac.in/courses/112108092

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
MODULE 1		
1.1	Introduction to MEMS and Microsystems	1
1.2	Applications – multidisciplinary nature of MEMS – principles and examples of Micro sensors and micro actuators	1
1.3	micro accelerometer, comb drives	1
1.4	Micro grippers – micro motors	1
1.5	Micro valves, micro pumps, Shape Memory Alloys.	1
1.6	Actuation and Sensing techniques: Thermal sensors and actuators.	1
1.7	Electrostatic sensors and actuators	1
1.8	Piezoelectric sensors and actuators, magnetic actuators	1
MODULE II		
2.1	Review of Mechanical concepts: Stress, Strain, Modulus of Elasticity	1
2.2	Review of Mechanical concepts: yield strength, ultimate strength	1
2.3	General stress strain relations – compliance matrix	1
2.4	Overview of commonly used mechanical structures in MEMS - Beams, Cantilevers, Plates, Diaphragms – Typical applications	1
2.5	Overview of commonly used mechanical structures in MEMS: Plates, Diaphragms – Typical applications	1
2.6	Flexural beams: Types of Beams, longitudinal strain under pure bending	1
2.7	Deflection of beams – Spring constant of cantilever, Intrinsic stresses	1
MODULE III		
3.1	Scaling laws in miniaturization - scaling in geometry, scaling in rigid body dynamics	1
3.2	Trimmer force scaling vector	1
3.3	scaling in electrostatic and electromagnetic forces	1
3.4	scaling in electricity and fluidic dynamics	1
3.5	scaling in heat conducting and heat convection	1
3.6	Materials for MEMS – Silicon – Silicon compounds- Silicon Nitride	1
3.7	Silicon Dioxide, Silicon Carbide	1
3.8	Poly Silicon, GaAs, Silicon Piezo resistors	1
3.9	Polymers in MEMS – SU-8, PMMA, PDMS, Langmuir – Blodgett Film	1
MODULE IV		
4.1	Microsystem fabrication, Photolithography– Ion implantation	1

4.2	Diffusion, Oxidation	1
4.3	Chemical vapour deposition, Etching	1
4.4	Overview of Micro manufacturing – Bulk micro manufacturing	1
4.5	Surface micro machining	1
4.6	LIGA process	1
4.7	Micro stereo lithography	1
MODULE V		
5.1	Micro system Packaging: general considerations in packaging design – Levels of Micro system packaging	1
5.2	Bonding techniques for MEMS: Surface bonding, Anodic bonding	1
5.3	Silicon - on - Insulator, wire bonding	1
5.4	Sealing – Assembly of micro systems	1
5.5	Overview of MEMS areas: RF MEMS, BioMEMS, MOEMS, NEMS	1

	CO Assessment Questions	
1	1. Explain the principle of operation of two types of micro-accelerometers. 2. Explain with relevant examples how the principle of electrostatics may be used for the design of MEMS based sensors and actuators. 3. Explain how smart materials can be used for the design of MEMS based sensors and actuators.	
2	1. Explain the purpose of micro cantilevers in MEMS systems. What is the relevance of spring constant (k) of a mechanical structure in micro system design? 2. Derive the expression for the magnitude of applied bending moment with reference to pure bending of longitudinal beams.	
3	1. Explain force scaling vector, what information does it provide to a MEMS designer? 2. Derive equations for acceleration a, time t and power density P/V based on the Trimmer Force Scaling Vector. 3. Explain why electrostatic actuation is preferred over electromagnetic actuation at the micro-scale.	
4	1. State the relevant properties of Silicon Carbide and Silicon Nitride for use in Microsystems. 2. Explain why Silicon evolved as the ideal substrate material for MEMS fabrication. 3. Explain with examples the advantages of use of polymers in microsystems fabrication?	

5	1. Explain the steps involved in photolithography. State the chemicals used in each of the stages along with the operating conditions. 2. Explain the criteria for choice of surface or bulk micromachining techniques in the design of microsystems. 3. Explain with block diagram the steps in LIGA process. State two advantages o f LIGA process over other micromachining techniques.

24ECO822	ELECTRONIC HARDWARE FOR ENGINEERS	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: This offers a comprehensive exploration into the world of electronic components and systems, tailored specifically for engineering students. The syllabus covers a wide range of topics, including electronic components, electronic design automation, testing procedures, safety testing, and practical skills in PC assembly and maintenance. Students will gain valuable hands-on experience and a deep understanding of electronic hardware, equipping them with the skills and knowledge to excel in modern engineering environments.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO 1	Demonstrate mastery in identifying and using various electronic components and package types, essential for electronic applications. (Analyze Level)
CO 2	Acquire proficiency in Electronic Design Automation (EDA) tools such as SPICE and PROTEUS for effective circuit design and simulation. (Apply Level)
CO 3	Acquire skills in standard testing of electronic devices like power supplies and UPS, ensuring compliance with safety and performance standards. (Apply Level)
CO 4	Build competency in safety testing for household appliances, focusing on electric strength, leakage current, and regulatory compliance. (Apply Level)
CO 5	Acquire essential skills in PC assembly, maintenance, and troubleshooting, including software installation and system optimization. (Apply Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	✓											
CO 2	✓			✓	✓							✓
CO 3	✓					✓						
CO 4	✓					✓						
CO 5	✓											

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA			
		Theory [L- T]	

Course Structure [L-T-P-J]	Assignment	Test-1	Test-2	
3-0-0-0	5	15	10	10	**40**

Total Mark Distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 Hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I: Electronic Components (5 Hours)

Types of Components: Active Components: Diode, Transistor, MOSFET, LED, SCR, Integrated Circuits. Passive Components: Resistor, Capacitor, Inductor, Transformer, Speaker/Buzzer.

Component Package Types: Axial lead, Radial Lead, Single Inline Package (SIP), Dual Inline Package (DIP), Transistor Outline (TO), Pin Grid Array (PGA), Metal Electrode Face (MELF), Leadless Chip Carrier (LCC), Small Outline Integrated Circuit (SOIC), Quad Flat Pack (QPF) and Thin QFP (TQFP), Ball Grid Array (BGA), Plastic Leaded Chip Carrier (PLCC).

MODULE II: Electronic Design Automation (6 Hours)

Introduction to Electronic Design Automation (EDA), Brief History of EDA, Latest Trends in Market, How it helps and why it requires, Different EDA tools, Introduction to SPICE and PSPICE Environment, Introduction and Working of PROTEUS, Simulation of simple circuits using EDA tools.

MODULE III: Testing Procedures (5 Hours)

Testing Procedures: Switch Mode Power Supply - (Applicable Standard: IS 14886) Safety Testing (Earth Leakage current Test, Dielectric Test, Short Circuit Protection), Performance Testing (Line Regulation, Load Regulation for a variation of Load Min to Max load and vice versa).

Inverter, UPS - Inverter (Applicable Standard: IS 13314) Visual Inspection, High Voltage Test, Insulation Resistance Test, No Load Test, Output Test. UPS (Applicable Standard: IEC 62040-3) Steady State Input Voltage Tolerance, Output-Normal Mode – No Load, Full Load, Overload, Short Circuit.

MODULE IV: Safety Testing (5 Hours)

Safety Testing of Household Appliances: (Applicable Standard IS 302-1) Definitions and Terminology, Protection against Shock, Power Input and Current, Leakage Current and Electric Strength at Operating Temperature.

Testing of Electric Iron/Electric Kettle: (Applicable Standard: IS 302-2) Ground bond resistance, Touch Current, Temperature (Thermostatic Cut off) Power Consumption.

MODULE V: Assembly and Maintenance of PC (6 Hours)

Introduction to Computer - Difference between Hardware & Software, Booting concept, Different input and output devices/ cables, connectors, different types of motherboards, controller cards, Ethernet cards, Different types of RAM used in PC's.

Installation: BIOS setting, Formatting of Hard Disk, Installation of Windows, Off-line drive installation / online drive installation / Windows file repairing / BIOS password break / Administrative password break / Data recovery. Application Software Installation, Dual Booting Installation.

Assembly and dismantling: Assembly and dismantling of PCs front panel connection, servicing of computer, Type of Backup, Taking Backup files and fine tuning the system, running diagnostics tool, running of virus protection program.

