SYLLABUS

(With effect from 2022-23)

Bachelor Degree
In

Electronics & Communication Engineering

V & VI Semester

Out Come Based Education
With
Choice Based Credit System

[National Education Policy Scheme]

P.E.S. College of Engineering, Mandya - 571 401, Karnataka
[An Autonomous Institution affiliated to VTU, Belagavi,
Grant – in – Aid Institution (Government of Karnataka),
Accredited by NBA (All UG Programs), NAAC and Approved by AICTE, New Delhi]

Ph: 08232- 220043, Fax : 08232 – 222075, Web: www.pesce.ac.in

VISION

"PESCE shall be a leading institution imparting quality Engineering and Management education developing creative and socially responsible professionals."

MISSION

- *Provide state of the art infrastructure, motivate the faculty to be proficient in their field of specialization and adopt best teaching-learning practices.*
- *Impart engineering and managerial skills through competent and committed faculty using outcome based educational curriculum.*
- *Inculcate professional ethics, leadership qualities and entrepreneurial skills to meet the societal needs.*
- *Promote research, product development and industry-institution interaction.*

QUALITY POLICY

Highly committed in providing quality, concurrent technical education and continuously striving to meet expectations of stake holders.

CORE VALUES

***P**rofessionalism*
***E**mpathy*
***S**ynergy*
***C**ommitment*
***E**thics*

Department of Electronics and Communication Engineering

The department of Electronics and Communication Engineering was incepted in 1967 with an undergraduate program in Electronics and Communication Engineering. Initially, the program had an intake of 60 students, which increased to 120 in 2012, and further increased to 180 in 2019. Almost 200 students graduate every year, and the long journey of 50 years has seen satisfactory contributions to society, the nation, and the world. The alumni of this department have a strong global presence, making their alma mater proud in every sector they represent.

The department started its PG program in 2012 in the specializations of VLSI design and embedded systems. Equipped with well qualified and dedicated faculty, the department has a focus on VLSI design, embedded systems, and image processing. The quality of teaching and training has yielded a high growth rate of placement at various organizations. The large number of candidates pursuing research programs (M.Sc. and Ph.D.) is a true testimonial to the research potential of the department. The department is recognized as a research centre by VTU, and Mysore University offers a part-time and full-time Ph.D. Program.

Vision

The department of E & C would endeavour to create a pool of Engineers who would be extremely competent technically, ethically strong also fulfil their obligation in terms of social responsibility.

Mission

- M1: Adopt the best pedagogical methods and provide the best facility, infrastructure and an ambience conducive to imbibe technical knowledge and practicingethics.
- M2: Group and individual exercises to inculcate habit of analytical and strategic thinking to help the Students to develop creative thinking and instil team skills.
- M3: MoUs and Sponsored projects with industry and R & D organizations for collaborative learning.
- M4: Enabling and encouraging students for continuing education and moulding them for life-long learning process.

Program Educational Objectives (PEOs)

- **PEO1:** Graduates to exhibit knowledge in mathematics, engineering fundamentals applied to Electronics and Communication Engineering for professional achievement in industry, research and academia.
- **PEO2:** Graduates to identify analyse and apply engineering concepts for design of Electronics and Communication Engineering systems and demonstrate multidisciplinary expertise to handle societal needs and meet contemporary requirements.
- **PEO3:** Graduates to perform with leadership qualities, team spirit, management skills, attitude and ethics need for successful career, sustained learning and entrepreneurship.

Program Outcomes (POs)

- **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineeringsciences.
- **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
- **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
- **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of thelimitations.
- **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
- **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
- **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
- **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multi disciplinary settings.
- **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clearinstructions.
- **Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multi disciplinary environments.
- **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes (PSOs)

Electronics and Communication Engineering Graduates will be able to

- **PSO1:** An ability to understand the basic concepts in Electronics and Communication Engineering and to apply them in the design and implementation of Electronics and Communication Systems.
- **PSO2:** An ability to solve complex problems in Electronics and Communication Engineering, using latest hardware and software tools, along with analytical skills to arrive at appropriate solutions.

Bachelor of Engineering (V –Semester)											
Sl. No.	**Course Code**	**Course Title**	**Teaching Department**	**Hrs / Week**				**Credits**	**Examination Marks**		
				L	**T**	**P**	**PJ**		**CIE**	**SEE**	**Total**
1	P22EC501	Innovation Entrepreneurship and Management	EC	3	-	-	-	3	50	50	100
2	P22EC502	Digital CMOS VLSI Design	EC	3	-	-	-	3	50	50	100
3	P22EC503X	Professional Elective Course - I	EC	3	-	-	-	3	50	50	100
4	P22EC504	Digital Signal Processing (Integrated)	EC	3	-	2	-	4	50	50	100
5	P22EC505	Control Systems	EC	3	-	-	-	3	50	50	100
6	P22ECL506	Circuit Simulation Laboratory	EC	-	-	2	-	1	50	50	100
7	P22ECINT507	Internship - II	EC	-	-	-	-	2	-	100	100
8	P22HSMC508	Employability Enhancement Skills – V	HSMC	1	-	-	-	1	50	50	100
9	P22UHV509	Social Connect and Responsibility	EC	1	-	-	-	1	50	50	100
10	P22NSS510	National Service Scheme(NSS)	NSS coordinator	-	-	2	-	0	100	-	100
	P22PED510	Physical Education (PE) (Sports and Athletics)	PED								
	P22YOG510	Yoga	YOGA								
Total								**21**	500	500	1000

Professional Elective Course – I (P22EC503X)	
Course Code	**Course Title**
P22EC5031	Fundamentals of object oriented Language and Data structures
P22EC5032	System Verilog
P22EC5033	Computer Organization
P22EC5034	ARM Processor

Bachelor of Engineering (VI –Semester)											
Sl. No.	**Course Code**	**Course Title**	**Teaching Department**	**Hrs / Week**				**Credits**	**Examination Marks**		
				L	**T**	**P**	**PJ**		**CIE**	**SEE**	**Total**
1	P22EC601	Analog CMOS VLSI Design	EC	3	-	-	-	3	50	50	100
2	P22EC602X	Professional Elective Course – II	EC	3	-	-	-	3	50	50	100
3	P22EC603X	Professional Elective Course - III	EC	3	-	-	-	3	50	50	100
4	P22EC604	Microwave and Antenna (Integrated)	EC	3	-	2	-	4	50	50	100
5	P22ECO605X	Open Elective – II	EC	3	-	-	-	3	50	50	100
6	P22ECL606	VLSI Laboratory	EC	-	-	2	-	1	50	50	100
7	P22ECMP607	Mini – Project	EC	-	-	2	2	2	50	50	100
8	P22HSMC608	Employability Enhancement Skills - VI	HSMC	1	-	-	-	1	50	50	100
9	P22UHV609	Universal Human Values and Professional Ethics	EC	1	-	-	-	1	50	50	100
10	P22NSS610	National Service Scheme(NSS)	NSS coordinator	-	-	2	-	0	100	-	100
	P22PED610	Physical Education (PE) (Sports and Athletics)	PED								
	P22YOG610	Yoga	YOGA								
Total								**21**	550	450	1000

Professional Elective Course – II (P22EC602X)	
Course Code	**Course Title**
P22EC6021	ITC and Multimedia
P22EC6022	DSP Processor and Applications
P22EC6023	Embedded Systems
P22EC6024	Operating System

Professional Elective Course – III (P22EC603X)	
Course Code	**Course Title**
P22EC6031	Radar and Navigational Systems
P22EC6032	Digital Image Processing
P22EC6033	Design for Testability
P22EC6034	Artificial Intelligence and Machine Learning in VLSI

Open Elective – II (P22ECO605X)	
Course Code	**Course Title**
P22ECO6051	Electronic Instrumentation
P22ECO6052	Introduction to Embedded Systems
P22ECO6053	Introduction to Image Processing
P22ECO6054	Automotive Electronics

L: Lecture	T: Tutorial	CIE: Continuous Internal Evaluation
P: Practical/ Drawing	PJ: Project	SEE: Semester End Examination

Innovation, Entrepreneurship and Management [As per Choice Based Credit System (CBCS) & OBE Scheme] **SEMESTER – V**			
Course Code:	**P22EC501**	**Credits:**	**03**
Teaching Hours/Week (L:T:P):	**3 : 0 : 0**	**CIE Marks:**	**50**
Total Number of Teaching Hours:	**40**	**SEE Marks:**	**50**

Course Learning Objectives: This course will enable the students to:

- Relate the role and importance of innovation in economic growth, skills of innovator, types of innovation and output forms of innovation.
- Understand various ways to create and manage intellectual property and prepare innovation proposal.
- Understand the entrepreneurial development process and recognize the core role of creativity and innovation in managing the entrepreneurial process effectively.
- Understand the fundamental concepts and principles of management, including the basic roles, skill, and functions of management.
- Understand the procedure of creating an ownership and its types.
- Express the meaning of Professional Ethics, its importance and needs.

UNIT - I	**8 Hours**

Introduction to Innovation and Innovator: Introduction, understanding Innovation, Creativity and Research, Role of Innovation in economic growth of country, companies and community, phases of innovation journey, Roles of Innovator.

Text 1: Chapter 1 to 5

Self-Study Component:	**1.** Prepare a Case study of An Innovator: How did he/she find the problem, thought about a solution and steps/situations came across during implementation.

UNIT – II	**8 Hours**

Innovator Skills and Innovation: Introduction to Innovative Skills, Types of Innovation, Introduction to patents and IP, preparing an innovation proposal Pitching an innovation proposal, Sustaining innovation.

Text 1: Chapter 6 to 13

Self-Study Component:	**1.** Explore the innovative projects from IDC School of Design http://www.idc.iitb.ac.in/project/faculty-projects

UNIT - III	**8 Hours**

Entrepreneurship and Entrepreneurs: Evolution of the concept of Entrepreneur, Characteristics of an Entrepreneur, Distinction between an Entrepreneur & a Manager, Functions of an Entrepreneur, Types of Entrepreneur. Concept of Entrepreneurship, Growth of Entrepreneurship in India, Role of Entrepreneurship in Economic Development.

Text 2: 1.1 to 1.10, 2.1 to 2.3

Self-Study Component:	**1.** Prepare a Case Study of an Entrepreneur / an Enterpriser or an Enterprise.

UNIT - IV	**8 Hours**

Management and Business Ownership: Fundamentals of Management: Meaning of Management, Management as Science, Art & Profession, Importance of Management, Scope of Management, Functions of Management, Management Process, Principles of Management. Forms of Business Ownership: Sole Proprietorship, Partnership, Company, Cooperative, Selection of Appropriate Form of Ownership Structure.

Text 2: 24.1 to 24.9 & 18.1 to 18.5

Self-Study Component:	**1.** Being in different positions as an employee: Understanding Self, Self-Management& Understanding others for Effective Relationships and Communication.

UNIT - V	**8 Hours**

Engineering and Professional Ethics: Making a Case: Introduction, Role Morality, What is a Profession?, Professional Ethics, The NSPE Board of Ethical Review, Engineering Ethics as Preventive Ethics

Honesty: Introduction, Ways of Misusing Truth, Why is Dishonesty Wrong?

International Engineering Professionalism: Introduction, Problems in International Professionalism, Problems in Interpreting and Applying the Codes, Striking a Balance, Guidelines for Interpreting the Codes: Human Rights, Avoiding Paternalism and Exploitation and Applying the Golden Rule, Bribery-Extortion-Grease Payments and Gifts.

Text 3: 1.1 to 1.6, 6.1 to 6.3 & 10.1 to 10.8

Self-Study Component:	**1.** Survey and Study the importance of Professional Ethics

Course Outcomes: On completion of this course, students are able to:

COs	Course Outcomes with ***Action verbs*** for the Course topics	Bloom's Taxonomy Level	Program Outcome Addressed (PO #) with BTL
CO1	**Identify** the innovation phases and skills required for innovation	L3	PO1,PO12(L3)
CO2	**Understand** the importance of various types of patents and its uses.	L3	PO1(L3)
CO3	**Analyze** entrepreneurship with necessary theories	L4	PO2,PO5,PO9(L4)
CO4	**Examine** the role of management in an organization and the importance of various types of business ownership.	L4	PO2(L4)
CO5	**Interpret** the role of professional ethics including international engineering professionalism	L4	PO8,PO10,PO12(L4)

Text Book(s):

1. A Conversation with the Innovator in You, Sudeendra Koushik and Pragya Dixit, Kindle Direct Publishing, ISBN-13: 978-152051271.
2. Entrepreneurial Development, by Dr S S Khanka, S Chand & Company Ltd. ISBN-13: 978-8121918015.
   Engineering Ethics (2nd edition), Charles E. Harris, Michel S. Pritchard and Michel J. Rabins, Thomson Wadsworth Asia Pte Ltd, ISBN: 981-243-676-6.

Reference Book(s):

1. Six thinking hats by Edward De bono, Penguin Books (2000). ISBN 10: 0140296662 ISBN 13: 9780140296662.
2. Entrepreneurship by Robert D Hisrich, Micheal P Peters, Dean A Shepherd, 6/e, TataMcGraw – Hill Companies. ISBN-10: 0078029198.
3. Principles and practice of management – L. M. Prasad. ISBN-13: 9789351610502.

Web and Video link(s):

1. Principles of Management By Prof. UshaLenka, IIT Roorkee
   https://onlinecourses.nptel.ac.in/noc23_mg33/preview

2. Design, Technology and Innovation By Prof. B.K. Chakravarthy, IIT Bombay https://onlinecourses.nptel.ac.in/noc24_de14/preview

E-Books/Resources:

1. Principles of Management by Koontz and O'Donell http://library.lol/main/74F83959D63DB9CC5365AF843C564914

Course Articulation Matrix (CAM)

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2
# 1	2											2	3	
# 2	2												2	
# 3		2			3				3					2
# 4		2												2
# 5								3		3		3		

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Digital CMOS VLSI Design [As per Choice Based Credit System (CBCS) & OBE Scheme] **SEMESTER – V**			
Course Code:	**P22EC502**	**Credits:**	**03**
Teaching Hours/Week (L:T:P):	**3 : 0 : 0**	**CIE Marks:**	**50**
Total Number of Teaching Hours:	**40**	**SEE Marks:**	**50**

Course Learning Objectives: This course will enable the students to:

- Discuss the VLSI Design Flow, MOS Structure, and the MOS System under External Bias, Structure and Operation of MOS Transistor, MOSFET Current–Voltage Characteristics.
- Analyze the MOS Inverters, Static Characteristics, Switching Characteristics and Interconnect Effects.
- Examine the static and dynamic characteristics of Combinational MOS logic circuits and Pass Transistor Circuits.
- Explain the SR Latch Circuits, Voltage Bootstrapping, Synchronous Dynamic Circuit Techniques, Dynamic CMOS Circuit Techniques, High–Performance Dynamic CMOS Circuits.
- Examine the MOS Technology and MOS circuit design processes.

UNIT - I	**8 Hours**

Introduction: Historical Perspective, VLSI Design Flow,
MOS Transistor: The Metal Oxide Semiconductor(MOS) Structure, The MOS System under External Bias, Structure and Operation of MOS Transistor (MOSFET), MOSFET Current –Voltage Characteristics.
Text 1: 1.1, 1.5, 3.1 to 3.4.

Self-Study Component:	**1.** Understand the concept of Design hierarchy in VLSI and VLSI Design Styles.

UNIT – II	**8 Hours**

MOS Transistor: MOSFET Scaling and Small geometry effects, MOSFET Capacitance
MOS Inverters, Static Characteristics: Introduction, CMOS Inverter: Calculation of V_{IL}, V_{IH}, and V_{th}, Design of CMOS Inverter, Supply Voltage Scaling in CMOS Inverter.
Text 1: 3.5, 3.6, 5.1, 5.4,

Self-Study Component:	**1.** Understand the working of Super buffer Design and Switching Power Dissipation of CMOS Inverter

UNIT - III	**8 Hours**

Switching Characteristics and Interconnect Effects: Introduction, Delay-Time Definitions, Calculation of Interconnect Delay.
Combinational MOS Logic Circuits: Introduction, CMOS Logic Circuits, Complex Logic Circuits, Basic Principles of Pass Transistor Circuits, CMOS Transmission Gates (Pass Gates).
Text 1: 6.1, 6.2, 6.6, 7.1, 7.3, 7.4, 7.5, 9.2

Self-Study Component:	**1.** Modeling of MOS Transistor using SPICE: Know about MODEL statement in SPICE. Plot O/P characteristics of N-MOS and P-MOS transistors and C-MOS inverter using, LEVEL-1 and LEVEL-2 model in SPICE and Scilab/Math lab.

UNIT - IV			8 Hours
Sequential MOS Logic Circuits: Introduction, SR Latch Circuit **Dynamic Logic Circuits:** Introduction, Voltage Bootstrapping, Synchronous Dynamic Circuit Techniques, Dynamic CMOS Circuit Techniques, High–Performance Dynamic CMOS Circuits (Including only Domino CMOS logic). **Text 1: 8.1, 8.3, 9.1, 9.3 to 9.6**			
Self-Study Component:	**1.** Understand the concept of Clocked Latch and Flip-Flop Circuits **2.** Explore the CMOS D-Latch and Edge Triggered Flip-Flop.		
UNIT - V			**8 Hours**
Introduction to MOS Technology: nMOS Fabrication, CMOS Fabrication, Thermal Aspects of Processing, Latch-up in CMOS Circuits. **MOS Circuits Design Processes:** MOS Layers, Design rules and Layout, General Observations on the Design rules. **Text 2: 1.7, 1.8, 1.9, 2.13, 3.1, 3.3, 3.4.**			
Self-Study Component:	**1.** Understand the Concept of BiCMOS Technology and BiMOS Circuits Design Processes		

Course Outcomes: On completion of this course, students are able to:

COs	Course Outcomes with ***Action verbs*** for the Course topics	Bloom's Taxonomy Level	Program Outcome Addressed (PO #) with BTL
CO1	**Apply** the basic knowledge of Physics and mathematics to understand the MOS Fabrication Process, MOS structure, MOS energy band, MOS Capacitance, MOSFET I-V characteristics, scaling and its effects.	Apply	PO1(L3)
CO2	**Interpret and/or Illustrate** the mechanism of operation of CMOS gates, latches and their delay with different delay models.	Apply	PO1 (L3)
CO3	**Analyze** MOS and CMOS circuits for noise margin, delay, power dissipation and threshold voltage.	Analyze	PO2 (L4)
CO4	**Design** the Combinational, Sequential and Dynamic MOS circuits for the given specifications and Simulate the circuits using modern tools.	Create	PO2, PO3,PO5, PO9,PO10(L6)

Text Book(s):

1. CMOS Digital Integrated Circuits Analysis and Design, Sung Mo Kang, Yusuf Leblebici, 3rd edition, McGraw Hill Education 2003, ISBN-13: 978-0-07-053077-5, ISBN-10:0-07-053077-7.
2. Basic VLSI Design, Douglas A. Pucknell, Kamran Eshraghian, 3rd edition 2006, PHI, ISBN: 978-81-203-0986-9.**Text Book(s):**

Reference Book(s):

1. Introduction to VLSI Circuits and Systems, John .P. Uyemura, John Wiley, 3rd edition 2002. ISBN: 978-81-265-0915-7
2. Principles of CMOS VLSI Design, Neil. H. E. Weste, Kamran Eshraghian, 3rd edition, Pearson Education 2005, ISBN:978-81-317-6467-1.

Web and Video link(s):

1. https://archive.nptel.ac.in/courses/108/107/108107129/
2. https://www.youtube.com/watch?v=Iv4Cj2A3ldw&list=PLuv3GM6-gsE3npYPJJDnEF3pdiHZT6Kj3&index=3

E-Books/Resources:

1. http://brharnetc.edu.in/br/wp-content/uploads/2018/11/31.pdf

Course Articulation Matrix (CAM)

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2
# 1	2												2	
# 2	3												3	
# 3		2												2
# 4		2	2		2				1	1				2

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Fundamentals of Object Oriented Language and Data Structures [As per Choice Based Credit System (CBCS) & OBE Scheme] **SEMESTER – V**			
Course Code:	**P22EC5031**	**Credits:**	**03**
Teaching Hours/Week (L:T:P):	**3 : 0 : 0**	**CIE Marks:**	**50**
Total Number of Teaching Hours:	**40**	**SEE Marks:**	**50**

Course Learning Objectives: This course will enable the students to:

- Understand the significance of object oriented concepts.
- Apply the concept of class, objects and methods in Java.
- Illustrate usage of packages, string handling and exception handling in Java.
- Understand the fundamentals of Data Structures.
- Analyze problem and develop program using stacks and queues and applications like parenthesis matching and railroad car rearrangement.
- Develop programs using binary trees, their traversals, and implement priority queues using heaps.

UNIT - I	**8 Hours**

Fundamentals of Object Oriented Programming: Introduction, Object oriented paradigm, Basics concepts of object oriented programming, Benefits of object oriented programming, Applications of object oriented programming.

Java: Features, Simple Java Program, Java Program Structure, Data types, Operators overview.

Decision Making and Branching: if, if else, else if ladder, nesting of if else statements, switch.

Decision Making and Looping: do, while, for, Jumps in loop

Text 1:1. 1.1-1.5, 2.2, 3.2, 3.5, 4.4, 4.5, 5.1-5.9, 6.2-6.7, 7.2-7.5.

Self-Study Component:	**1.** Illustrate the application of variables Labelled Loops..

UNIT – II	**8 Hours**

Classes, Objects and Methods: Introduction, Defining a class, Fields declaration, Methods declaration, Creating objects, Accessing class members, Constructors, Method Overloading, Static members, Nesting of Methods, Inheritance, Overriding methods.

Arrays: Creating array, 1D array and 2D array.

Text 1: 8.1-8.12, 9.2-9.3.

Self-Study Component:	1. Use the concept of Inheritance to develop a java program using: subclasses.

UNIT - III	**8 Hours**

Strings: String Arrays, String Methods.

Interfaces: Introduction, Defining interfaces, Extending interfaces, implementing interfaces

Packages: Introduction, Java API packages, Using System packages, Naming conventions, creating packages, accessing a package, using a package, adding a class to a package.

Text 1: 9.5, 10.1-10.4, 11.1-11.8.

Self-Study Component:	**1.** Develop a java program which access interface variables and String buffer class.

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UNIT - IV	8 Hours
Stacks: Definition and Applications, The Abstract Data Type, Array Representation- Linked Representation, Applications- Parenthesis Matching, Towers of Hanoi, Rearranging railroad cars. **Queues**: Definition and Applications, The Abstract Data Type, Array Representation- Linked Representation, Applications- Railroad Car Rearrangement. **Text 2: 9.1,9.2,9.3,9.5,9.5.1,9.5.2,9.5.3,10.1,10.2,10.3,10.4,10.5,10.5.1.**	
Self-Study Component:	1. Understand the concept of Singly Linked Lists & Write a Java program for sorting using linked lists. 2. Explore the use of Data Structures in the application - Rat in a Maze.
UNIT - V	**8 Hours**
The Greedy Method: Optimization Problems, The Greedy Method, Applications - Container Loading, 0/1 Knapsack Problem, Topological Sorting, Bipartite Cover, Single-Source Shortest Paths, Minimum-Cost Spanning Trees. **Divide and Conquer:** The Method, Applications - Defective Chessboard, Merge Sort, Quicksort, Selection, Closest Pair of Points, Solving Recurrence Equations, Lower Bounds on Complexity - Lower Bound for the Minmax Problem, Lower Bound for Sorting. **Text 2: 18.1,18.2,18.3,18.3.1-18.3.6,19.1,19.2,19.2.1-19.2.5,19.3,19.4,19.4.1,19.4.2.**	
Self-Study Component:	1. Write a Java code to sort a given random number using the Divide & Conquer algorithm in Java. 2. Study the concept of Dynamic programming algorithms and highlights their advantages.

Course Outcomes: On completion of this course, students are able to:

COs	Course Outcomes with ***Action verbs*** for the Course topics	Bloom's Taxonomy Level	Program Outcome Addressed (PO #) with BTL
CO1	**Apply** knowledge of programming in Java to understand the basic concept of object-oriented programming.	L3	PO1(L2)
CO2	**Analyse** the complex engineering problem and propose suitable programming solutions using features of object-oriented programming, arrays and strings.	L4	PO2(L4)
CO3	**Develop** a solution to engineering problems using suitable Data structure and algorithms.	L6	PO3(L6), PO4(L6)
CO4	Demonstrate the knowledge of problem solving either in team or individually to solve engineering problems using Java and its compiler	L5	PO5(L5), PO9(L3), PO10(L3)

Text Book(s):

1. Programming with JAVA: A Primer, E Balagurusamy, 6th edition Tata McGraw Hill. ISBN 13: 978-93-5316-233-7, ISBN 10:-93-5316-233-5.
2. Data Structures, Algorithms and Applications in JAVA – SartajSahni, 2nd edition, Universities Press (India) Private Limited, 2005, ISBN 81-7371-523-8.

Reference Book(s):

1. The Complete Reference JAVA, J2SE, Herbert Schildt, 6th edition, Tata McGraw Hill, 2010. ISBN-0070598789.
2. Data Structures and Algorithms in Python, Michael T. Goodrich, Roberto Tamassia, Michael H. Goldwasser, Wiley, 2013, ISBN- 11-1829-027-5

Web and Video link(s):

1. Java Programming - https://nptel.ac.in/courses/106/105/106105191/.
2. https://www.youtube.com/watch?v=8hly31xKli0.

E-Books/Resources:

1. https://books.google.co.in/books?id=a9q5AwAAQBAJ&printsec=frontcover#v=onepage&q&f=false.
2. https://books.google.co.in/books?id=aew7q_cMJRIC&pg=PR13&source=gbs_selected_pages&cad=1#v=onepage&q&f=false.

Course Articulation Matrix (CAM)

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2
# 1	3												3	
# 2		2												2
# 3			2	1										
# 4					3				1	1				

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System Verilog [As per Choice Based Credit System (CBCS) & OBE Scheme] SEMESTER – V			
Course Code:	**P22EC5032**	**Credits:**	**03**
Teaching Hours/Week (L:T:P):	**3 : 0 : 0**	**CIE Marks:**	**50**
Total Number of Teaching Hours:	**40**	**SEE Marks:**	**50**

Course Learning Objectives: This course will enable the students to:

- Develop an understanding of the System Verilog language constructs.
- Introduce the facilities and features of System Verilog for unified Design.
- Illustrate the testing and verification in System Verilog Design.
- Introduce the programming approach for testing and verification.
- Provide framework of System Verilog for functional coverage.

UNIT - I	**8 Hours**

Verification Guidelines: The Verification Process, Basic Test Bench Functionality, Directed testing, Methodology Basics, Constrained Random Stimulus, Functional Coverage, Testbench Components, Layered Test bench.

Data Types: Built-in Data Types, Fixed-Size Arrays, Dynamic Arrays, Queues, Associative Arrays, Linked Lists, Array Methods, Choosing a Storage Type, Creating New Types with typedef, Creating User-Defined Structures, Enumerated Types, Constants, Strings, Expression Width.

Procedural Statements and Routines: Procedural Statements, Tasks, Functions, and Void Functions, Task and Function Overview, Routine Arguments, Returning from a Routine, Local Data Storage, Time Values.

Text 1: 1.1,1.3-1.10,2.1-2.16, 3.1-3.7.