Text books
1. C. Robertson. PCB Designer´s Reference. Prentice Hall, 2003.
2. D. Brooks, Signal Integrity Issues and Printed Circuit Board Design, Prentice Hall, 2003.
3. Advances in Electronic Testing, edited by D Gizopoulos, 2006

Reference books
1. C. Coombs, Printed Circuits Handbook, McGraw-Hill Professional, 6 Edition, 2007.
2. Electronic Testing Handbook, McGraw-Hill, Dec 1993
3. PC Repair and Maintenance, A Practical Guide, Joel Rosenthal, Kevin Irwin, 2003
4. A Simple Guide to Computer Maintenance and Troubleshooting, Adane Nega Tarekegn, Alemu Kumilachew Tegegne, 2015
5. https://ocw.mit.edu/courses/6-002-circuits-and-electronics-spring-2007/pages/lecture-notes/
6. https://ocw.mit.edu/courses/6-002-circuits-and-electronics-spring-

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
MODULE 1		
1.1	Types of Components. Active Components: Diode, Transistor	1
1.2	MOSFET, LED, SCR, Integrated Circuits	1
1.3	Passive Components: Resistor, Capacitor, Inductor, Transformer, Speaker/Buzzer	1
1.4	Component Package Types:	1
1.5	Axial lead, Radial Lead, Single Inline Package (SIP), Dual Inline Package (DIP), Transistor Outline (TO), Pin Grid Array (PGA), Metal Electrode Face (MELF), Leadless Chip Carrier (LCC)	1
MODULE II		
2.1	Introduction to Electronic Design Automation (EDA), Brief History of EDA, Latest trends in market, how it helps and why it requires	1
2.2	Different EDA tools, Introduction to SPICE and PSPICE Environment	1
2.3	Introduction and working of PROTEUS	1
2.4	Simulation of simple circuits using EDA tools	1
2.5	Simulation of simple circuits using EDA tools	1
2.6	Simulation of simple circuits using EDA tools	1
MODULE III		
3.1	Testing Procedures: Switch Mode Power Supply - (Applicable Standard: IS 14886) Safety Testing (Earth Leakage current Test, Dielectric Test, Short Circuit Protection)	1
3.2	Performance Testing (Line Regulation, Load Regulation for a variation of Load Min to Max load and vice versa)	1
3.3	Inverter, UPS - Inverter (Applicable Standard: IS 13314) Visual Inspection, High Voltage Test, Insulation Resistance Test, No Load Test, Output Test	1
3.4	UPS (Applicable Standard: IEC 62040-3) Steady State Input Voltage Tolerance	1
3.5	Output-Normal Mode – No Load, Full Load, Overload, Short Circuit	1
MODULE IV		
4.1	Safety Testing of Household Appliances: (Applicable Standard IS 302-1) Definitions and Terminology	1
4.2	Protection against Shock, Power Input and Current	1
4.3	Leakage Current and Electric Strength at Operating Temperature	1

4.4	Testing of Electric Iron/Electric Kettle: (Applicable Standard: IS 302-2) Ground bond resistance	1
4.5	Touch Current, Temperature (Thermostatic Cut off) Power Consumption	1
MODULE V		
5.1	Introduction to Computer - Difference between Hardware & Software, Booting concept, Different input and output devices/ cables, connectors	1
5.2	Different types of motherboards, controller cards, Ethernet cards, Different types of RAM used in PC's	1
5.3	Installation: BIOS setting, Formatting of Hard Disk, Installation of Windows, Off-line drive installation / online drive installation / Windows file repairing / BIOS password break / Administrative password break / Data recovery	1
5.4	Application Software Installation, Dual Booting Installation	1
5.5	Assembly and dismantling: Assembly and dismantling of PCs front panel connection, servicing of computer	1
5.6	Type of Backup, Taking Backup files and fine tuning the system, running diagnostics tool, running of virus protection program	1

CO Assessment Questions	
1	1. Identify the main differences between active and passive electronic components and provide two examples of each. 2. Describe the characteristics and applications of two specific package types such as Dual Inline Package (DIP) and Ball Grid Array (BGA). 3. Explain the function of a MOSFET and compare it with a traditional transistor in terms of operation and applications.
2	1. Discuss the role of SPICE in circuit simulation and design, and describe how it differs from traditional circuit analysis methods. 2. Explain how PROTEUS aids in electronic design automation and illustrate with an example of a simple circuit simulation. 3. Compare and contrast two EDA tools in terms of features and suitability for different types of electronic circuit designs.
3	1. Outline the standard testing procedure for a Switch Mode Power Supply and explain its importance. 2. Describe the testing protocols for an Inverter, focusing on the No Load Test and Output Test. 3. Explain the significance of the Earth Leakage Current Test and Dielectric Test in the safety testing of electronic devices.
4	1. Describe the safety testing procedure for an electric kettle as per IS 302-2, focusing on ground bond resistance and touch current. 2. Explain the process and importance of testing for leakage current and electric strength in household appliances. 3. Describe the key aspects of protection against shock in the safety testing of household appliances as per IS 302-1.

5	1. Explain the process of assembling a PC, highlighting the importance of front panel connections and BIOS settings. 2. Describe the steps involved in the installation of an operating system on a PC, including drive formatting and driver installation. 3. Describe the methods and importance of data recovery and virus protection in maintaining and troubleshooting PCs.

24ECO832	INDUSTRIAL INSTRUMENTATION	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: This course introduces the principle of Industrial Instrumentation for measuring physical variables using transducers and familiarizes the concepts of the process control using PLC, DCS and SCADA.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO 1	Understand the principles of measurement and control in industrial processes. (Understand Level)
CO 2	Describe the working of various sensors and transducers used in industry. (Understand Level)
CO 3	Select appropriate instrumentation for specific industrial applications. (Understand Level)
CO 4	Interpret and analyze data from industrial instruments. (Apply Level)
CO 5	Design simple control systems incorporating industrial sensors and instruments. (Apply Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	✓	✓										
CO 2	✓	✓										
CO 3	✓	✓										
CO 4	✓	✓			✓							
CO 5	✓	✓			✓							

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA						
Course Structure [L-T-P-J]	Attendance	Theory [L- T]				Total Marks
		Assignment	Test-1	Test-2		
3-0-0-0	5	15	10	10		**40**

Total Mark Distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 Hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I : Introduction to Industrial Instrumentation (7 Hours)

Overview of industrial instrumentation and control. Static and Dynamic characteristics of Instruments. Standards and calibration. Displacement and proximity gauges. Linear Variable Differential Transformer (LVDT). Generalized configurations and Functional elements of Instrumentation systems.
Importance of measurement: accuracy, precision, resolution, and sensitivity.

MODULE II: Sensors and Transducers (8 Hours)

Principles of sensing and transduction. Measurement: Temperature, Flow and Pressure. Temperature measurements: Thermocouples, Resistance Temperature Detectors (RTDs), thermistors, and Radiation pyrometer. Flow: Differential Pressure Flowmeter, Variable area flowmeter, Variable reluctance transducer, Turbine flowmeter, Orifice plates, venturi tubes, Ultrasonic flow detectors (Both transit time and Doppler Shift), electromagnetic flowmeter and Mass flowmeter.

Pressure measurements: Elastic transducers (Bourdon Gauge, Bellow and Diaphragm Gauge). Low pressure measurement: McLeod and ionization gauge.
MODULE III: Signal Conditioning and Data Acquisition (7 Hours)
Measurement of level: Capacitance based and Float based method. Measurement of strain: Strain Gauge, unbalanced Wheatstone bridge, Load cell, Torque Cell. pH probe and viscosity measurement.
Signal conditioning: Amplification, filtering, linearization, and compensation. Data acquisition systems (DAS). Analog-to-digital and Digital-to-Analog conversion. Data presentation: Recorders and display systems.
Basics of Data transmission: Synchro and Servo motor. IEEE-488 bus, RS 232 and RS 485 interface. Pneumatic and Hydraulic Instrumentation system.
MODULE IV: Control Elements and Control Strategies (7 Hours)
Final control elements: Valves, actuators, and positioners. Basic control actions: On-off, PID, feedforward, and feedback control. Control loop components and troubleshooting. Smart transmitters and controllers.
Programmable Logic Controllers (PLCs): Basic PLC Programming, Programming ON/OFF Inputs, Creating Ladder diagrams, Register Basics, PLC Timers and Counters, PLC Arithmetic functions.
MODULE V: Advanced Instrumentation Systems (7 Hours)
Distributed Control Systems (DCS): Necessity of distributed control; hardware components of DCS; DCS software. Supervisory Control and Data Acquisition (SCADA) systems: SCADA overview, SCADA Architecture – Monolithic, Distributed and Networked, SCADA Protocols- IEC 60870-5-101, DNP-3, Profibus, Modbus. Wireless instrumentation and the Industrial Internet of Things (IIoT). Safety and reliability in instrumentation.

Text books

1. Curtis D. Johnson, "Process Control Instrumentation Technology", Eighth edition, Pearson new international publications, 2005.
2. John W Webb, Ronald A. Reis, "Programmable Logic Controllers- Principles and applications", PHI, ND, 2006.
3. Michael P. Lucas, "Distributed Control System Lucas", Van Nastrant Reinhold Company, Van Nostrand Reinhold Co, 1986.

Reference books

1. Thomas A. Hughes "Measurement and Control Basics", ISA publications, 2006
2. Tattamangalam R. Padmanabhan, "Industrial Instrumentation: Principles and Design", first edition, Springer, 2000.
3. Alan S. Morris and Reza Langari, Measurement and Instrumentation: Theory and Application, Second edition, Elsevier Science Publications, 2015.
4. https://archive.nptel.ac.in/courses/108/105/108105064/

No.		No. of Hours
COURSE CONTENTS AND LECTURE SCHEDULE		
MODULE 1		
1.1	Overview of industrial instrumentation and control	1
1.2	Static and Dynamic characteristics of Instruments. Standards and calibration	1
1.3	Importance of measurement: accuracy, precision materials	1
1.4	Displacement and proximity gauges. Linear Variable Differential Transformer (LVDT)	1
1.5	Generalized configurations	1
1.6	Functional elements of Instrumentation systems	1
1.7	Importance of measurement: accuracy, precision, resolution, and sensitivity	1
MODULE II		
2.1	Principles of sensing and transduction Measurement: Temperature, Flow and Pressure	1
2.2	Temperature measurements: Thermocouples, RTDs	1
2.3	Thermistors, and Radiation pyrometer	1
2.4	Flow: Differential Pressure Flowmeter, Variable area flowmeter	1
2.5	Variable reluctance transducer, Turbine flowmeter, Orifice plates, venturi tubes	1
2.6	Ultrasonic flow detectors (Both transit time and Doppler Shift), electromagnetic flowmeter and Mass flowmeter	1
2.7	Pressure measurements: Elastic transducers (Bourdon Gauge Bellow and Diaphragm Gauge)	1
2.8	Low pressure measurement: McLeod and ionization gauge	1
MODULE III		
3.1	Measurement of level: Capacitance based and Float based method	1
3.2	Measurement of strain: Strain Gauge, unbalanced Wheatstone bridge, Load cell, Torque Cell. pH probe and viscosity measurement	1
3.3	Signal conditioning: Amplification, filtering, linearization, and compensation	1
3.4	Data acquisition systems (DAS). Analog-to-digital and Digital-to-Analog conversion	1
3.5	Data presentation: Recorders and display systems	1
3.6	Basics of Data transmission: Synchro and Servo motor. IEEE-488 bus, RS 232 and RS 485 interface	1
3.7	Pneumatic and Hydraulic Instrumentation system	1
MODULE IV		
4.1	Final control elements: Valves, actuators, and positioners	1
4.2	Basic control actions: On-off, PID, feedforward, and feedback control	1

4.3	Control loop components and troubleshooting. Smart transmitters and controllers	1
4.4	Programmable Logic Controllers (PLCs): Basic PLC	1
4.5	Programming: Programming ON/OFF Inputs	1
4.6	Creating Ladder diagrams	1
4.7	Register Basics, PLC Timers and Counters, PLC Arithmetic functions	1
MODULE V		
5.1	Distributed Control Systems (DCS): Necessity of distributed control	1
5.2	Hardware components of DCS; DCS software	1
5.3	Supervisory Control and Data Acquisition (SCADA) systems: SCADA overview, SCADA Architecture – Monolithic	1
5.4	SCADA Architecture: Distributed and Networked	1
5.5	SCADA Protocols: IEC 60870-5-101, DNP-3, Profibus, Modbus	1
5.6	Wireless instrumentation and the Industrial Internet of Things (IIoT)	1
5.7	Safety and reliability in instrumentation	1

CO Assessment Questions	
1	Explain the functions of each block in an instrumentation system?
2	Explain the factors influencing the choice of a transducer for an industrial instrumentation system?
3	Explain the importance of signal conditioning in Industrial instrumentation systems?
4	Design a PLC based temperature sensing using RTD?
5	Develop a SCADA system for a water tank to monitor and control its water level. Describe the integration of level sensors, valve controls, and emergency response mechanisms.

24ECO842	COMPUTER COMMUNICATION	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: Computer communication courses enable the learners to understand networking concepts, technologies, and terminologies which in turn helps the students to analyze the various layers and protocols used in computer networks. The course provides an insight to computer networking concepts and the functions of each layer in detail. In order to understand efficient and robust applications it is essential to have a firm grasp of communication protocols.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO 1	Explain the layers of the OSI model and the TCP/IP model. (Understand Level)
CO 2	Describe the way to implement data link layer technologies, to enable seamless and reliable data transmission between connected devices. (Understand Level)
CO 3	Apply Dijkstra's algorithm and distance-vector algorithm in the context of routing over computer networks. (Apply Level)
CO 4	Explain problems pertaining to reliable data transfer, flow control and congestion over a TCP network. (Understand Level)
CO 5	Describe the protocols used in web and email applications. (Understand Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	✓	✓										
CO 2	✓	✓										
CO 3	✓	✓										
CO 4	✓	✓										
CO 5	✓	✓										

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
3-0-0-0	5	15	10	10	**40**

Total Mark Distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 Hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I: Introduction to Computer Networking Concept (8 Hours)

Introduction to computer communication: Transmission modes - serial and parallel transmission, asynchronous, synchronous, simplex, half duplex, full duplex communication.
Switching: circuit switching and packet switching.
Networks: Physical structures, network models, categories of networks, Internetwork
Network models: Layered tasks, OSI model, Layers in OSI model, TCP/IP protocol suite.

MODULE II: Physical and Data Link Layer (9 Hours)

Physical Layer: Transmission modes, Types of transmission media -Guided and unguided transmission media (Co-axial cable, Twisted pair cable, Fiber optic cable)

Data Link Layer: Framing, Flow and error control (stop and wait, Stop-and-Wait Automatic Repeat Request, Go-Back-N Automatic Repeat Request, Selective Repeat, Automatic Repeat Request), Error detection (check sum, CRC), Bit stuffing, Media access control: Ethernet (802.3), CSMA/CD, CAN protocol Logical link control, Wireless LAN (802.11), CSMA/CA.

MODULE III: Network Layer (8 Hours)

Networking devices: Hubs, Bridges & Switches
Internet Protocol: Network Layer Services, Logical addressing-IPv4 & IPV6 header format.
Address Mapping: Address Resolution protocol (ARP), Reverse Address Resolution Protocol (RARP). Internet Control Message Protocol (ICMP), Dynamic Host Configuration Protocol (DHCP) Routing and Forwarding, Static routing and Dynamic routing.
Routing Algorithms: Distance vector routing algorithm, Link state routing (Dijkstra's algorithm) Routing Protocols: Routing Information Protocol (RIP), Open Shortest Path First (OSPF).

MODULE IV: Transport Layer (6 Hours)

Services of transport layer, Process to process delivery, Transport Layer protocol-UDP-header format, operation. Protocols for reliable data transfer. Go-back-N, Selective Repeat. TCP-header format, operation. Congestion Control & Quality of Service- Traffic Descriptor, Traffic Profiles, QoS and flow characteristics.

MODULE V: Application Layer and Network Security (5 Hours)

Application Layer – Communication between processes. Web Applications- Hyper Text Transfer Protocol (HTTP), Domain Name System (DNS), Remote Logging (Telnet), Simple Mail Transfer Protocol (SMTP), File Transfer Protocol (FTP), World Wide Web (WWW), Post Office Protocol (POP3).

Text books
1. Behrouz A Forouzan, Data Communications and Networking, 4/e, Tata McGraw-Hill, 2006
2. J F Kurose and K W Ross, Computer Network A Top-down Approach Featuring the Internet, 3/e, Pearson Education, 2010

Reference books
1. Larry Peterson and Bruce S Davie: Computer Network- A System Approach, 4/e, Elsevier India, 2011.
2. S. Keshav, An Engineering Approach to Computer Networking, Pearson Education, 2005.
3. Achyut S. Godbole, Data Communication and Networking, 2e, McGraw Hill Education New Delhi, 2011.
4. NPTEL course on communication networks by IIT Kharagpur
   https://onlinecourses.nptel.ac.in/noc22_ee61/preview

	COURSE CONTENTS AND LECTURE SCHEDULE	
No.		No. of Hours
MODULE 1		
1.1	Introduction to computer communication: Transmission modes - serial and parallel transmission	1
1.2	Asynchronous, synchronous, simplex, half duplex, full duplex communication	1
1.3	Switching: circuit switching and packet switching	1
1.4	Networks: Physical structures, models, categories of networks	1
1.5	Interconnection of Networks: Internetwork	1
1.6	Network models: Layered tasks	1
1.7	OSI model-Services provided by each layer	1
1.8	TCP/IP protocol suite	1
MODULE II		
2.1	Physical Layer: Transmission modes	1
2.2	Types of transmission media - Guided and unguided transmission media (Co-axial cable, Twisted pair cable, Fiber optic cable)	1
2.3	Data Link Layer: Framing-Fixed-Size Framing	1
2.4	Variable-Size Framing	1
2.5	Flow and error control (stop and wait, Stop-and-Wait Automatic Repeat Request)	1
2.6	Go-Back-N Automatic Repeat Request, Selective Repeat Automatic Repeat Request	1
2.7	Error detection (check sum, CRC), Bit stuffing	1
2.8	Media access control: Ethernet (802.3)-Frame format	1
2.9	Carrier Sense Multiple Access with Collision Detection (CSMA/CD), CAN Protocol	1
MODULE III		
3.1	Networking devices: Hubs, Bridges & Switches Internet Protocol: Network Layer Services	1
3.2	Logical addressing-IPV4 & IPV6 header format	1
3.3	Address Mapping: Address Resolution Protocol (ARP)	1
3.4	Reverse Address Resolution Protocol (RARP)	1
3.5	Internet Control Message Protocol (ICMP), Dynamic Host Configuration Protocol (DHCP)	1
3.6	Routing and Forwarding, Static routing and Dynamic routing.	1
3.7	Routing Algorithms: Distance vector routing algorithm, Link state routing (Dijkstra's algorithm)	1
3.8	Routing Protocols: Routing Information protocol (RIP), Open	1