Self-Study Component:	**1.** Analyze different Synthesizable Constructs in System Verilog. (Refer: Synthesizing System Verilog Busting the Myth that System Verilog is only for Verification by Stuart Sutherland and Don Mills)

UNIT – II	**8 Hours**

Basic OOPs: Your First Class, Where to Define a Class, Creating New Objects, Object De allocation, Using Objects, Class methods, Defining methods outside of the class. Static Variables vs. Global Variables, Scoping Rules, Using One Class inside Another, Understanding Dynamic Objects, Copying Objects, Public vs. Private Straying off Course, Building a Test bench.

Text 1: 5.3-5.18.

Self-Study Component:	**1.** Understand different System Verilog Macro's and their usage for developing System Verilog instances.

UNIT - III	**8 Hours**

Randomization and Constraints: Introduction, What to Randomize, Randomization in System Verilog, Constraint Details, Solution Probabilities, Controlling Multiple Constraint Blocks, Valid Constraints, In-line Constraints. The pre_randomize and post_randomize Functions, Random Number Functions, Constraints Tips and Techniques, Common Randomization Problems. Iterative and Array Constraints, Atomic Stimulus Generation vs. Scenario Generation, Random Control, Random Number Generators, Random Device Configuration.

Text 1: 6.1-6.17.

Self-Study Component:	**1.** Using Randomization Methods Write a test bench in system verilog.

UNIT - IV	8 Hours

Threads and Inter Process Communication: Working with Threads, Disabling Threads, Inter process Communication, Events, Semaphores, Mailboxes, Building a Test bench with Threads and IPC.
Text 1: 7.1-7.7.

Self-Study Component:	**1.** Develop system verilog code using Built in class process and related methods to control the process in Inter Process Communication.

UNIT - V	8 Hours

Functional Coverage: Gathering Coverage Data, Coverage Types, Functional Coverage Strategies, Simple functional Coverage examples, Anatomy of a cover group, triggering a cover group. Data Sampling, Cross coverage, Generic cover groups, Coverage Options, Analyzing Coverage Data, and Measuring Coverage Statistics during simulation, System Verilog Assertions.
Text 1: 9.1-9.12, 4.8.

Self-Study Component:	**1.** Summarize the concepts of functional coverage constructs and functional coverage flow.

Course Outcomes: On completion of this course, students are able to:

COs	Course Outcomes with *Action verbs* for the Course topics	Bloom's Taxonomy Level	Program Outcome Addressed (PO #) with BTL
CO1	**Apply** the knowledge of Verilog and Digital Design to **Understand** the System Verilog language constructs.	L1	**PO1, PO2, PO3 (L1)**
CO2	**Understand** the System Verilog OOPs facilities and framework for the verification.	L1	**PO2, PO3 (L1)**
CO3	**Develop** programs by applying the System Verilog facilities and framework.	L3	**PO1, PO3, PO4 (L3)**
CO4	Explore and **Understand Modern Software tools** to perform different operations in System Verilog.	L3	**PO1, PO2, PO5 (L3)**
CO5	**Interpret** and **analyze** the given code for logical & design anomalies.	L4	**PO10, PO12 (L4)**

Text Book(s):

1. System Verilog for Verification: A Guide to Learning the Test bench Language Features, Chris Spear, Springer-Verlag New York, Inc, 3rd edition, ISBN 978-1-4614-0714-0, 2012.

Reference Book(s):

1. Hardware Verification with System Verilog (An Object Oriented Framework), Mike Mintz and Robert Ekehndal, Springer, USA, ISBN 0-387-71738-2, 2007.
2. System Verilog For Design A Guide to Using System Verilog for Hardware Design and Modeling", Stuart Sutherland, Simon Davidmann and Peter Falke, Springer, USA, ISBN 9781475766820, 1475766823, 2013.

Web and Video link(s):

1. https://youtu.be/U18k9TDP5uw?si=gS3EMTBTFvoqj3LE
2. https://youtu.be/aNzTS1otRrs?si=XwJNweNiYcvxcTZ8

E-Books/Resources:

1. https://www.kobo.com/in/en/ebook/systemverilog-for-verification
2. https://www.chipverify.com/systemverilog/systemverilog-tutorial

Course Articulation Matrix (CAM)													
CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2
# 1	1	2	1										1	2
# 2		3	1											3
# 3	1		2	1									1	
# 4	2	2			2								2	2
# 5										2		2		
*****														

Computer Organization [As per Choice Based Credit System (CBCS) & OBE Scheme] **SEMESTER – VI**			
Course Code:	**P22EC5033**	**Credits:**	**03**
Teaching Hours/Week (L:T:P):	**3 : 0 : 0**	**CIE Marks:**	**50**
Total Number of Teaching Hours:	**40**	**SEE Marks:**	**50**

Course Learning Objectives: This course will enable the students to:

- Conceptualize the basics of Organizational issues of a digital computer and compare the performance of machine instruction.
- Expose different ways of communication with I/O Devices.
- Notice how to perform computer arithmetic operation.
- Understand working of processing unit using different bus structures.
- Illustrate different Types of memory devices with their principles.

UNIT - I	**8 Hours**

Basic Structure of Computers: Basic operational Concepts, Performance.
Instruction Set Architecture: Memory Location and Addresses, Memory Operations, Instruction and Instruction Sequencing, Addressing Modes, Assembly Language.
Text 1: Ch 1:1.3 to 1.6 Ch 2:2.1-2.5

Self-Study Component:	**1.** Prepare a report on historical perspectives of electonic digital computers.

UNIT – II	**8 Hours**

Instruction Set Architecture: (Continued): Subroutines, Additional instructions.
Basic Input/Output: Accessing I/O Devices-I/O Device Interface, Program Controlled I/O, Interrupts-Enabling and Disabling Interrupts, Handling Multiple Devices, Exceptions.
Input/Output Organization: Bus Structure, Bus Operation-Synchronous Bus, Asynchronous Bus, Arbitration.
Text 1: Ch 2:2.7, 2.8.Ch 3:3.1.1,3.1.2,3.2.1,3.2.2,3.2.6.Ch 7:7.1,7.2.1,7.2.2,7.3

Self-Study Component:	**1.** Understand the interconnection standards such as USB, SATA

UNIT - III	**8 Hours**

Software: The Assembly Process, Loading and Executing Object Programs, The Linker, Libraries, The Compiler, The Debugger, Using a High-level Language for I/O Tasks, Interaction between Assembly Language and C Language, The Operating System
Text 1: 4.1 - 4.9

Self-Study Component:	**1.** Basics of Pipelining

UNIT - IV	**8 Hours**

Basic Processing Unit: Some Fundamental Concepts, Instruction Execution, Hardware Components, Instruction Fetch and Execution Steps, Control Signals, Hardwired Control
Text 1: Ch 5:5.1 to 5.6.

Self-Study Component:	**1.** Compare and contrast performance evaluation of non-pipelined processor and pipelined processor.

UNIT - V	**8 Hours**

The Memory System: Basic Concepts, Semiconductor RAM Memories, Read-only Memories, Direct Memory Access, Memory Hierarchy, Cache Memories, Virtual Memory, Memory Management Requirements.
Text 1: Ch 9: 8.1-8.6, 8.8

Self-Study Component:	**1.** Memory Management Requirements..

Course Outcomes: On completion of this course, students are able to:

COs	Course Outcomes with *Action verbs* for the Course topics	Bloom's Taxonomy Level	Program Outcome Addressed (PO #) with BTL
CO1	**Interpret** the operation and organization of a digital computer system using knowledge of digital logic circuits.	L2	PO1 (L2)
CO2	**Apply** instruction set architecture (ISA) concepts to develop assembly language programs.	L3	PO2 (L3)
CO3	**Analyze** the given assembly language code to find out the outputs.	L4	PO3 (L4)
CO4	**Design** and simulate functional units of a computer using any suitable tool.	L6	PO5 (L6)

Text Book(s):

1. Computer Organization and Embedded Systems, 6th Edition, Carl Hamacher, Zvonko Vranesic, Safwat Zaky, Tata McGraw Hill. ISBN-13: 978-9355323729

Reference Book(s):

1. Computer Organization &Architecture, William Stallings, 9th Edition, PHI, 2013.
2. Computer Systems Design and Architecture, Vincent P. Heuring & Harry F. Jordan, 2nd Edition, PearsonEducation, 2004.

Web and Video link(s):

1. Introduction to Computer System and its Submodules
   https://nptel.ac.in/courses/106103068
2. Computer Architecture and Organization, IIT Kharagpur
   by Prof. Indranil Sengupta and Prof. Kamalika Datta
   https://archive.nptel.ac.in/courses/106/105/106105163/

E-Books/Resources:

1. Computer Organization and Embedded Systems
   By Carl Hamacher, Zvonko Vranesic, Safwat Zaky
   http://library.lol/main/BBC56E03C87F1A67E4BBD7B510FF714F

Course Articulation Matrix (CAM)

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2
# 1	2													
# 2		3												
# 3			3											
# 4					2									

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ARM Processor [As per Choice Based Credit System (CBCS) & OBE Scheme] **SEMESTER – V**			
Course Code:	**P22EC5034**	**Credits:**	**03**
Teaching Hours/Week (L:T:P):	**3 : 0 : 0**	**CIE Marks:**	**50**
Total Number of Teaching Hours:	**40**	**SEE Marks:**	**50**

Course Learning Objectives: This course will enable the students to:

- Understand basic components of embedded systems and its characteristic attributes.
- Demonstrate the communication interface required to develop an embedded system.
- Understand Memory system, exceptions and interrupt control.
- Provide the knowledge of fault interrupt behavior, Cortex-M3 and Exceptions Programming.
- Develop a code for the embedded system using Embedded C.
- Choose proper IDE for the design and follow the recent trends in the embedded system design.

UNIT - I	**8 Hours**

Introduction to Embedded Systems: What is an Embedded System, Embedded Systems Overview, History of Embedded Systems, Classification of Embedded Systems, Major Application Area of Embedded Systems, Purpose of Embedded Systems

Introduction to ARM: What Is the ARM Cortex-M3 Processor, Background of ARM and ARM Architecture, Instruction Set Development, The Thumb-2 Technology and Instruction Set Architecture (ISA), Cortex-M3 Processor Applications

Programming in Embedded C: Embedded C, Compiler vs. Cross Compiler, Using C in Embedded C, Storage classes, Arrays and Pointers, Function Pointers, Structures and Unions, Pre-Processors and Macros, Constant Declarations, Volatile

Text 1: 1.1 - 1.6.

Text 2: 1.1 – 1.5, 9.3.1, 9.3.2, 9.3.3 9.3.3.3, 9.3.3.9, 9.3.3.12 - 9.3.3.16

Self-Study Component:	1. Study the C programming for advanced Cortex processors. 2. Discuss the various advantages of using Cortex-M3.

UNIT – II	**8 Hours**

Overview of the Cortex-M3:

Fundamentals, Registers, Operation Modes, The Pipeline, A Detailed Block Diagram, Bus Interfaces on the Cortex-M3, Other Interfaces on the Cortex-M3, The External Private Peripheral Bus, Typical Connections, Reset types and Reset Signals

Memory Systems: Memory System Features Overview, Memory Maps, Memory Access Attributes, Default Memory Access Permissions, Bit-Band Operations, Unaligned Transfers, Exclusive Accesses, Endian Mode.

Text 2: 5.1-5.8, 6.1 - 6.7

Self-Study Component:	1. Identify the advantages and disadvantages of big Endian and little-Endian processor. 2. Identify the different reset signals in Cortex-M3.

UNIT - III	**8 Hours**

Exceptions: Exception Types, Definitions of Priority, Vector Tables, Interrupt Inputs and Pending Behavior, Fault Exceptions,

The NVIC and Interrupt Control: NVIC Overview, the Basic Interrupt Configuration, Example Procedures in Setting up an Interrupt, Software Interrupts

Interrupt Behavior: Interrupt/Exception Sequences, Exception Exits, Nested Interrupts, Tail-Chaining Interrupts, Late Arrivals, More on the Exception Return Value, Interrupt Latency, Faults Related to Interrupts.

Text 2: 7.1 - 7.5, 8.1 - 8.4, 9.1 - 9.8	
Self-Study Component:	1. Discuss the applications of Systick timer. 2. Understand the concept of supervisor calls and pendable service call

UNIT - IV	**8 Hours**

Cortex-M3 Programming: A Typical Development Flow, CMSIS, Linker Script , makefiles.
Embedded networks: communication interface. Onboard communication interface –I2C, SPI, UART. External communication interface- CAN and RS-485, USB, Bluetooth (BT). Need for Device drivers.
Text 1: **10.1 - 10.2, 10.4**
Text 2 : **2.4, 2.4.1.1 to 2.4.1.3 , 2.4.2 , 2.4.2.1 ,2.4.2.2 , 2.4.2.4, 2.4.2.5, 10.9**

Self-Study Component:	1. Understand communication protocols implementation. 2. Design and develop any one communication protocol as per current industry need using Cortex-M3 and embedded C.

UNIT - V	**8 Hours**

Real-Time Operating System (RTOS) based Embedded System Design: Operating System Basics, Types of OS, Tasks, Process and Threads, Multiprocessing and Multitasking, Task Scheduling, Task Synchronization, how to Choose an RTOS. Debugging
Text 1:10.1 to 10.5, 10.8, 10.10.

Self-Study Component:	**1.** Analyze Threads, Processes and Scheduling : Putting them all together with programming **2.** Understand different methods of task communication.