	Shortest Path First (OSPF)	
MODULE IV		
4.1	Services of transport layer, Process to process delivery	1
4.2	Transport Layer protocol –UDP-Header format, operation	1
4.3	Protocols for reliable data transfer- Go-back-N, Selective Repeat. TCP-header format, operation	1
4.4	Transport Layer protocol –TCP-header format, operation	1
4.5	Congestion Control & Quality of Service- Traffic Descriptor, Traffic Profiles	1
4.6	QoS and flow characteristics	1
MODULE V		
5.1	Application Layer – Communication between processes	1
5.2	Web Applications- Hyper Text Transfer Protocol (HTTP)	1
5.3	Domain Name System (DNS), Remote Logging (Telnet)	1
5.4	Simple Mail Transfer Protocol (SMTP), File Transfer Protocol (FTP)	1
5.5	World Wide Web (WWW), Post Office Protocol (POP3)	1

CO Assessment Questions	
1	1. Dialog control and synchronization are two responsibilities of the session layer in the OSI model. Which layer do you think is responsible for these duties in the Internet model? Explain your answer. 2. Compare OSI model to TCP/IP model.
2	1. Explain Carrier Sense Multiple Access with Collision Detection with the help of flow chart. 2. Explain the various types of flow control mechanisms done at data link layer.
3	1. Apply Dijkstra's algorithm and distance-vector algorithm in the context of routing over computer networks. 2. Consider the following network. Compute the shortest-path from the node D to all other nodes using Dijkstra's shortest path algorithm. (Numbers indicated show the link costs).
4	1. Why is it that voice and video traffic is often sent over TCP rather than UDP in today's Internet? 2. Explain the header format of TCP and UDP.

5	Describe the protocols used in web and email applications. 1. Describe the HTTP message format 2. Compare and contrast two application layer protocols SMTP and HTTP

OPEN ELECTIVE - 3

24ECO813	INTRODUCTION TO COMPUTER VISION	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: The course aims to equip students with a comprehensive understanding of how machines can learn to gain high-level comprehension from digital images or videos. From the foundational concepts of image formation and processing to the advanced techniques involving deep learning and real-world applications, this course delves into the mechanisms that enable computers to interpret visual information. By exploring feature detection, image segmentation, object recognition, and cutting-edge trends, students will be well-prepared to apply computer vision techniques across various domains, fostering innovation and practical problem-solving.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO 1	Understand the fundamentals of image formation and image processing techniques. (Understand Level)
CO 2	Apply feature detection and description algorithms for image analysis. (Apply Level)
CO 3	Implement image segmentation and object recognition techniques. (Apply Level)
CO 4	Utilize deep learning, specifically CNNs, for advanced computer vision tasks. (Apply Level)
CO 5	Explore advanced topics and applications of computer vision in real-world scenarios. (Apply Level).

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	✓											
CO 2	✓				✓							
CO 3	✓											
CO 4	✓				✓							
CO 5	✓				✓							

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓		✓
Understand	✓	✓		✓
Apply	✓	✓		✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
3-0-0-0	5	15	10	10	**40**

Total Mark Distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I : Introduction to Computer Vision (7 Hours)

Overview of Computer Vision: Significance, applications, and evolution, Basics of Image Formation: Cameras, lenses, sensors, and pixel representation, Image Processing Fundamentals: Grayscale conversion, histogram equalization, filtering -Introduction to convolution and correlation, edge detection.

MODULE II: Feature Detection and Description   (7 Hours)

Introduction to Features: Corners, edges, and blob, Feature Detection Algorithms: Harris Corner Detector, SIFT, SURF, and FAST, Feature Description and Matching: Brief, ORB, and feature matching techniques.

MODULE III: Image Segmentation and Object Recognition (7 Hours)

Image Segmentation Techniques: Thresholding, region growing, and watershed segmentation, Object Recognition: Template matching, Haar cascades, and object classification.

MODULE IV: Deep Learning in Computer Vision (8 Hours)
Introduction to Neural Networks: Perceptrons, multi-layer Perceptrons, and activation functions, Convolutional Neural Networks (CNNs): Architecture, convolution, pooling, and applications, Transfer Learning and Pre-trained Models: VGG, ResNet, and applications in computer vision.
MODULE V: Advanced Topics and Applications (7 Hours)
Object Detection and Tracking: YOLO, SSD, and tracking algorithms, Semantic and Instance Segmentation: FCN, Mask R-CNN, Future Trends and Applications: Augmented reality, 3D reconstruction, and ethical considerations in computer vision.

Text books

Szeliski, R. (2010). Computer Vision: Algorithms and Applications. Springer Science & Business Media.

Reference books

1. Gonzalez, R. C., & Woods, R. E. (2002). Digital Image Processing (2nd ed.). Prentice Hall.
2. Forsyth, D. A., & Ponce, J. (2002). Computer Vision: A Modern Approach. Prentice Hall.
3. Goodfellow, I., Bengio, Y., & Courville, A. (2016). Deep Learning. MIT Press.
4. Bradski, G., & Kaehler, A. (2008). Learning OpenCV: Computer Vision with the OpenCV Library. O'Reilly Media, Inc.
5. Prince, S. J. D. (2012). Computer Vision: Models, Learning, and Inference. Cambridge University Press.
6. NPTEL Course Link: https://nptel.ac.in/courses/108103174
7. NPTEL Course Link: https://onlinecourses.nptel.ac.in/noc19_cs58/preview

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
MODULE 1		
1.1	Introduction to Computer Vision Overview of Computer Vision Significance, Applications, Evolution	1

1.2	Basics of Image Formation - Part 1
	    Introduction to Cameras and Lenses
	    Types of cameras, Role of lenses in image formation
		1

1.3	Basics of Image Formation - Part 2
	    Sensors and Pixel Representation
	    Types of sensors, How pixels represent images
		1

1.4	Image Processing Fundamentals - Part 1 Grayscale Conversion, Concept and significance, Practical examples	1

1.5	Image Processing Fundamentals - Part 2
	    Histogram Equalization, Concept and significance
	    Practical examples
		1

1.6	Image Processing Fundamentals - Part 3 Image Filtering, Types of filters Applications in computer vision	1
1.7	Image Processing Fundamentals - Part 4 Edge Detection, Concept and significance, Edge detection algorithms	1
MODULE II		
2.1	Introduction to Features Overview of Features, Corners, Edges, Blobs	1

2.2	Feature Detection Algorithms - Part 1
	    Introduction to Harris Corner Detector
	    Concept and significance, Practical examples
		1

2.3	Feature Detection Algorithms - Part 2
	    Scale-Invariant Feature Transform (SIFT)
	    Concept and significance, Practical examples
		1

2.4	Feature Detection Algorithms - Part 3
	    Speeded-Up Robust Features (SURF) and Features from
	    Accelerated Segment Test (FAST)
	    Overview and comparison, Practical examples
		1

2.5	Feature Description and Matching - Part 1
	    Introduction to Binary Robust Independent Elementary
	    Features (Brief), Concept and significance, Practical
	    examples.
		1

2.6	Feature Description and Matching - Part 2
	    Oriented FAST and Rotated BRIEF (ORB)
	    Concept and significance, Practical examples
		1

2.7	Feature Description and Matching - Part 3	1
	Feature Matching Techniques Overview of different techniques Practical examples and applications	
MODULE III		

3.1	Introduction to Image Segmentation
	    Overview of Image Segmentation
	    Concept and significance, Applications in computer vision
		1

3.2	Image Segmentation Techniques - Part 1
	    Thresholding, Basic thresholding techniques, Adaptive
	    thresholding
		1

3.3	Image Segmentation Techniques - Part 2 Region Growing, Concept and significance, Practical examples	1

3.4	Image Segmentation Techniques - Part 3
	    Watershed Segmentation, Concept and significance
	    Practical examples
		1

3.5	Introduction to Object Recognition
	    Overview of Object Recognition
	    Template matching, Applications in computer vision
		1

3.6	Object Recognition Techniques - Part 1 Haar Cascades, Concept and significance, Practical examples	1

3.7	Object Recognition Techniques - Part 2
	    Object Classification
	    Overview of classification techniques
	    Practical examples and applications
		1

MODULE IV		

4.1	Introduction to Neural Networks - Part 1
	    Overview of Neural Networks
	    Concept and significance, Introduction to Perceptrons
		1

4.2	Introduction to Neural Networks - Part 2
	    Multi-layer Perceptrons (MLP)
	    Architecture and working, Activation functions
		1

4.3	Introduction to Convolutional Neural Networks (CNNs) - Part 1
	    Overview of CNNs, Concept and significance, Applications in
	    computer vision
		1

4.4	CNNs - Architecture and Convolution
	    Detailed exploration of CNN architecture
	    Convolution operation, Feature maps
		1

4.5	CNNs - Pooling and Layers
	    Pooling operations, Max pooling, average pooling
	    Fully connected layers and output
		1