Course Outcomes: On completion of this course, students are able to:

COs	**Course Outcomes** with ***Action verbs*** for the Course topics	**Bloom's Taxonomy Level**	**Program Outcome Addressed (PO #) with BTL**
CO1	**Apply** the knowledge of basic Controller to understand the architecture, instruction set, addressing modes, other features of ARM cortex-M3 processor and C programming to understand the concept of embedded C.	Implement	PO1(L2)
CO2	**Classify** the different peripheral components associated with ARM cortex-M3 processor	Examine	PO2(L3)
CO3	**Illustrate** the ARM processor based applications, interrupts and exceptions	Analyze	PO2(L2), PO3(L2)
CO4	**Develop** the embedded system applications for the given specification using the Basic knowledge of cortex M-3 and using 'C' Programming.	Create	PO3(L4)
CO5	**Design** solutions for real-world engineering problems using modern tools ARM applications using Modern tools.	Integrate	PO5(L5)

Text Book(s):
1. Introduction to Embedded Systems,Shibu K V, Tata McGraw Hill, 2nd Edition, ISBN 13: 978-0-07-014589-4.
2. The Definitive Guide to the ARM Cortex-M3 by Joseph Yiu, 2nd edition, Newnes, (Elsevier), ISBN:978-0-7506-8534-4,2007.

Reference Book(s):
1. Embedded Systems – A contemporary Design Tool, James K Peckol, John Wiley, 2008.

ISBN: 978-1-119-45750-3.
2.Embedded Systems Design, An Introduction to Processes, Tools, and Techniques by Arnold S. Berger ISBN:1578200733 CMP Books

Web and Video link(s):

1. https://youtu.be/TP1_F3IVjBc
2. https://nptel.ac.in/courses/108105057

E-Books/Resources:

1. https://sushmatoravi.wordpress.com/wp-content/uploads/2017/08/233633895 intro-to-embedded-systems-by-shibu-kv.pdf

Course Articulation Matrix (CAM)

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2
# 1	3												3	
# 2		3												3
# 3		2	2											2
# 4			2											
# 5					2				1					

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Digital Signal Processing (Integrated) [As per Choice Based Credit System (CBCS) & OBE Scheme] SEMESTER – V			
Course Code:	**P22EC504**	**Credits:**	**04**
Teaching Hours/Week (L:T:P):	**3 : 0 : 2**	**CIE Marks:**	**50**
Total Number of Teaching Hours:	**40**	**SEE Marks:**	**50**

Course Learning Objectives: This course will enable the students to:

- Provide the knowledge of DFT/ IDFT and its various properties.
- Explain the different Fast–Fourier–Transform (FFT) algorithms along with its applications.
- Understand the design procedure of IIR filters and FIR filters using different techniques.
- Design the IIR filters from analog filters using different methods.
- Implementation scheme of IIR and FIR filters using different methods.
- Exposure to different applications of DSP.

UNIT - I	**8 Hours**

Discrete Fourier Transforms (DFT): Frequency Domain Sampling and Reconstruction of discrete-time Signals, Discrete Fourier Transforms, DFT as a linear transformation, its relationship with other transforms. Properties of DFT– Periodicity, linearity and Symmetry Properties, Multiplication of two DFTs–the circular convolution, use of DFT in linear filtering, overlap–save and overlap–add method.

Text 1:7.1.1 ,7.1.2, 7.1.3, 7.1.4, 7.2.1 7.2.2, 7.2.3, 7.3.1

Self-Study Component:	**1.** Explore the Additional properties of DFT (circular-time shift, Circular- frequency shift, Time reversal, circular convolution, Parseval's relation). **2.** Discuss the application of DFT.
Practical Topics:	**1.** Develop MATLAB code for Computation of the N point DFT and IDFT of a given sequence and to plot magnitude and phase spectrum. **2.** Develop MATLAB code Circular convolution of the two given sequences without using function and using DFT and IDFT. **3.** Develop MATLAB code for Linear convolution using DFT and IDFT without using inbuilt function and simulate.

UNIT – II	**8 Hours**

Fast–Fourier–Transform (FFT) Algorithms: Efficient computation of the DFT (FFT algorithms), Direct computation of DFT, Goertzel algorithm, and chirp–z transform. Radix–2 FFT algorithm for the computation of DFT and IDFT–decimation in–time and decimation–in –frequency algorithms.

Text 1: 8.1, 8.1.1, 8.1.2, 8.1.3, 8.1.5, 8.1.6, 8.2

Self-Study Component:	**1.** Using different tools develop simulations for applications of FFT algorithm.
Practical Topics:	**1.** Develop MATLAB code for computing the frequency spectrum of a given sequence using FFT and IFFT. **2.** Develop MATLAB code for Autocorrelation and Cross correlation of the given sequence and verification of its properties. **3.** Develop MATLAB code for voice and Music. Plot the spectrum.

UNIT - III	8 Hours
FIR Filter Design: Characteristics of Practical Frequency Selective filters, FIR filter design: Introduction to FIR filters, design of FIR filters using – Rectangular and Hamming windows, FIR filter design using frequency sampling technique **Text 1: 10.1.2, 10.2.1, 10.2.2, 10.2.3, 10.4**	
Self-Study Component:	**1.** Explore the concept of Hanning window, Blackmann window
Practical Topics:	**1.** Design and Develop MATLAB code for FIR Filters to meet the given specifications using Simulink. **2.** Experiments Using Digital Signal Processor (TMS320c54xx) and Code Composer Studio (CCS). a. Circular convolution of the two given sequences.
UNIT - IV	**8 Hours**
Design of IIR Filters From Analog Filters (Butterworth and Chebyshev): Characteristics of commonly used analog filters – Butterworth and Chebyshev filters, analog to analog frequency transformations. Impulse invariance method. Mapping of transfer functions: Approximation of derivative (Bilinear transformation) method. **Text 1:** 10.3.1, 10.3.2, 10.3.3 ,10.3.4,10.4.1	
Self-Study Component:	**1.** Understand the concept Matched z transforms. **2.** Understand and design the transform the analog filter H(S) = $\frac{S+3}{(S+1)(S+2)}$ to a digital filter using Matched Z-Transform (T=0.5sec).
Practical Topics:	**1.** Design and develop MATLAB code for IIR Filters to meet the given specifications using Simulink. **2.** Experiment Using Digital Signal Processor (TMS320C54xx) and Code Composer Studio (CCS): Computation of the N Point DFT of a given sequence.
UNIT - V	**8 Hours**
Implementation of Discrete–Time Systems: Structures for IIR and FIR systems– direct form I and direct form II systems, cascade and parallel realization, Applications of DSP **Text 1:** 9.1, 9.2, 9.3 **Text 2:** 12.1 to 12.8	
Self-Study Component:	**1.** Understand the concept Speech processing with different application.
Practical Topics:	**1.** Analyze the impulse response and step response of a system using MATLAB/SIMULINK **2.** Analyze the operation of Basic Communication model using Simulink. Noise: Add noise above 3 kHz and then remove; Interference suppression using 400 Hz tone.

Course Outcomes: On completion of this course, students are able to:

COs	**Course Outcomes** with ***Action verbs*** for the Course topics	**Bloom's Taxonomy Level**	**Program Outcome Addressed (PO #) with BTL**
CO1	Apply the knowledge of signals and system to the solve the DFT, FFT and Filters.	L2	PO1(L2)
CO2	Differentiate the DFT, FFT, IDFT, IFFT and filtering techniques.	L3	PO2(L3)
CO3	Evaluate the discrete–time systems using various DSP approaches	L4	PO2(L2), PO3(L4)
CO4	Design the FIR & IIR filters for given	L5	PO2(L2), PO3(L5)

	specification.		
CO5	Conduct experiments to verify DSP concepts and applications of DSP using Hardware DSP board	L3	PO4(L4), PO5(L4), PO9(L2),PO109(L2)

Text Book(s):

1. Digital Signal Processing–Principles Algorithms and Applications, Proakis & Monalakis, PHI / Pearson Education, 4th Edition, New Delhi, 2007. ISBN: 978-81-317-1000-5.
2. Digital Signal Processing – A. Nagoor Kani, McGraw Hill education, 2nd edition, 2012. ISBN-13: 978-0-07-008665-4, ISBN-10: 0-07-008665-6.

Reference Book(s):

1. Discrete Time Signal Processing, Oppenheim and Schaffer, PHI, 2003, ISBN -10:9332535035, ISBN-13:9789332535039.
2. Digital Signal Processing, S. K. Mitra, Tata Mc–Graw Hill, 3rd Edition, 2007. ISBN: 9780070667563, ISBN-007066756X.
3. Digital Signal Processing, Lee Tan, Elsevier publications, 2007. ISBN-9780124159822, ISBN-9780124158931.
4. Digital Signal Processing using MATLAB, Sanjit K Mitra, TMH, 2001.
5. Digital Signal Processing using MATLAB, J.G. Proakis & Ingle, MGH, 2000

Web and Video link(s):

1. http://acl.digimat.in/nptel/courses/video/117102060/L01.html

E-Books/Resources:

1. http://libgen.rs/book/index.php?md5=8FA146CE83BC35BE9171560760124653
2. http://libgen.rs/book/index.php?md5=D4D60EB785E913243C06C021246C2EE4

Course Articulation Matrix (CAM)

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2
# 1	2												2	
# 2	3												3	
# 3		2	2											
# 4			3											
# 5				1	2				1	1				

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Control Systems [As per Choice Based Credit System (CBCS) & OBE Scheme] **SEMESTER – V**			
Course Code:	**P22EC505**	**Credits:**	**03**
Teaching Hours/Week (L:T:P):	**3 : 0 : 0**	**CIE Marks:**	**50**
Total Number of Teaching Hours:	**40**	**SEE Marks:**	**50**

Course Learning Objectives: This course will enable the students to:

- Obtain the mathematical model for electrical and mechanical systems.
- Determine the time domain and frequency domain response of systems.
- Deduce the transfer function from the block diagrams and signal flow graph.
- Evaluate the system stability by using the time domain and frequency domain Responses.
- Analyze electrical systems using state space models

UNIT - I	**8 Hours**

Fundamental Concepts of Control Systems: Basic definitions of control systems, Classification, Open loop and closed loop systems,

Modeling of Systems: Differential equations of physical systems, Determinations of transfer function models for Electrical, Mechanical and Analogous systems.

Block Diagrams and Signal Flow Graphs: Transfer functions, Block diagram algebra, Signal Flow graphs (State variable formulation excluded).

Text 1: 1.1, 2.1, 2.2, 2.4, 2.5, 2.6, 2.7.

Self-Study Component:	**1.** Study the Application of Control Theory in non-engineering fields. **2.** Study the Dynamic of Robotic mechanism.

UNIT – II	**8 Hours**

Time Domain (Transient and Steady State Response) Analysis of Feedback Control Systems: Standard test signals, Unit step response of First and second order systems.

Time Response Specifications: Transient response specifications of second order systems, steady state errors and static error constants.

Text 1: 5.1, 5.2, 5.3, 5.4, 5.5

Self-Study Component:	**1.** Design the second-order systems for the given specifications. **2.** Write the MATLAB program to find the time response of second order systems.

UNIT - III	**8 Hours**

Stability Analysis: Concepts of stability, asymptotic stability, necessary conditions for stability, Routh-Hurwitz stability criterion, Routh's tabulation, special cases when Routh's tabulation terminates prematurely.

Root Locus Techniques: The root locus concepts, summary of general rules for constructing Root Loci, Stability analysis.

Text 1: 6.1, 6.2, 6.4, 6.5, 6.6, 7.1, 7.2, 7.3

Self-Study Component:	**1.** Write the MATLAB program to draw the Root Locus diagrams of open loop transfer function of different systems. **(Refer Text 2)**

UNIT - IV	**8 Hours**

Frequency-Response Analysis: Stability in the frequency domain: Introduction to frequency domain analysis, Experimental determination of transfer functions in Bode plots. Assessment of relative stability using bode Plots.

Polar Plot: Introduction to Polar plot and Nyquist plots, Nyquist stability criterion, Stability analysis using Polar plot, Numerical problems.

Text 1: 8.1, 8.4, 8.5, 8.6, 9.1, 9.2, 9.3, 9.4.

Self-Study Component:	**1.** Write the MATLAB program to draw the Bode diagrams of open loop transfer function of different systems. **(Refer Text 2)** **2.** Study the Frequency response specifications- resonant peak, resonant frequency and bandwidth

UNIT - V	**8 Hours**

Introduction to State variable analysis: Concepts of state, state variable and state models for electrical systems, Controllability and Observability, Derivation of transfer functions from the state model, Solution of state equations.
Text 1: 12.1, 12.2, 12.3, 12.6, 12.7

Self-Study Component:	**1.** Obtain the time response for different state models.

Course Outcomes: On completion of this course, students are able to:

COs	Course Outcomes with *Action verbs* for the Course topics	Bloom's Taxonomy Level	Program Outcome Addressed (PO #) with BTL
CO1	**Apply** mathematical knowledge to determine the Transfer function of a system.	L2	PO1 (L2)
CO2	**Analyze** the stability of the system using time domain, frequency domain and state variable techniques.	L3	PO2 (L3)
CO3	**Develop** the mathematical models using different techniques of state variables.	L4	PO3(L4)
CO4	**Simulate** the given linear control system using MATLAB/SIMULINK.	L5	PO5, PO9,PO10 (L5)

Text Book(s):

1. Control Systems Engineering, I. J. Nagarath and M. Gopal, New Age International (P) Limited, 4th edition – 2018, ISBN: 9789386070111; ISBN: 9386070111.
2. Modern Control Engineering, K. Ogata, Pearson Education Asia/ PHI, 4th edition, 2002. ISBN 0-13-043245-8.