4.6	CNNs - Applications
	    Practical applications of CNNs, Image classification, Object
	    detection
		1

4.7	Transfer Learning and Pre-trained Models - Part 1
	    Introduction to Transfer Learning
	    Concept and significance, Introduction to VGG
		1

4.8	Transfer Learning and Pre-trained Models - Part 2
	    ResNet and other pre-trained models
	    Architecture and applications, Use cases in computer vision
		1

MODULE V		

5.1	Introduction to Object Detection
	    Overview of Object Detection, Concept and significance,
	    Applications in computer vision
		1

5.2	Object Detection Techniques - YOLO
	    You Only Look Once (YOLO), Architecture and working
	    Practical examples
		1

5.3	Object Detection Techniques - SSD
	    Single Shot MultiBox Detector (SSD)
	    Architecture and working, Practical examples
		1

5.4	Object Tracking
	    Object Tracking Algorithms, Overview and applications,
	    Tracking techniques
		1

5.5	**Semantic and Instance Segmentation - Part 1** Fully Convolutional Networks (FCN), Concept and significance, Applications in semantic segmentation	1
5.6	**Semantic and Instance Segmentation - Part 2** Mask Region-based Convolutional Network (Mask R-CNN) Architecture and working, Applications in instance segmentation	1
5.7	**Future Trends and Applications** Augmented Reality and 3D Reconstruction, Concepts and applications, Ethical Considerations in Computer Vision, Overview and significance	1

CO Assessment Questions	
1	1. Define computer vision and explain its significance in various applications. 2. Briefly describe the evolution of computer vision and highlight some key milestones in its development. 3. Explain the role of cameras, lenses, and sensors in the process of image formation. 4. Describe how pixels are represented in digital images and discuss the importance of pixel representation in computer vision. 5. What is the purpose of converting an image to grayscale in image processing? Provide an example scenario where this conversion is beneficial. 6. Explain the concept of histogram equalization and how it contributes to image enhancement. 7. Differentiate between filtering and edge detection in image processing. Provide examples of scenarios where each technique is useful.
2	1. Implement Harris Corner Detector: Using Matlab or Python, write a program to implement the Harris Corner Detection algorithm. Apply it to a given image and display the corners detected by the algorithm. Explain the steps involved in the algorithm and how it identifies corners in an image. 2. Compare SIFT and SURF: Write a brief report comparing the SIFT (Scale-Invariant Feature Transform) and SURF (Speeded Up Robust Features) algorithms. Implement both algorithms in Matlab or Python to detect and describe features in an image. Discuss the differences in terms of computational efficiency, accuracy, and scenarios where one might be preferred over the other. 3. FAST Algorithm Application: Implement the FAST (Features from Accelerated Segment Test) algorithm in Python or Matlab. Use it to detect features in a real-time video feed. Discuss how the FAST algorithm is optimized for speed and the trade-offs it makes for this optimization. 4. Feature Description with ORB: Use the ORB (Oriented FAST and Rotated BRIEF) algorithm in Matlab or Python to perform feature detection and description on a set of images. Explain how ORB

	combines the best aspects of both FAST and BRIEF and its advantages over them. 5. Feature Matching Techniques: Demonstrate feature matching using any of the algorithms you've studied (like BRIEF, ORB, etc.). Apply the technique to match features between two images that have some degree of overlap or are different views of the same scene. Explain the process and how the algorithm decides on a match. 6. Real-World Application Challenge: Choose a real-world scenario (e.g., object recognition, panorama stitching) and apply a combination of feature detection, description, and matching techniques to solve a problem. Discuss the choice of algorithms, the challenges faced, and how the techniques helped in solving the problem.
3	1. Implement Thresholding Segmentation: Write a program in Matlab or Python to perform thresholding segmentation on a given image. Explain how you determine the threshold value and the impact of different threshold values on the segmentation result. 2. Region Growing Algorithm: Implement the region growing algorithm for segmenting an image in Matlab or Python. Describe how this algorithm works and discuss its advantages and limitations based on the results obtained from your implementation. 3. Watershed Segmentation Application: Apply watershed segmentation to a complex image with overlapping objects using Matlab or Python. Explain the principle behind watershed segmentation and how it helps in separating the objects effectively. 4. Template Matching Technique: Use template matching in Python or Matlab for object recognition in a given set of images. Explain how template matching works and discuss its effectiveness and limitations in various scenarios. 5. Implementing Haar Cascades for Face Detection: Implement face detection using Haar cascades in Matlab or Python. Discuss how Haar cascades work and why they are effective for object detection, particularly for faces. 6. Object Classification Challenge: Create a simple object classification system using Matlab or Python. This could involve classifying objects into categories like 'vehicles', 'animals', etc., based on their features. Discuss the method you used for classification and the challenges you faced.
	1. Build a Basic Neural Network: Using Matlab or Python, construct a multi-layer perceptron to classify a simple dataset (e.g., MNIST). Explain the choice of activation functions in different layers and the impact of the number of layers and neurons on the model's performance. 2. CNN Architecture Design: Design and implement a CNN in Python or Matlab for image classification. Describe each layer's role in the network (convolution layers, pooling layers, fully connected layers) and how they work together for feature extraction and classification. 3. Pooling Layer Analysis: Implement two variants of the same CNN model – one with max pooling and the other with average pooling. Compare

4		their performance on a standard dataset and discuss the impact of pooling techniques on the results. <ol start="4"> - Transfer Learning with Pre-trained Models: Utilize a pre-trained model (like VGG or ResNet) in Python or Matlab for a computer vision task such as object detection or image segmentation. Explain the concept of transfer learning and why it's advantageous to use these pre-trained models. - Fine-tuning a Pre-trained Model: Take a pre-trained CNN model and fine-tune it on a specific dataset (different from the original training dataset of the model). Discuss the process of fine-tuning and how it affects the model's ability to generalize to new data. - Application-Specific CNN Development: Develop a CNN for a specific application (e.g., facial recognition, scene recognition) and explain the design choices tailored to that particular application. Discuss how the chosen architecture and parameters cater to the specific needs of the task.
5		- Implementing Object Detection with YOLO/SSD: Utilize either YOLO (You Only Look Once) or SSD (Single Shot Multibox Detector) in Python or Matlab to detect objects in a series of images or a video stream. Explain how these algorithms differ from traditional object detection methods and discuss their performance in terms of speed and accuracy. - Object Tracking Algorithm Application: Implement an object tracking algorithm in Matlab or Python. Test it on a video sequence where objects move in various patterns. Discuss the challenges faced in tracking objects, especially in scenarios with occlusion, varying speeds, and sizes. - Semantic Segmentation with FCN: Apply a Fully Convolutional Network (FCN) for semantic segmentation on a dataset in Matlab or Python. Explain the concept of semantic segmentation and how FCN architecture enables this task. - Instance Segmentation using Mask R-CNN: Implement Mask R-CNN in Python or Matlab for instance segmentation tasks. Describe the difference between semantic segmentation and instance segmentation, and the advantages of Mask R-CNN in handling instance segmentation. - Exploring Augmented Reality Applications: Develop a basic augmented reality application using computer vision techniques in Python or Matlab. Discuss how computer vision algorithms contribute to augmented reality experiences. 3D Reconstruction Challenge: Create a simple 3D reconstruction from a set of images using computer vision techniques in Matlab or Python. Discuss the algorithms used and the challenges faced in reconstructing 3D models from 2D images. - Ethical Considerations in Computer Vision: Write an essay or prepare a presentation on the ethical considerations in computer vision. Discuss issues such as privacy, bias in AI, and the use of computer vision in surveillance.

24ECO823	APPLIED COMMUNICATION SYSTEMS	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: This course covers the fundamental concepts and key principles of analog communication used for the transmission of information from source to destination. The course also provides a solid foundation on the models used for the key components such as transmitters, channel and receivers. The course also explores the implementation/simulation of these modulation techniques so that students from other branches will get a greater insight into the subject.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO 1	Describe various Amplitude modulation and demodulation schemes (Understand Level)
CO 2	Explain various Angle modulation and demodulation schemes (Understand Level)
CO 3	Describe the effect of noise in analog modulation schemes (Apply Level)
CO 4	Explain the block diagram for AM and FM receivers (Understand Level)
CO 5	Implement/Simulate AM and FM modulation systems (Apply Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	✓	✓										
CO 2	✓	✓										
CO 3	✓	✓										
CO 4	✓	✓										
CO 5	✓				✓							

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply		✓	✓	✓
Analyse				
Evaluate				
Create				

*

Mark Distribution of CIA					
Course Structure [L-T-P-J]	**Attendance**	**Theory [L- T]**			**Total Marks**
		Assignment	**Test-1**	**Test-2**	
3-0-0-0	5	15	10	10	**40**

Total Mark Distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I : Amplitude Modulation (8 Hours)

Introduction to communication system, Need for modulation, Amplitude Modulation, Time domain and frequency domain description, single tone modulation, power relations in AM waves, Generation of AM waves, square law Modulator, Detection of AM Waves - Envelop detector, Double side band suppressed carrier modulators, Single Side band Modulation.