Reference Book(s):

1. Automatic Control Systems, Benjamin C. Kuo, John Wiley India Pvt. Ltd., 8th edition, 2008, ISBN 978-81-203-4010-7
2. Feedback Control System Analysis and Synthesis, J. J. D'Azzo and C. H. Houpis McGraw Hill, International student Edition, ISBN 13: 9780070161757

Web and Video link(s):

1. NPTEL course on "Introduction to System and Control"
   by Prof Ramakrishna Pasumarthy, IIT Madras
   https://nptel.ac.in/courses/108/106/108106098/

E-Books/Resources:

1. https://www.google.co.in/books/edition/Control_Systems_As_Per_Latest_Jntu_Sylla/VMBWs_8hyBgC?hl=en&gbpv=1&dq=control+systems+by+ij+nagrath&printsec=frontcover

Course Articulation Matrix (CAM)													
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**
# 1	**3**												**3**	
# 2		**3**												**3**
# 3			**3**											
# 4					**1**				**1**	**1**				
*****														

Circuit Simulation Laboratory
[As per Choice Based Credit System (CBCS) & OBE Scheme]
SEMESTER – V

Course Code:	**P22ECL506**	**Credits:**	**1**
Teaching Hours/Week (L:T:P):	**0-0-2**	**CIE Marks:**	**50**
Total Number of Teaching Hours:	**Lecture :2 Hr, Exam: 2Hr**	**SEE Marks:**	**50**

Course Learning Objectives: This course will enable the students to:

- Learning computer aided design and simulation tools.
- Design and verification of circuits at system level.
- Capturing system requirements and optimize design.

Course Content

The design flow must consists of the following

PART –A

Draw the schematic and perform

Transient analysis using **PSpice simulator** for given specification

1. Clipper and Clamper Circuit
2. CMOS Inverter
3. Current Controlled Voltage Source
4. Voltage Controlled Current Source
5. Summing Amplifier

PART –B

For the following set of experiments the design flow must consists of

- **Draw the schematic**
- **Draw the PCB layout and verify with DRC**
- **Generate the Gerber file for given specifications**

1. Inverting amplifier
2. Half wave Rectifier
3. Monostable multivibrator
4. Power supply design with regulators
5. Astable multivibrator

Open ended experiments:

1. Temperature monitoring based on environmental condition.
2. Implement home automation with the help of relays.

Course Outcomes: On completion of this course, students are able to:

COs	**Course Outcomes** with ***Action verbs*** for the Course topics	**Bloom's Taxonomy Level**	**Program Outcome Addressed (PO #) with BTL**	
CO1	**Apply** the knowledge of engineering to simulate simple circuits, using Pspice OrCAD tools to analyze circuit performance.	L3	PO1	PO5
CO2	**Analyze** circuit behavior and performance under various conditions, using Pspice OrCAD tools to validate theoretical concepts and optimize designs.	L4	PO2	
CO3	Design PCB for the basic analog and digital circuit using OrCAD tool after optimized simulation results.	L5	PO3	
CO4	Ability to demonstrating the given open ended experiment design and simulation results.	L6	PO4, PO9, PO10	

Course Articulation Matrix (CAM)														
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**
# 1	**3**												**3**	
# 2		**2**												**2**
# 3			**2**											
# 4				**1**	**3**				**1**	**1**				
*****														

Internship

[As per Choice Based Credit System (CBCS) & OBE Scheme]

SEMESTER – V

Course Code:	**P22ECINT507**	**Credits:**	**02**
Teaching Hours/Week (L:T:P):	**0 : 0 : 0**	**CIE Marks:**	**50**
Total Number of Teaching Hours:	**-**	**SEE Marks:**	**50**

Course Learning Objectives: This course will enable the students to:

- To understand business model, socio-economic structure, professional etiquettes and corporate culture.
- To apply theoretical engineering knowledge in solving practical problems in the area of electronics and communication engineering.
- To document, prepare reports and present
- To analyze, design and develop electronic and communication systems for the given requirements and specifications which has practical, socio-economic implications and business outcomes.
- To use modern tools in technical project and people management
- To learn integrity, importance of professional ethics, attitude, individual contribution and team skills
- To develop life-long learning skills
- To learn end-to-end project management

Course Outcomes: On completion of this course, students are able to:

COs	**Course Outcomes** with ***Action verbs*** for the Course topics	**Bloom's Taxonomy Level**	**Program Outcome Addressed (PO #) with BTL**
CO1	Demonstrate the ability to apply Engineering Knowledge practices solve complex problems in a real-world context.	Apply	PO2,PO4(L3)
CO2	Develop and implement effective solutions to technical challenges encountered during the internship, showcasing problem-solving skills.	Design and Develop	PO3,PO5 (L4)
CO3	Communicate technical information clearly and effectively through well-structured reports and presentations.	Create & Present	PO10 (L4)
CO4	Demonstrate knowledge and understanding of engineering and management principles, applying them in a team to manage projects in multidisciplinary environments.	Analyze	PO6,PO7,PO8,PO9, PO11 (L5)

Course Articulation Matrix (CAM)

CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**
# 1		**3**		**2**									**3**	
# 2			**2**		**3**								**2**	**2**
# 3										**3**				
#4						**2**	**2**	**2**	**3**	**3**	**2**			

Social Connect and Responsibility
[As per Choice Based Credit System (CBCS) & OBE Scheme]
SEMESTER – V

Course Code:	**P22UHV509**	**Credits:**	**01**
Teaching Hours/Week (L:T:P):	**1:0:0**	**CIE Marks:**	**100**
Total Number of Teaching Hours:	**25+5**	**SEE Marks:**	**--**

Course Outcomes: This course will enable the students to:

- **Identify** the needs of the community and involve them in problem solving.
- **Demonstrate** the knowledge about the culture and societal realities.
- **Develop** sense of responsibilities and bond with the local community.
- **Make use** of the Knowledge gained towards significant contributions to the local community and the society at large
- **Develop** among themselves a sense of social & civic responsibility & utilize their knowledge in finding practical solutions for individual and community problems.

PART-I	

Plantation and adoption of a tree: Plantation of a tree that will be adopted for four years by a group of BE / B.Tech students. (ONE STUDENT ONE TREE) They will also make an excpert either as a documentary or a photo blog describing the plant's origin, its usage in daily life, its appearance in folklore and literature – Objectives, Visit, case study, report, outcomes.

PART-II	

Heritage walk and crafts corner: Heritage tour, knowing the history and culture of the city, connecting to people around through their history, knowing the city and its craftsman, photo blog and documentary on evolution and practice of various craft forms - – Objectives, Visit, case study, report, outcomes.

PART-III	

Organic farming and waste management: Usefulness of organic farming, wet waste management in neighboring villages, and implementation in the campus.

PART-IV	

Water conservation: Knowing the present practices in the surrounding villages and implementation in the campus, documentary or photoblog presenting the current practices – Objectives, Visit, case study, report, outcomes.

PART-V	

Food walk: City's culinary practices, food lore, and indigenous materials of the region used in cooking – Objectives, Visit, case study, report, outcomes.

Course Outcomes: On completion of this course, students are able to:

COs	**Course Outcomes** with ***Action verbs*** for the Course topics	**Bloom's Taxonomy Level**	**Program Outcome Addressed (PO #) with BTL**
CO1	**Identify** the needs of the community and involve them in problem **solving.**	**Knowledge / Apply**	**L1 & L3**

CO2	**Demonstrate** the knowledge about the culture and societal realities.	**Understand**	**L2**
CO3	**Develop** sense of responsibilities and bond with the local community	**Apply**	**L4**
CO4	**Make use** of the Knowledge gained towards significant contributions to the local community and the society at large.	**Apply**	**L4**
CO5	**Develop** among them selves a sense of social & civic responsibility & utilize their knowledge in finding practical solutions for individual and community problems.	**Create**	**L6**

Course Articulation Matrix

Mapping of Course Outcomes (CO) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)

Sl. No.	Course Outcome	Programme Outcomes												Programme Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	**Identify** the needs of the community and involve them in problem **solving.**	-	-	-	-	-	2	2	3	3	3	-	3	-	-	-
2	**Demonstrate** the knowledge about the culture and societal realities.	-	-	-	-	-	2	2	3	3	3	-	3	-	-	-
3	**Develop** sense of responsibilities and bond with the local community.	-	-	-	-	-	2	2	3	3	3	-	3	-	-	-
4	**Make use** of the Knowledge gained towards significant contributions to the local community and the society at large.	-	-	-	-	-	2	2	3	3	3	-	3	-	-	-
5	**Develop** among themselves a sense of social & civic responsibility & utilize their knowledge in finding practical solutions to individual and community problems.	-	-	-	-	-	2	2	3	3	3	-	3	-	-	-

Guideline for Assessment Process:

Continuous Internal Evaluation (CIE) :

After completion of the social connect and responsibility course, the student shall prepare, with daily diary/ report as reference and a comprehensive report in consultation with the faculty/mentor to indicate what he has observed and learned in the social connect period.

The report shall be evaluated on the basis of the following below criteria's or other relevant criteria pertaining to the activity completed.

- Planning and scheduling the social connect.
- Information/Data collected during the social connect.
- Analysis of the information/data and report writing.
- Presentation and interaction.

CIE Rubrics for Evaluation.

Report	Video presentation	Interaction	Total
10	05	05	20

Note:

- Video presentation of **4 to 5 min** in a team to be presented and the same to be uploaded in the department YouTube channel.
- The number of students in each team can be from **4 to 5** members.
- Each activities has to be evaluated on above basis that is [20 * 5 = 100 marks] for final total marks.

Duration : A total of 25 – 30 hours engagement per semester is required for the 5^{th} semester of the B.E./B.Tech. program. The students will be divided into groups and each group will be handled by faculty mentor.

Pedagogy – Guidelines:

Special Note: NO SEE – Semester End Exam – Completely Practical and activities based evaluation

It may differ depending on local resources available for the study as well as environment and climatic differences, location and time of execution.

Sl No	Topic	**Group size**	Location	**Activity execution**	**Reporting**	**Evaluation Of the Topic**
1.	**Plantation and adoption of a tree:**	May be individual or team	Farmers land/ parks / Villages / roadside/ community area / College campus etc…..	Site selection /proper consultation/Continuous monitoring/ Information board	Report should be submitted by individual to the concerned evaluation authority	Evaluation as per the rubrics Of scheme and syllabus by Faculty
2.	**Heritage walk and crafts corner:**	May be individual or team	Temples / monumental places / Villages/ City Areas / Grama panchayat/ public associations/Government Schemes officers/ campus etc…..	Site selection /proper consultation/Continuous monitoring/ Information board	Report should be submitted by individual to the concerned evaluation authority	Evaluation as per the rubrics Of scheme and syllabus by Faculty
3.	**Organic farming and waste management:**	May be individual or team	Farmers land / parks / Villages visits / roadside/ community area / College campus etc…..	Group selection / proper consultation / Continuous monitoring / Information board	Report should be submitted by individual to the concerned evaluation authority	Evaluation as per the rubrics Of scheme and syllabus by Faculty
4.	**Water conservation:** & conservation techniques	May be individual or team	Villages/ City Areas / Grama panchayat/ public associations/Government Schemes officers / campus etc…..	site selection / proper consultation/Continuous monitoring/ Information board	Report should be submitted by individual to the concerned evaluation authority	Evaluation as per the rubrics Of scheme and syllabus by Faculty
5.	**Food walk: Practices in society**	May be individual or team	Villages/ City Areas / Grama panchayat/ public associations/Government Schemes officers/ campus etc…..	Group selection / proper consultation / Continuous monitoring / Information board	Report should be submitted by individual to the concerned evaluation authority	Evaluation as per the rubrics Of scheme and syllabus by Faculty

Employability Enhancement Skills (EES) - V [As per Choice Based Credit System (CBCS) & OBE Scheme] **SEMESTER – V**			
Course Code:	**P22HSMC508**	**Credits:**	**01**
Teaching Hours/Week (L:T:P):	**0:2:0**	**CIE Marks:**	**50**
Total Number of Teaching Hours:	**28**	**SEE Marks:**	**50**

Course Learning Objectives: This course will enable students to:

- Apply programming constructs of C language to solve the real-world problem.
- Explore user-defined data structures like arrays, structures and pointers in implementing solutions to problems.
- Design and Develop solutions to problems using functions.

UNIT - I	**10 Hours**

Problem solving through C -

Flow Control: If…else, for Loop, while Loop, break and continue, switch…case, goto, Control Flow Examples, Simple Programs.

Functions: Functions, User-defined Functions, Function Types, Recursion, Storage Class, Programs

Arrays: Arrays, Multi-dimensional Arrays, Arrays & Functions, Programs.

Self-Study	Variables and constants

UNIT – II	**10 Hours**

Problem solving through C -

Pointers: Pointers, Pointers & Arrays, Pointers and Functions, Memory Allocation, Array & Pointer Examples.

Strings: String Functions, String Examples, Programs.

Self-Study	Evaluation of Expression

UNIT - III	**8 Hours**

Problem solving through C -

Structure and Union: Structure, Struct & Pointers, Struct & Function, Unions, Programs.

Programming Files: Files Input/output

Self-Study	Error handling during I/O operations.

Course Outcomes: On completion of this course, students are able to:

CO – 1:	Apply suitable programming constructs of C language to solve the given problem.
CO – 2:	Explore user-defined data structures like arrays in implementing solutions to problems like searching and sorting.
CO – 3:	Design and Develop solutions to problems using functions.

Text Book(s):

1. The C Programming Language (2^{nd} edition) by Brian Kernighan and Dennis Ritchie.
2. C in Depth by S K Srivastava and Deepali Srivastava.
3. Computer fundamentals and programming in c, "Reema Thareja", Oxford University, Second edition, 2017.

Reference Book(s):

1. E. Balaguruswamy, Programming in ANSI C, 7th Edition, Tata McGraw-Hill. Brian W. Kernighan and Dennis M. Ritchie, The 'C' Programming Language, Prentice Hall of India.