MODULE II: Frequency Modulation (8 Hours)

Frequency Modulation: Single tone frequency modulation, Spectrum Analysis of Sinusoidal FM Wave, Narrow band FM, Wide band FM, Constant Average Power, Transmission bandwidth of FM Wave, Generation of FM Waves - Varactor Diode modulator, Armstrong Method, Detection of FM Waves - Slope Detector, Comparison of FM and AM.

MODULE III: Radio Receivers (6 Hours)
Receiver Types - Tuned radio frequency receiver, Superheterodyne receiver, RF section and Characteristics - Frequency changing and tracking, Intermediate frequency, AGC, FM Receiver, Comparison with AM Receiver, Amplitude limiting.
MODULE IV: Noise in Analog Communication System (7 Hours)
Types of Noise: Resistive (Thermal) Noise Source, Shot noise, Extraterrestrial Noise, Arbitrary Noise Sources, White Noise, Narrowband Noise- In phase and quadrature phase components and its Properties, Modeling of Noise Sources, Average Noise Bandwidth, Effective Noise Temperature, Average Noise Figures, Average Noise Figure of cascaded networks. Noise in AM System.
MODULE V: Simulation of AM/FM Signals (7 Hours)
Study and design of AM and FM modulator/demodulator using Matlab/SDR Generate a carrier and a modulating signal using Matlab. Modulate the carrier using AM and FM. Show the modulated waveform in time domain and analyze its frequency spectrum using Matlab.

Text books
1. B.P. Lathi, Modern Analog and Digital communication Systems, Oxford
2. Kennedy (2005), Davis, Electronic Communication Systems, 4th Edition, Tata McGraw Hill, New Delhi.
3. Dennis Roddy and John Coolen, Electronic Communications Systems, 4th Edition, Pearson

Reference books
1. Simon Haykin (1994), Communication Systems, 2nd edition, Wiley Eastern, India.
2. Taub and schilling (2015), Principles of Communication Systems, Tata McGraw Hill, India.
3. NPTEL Course on Analog Communication
   https://archive.nptel.ac.in/courses/117/105/117105143/

COURSE CONTENTS AND LECTURE SCHEDULE		
No.		No. of Hours
MODULE 1		
1.1	Introduction to communication system, Need for modulation	1
1.2	Amplitude Modulation, Time domain and frequency domain description of AM	1
1.3	Single tone modulation, power relations in AM waves	1
1.4	Generation of AM waves, square law Modulator	1
1.5	Detection of AM Waves - Envelop detector	1
1.6	Double side band suppressed carrier modulators	1

1.7	Single Side Band Modulation (SSB)	1
1.8	Comparison of AM, DSBSC, SSB	1
MODULE II		
2.1	Frequency Modulation, Expression for FM carrier	1
2.2	Spectrum Analysis of Sinusoidal FM Wave	1
2.3	Narrow band FM, Wide band FM	1
2.4	Transmission bandwidth of FM Wave	1
2.5	Generation of FM Waves – Armstrong Method	1
2.6	Generation of FM from Phase Modulation	1
2.7	Comparison of FM and AM	1
2.8	Narrow band FM, Wide band FM	1
MODULE III		
3.1	Receiver Types - Tuned radio frequency receiver	1
3.2	Superheterodyne receiver	1
3.3	RF section and Characteristics	1
3.4	Intermediate frequency	1
3.5	Amplitude limiting, FM Superheterodyne Receiver	1
3.6	Comparison with AM Receiver	1
MODULE IV		
4.1	Types of Noise: Resistive (Thermal) Noise Source, Shot noise, Extraterrestrial Noise, White Noise	1
4.2	Narrowband Noise- In phase and quadrature phase components	1
4.3	Properties of narrow band noise	1
4.4	Modeling of Noise Sources	1
4.5	Average Noise Bandwidth, Noise Figures	1
4.6	Average Noise Figure of cascaded networks	1
4.7	Noise in AM System	1
MODULE V		
5.1	Overview of MATLAB software	1
5.2	Basic commands in MATLAB	1
5.3	Generation of sinusoidal signal in MATLAB	1
5.4	Using MATLAB generate a carrier and a modulating signal. Modulate the carrier using AM.	1
5.5	Show the modulated waveform in time domain and analyze its frequency spectrum.	1
5.6	Using MATLAB generate a carrier and a modulating signal. Modulate the carrier using FM.	1
5.7	Show the waveform in time domain and analyze its frequency spectrum.	1

CO Assessment Questions		
1		1. Derive an expression for Amplitude Modulated carrier and plot the spectrum 2. Explain the working of envelope detector 3. Explain the principle for the generation of DSBSC and SSB
2		1. Derive an expression for Frequency Modulated carrier and find the bandwidth of FM 2. Explain the generation of FM signal
3		1. Apply the concept of an AM superheterodyne receiver to troubleshoot a scenario where the receiver fails to demodulate a signal properly. What steps would you take to identify and fix the issue? 2. Given a specific set of frequencies and signal conditions, design a basic FM superheterodyne receiver layout. Explain how each component contributes to the successful demodulation of the FM signal.
4		1. Explain different noises encountered in analog communication systems 2. Briefly explain the noise in AM systems
5		1. Simulate AM in MATLAB 2. Simulate FM in MATLAB

24EC0833	ROBOTICS & AUTOMATION	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: The objective of this course is to introduce to the students the emerging field of robotics by imparting the fundamental knowledge on the design and control of robots, their multi-disciplinary engineering aspects and applications.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO 1	Describe the different types of robots and their applications. (Understand Level)
CO 2	Identify appropriate sensors and actuators for specific robotic applications. (Understand Level)
CO 3	Apply kinematic and dynamic principles to analyze robot movements. (Apply Level)
CO 4	Design and implement control strategies for a simple robot. (Apply Level)
CO 5	Explain the integration process of mechanical and electrical components in a robotic device. (Understand Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	✓	✓										
CO 2	✓	✓										
CO 3	✓	✓			✓							
CO 4	✓	✓			✓							
CO 5	✓	✓										✓

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	**Attendance**	**Theory [L- T]**			**Total Marks**
		Assignment	**Test-1**	**Test-2**	
3-0-0-0	**5**	**15**	**10**	**10**	**40**

Total Mark Distribution			

Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions.	60
	Marks: (2x10 =20 marks)	Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	
	Total Marks: 20	Total Marks: [5 x 8 = 40 marks]	

SYLLABUS

MODULE I : Introduction to Robotics (8 Hours)

Introduction to Robotics: Definition and Origin of Robotics. Robot Anatomy. Robot Specifications. Robot Characteristics – Accuracy, Precision, and Repeatability. Classification of Robots. Advantages and Disadvantages of Robots. Robot Structure - Types of Joints and End Effectors, Mechanisms and Manipulators. Common Kinematic Arrangements. Degree of Freedom. Robot Coordinates. Reference Frames. Robot Workspace. Areas of Application for Robots. Introduction to automation - Components and subsystems, basic building block of automation. Industrial robots and their applications Automated manufacturing systems

MODULE II: Introduction to Actuation Systems for Robots (6 Hours)

Introduction to Actuation Systems for Robots: Actuators: Types of Robotic Drive Systems and Actuators: Hydraulic, Pneumatic and Electric drives. Transmission: Gears, Timing Belts and Bearings. Parameters for selection of actuators.

Specification. Areas of Application for: Stepper Motor, Servo Motor and Brushless DC Motor. Microprocessor Control of Motors. Speed Control using PWM and Direction Control using H- Bridge.

MODULE III: Introduction to Sensor Systems for Robots (5 Hours)

Introduction to Sensor Systems for Robots: Sensors-Types and Applications of Sensors in Robotics: Position, Displacement and Velocity Sensors. Tactile Sensors for Contact and Proximity Assessment. Strain Gauge based Force and Torque Sensors. Tachometers, etc. Robotic Vision Systems- Introduction to Cameras, Imaging, Sensing and Digitization. Vision Applications in Robotics.

MODULE IV: Introduction to Robot Kinematics (8 Hours)

Introduction to Robot Kinematics: Position and Orientation of Objects. Rotation. Euler Angles. Rigid Motion Representation using Homogenous Transformation Matrix. Kinematic Modelling: Translation and Rotation Representation, Coordinate Transformation, Forward and Inverse Kinematics. Forward Kinematics-Link Coordinates, Denavit-Hartenberg Representation, Application of DH Convention to Different Serial Kinematic Arrangements. Inverse Kinematics – General Properties of Solutions, Kinematic Decoupling

MODULE V: Velocity Kinematics and Robot Programming (9 Hours)

Velocity Kinematics – Derivation of the Jacobian, Application of Velocity Kinematics for Serial Manipulators, Importance of Singularities. Introduction to Dynamic Modelling: Forward and Inverse Dynamics- Equations of Motion using Euler-Lagrange formulation, Newton Euler Formulation.

Introduction to Robot Programming – Programming Methods, Robot Language Classification, Robot Language Structure, Elements and its Functions. Motion, End-Effector and Sensor Commands in VAL Programming Language.

Simple Programs.