Web and Video link(s):

1. Problem Solving through Programming in C - https://archive.nptel.ac.in/courses/106/105/106105171/

COURSE ARTICULATION MATRIX [Employability Enhancement Skills (EES) - V**]**												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO-1	2	2	2	-	-	-	-	-	-	-	-	-
CO-2	2	2	2	-	-	-	-	-	-	-	-	-
CO-3	2	2	1	-	-	-	-	-	-	-	-	-
*****												

Analog CMOS VLSI Design [As per Choice Based Credit System (CBCS) & OBE Scheme] SEMESTER – VI			
Course Code:	**P22EC601**	**Credits:**	**03**
Teaching Hours/Week (L:T:P):	**3 : 0 : 0**	**CIE Marks:**	**50**
Total Number of Teaching Hours:	**40**	**SEE Marks:**	**50**

Course Learning Objectives: This course will enable the students to:

- Understand the basic MOS device physics and models.
- Apply small signal and large signal models in the low and high frequency analysis of MOS circuits.
- Understand the working mechanism and significance of the Current mirrors in MOS circuits.
- Analyze and Design the Operational amplifiers and oscillators

UNIT – I	**8 Hours**

Single– Stage Amplifiers: MOS Device Models**,** Basic Concepts, Common–Source Stage, Source Follower, Common–Gate Stage, Cascode Stage.

Text 1: 2.4, 3.1to 3.5

Self-Study Component:	**1.** Design and simulate a single stage Amplifier for given requirements across different technologies, note the limitations and benefits.

UNIT – II	**8 Hours**

Differential Amplifiers: Single– Ended and Differential Operation. Basic Differential Pair, Common–Mode Response, Differential Pair with MOS Loads, Gilbert Cell.

Text 1: 4.1 to 4.3, 4.4 to 4.5

Self-Study Component:	**1.** Explore and analyze the Difference Amplifier.

UNIT - III	**8 Hours**

Passive and Active Current Mirrors: Basic Current Mirrors Cascode Current Mirrors, Active Current Mirrors.

Frequency Response of Amplifiers: General Considerations, Miller Effect, Association of Poles with Nodes Common source stage and Source Followers.

Text 1:5.1 to 5.3 and 6.1-6.3

Self-Study Component:	**1.** Study and understand the procedure of calculating Network functions along with the analysis of its Poles and Zeros (Ref: Ch.10 of Network Analysis, 3rdedn, M.E. Van Valkenburg, PHI.)

UNIT - IV	**8 Hours**

Frequency Response of Amplifiers: Common Gate stage, Cascode Stage and Differential Pair.

Operational Amplifiers: General considerations, One stage op-amp, Two stage op-amp, Gain Boosting, Comparison, Common Mode feedback,

Text 1: 6.4-6.6, 9.1 to 9.6

Self-Study Component:	**1.** Read and explore the design of Fully differential OPAMP System of Cirrus Logic International (Patent No: US20180062583A1).

UNIT - V	**8 Hours**

Operational Amplifiers: Input Range limitations, Slew rate, Power supply rejection, Noise in Op-amps.

Oscillators: General Considerations, Ring Oscillators, LC Oscillators, Voltage–Controlled

Oscillators, Mathematical Model of VCOs.
Text 1: 9.7 to 9.9 14.1 to 14.5 (excluding 14.4.1-14.4.2)

Self-Study Component:	**1.** Read and explore the Qualcomm VCO design.

Course Outcomes: On completion of this course, students are able to:

COs	**Course Outcomes** with ***Action verbs*** for the Course topics	**Bloom's Taxonomy Level**	**Program Outcome Addressed (PO #) with BTL**
CO1	**Apply** the knowledge of basic principles of devices and circuits to understand MOS devices models, operation of amplifiers and oscillators.	Apply	PO1 (L3)
CO2	**Analyze** the MOS circuits for input impedance, output impedance, gain and frequency response.	Analyze	PO2 (L4)
CO3	**Investigate** the prescribed analog CMOS circuits through simulation using **EDA tools** and present a report.	Evaluate	PO4 (L5), PO5, PO9, PO10
CO4	**Develop** a single stage amplifiers, current mirror, differential amplifier and oscillator for the given specifications.	Create	PO3 (L6)

Text Book(s):

1. Design of Analog CMOS Integrated Circuits, Behzad Razavi, Tata McGraw Hill, Indian Edition, 2008, ISBN: 0-07-238032-2.

Reference Book(s):

1. CMOS Analog Circuit Design, Phillip E. Allen, Douglas R. Holberg, Oxford University Press, 3rd edition 2011, ISBN: 9780199765072.
2. CMOS Circuit Design, Layout and Simulation, R. Jacob Baker, Harry W. Li, David E. Boyce, Prentice Hall of India, 1st edition 2005, ISBN-13: 978-0780334168

Web and Video link(s):

1. https://nptel.ac.in/courses/117/101/117101105/
   (By Prof. A N Chandorkar, IIT, Bombay)
2. https://nptel.ac.in/courses/108/106/108106105/
   (By Prof. Aniruddhan S, IIT, Madras) SWAYAM:
3. https://swayam.gov.in/nd1_noc20_ee13/preview
   (By Prof. Hardik Jeetendra Pandya, IISC, Bengaluru).
4. https://www.youtube.com/@AliHajimiriChannel
   (By Prof. Ali Hajimiri, California Institute of Technology, Chicagos)

E-Books/Resources:

1. https://books.google.co.in/books?hl=en&lr=&id=hl6JZ8DKlFwC&oi=fnd&pg=PA1&dq=Design+of+Analog+CMOS+Integrated+Circuits%E2%80%9D,+Behzad+Razavi,+Tata+McGraw+Hill,+Indian+Edition,+2008,+ISBN:0-07-238032-2.&ots=GvxTCspLQf&sig=QjG2LFBtTCKMChk8RpXRCSlAn4U&redir_esc=y#v=onepage&q&f=false

Course Articulation Matrix (CAM)														
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**
# 1	**3**												**3**	
# 2		**2**												**2**
# 3				**1**	**2**				**2**	**2**				
# 4			**1**											
*****														

ITC and Multimedia

[As per Choice Based Credit System (CBCS) & OBE Scheme]

SEMESTER – VI

Course Code:	**P22EC6021**	**Credits:**	**03**
Teaching Hours/Week (L:T:P):	**3 : 0 : 0**	**CIE Marks:**	**50**
Total Number of Teaching Hours:	**40**	**SEE Marks:**	**50**

Course Learning Objectives: This course will enable the students to:

- Provide the knowledge of probability, information theory and source coding theorem..
- Analyze the efficient data compression methods and describe the most efficient compression method.
- Develop the channel model and channel capacity theorem.
- Describe the linear block codes, cyclic codes, BCH codes and Reed-Solomon codes.
- Explain the types of multimedia network and its applications.
- Describe the digitization principles of text and images and provide the understanding of digitization techniques of audio.

UNIT - I	**8 Hours**

Information Theory and Source Coding: Introduction to Information Theory, Uncertainty and Information, Average Mutual Information and Entropy, Information Measures for Continuous Random Variables, Relative Entropy, Source Coding Theorem, Huffman Coding, Shannon-Fano-Elias Coding, Arithmetic Coding, The Lempel-Ziv Algorithm, Run Length Encoding, Rate Distortion Function, Optimum Quantizer Design, Entropy Rate of a Stochastic Process, Introduction to Image Compression, The JPEG Standard for Lossless Compression, The JPEG Standard for Lossy Compression, Video Compression Standards..

Text 1: 1.1-1.18.

Self-Study Component:	**1.** Understand the properties of codes and applications of information theory. **2.** Study and compare the different lossy and lossless compression techniques.

UNIT – II	**8 Hours**

Channel Capacity and Coding: Introduction, Channel Models, Channel Capacity, Channel Coding, Information Capacity Theorem, Parallel Gaussian Channels, The Shannon Limit, and Channel Capacity for MIMO Systems.

Error Control Coding (Channel Coding): Linear Block Codes for Error Correction, Introduction to Error Correcting Codes, basic definitions , Matrix Description of Linear Block, Equivalent Codes, Parity Check Matrix, Decoding of a Linear Block Code, Syndrome Decoding, Error Probability after Coding (Probability of Error Correction), Perfect Codes, Hamming Codes, Low Density Parity Check (LDPC) Codes, Optimal Linear Codes.

Text1: 2.1-2.8, 3.1-3.12.

Self-Study Component:	**1.** Identify the practical Applications of MIMO system. **2.** Understand the uses of Linear and non Linear block codes.

UNIT - III	**8 Hours**

Cyclic Codes: Introduction to Cyclic Codes, Polynomials, The Division Algorithm for Polynomials, A Method for Generating Cyclic Codes, Matrix Description of Cyclic Codes, Quasi-Cyclic Codes and Shortened Cyclic Codes.

Bose–ChaudhuriHocquenghem (BCH) Codes: Introduction to BCH Codes, Primitive Elements, Minimal Polynomials, Generator Polynomials in Terms of Minimal Polynomials, Some Examples of BCH Codes, Decoding of BCH Codes, Reed-Solomon Codes.

Text 1: 4.1-4.6, 5.1-5.7.

Self-Study Component:	**1.** Discuss the concept of Convolutional Codes, AWGN Channel and identify the noises associated. **2.** Design the decoding and encoding circuits for linear block codes, cyclic codes, BCH of Reed-Solomon codes using MATLAB.

UNIT - IV	**8 Hours**

Multimedia Communications: Introduction, Multimedia information representation, Multimedia networks: Telephone, data, Broadcast television, ISDN and Broadband multiservice digital networks, Multimedia applications: Interpersonal communication, Interactive applications over the internet, Entertainment applications, Application and networking terminology: Media types, Communication modes, Network types..

Text 2: 1.1 to 1.5

Self-Study Component:	**1.** Discuss the Multipoint conferencing modes of operation. **2.** Study the Network QoS Parameters and its Applications.

UNIT - V	**8 Hours**

Multimedia Information Representation: Introduction, Digitization principles: Analog signals, Encoder design, and Decoder design, Text: Unformatted text, Formatted text, Hypertext, Images: Graphics, Digitized documents, Digitized pictures, Audio: PCM speech, Video: Broadcast television, Digital Video.

Text2: 2.1 - 2.5.1, 2.6.1,2.6.2

Self-Study Component:	**1.** Study the CD-quality audio and Synthesized audio. **2.** Discuss the PC video digitization formats and video content.

Course Outcomes: On completion of this course, students are able to:

COs	**Course Outcomes** with ***Action verbs*** for the Course topics	**Bloom's Taxonomy Level**	**Program Outcome Addressed (PO #) with BTL**
CO1	**Apply** the knowledge of mathematics to understand concepts of Probability, Information theory, communication channel, source code and Error control coding and multimedia.	Apply	PO1 (L3)
CO2	**Analyze** the performance of Information encoding and multimedia systems.	Analyze	PO2 (L4)
CO3	**Design** the encoding and decoding circuits for the given specifications.	Create	PO3 (L6)
CO4	**Demonstrate** ethical responsibility in the implementation and evaluation of information coding and multimedia systems, ensuring compliance with professional standards, data privacy and intellectual property rights	Apply	PO7,PO8(L3)

Text Book(s):

1. Ranjan Bose: Information Theory, Coding and Cryptography, 3rd edition. Tata McGraw Hill. ISBN: 978-0-07-0669017, 2016.
2. Fred Halsall: Multimedia Communications, Applications, Networks, Protocols and Standards, Fifth Impression, Pearson, 2011.ISBN: 978-81-317-0994-8.

Reference Book(s):

1. Simon Haykin, John Wiley: Digital Communication Systems, 4th edition. ISBN-13: 978-0130426727.
2. Daniel J. Costello: Error Control Coding, Shu Lin, 2nd Edition, Pearson.
3. Ralf Steinmetz and Klara Nabrsted : "Multimedia: Computing, Communications and Applications", Pearson Education, 2004, ISBN: 9788177584417.

Web and Video link(s):

1. https://nptel.ac.in/courses/108/102/108102117/
2. https://nptel.ac.in/courses/117/105/117105083/#

E-Books/Resources:

1. https://www.scribd.com/document/725120836/Download-Information-Theory-Coding-And-Cryptography-3Rd-Edition-Ranjan-Bose-full-chapter
2. https://link.springer.com/book/10.1007/978-3-642-20347-3

Course Articulation Matrix (CAM)

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2
# 1	3												3	
# 2		3												3
# 3			3											
# 4							1	1						

*****

DSP Processor and Applications [As per Choice Based Credit System (CBCS) & OBE Scheme] SEMESTER – VI			
Course Code:	**P22EC6022**	**Credits:**	**03**
Teaching Hours/Week (L:T:P):	**3 : 0 : 0**	**CIE Marks:**	**50**
Total Number of Teaching Hours:	**40**	**SEE Marks:**	**50**

Course Learning Objectives: This course will enable the students to:

- Provide the understanding of architecture, programming and interfacing of commercially available Digital Signal Processor.
- Discuss the effective use of Digital Signal Processor in system implementation.
- Provide the understanding of architecture features and programming concepts of TMS320C54XX for several basic DSP algorithms.
- Understand the interfacing procedure to use programmable Digital Signal Processor.
- Discuss the applications of programmable DSP devices

UNIT - I	**8 Hours**

Architectures for Programmable DSP Devices: Introduction, Basic Architectural Features, DSP Computational Building Blocks, Bus Architecture and Memory, Data Addressing Capabilities, Address Generation Unit, Speed Issues.

Text 1: 4.1, 4.2, 4.3, 4.4, 4.5, 4.6, 4.8

Self-Study Component:	**1.** List and explain important features needed for external interfacing with DSP device. **2.** Explain pipelining and parallel processing with real life example. Also comment on time requirement in each process.

UNIT – II	**8 Hours**

Programmable Fixed Point Digital Signal Processors: Introduction, Commercial Digital Signal– processing Devices, Data Addressing Modes of TMS32OC54xx DSPs, Memory Space of TMS32OC54xx Processors, Program Control, TMS32OC54xx Instructions, Pipeline Operation of TMS32OC54xx Processors.

Text 1:5.1, 5.2, 5.3.1, 5.3.2, 5.3.3, 5.4, 5.5, 5.6, 5.7.1(Mentioned topics only)**, 5.10**

Self-Study Component:	**1.** Compare and contrast the capabilities of DSP processors and conventional processors, highlighting the unique strengths of DSPs in processing digital signals. **2.** Study memory (internal and extended), peripherals and general purpose I/O pins characteristics of 54X processors.

UNIT - III	**8 Hours**

Implementation of Basic DSP Algorithms: Introduction, the Q–notation, FIR Filters, IIR Filter, Interpolation Filters, Decimation Filters, PID controller, Adaptive Filters.

Implementation of FFT Algorithms: Introduction, An FFT Algorithm for DFT, A Butterfly Computation, Overflow and Scaling.

Text 1: 7.1, 7.2, 7.3, 7.4, 7.5, 7.6, 7.7, 7.8, 8.1, 8.2, 8.3, 8.4

Self-Study Component:	**1.** Study an 8-point FFT implementation on the TMS320C54XX processor. **2.** Design and implement 4 tap FIR filter using Verilog.

UNIT - IV	**8 Hours**

Interfacing Memory and Parallel I/O Peripherals to Programmable DSP Devices: Introduction, External Bus Interfacing signals, Memory Interface, Parallel I/O Interface, Programmed I/O, Interrupts and I/O, Direct Memory Access (DMA).

Interfacing and Applications of DSP Processor: Introduction, Synchronous Serial Interface, A CODEC Interface Circuit.

Text 1: 9.1, 9.3, 9.4, 9.5, 9.6, 9.7, 9.8, 10.1, 10.2, 10.5	
Self-Study Component:	**1.** Study of Multi-channel Buffered Serial Port Programming (McBSP). **2.** Design a simple CODEC interface circuit and write a code snippet to program the CODEC for a specific application, such as audio compression or decompression.

UNIT - V	**8 Hours**

Programmable Floating Point Digital Signal Processors: Introduction, Features of TMS320C6713, TMS320C6713 Architecture, Linear and Circular addressing modes, Instruction set, TMS 320C6713 DSK Boards, TMS 320C6713 Programming.

Applications of DSP Devices: DSP Based Bio–telemetry DSP based Speech Processing System, Data compression in DSP Based Image Processing System.

Text 2: 23.1 to 23.4, 23.5 (23.5.1 Excluded), 23.6, 23.7.1, 23.8

Self-Study Component:	**1.** Compare and contrast the performance of floating-point processors and fixed-point processors in various applications, analyzing their strengths and weaknesses. **2.** Implement speech processing system using MATLAB.

Course Outcomes: On completion of this course, students are able to:

COs	**Course Outcomes** with ***Action verbs*** for the Course topics	**Bloom's Taxonomy Level**	**Program Outcome Addressed (PO #) with BTL**
CO1	Apply the knowledge of binary math problems to illustrate the internal architecture and its operation of the DSP processor.	L2	PO1(L1)
CO2	Demonstrate programming proficiency using various addressing modes and data transfer instructions of DSP processor.	L3	PO1 (L3)
CO3	Analyze the application areas of DSP processor using signal processing concepts.	L3	PO2 (L3)
CO4	Evaluate electrical circuitry to the DSP processor I/O ports in order to interface the processor to external devices.	L2, L3	PO2 (L2), PO3 (L3)
CO5	Design and implement the DSP algorithms for given application using MATLAB.	L3, L4	PO3 (L3), PO5 (L4)

Text Book(s):

1. Digital Signal Processing, Avatar Singh and S. Srinivasan, Thomson Learning, 1st edition 2004. ISBN 10: 0534391230 / ISBN 13: 9780534391232.
2. Modern Digital Signal Processing, V. Udayashankara, Eastern Economy Edition, 2016. ISBN 10: 8120345673 / ISBN 13: 9788120345676.

Reference Book(s):

1. Digital Signal Processors Architectures, Implementations, and Applications, Sen M Kuo, Woon-seng Gan, Pearson Edition, 2005.ISBN-13: 978-0130352149
2. Digital Signal Processors: Architecture, Programming and Applications, Venkataramani, Bhaskar, McGraw Hill Education, 2015.ISBN-10: 9780070702561

Web and Video link(s):

1. https://youtu.be/t0otg_QxGeM?si=h9zTM_JM95UojtIZ
2. https://www.youtube.com/watch?v=04UvJkki0Ig

E-Books/Resources:

1. https://www.scribd.com/document/418385964/DSP-by-avatar-singh-pdf

Course Articulation Matrix (CAM)														
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**
# 1	**3**												**2**	
# 2	**3**												**3**	
# 3		**2**												**2**
# 4			**2**				**1**							**2**
# 5					**1**			**1**						
*****														

Embedded Systems

[As per Choice Based Credit System (CBCS) & OBE Scheme]

SEMESTER – VI

Course Code:	**P22EC6023**	**Credits:**	**03**
Teaching Hours/Week (L:T:P):	**3** : 0 : 0	**CIE Marks:**	**50**
Total Number of Teaching Hours:	**40**	**SEE Marks:**	**50**

Course Learning Objectives: This course will enable the students to:

- Understand basic components of embedded systems and its characteristic attributes.
- Demonstrate the communication interface required to develop an embedded system.
- Analyze embedded design problem and develop system to meet the needs.
- Use of Firmware design tools based the industry requirements.
- Develop a code for the embedded system using Embedded C.
- Choose proper IDE for the design and follow the recent trends in the embedded system design.

UNIT - I — **8 Hours**

Introduction to Embedded Systems: What is an Embedded System, Embedded Systems vs. General Computing Systems, History of Embedded Systems, Classification of Embedded Systems, Major Application Area of Embedded Systems, Purpose of Embedded Systems.

Typical Embedded System: General purpose and domain specific processors, Memory, Sensors and Actuators, Other System Components.

Text 1: 1.1 - 1.6, 2.1.1, 2.2, 2.3, 2.6.

Self-Study Component:	**1.** Discuss 'Smart' running shoes from Adidas- the Innovative Bonding of Lifestyle with Embedded Technology. **2.** Demonstration of practical application of embedded design.

UNIT – II — **8 Hours**

Embedded networks: communication interface. Onboard communication interface –I2C, SPI, Serial peripheral interface (SPI), UART. External communication interface- RS -232C and RS-485, USB, Infrared (IrDA), Bluetooth (BT). Need for Device drivers.

Text 1:2.4, 2.4.1.1 to 2.4.1.3 , 2.4.2 , 2.4.2.1 ,2.4.2.2 , 2.4.2.4, 2.4.2.5, 10.9

Self-Study Component:	**1.** Understand other Communication Interfaces like Controller Area Network (CAN), Wi-Fi etc. **2.** Understand different types of Device Drivers.

UNIT - III — **8 Hours**

Characteristics and Quality Attributes of Embedded Systems: Characteristics of an embedded system, Quality attributes of embedded systems.

Embedded System- Application and Domain Specific: Consumer (Washing Machine), Automotive.

Hardware Software Co-Design and Program Modeling: Fundamental Issues in Hardware Software Co-Design, Computational Models in Embedded Design, Introduction to Unified Modeling Language.

Text 1:3.1, 3.2, 4.1, 4.2, 7.1 - 7.3

Self-Study Component:	**1.** Discuss How to use Or-CAD tool. **2.** Understand schematic design using Or-CAD Capture CIS.

UNIT - IV — **8 Hours**

Embedded Firmware Design and Development: Embedded Firmware Design Approaches Embedded Firmware Development Languages.

Programming in Embedded C: Programming in Embedded C**,** C vs Embedded C, Compiler vs Cross Compiler, Using C in Embedded C.

Text 1:9.1 to 9.3, 9.3.1, 9.3.2, 9.3.3.	
Self-Study Component:	**1.** Understand Embedded C programs to control 8051 microcontrollers. **2.** Design and develop any one application as per current industry need using embedded C.

UNIT - V	**8 Hours**
Real-Time Operating System (RTOS) based Embedded System Design: Operating System Basics, Types of OS, Tasks, Process and Threads, Multiprocessing and Multitasking,Task Scheduling, Task Synchronization, how to Choose an RTOS. **Text 1:10.1 to 10.5, 10.8, 10.10**.	
Self-Study Component:	**1.** Analyze Threads, Processes and Scheduling : Putting them all together with programming **2.** Understand different methods of task communication.

Course Outcomes: On completion of this course, students are able to:

COs	Course Outcomes with *Action verbs* for the Course topics	Bloom's Taxonomy Level	Program Outcome Addressed (PO #) with BTL
CO1	**Apply** the fundamental knowledge of Electronic circuits to explain the concepts of Embedded systems and relevant operating systems.	Apply	PO1 (L3)
CO2	**Analyze** the operation of Embedded systems, interfaces which can enhance the performance of embedded systems and issues involved in embedded system development using real time operating systems.	Analyze	PO2 (L4)
CO3	**Design** and **implement** embedded system applications that adhere to given specifications using modern engineering tools.	Create	PO5, PO3 (L6)
CO4	**Analyse** embedded system based Engineering Solutions for the development of society demonstrating suitable ethical and professional responsibilities in embedded firmware development	Apply	PO7, PO8 (L3)

Text Book(s):

1. Introduction to Embedded Systems,Shibu K V, Tata McGraw Hill, 2nd Edition, ISBN 13: 978-0-07-014589-4.

Reference Book(s):

1. Embedded Systems – A contemporary Design Tool, James K Peckol, John Wiley, 2008. ISBN: 978-1-119-45750-3.
2. Embedded Systems Design, An Introduction to Processes, Tools, and Techniques by Arnold S. Berger ISBN:1578200733 CMP Books

Web and Video link(s):

1. https://youtu.be/TP1_F3IVjBc
2. https://nptel.ac.in/courses/108105057

E-Books/Resources:

1. https://sushmatoravi.wordpress.com/wp-content/uploads/2017/08/233633895 intro-to-embedded-systems-by-shibu-kv.pdf

Course Articulation Matrix (CAM)														
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**
# 1	**3**												**3**	
# 2		**2**												**2**
# 3			**2**		**2**									
# 4							**1**	**1**				**2**		
*****														

Operating Systems [As per Choice Based Credit System (CBCS) & OBE Scheme] **SEMESTER – VI**			
Course Code:	**P22EC6024**	**Credits:**	**03**
Teaching Hours/Week (L:T:P):	**3 : 0 : 0**	**CIE Marks:**	**50**
Total Number of Teaching Hours:	**40**	**SEE Marks:**	**50**

Course Learning Objectives: This course will enable the students to:

- Understand the architecture and principals of Operating System.
- Examine the issues of Mutual Exclusion and deadlock.
- Discuss the principle techniques of memory management.
- Analyze various scheduling policies.
- Understand RAID, CACHE and other I/O management

UNIT - I	**8 Hours**
Operating System Overview: Operating System Objectives and Functions, The Evolution of Operating Systems, Major Achievements, Developments Leading to Modern Operating Systems, Virtual Machines. **Process Description and Control**: What Is a Process?, Process States, Process Description, Process Control **Text 1: 2.1-2.5, 3.1-3.4**	
Self-Study Component:	**1.** Explore the concepts of Multicore Systems.

UNIT – II	**8 Hours**
Concurrency: Deadlock and Starvation - Principles of Deadlock, Deadlock Prevention, Deadlock Avoidance, Deadlock Detection, An Integrated Deadlock Strategy, Dining Philosophers Problem. **Text 1: 6.1 - 6.6**	
Self-Study Component:	**1.** Understand the Concepts of Mutual Exclusion and Semaphore.

UNIT - III	**8 Hours**
Memory Management: Memory Management Requirements, Memory Partitioning, Paging, Segmentation, Security Issues. **Text 1: 7.1 - 7.5**	
Self-Study Component:	**1.** Comment on Fixed and Dynamic Memory partitioning.

UNIT - IV	**8 Hours**
Uniprocessor Scheduling: Types of Processor Scheduling, Scheduling Algorithms, Traditional UNIX Scheduling **Text 1: 9.1 - 9.3**	
Self-Study Component:	**1.** Learn about Multiprocessor Scheduling, Real-Time Scheduling

UNIT - V	**8 Hours**
I/O Management and Disk Scheduling: I/O Devices, Organization of the I/O Function, Operating System Design Issues, I/O Buffering, Disk Scheduling, RAID, Disk Cache. **Text 1: 11.1 - 11.7**	
Self-Study Component:	**1.** Compare the types of I/O in UNIX, LINUX and WINDOWS.

Course Outcomes: On completion of this course, students are able to:

COs	Course Outcomes with *Action verbs* for the Course topics	Bloom's Taxonomy Level	Program Outcome Addressed (PO #) with BTL
CO1	**Apply** fundamental concepts of computer science to understand the theoretical concepts and components of an operating system.	L3	PO1
CO2	**Analyze** operating system structures and identify how different modules like process management and memory management interact to provide system-level functionalities.	L4	PO2
CO3	**Design and develop** solutions for managing memory and I/O devices in an efficient manner.	L5	PO3
CO4	**Evaluate** the performance of operating systems such as deadlock, scheduling algorithms and memory management strategies.	L6	PO7,PO8,PO10

Text Book(s):

1. Operating Systems by William Stallings, 7e, Pearson India. ISBN-13: 9789332518803.

Reference Book(s):

1. Operating Systems" by Godbole, 3rd Edition, McGraw Hill India. ISBN-13: 978-0070702035

Web and Video link(s):

1. Operating System Fundamentals, IIT Kharagpur
   By Prof. Santanu Chattopadhyay
   https://archive.nptel.ac.in/courses/106/105/106105214/
2. Introduction to Operating Systems, IIT Madras
   By Prof. Chester Rebeiro, https://onlinecourses.nptel.ac.in/noc21_cs72/preview
3. Operating Systems - NPTEL IITDBy Prof. Sampat Ghosh
   https://www.youtube.com/playlist?list=PLsylUObW5M3CAGT6OdubyH6FztKfJCcF

E-Books/Resources:

1. Operating Systems by William Stallings
   https://github.com/jyfc/ebook/blob/master/03_operating_system/Operatin20Systems%20-%20Internals%20and%20Design%20Principles%207th.pdf

Course Articulation Matrix (CAM)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
# 1	3												3	
# 2		2												2
# 3			2											
# 4							1	1		1				

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Radar and Navigational Systems [As per Choice Based Credit System (CBCS) & OBE Scheme] SEMESTER – VI			
Course Code:	**P22EC6031**	**Credits:**	**03**
Teaching Hours/Week (L:T:P):	**3 : 0 : 0**	**CIE Marks:**	**50**
Total Number of Teaching Hours:	**40**	**SEE Marks:**	**50**

Course Learning Objectives: This course will enable the students to:

- Describe the basic Radar operation, detection of echo signal and radar applications.
- Discuss different radar range equations and calculate the effect of various external / internal factors on radar accuracies.
- Explain the idea behind MTI and radar tracking systems.
- Examine the different technologies for Detection of targets.
- Explain different Clutters that affects the detection of radar signals.
- Discuss the different radar transmitters and receivers.
- Explain different navigational aids.