Text books

1. S.K. Saha, Introduction to Robotics, Tata McGraw Hill, 2nd Edition, 2014
2. Saeed B. Niku, Introduction to Robotics: Analysis, Systems, Applications, John Wiley & Sons, 2nd Edition, 2011.
3. Spong and Vidyasagar, Robot Dynamics and Control, John Wiley & Sons, 1990.
4. Mikell P. Groover, et al., Industrial Robotics – Technology, Programming and Applications, McGraw Hill, 2nd Edition, 2012.

Reference books

1. John. J.Craig, Introduction to Robotics: Mechanics and Control, PHI, 2005.
2. Ashitava Ghosal, Robotics, Fundamental concepts and analysis, OXFORD University Press, 2006
3. Fu, K.S, Gonzalez, R.C, Lee, C.S.G., Robotics, Control, Sensing, Vision and Intelligence, McGraw-Hill, 1987.
4. Asada, H., and J. J. Slotine. Robot Analysis and Control. New York, NY: Wiley,

1986.

5. Robert J. Schilling, Fundamentals of Robotics: Analysis & Control, Pearson Education, 2000

6. Klafter, R.D., Chmielewski, T.A, Negin, M, Robotic Engineering An Integrated Approach, PHI, 2007

7. S. R. Deb, Robotics Technology and Flexible Automation, Tata McGraw Hill, New Delhi, 1994.

8. NPTEL Course on Robotics by Prof. D K Pratihar, IIT Kharagpur, https://onlinecourses.nptel.ac.in/noc19_me74/preview

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours
MODULE 1		
1.1	Introduction to Robotics: Definition and Origin of Robotics, Robot Anatomy, Robot Specifications	1
1.2	Robot Characteristics – Accuracy, Precision, and Repeatability	1
1.3	Classification of Robots. Advantages and Disadvantages of Robots	1
1.4	Robot Structure - Types of Joints and End Effectors, Mechanisms and Manipulators. Common Kinematic Arrangements	1
1.5	Degree of Freedom. Robot Coordinates. Reference Frames	1
1.6	Robot Workspace. Areas of Application for Robots.	1
1.7	Introduction to automation - Components and subsystems, basic building block of automation	1
1.8	Industrial robots and their applications Automated manufacturing systems	1
MODULE II		
2.1	Introduction to Actuation Systems for Robots: Actuators: Types of Robotic Drive Systems and Actuators: Hydraulic	1
2.2	Robotic Drive Systems and Actuators: Pneumatic and Electric drives	1
2.3	Transmission: Gears, Timing Belts and Bearings. Parameters for selection of actuators. Specification	1
2.4	Areas of Application for: Stepper Motor	1
2.5	Areas of Application for: Servo Motor and Brushless DC Motor	1
2.6	Microprocessor Control of Motors. Speed Control using PWM and Direction Control using H- Bridge	1
MODULE III		
3.1	Sensors: Types and Applications of Sensors in Robotics: Position, Displacement and Velocity Sensors	1
3.2	Tactile Sensors for Contact and Proximity Assessment	1
3.3	Strain Gauge based Force and Torque Sensors. Tachometers	1
3.4	Robotic Vision Systems- Introduction to Cameras, Imaging	1
3.5	Sensing and Digitization, Vision Applications in Robotics	1

MODULE IV		
4.1	Introduction to Robot Kinematics: Position and Orientation of Objects. Rotation. Euler Angles	1
4.2	Rigid Motion Representation using Homogenous Transformation Matrix	1
4.3	Kinematic Modelling: Translation and Rotation Representation, Coordinate Transformation	1
4.4	Forward Kinematics-Link Coordinates	1
4.5	Denavit-Hartenberg Representation	1
4.6	Application of DH Convention to Different Serial Kinematic Arrangements	1
4.7	Inverse Kinematics – General Properties of Solutions	1
4.8	Kinematic Decoupling	1
MODULE V		
5.1	Velocity Kinematics – Derivation of the Jacobian	1
5.2	Application of Velocity Kinematics for Serial Manipulators	1
5.3	Importance of Singularities	1
5.4	Introduction to Dynamic Modelling: Forward and Inverse Dynamics- Equations of Motion using Euler-Lagrange formulation	1
5.5	Equations of motion using Newton Euler Formulation	1
5.6	Introduction to Position and force control of robotic manipulators Robot actuation and control using PID Controllers	1
5.7	Introduction to Position and force control of robotic Manipulators, Robot actuation and control using PID Controllers	1
5.8	Introduction to Robot Programming – Programming Methods, Robot Language Classification, Robot Language Structure, Elements and its Functions	1
5.9	Motion, End-Effecter and Sensor Commands in VAL Programming Language. Simple Programs	1

CO Assessment Questions	
1	Identify five different applications of non-industrial robots
2	Explain the functions of a robotic vision system? List two applications where vision systems can be employed in robots
3	An object in space executes the following sequence of motions: i. Rotation of 30^0 about the world z-axis ii. Translation of 3 unit along current y-axis iii. Rotation of 45^0 about world x-axis iv. Translation of 6 units along current x-axis. Establish the relationship between the world frame and the resultant object frame. Also determine the coordinates of a point in the world frame, if it is described by $[1\ 5\ 2]^T$ in the object frame

4	Describe the steps in frame assignment using D-H convention for a Cylindrical manipulator
5	Develop a working prototype of a simple manipulator configuration and demonstrate its workspace and the motion of End Effector in the workspace

24ECO843	CYBER SECURITY	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: This Cyber Security course offers a robust foundation in understanding and managing cyber threats and vulnerabilities, equipping students with the essential skills to protect digital assets in the ever-evolving digital landscape. The curriculum provides a comprehensive overview of topics such as core cyber security principles, cryptographic techniques, network and application security, as well as ethical hacking and cyber defense methodologies. Upon completion, students will gain a deep understanding of cyber security principles and practical skills, enabling them to effectively assess, mitigate, and respond to diverse cyber threats in various professional contexts.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO 1	Describe core cyber security concepts, evaluate global cyber threat landscapes, and outline advanced security architectures in various sectors. (Understand Level)
CO 2	Summarize the key principles of cyber laws. (Understand Level)
CO 3	Illustrate the functions and applications of Network Defense tools. (Understand Level)
CO 4	Clarify the uses and benefits of Web Application Tools. (Understand Level)
CO 5	Implement defensive techniques in response to specific cyber-attacks (Apply Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	✓											
CO 2	✓											
CO 3	✓											
CO 4	✓											
CO 5	✓											

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA			
		Theory [L- T]	

Course Structure [L-T-P-J]		Assignment	Test-1	Test-2	
3-0-0-0	5	15	10	10	**40**

Total Mark Distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I : Cyber Security from Basics to Advanced (7 Hours)

Overview of Cyber Security: Importance in various engineering fields, Current trends and future directions, Core Concepts of Cyber Security: Confidentiality, Integrity, and Availability (CIA), Overview of vulnerability scanning, Open Port / Service Identification, Banner / Version Check, Traffic Probe, Vulnerability Probe. Data loss prevention, Challenges and Solutions. Vulnerability examples, Openvas, Metasploit.

MODULE II: Network Vulnerability Scanning (7 Hours)

Networks Vulnerability Scanning - NETCAT, SOCAT, understanding port and services tools - DATAPIPE, FPIPE, WINRELAY, network reconnaissance – NMAP, THC-AMAP and system tools, network sniffers and injection tools – Tcpdump and Windump, Wireshark, Ettercap, Hping, Kismet.

MODULE III: Network Security and Defense (8 Hours)

Firewalls and Packet Filters: Firewall Basics, Packet Filter Vs Firewall, Understanding Firewall Protection: Exploring How Firewalls Safeguard Networks, Packet Characteristic to Filter, Stateless Vs Stateful Firewalls, Network Address Translation (NAT) and Port Forwarding, the basic of Virtual Private Networks, Linux Firewall, Windows Firewall, Snort: Introduction, Detection.

MODULE IV: Web Application Tools (6 Hours)
Scanning for web vulnerabilities tools: Nikto, W3af, HTTP utilities - Curl, OpenSSL and Stunnel, Application Inspection tools – Zed Attack Proxy, Sqlmap. DVWA, Webgoat, Password Cracking and Brute-Force Tools – John the Ripper, L0htcrack, Pwdump, HTC- Hydra.
MODULE V: Ethical Hacking and Cyber Defense (8 Hours)
Cyber Crimes, Types of Cybercrime, Hacking, Attack vectors, Cyberspace and Criminal Behavior, Clarification of Terms, Traditional Problems Associated with Computer Crime, Introduction to Incident Response, Digital Forensics, Computer Language, Network Language, Realms of the Cyber world, A Brief History of the Internet, Recognizing and Defining Computer Crime, Contemporary Crimes, Computers as Targets, Firewalls and Packet Filters, password Cracking, Keyloggers and Spyware, Virus and Warms, Trojan and backdoors, Steganography.

Text books
1. Stallings, W., & Brown, L. (Latest Edition). Computer Security: Principles and Practice. Pearson.
2. Stuttard, D., & Pinto, M. (2nd Ed.). (2011). The Web Application Hacker's Handbook: Finding and Exploiting Security Flaws. Wiley.

Reference books
1. Stallings, W. (Latest Edition). Cryptography and Network Security: Principles and Practice. Pearson.
2. Stuttard, D., & Pinto, M. (2nd ed.). (2011). The Web Application Hacker's Handbook: Finding and Exploiting Security Flaws. Wiley.
3. Stallings, W. (Latest Edition). Network Security Essentials: Applications and Standards. Pearson.
4. Baloch, R. (2014). Ethical Hacking and Penetration Testing Guide. CRC Press.
5. Anderson, R. (2nd ed.). (2008). Security Engineering: A Guide to Building Dependable Distributed Systems. Wiley.
6. NPTEL Course on Cyber Security and Privacy:
   https://onlinecourses.nptel.ac.in/noc23_cs127/preview

COURSE CONTENTS AND LECTURE SCHEDULE		
No.		No. of Hours
MODULE 1		
1.1	Introduction to Cyber Security, Overview of the importance of cyber security in various engineering fields, Current trends and future directions	1
1.2	Core Concepts of Cyber Security: Confidentiality, Integrity, and Availability (CIA)	1
1.3	Overview of vulnerability scanning, Open Port / Service Identification, Banner / Version Check	1
1.4	Traffic Probe, Vulnerability Probe	1

1.5	Data loss prevention, Challenges and Solutions	1
1.6	Vulnerability examples, Openvas	1
1.7	Metasploit-Architectural concepts of Metasploit	1
MODULE II		
2.1	Networks Vulnerability Scanning - NETCAT, SOCAT	1
2.2	Understanding port and services tools - DATAPIPE, FPIPE, and WINRELAY	1
2.3	Network reconnaissance – NMAP	1
2.4	THC-AMAP and system tools	1
2.5	Network sniffers and injection tools – Tcpdump and Windump	1
2.6	Wireshark	1
2.7	Ettercap, Hping, Kismet	1
MODULE III		
3.1	Firewalls and Packet Filters: Firewall Basics, Packet Filter Vs Firewall	1
3.2	Understanding Firewall Protection: Exploring How Firewalls Safeguard Networks	1
3.3	Packet Characteristic to Filter, Stateless Vs Stateful Firewalls	1
3.4	Network Address Translation (NAT) and Port Forwarding	1
3.5	The basic of Virtual Private Networks	1
3.6	Linux Firewall	1
3.7	Windows Firewall	1
3.8	Snort: Introduction Detection	1
MODULE IV		
4.1	Scanning for web vulnerabilities tools: Nikto, W3af	1
4.2	HTTP utilities - Curl, OpenSSL and Stunnel	1
4.3	Application Inspection tools – Zed Attack Proxy, Sqlmap	1
4.4	DVWA, Webgoat	1
4.5	Password Cracking and Brute-Force Tools – John the Ripper	1
4.6	L0htcrack, Pwdump, HTC- Hydra	1
MODULE V		
5.1	Cyber Crimes, Types of Cybercrime, Hacking, Attack vectors	1
5.2	Cyberspace and Criminal Behavior, Clarification of Terms	1
5.3	Traditional Problems Associated with Computer Crime, Introduction to Incident Response, Digital Forensics	1
5.4	Computer Language, Network Language, Realms of the Cyber world, A Brief History of the Internet	1
5.5	Recognizing and Defining Computer Crime, Contemporary Crimes, Computers as Targets	1
5.6	Firewalls and Packet Filters, password Cracking	1
5.7	Keyloggers and Spyware, Virus and Warms	1
5.8	Trojan and backdoors, Steganography	1

	CO Assessment Questions
1	1. Describe the importance of assessing cyber aspects in engineering perspective. 2. Explain the security measures to be incorporated to prevent data loss.
2	1. Explain the concept of Network Reconnaissance and describe any tool that supports it? 2. False Positives and False Negatives. What is Zero-day Vulnerability?
3	1. Explain the architecture of Firewall. What are the various characteristics of a secure Firewall? 2. Explain the concept of Virtual Private Network.
4	1. Evaluate the role of HTTP Utilities in network communication. Then, compare and contrast OpenSSL with Curl, highlighting their key features and use cases. 2. Assess the impact of Brute-Force Attacks on cybersecurity. Describe how the L0phtCrack tool assists in mitigating these attacks, including its strategies and effectiveness.
5	1. Given a hypothetical cyber-attack on an organization, outline an incident response plan detailing the steps you would take across the different phases of incident response. Justify the inclusion of each phase in your plan? 2. Analyze a recent cybercrime case study involving an individual. Classify the type of cybercrime, discuss the tactics used by the cybercriminals, and propose preventive measures that could have been implemented to thwart the attack?

24ECH809	PROJECT IN HONORS	L	T	P	J	S	C	Year of Introduction
		0	0	0	4	0	4	2024

Preamble: The Honors Project is a mandatory course requirement for the completion of the Honors degree during the 8th semester. This project work can take the form of implementing or working on a recent research paper or developing an innovative product. The Honors Project is a crucial component of the Honors degree program, requiring students to apply their acquired knowledge in a specialized area through an innovative project. These guidelines provide a detailed structure for students to successfully undertake and complete their Project in Honors, ensuring alignment with the specialized areas of their stream and the application of knowledge gained during their honors courses.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO 1	Identify technology/research gaps and propose innovative/creative solutions considering societal/sustainable aspects. (Analyze Level)
CO 2	Model and solve real world problems by applying knowledge across domains. (Apply Level)
CO 3	Develop products, processes or technologies for sustainable and socially relevant applications. (Apply Level).
CO 4	Plan and execute tasks utilizing available resources within timelines, following ethical and professional norms. (Apply Level)
CO 5	Perform as team player and organize and communicate technical and scientific findings effectively in written and oral forms. (Apply Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	✓	✓	✓			✓	✓					✓
CO 2	✓	✓	✓									✓
CO 3	✓	✓	✓	✓	✓							
CO 4								✓			✓	
CO 5								✓	✓	✓		

1. **Project Initiation:**

   a. Students can opt for individual or group projects, with a maximum of two students per group.
   b. Consult with the Project Coordinator of the honors courses to identify a project topic of interest.
   c. Finalize the project area by first week of the 8th semester in consultation with Project Coordinator of the honors courses.
   d. The project shall be carried out under the guidance of a faculty member assigned by the Head of the Department (HoD), final year project coordinator, and the Project Coordinator of the honors courses.
   e. Finalize the project topic before the mid of the second week after discussion with the project guide.

2. Student Responsibilities:

a. Choose a project that aligns with the specialized areas of the honors stream.
b. The project can involve implementing or working on a recent research paper, or developing an innovative product.
c. Emphasize innovation, creativity, and the practical application of theoretical knowledge.
d. Clearly define the scope and objectives of the project.
e. Adhere to all instructions and guidelines issued for the honors project.
f. Regularly update the mentor/supervisor on the progress of work.
g. Ensure the timely submission of all required documents through the designated portal.

3. Learning Outcomes:

Upon completion of this course, students are expected to demonstrate the following capabilities:
a. **Design and Development:** Proficiently design and develop sustainable solutions within the specialization domain, addressing and meeting societal needs.
b. **Ethical Awareness:** Exhibit a comprehensive understanding of ethical principles and showcase a strong commitment to professional ethics and responsibilities.
c. **Collaborative Skills:** Effectively collaborate both as an individual and as a team member in diverse multidisciplinary settings, leveraging collective strengths for optimal results.
d. **Communication Mastery:** Communicate proficiently on intricate environmental problems and concerns with the community and society at large. This includes the ability to comprehend, articulate, and translate effective solutions into comprehensive reports and documentation.

4. Project Evaluation:

a. The progress of the Project in Honors is evaluated through three reviews: two interim reviews and a final review.
b. Evaluations will be conducted by a three-member Continuous Internal Evaluation Committee, including the honors project guide, Project Coordinator of the honor courses, and a faculty member handling courses in the honors basket.
c. During the final review, students are obligated to submit a comprehensive report. Students are required to give presentations during the evaluation, followed by a question-answer session.

5. Time line:

First Interim Evaluation:
Timing: Within the third week of the commencement of 8th-semester classes.
Purpose: To assess the initial progress on literature review and design.

Second Interim Evaluation:
Timing: Three weeks after the first series test. Students are expected to complete 80% of their proposed work.
Purpose: This evaluation likely serves to assess the students' improvement and grasp of the material following the first assessment.
Final Evaluation:
Timing: Immediately after or before the 8th semester end semester examination.
Purpose: To provide a comprehensive assessment of the students' overall performance at the end of the semester, taking into account the entire semester's project work.

Total Marks Distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	100	--	--

Mark Distribution

First interim evaluation – (10%)
    a. Presentation: 5%
    b. Question & Answer session: 5%
Second interim evaluation – (20%)
    a. Presentation: 10%
    b. Question & Answer session: 10%
Draft report submitted at the time of second evaluation: 5%
Work assessed by the project guide – (25%)
After the
    a. First assessment   - 5%
    b. Second assessment - 10%
    c. Third assessment   -10%
Final evaluation – (25%)
    a. Presentation: 15%
    b. Question & Answer session: 10%
Final Report: (15%)