UNIT - I	**8 Hours**

An Introduction to Radar: Basic Radar, Simple form of the Radar equation, Radar block diagram, Radar frequencies, Applications of radar. **The Radar Equation:** Introduction, Detection of signals in noise, Receiver noise and signal to noise ratio, Probabilities of detection and false alarm, Radar cross section of targets.

Text 1: 1.1 to 1.5, 2.1 to 2.3, 2.5, 2.7.

Self-Study Component:	**1.** Applications of modern radar systems. **2.** Household Radar Can See Through Walls and Knows How You're Feeling:- https://spectrum.ieee.org/telecom/wireless/household-radar-can-see-through-walls-and-knows-how-youre-feeling. **3.** MIT Lincoln Laboratory- Introduction to Radar Systems – Lecture 1 – Introduction; Part 1 https://www.youtube.com/watch?v=Hw5IaS6-Fzw

UNIT – II	**8 Hours**

MTI and Pulse Doppler Radar: Introduction, Delay line cancellers, Digital MTI processing, Moving target detection. **Tracking Radar:** Tracking with Radar, Monopulse tracking, Conical scan and sequential lobing.

Text 1: 3.1, 3.2, 3.5 to 3.7,4.1 to 4.3.

Self-Study Component:	**1.** Limitations to tracking accuracy

UNIT - III	**8 Hours**

Detection of Signals in Noise: Introduction, Matched filter receiver, Detection criteria, Detectors, Automatic detection. **Radar Clutter:** Introduction to Radar clutter, surface clutter radar equation, land clutter, sea clutter, weather clutter.

Text 1: 5.1 to 5.5, 7.1 to 7.4, 7.6.

Self-Study Component:	**1.** Detection of targets in clutter

UNIT - IV	**8 Hours**

Radar Transmitter: Introduction, linear beam power tubes, solid state RF power sources, cross field amplifiers. **Radar Receiver:** Radar noise figures, Super-heterodyne receiver, Duplexers and receiver protectors, Radar displays.

Text 1: 10.1 to 10.3, 10.5, 11.1 to 11.5.

Self-Study Component:	**1.** Other RF Power Sources

UNIT - V	**8 Hours**

Navigation: Hyperbolic Navigation: Introduction, LORAN-A, LORAN-C, DECCA, OMEGA, DECTRA, DERLAC.

Satellite Navigation: Introduction, Doppler Navigation, GPS, Principle of operation of GPS, GPS Segments, GPS Navigation Message, GPS Data Subframe, Source of Errors in GPS. Modern Navigational Method.

Text 2: 14.1 to 14.10, 15.1, 17.3.

Self-Study Component:	**1.** Differential Global Positioning System (DGPS)

Course Outcomes: On completion of this course, students are able to:

COs	**Course Outcomes** with ***Action verbs*** for the Course topics	**Bloom's Taxonomy Level**	**Program Outcome Addressed (PO #) with BTL**
CO1	Apply the fundamentals of electronics and communication engineering to gain comprehensive knowledge of radar, its sub blocks, types and navigation principles.	**Apply**	**PO1 (L3)**
CO2	Analysis of radar signals and related parameters for the bandwidth, power, delay likelihood estimation.	**Analyse**	**PO2 (L4)**
CO3	Design system components related to development and application of radar and related systems for the given requirements.	**Evaluate**	**PO3 (L5)**
CO4	Industry visit and presentation on radar simulation, development and its applications.	**Analyse**	**PO5, PO8, PO9, P10 (L4)**

Text Book(s):

1. "**Introduction to Radar Systems**", Merill. I. Skolnik, 3rd Edition. Tata McGraw Hill, 2001. ISBN-13: 978-0-07-044533-8.
2. "**Radar Systems and Radio aids to Navigation**", Dr. A. K Sen, Dr. A .B Bhattacharya. Khanna Publishers. ISBN **:** 978-81-7409-08-9.

Reference Book(s):

1. "**Elements of Electronic Navigation**", N.S.Nagaraj, 2nd Edition, Tata McGRAW Hill
2. **Radar and Electronic Navigation**, Gerrit Jacobus Sonnenberg, Newnes-Butterworths; 5th edition (1978), ISBN-10: 0408002727, ISBN-13: 978-0408002721
3. **Radar Engineering**, G S N Raju, I. K. International Pvt Ltd, 2008,ISBN 8190694219, 9788190694216

Web and Video link(s):

E-Books/Resources:

Course Articulation Matrix (CAM)

CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**
# 1	**3**												**3**	
# 2		**3**												**3**
# 3			**2**											
# 4					**1**			**1**	**1**	**1**				

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Digital Image Processing [As per Choice Based Credit System (CBCS) & OBE Scheme] **SEMESTER – VI**			
Course Code:	**P22EC6032**	**Credits:**	**03**
Teaching Hours/Week (L:T:P):	**3** : 0 : 0	**CIE Marks:**	**50**
Total Number of Teaching Hours:	**40**	**SEE Marks:**	**50**

Course Learning Objectives: This course will enable the students to:

- Understand the fundamentals of digital image processing.
- Understand the image enhancement techniques used in digital image processing.
- Understand the image restoration techniques used in digital image processing.
- Understand the Morphological Operations and Segmentation used in digital image processing.
- Understand the image Representation and Description in digital image processing.

UNIT - I	**8 Hours**

Digital Image Fundamentals: What is Digital Image Processing?, Examples of fields that use DIP, Fundamental Steps in Digital Image Processing, Components of an Image Processing System, Elements of Visual Perception: Structure of the Human Eye, Brightness Adaption and discrimination, Image Sensing and Acquisition, Image Sampling and Quantization.

Text 1: 1.1,1.3-1.5,2.1,2.3,2.4

Self-Study Component:	**1.** Comprehend the array versus matrix operations. **2.** Write MATLAB code to perform basic image processing operations.

UNIT – II	**8 Hours**

Spatial Domain: The Basics of Intensity Transformation and Spatial Filtering, Some Basic Intensity Transformation Functions: Image Negatives, Log Transformations, Power-Law Transformation. **Smoothing Spatial Filters:** Order-Static Filters, **Sharpening Spatial Filters:** Using The Second derivative for image sharpening-The Laplacian, Using First-Order derivatives for image sharpening-The Gradient.

Text 1: 3.1, 3.2, 3.3,3.5, 3.6

Self-Study Component:	**1.** Write MATLAB code to enhance the image in spatial domain. **2.** Fundamentals of Frequency domain Filtering.

UNIT - III	**8 Hours**

Restoration: A model of the image Degradation/Restoration Process, Noise models, Restoration in the Presence of Noise Only using Spatial Filtering and Frequency Domain Filtering, Estimating the Degradation Function, Inverse Filtering, Minimum Mean Square Error (Wiener) Filtering.

Text 1: 5.1-5.4, 5.6-5.8.

Self-Study Component:	**1.** Write MATLAB code toadd various intensity levels of a given noise to an image and remove. **2.** Understand the Linear Position Invariant Degradations.

UNIT - IV	**8 Hours**

Color Image Processing: Color Fundamentals, Color Models, Pseudo-color Image Processing: Intensity slicing and color coding.

Morphological Image Processing: Erosion and Dilation, Opening and Closing, the Hit-or-Miss Transforms, Some Basic Morphological Algorithms: Thinning, Thickening.

Text 1: 6.1 - 6.3, 9.2-9.4,9.5.5,9.5.6

Self-Study Component:	**1.** Write MATLAB code to extract boundary pixels of an image using morphological operations. **2.** Write MATLAB code to perform any one morphological applications.

UNIT - V	**8 Hours**

Segmentation: Point, Line, and Edge Detection, Thresholding: Foundation Optium global thresholding using OTSU'S Method, Region Based Segmentation.
Text 1: 10.2, 10.3, 10.4

Self-Study Component:	**1.** Define a procedure for estimating the median of an image from its histogram. **2.** Write MATLAB code to perform following image segmentation, Simple threshold, multiple threshold, Adaptive threshold and optimal threshold.

Course Outcomes: On completion of this course, students are able to:

COs	**Course Outcomes** with ***Action verbs*** for the Course topics	**Bloom's Taxonomy Level**	**Program Outcome Addressed (PO #) with BTL**
CO1	**Apply the** basic mathematical and signal processing knowledge for the different image processing stages.	L3	PO1
CO2	**Interpret** the knowledge of image processing in Image Restoration, Color, Morphological processing and segmentation.	L4	PO1
CO3	**Analyze** the images in the spatial and frequency domain using various transforms.	L4	PO2
CO4	Implement algorithms for different feature extraction techniques for image analysis and recognition.	L5	PO3,PO5,PO9,PO10

Text Book(s):
1. Digital Image Processing, Rafael C. Gonzalez and Richard E. Woods, Pearson, 4th Edition 2018, ISBN: 9789353062989.

Reference Book(s):
1. Digital Image Processing, S.Jayaraman, S.Esakkirajan, T.Veerakumar, Tata McGraw Hill 2014.
2. Fundamentals of Digital Image Processing, A. K. Jain, Pearson 2004.

Web and Video link(s):
1. https://youtu.be/ArKe6zMkXnk
2. https://youtu.be/iZmHHVwp0Ow

E-Books/Resources:
1. https://sde.uoc.ac.in/sites/default/files/sde_videos/Digital%20Image%20Processing%203rd%20ed.%20-%20R.%20Gonzalez,%20R.%20Woods-ilovepdf-compressed.pdf

Course Articulation Matrix (CAM)														
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**
# 1	**3**												**3**	
# 2	**3**												**3**	
# 3		**2**												**2**
# 4			**2**		**1**				**1**	**1**				
*****														

Design For Testability [As per Choice Based Credit System (CBCS) & OBE Scheme] SEMESTER –VI			
Course Code:	**P22EC6033**	**Credits:**	**03**
Teaching Hours/Week (L:T:P):	**3 : 0 : 0**	**CIE Marks:**	**50**
Total Number of Teaching Hours:	**40**	**SEE Marks:**	**50**

Course Learning Objectives: This course will enable the students to:

- Understand the principles and significance of testability in Integrated Circuits.
- Identify and categorize the faults in Integrated circuits.
- Interpret the Test Pattern Generation and related algorithms for Combinational and Sequential Circuits.
- Analyze the circuits and device test pattern generators for the circuits.
- Articulate the techniques, structure and methods associated with built-in self-test (BIST), boundary scan testing, and fault injection to improve testability.

UNIT - I	**8 Hours**

Introduction to Testing: Introduction, Testing Philosophy, Role of Testing, Digital and Analog VLSI Testing, VLSI Technology Trends Affecting Testing.
Fault Modeling: Defects, Errors, and Faults, Functional Versus Structural Testing, Levels of Fault Models, A Glossary of Fault Models, Single Stuck-at Fault.
Text1: 1.1 to 1.4, 4.1 to 4.5.

Self-Study Component:	**1.** Design the modelling Circuits for Simulation **2.** Analyze the Algorithms for True-Value Simulation

UNIT – II	**8 Hours**

Testability Measures: SCOAP Controllability and Observability, High-Level Testability Measures
Combinational Circuit Test Generation: Algorithms and Representations, Redundancy Identification (RID), Testing as a Global Problem, Definitions, Significant Combinational ATPG Algorithms (Expect Advanced Algorithms).
Text1: 6.1-6.2, 7.1 to 7.5

Self-Study Component:	**1.** Understand different Advanced Test Pattern Algorithms

UNIT - III	**8 Hours**

Sequential Circuit Test Generation: ATPG for Single-Clock Synchronous Circuits, Time-Frame Expansion Method, Simulation-Based Sequential Circuit ATPG.
Memory Test: Memory Density and Defect Trends, Notation, Faults, Memory Test Levels, March Test Notation, Fault Modeling.
Text1: 8.1 to 8.2, 9.1-9.6.2

Self-Study Component:	**1.** Study on Memory Testing

UNIT - IV	**8 Hours**

Digital DFT and Scan Design: Ad-Hoc DFT Methods, Scan Design, Partial-Scan Design, Variations of Scan.
Built-In Self-Test: The Economic Case for BIST, Random Logic BIST.
Text1: 14.1 to14.4, 15.1, 15.2

Self-Study Component:	**1.** Know about Analog and Mixed-Signal Circuit Trends

UNIT - V	8 Hours
Built-In Self-Test: Memory BIST, Delay Fault BIST. **Boundary Scan Standard:** Motivation, System Configuration with Boundary Scan, Boundary Scan Description Language. **Text 1: 15.3, 15.4, 16.1-16.3.**	
Self-Study Component:	**1.** Supply current measurement based test (IDDQ TEST) for manufacturing faults in IC's.
Course Outcomes: On completion of this course, students are able to:	

COs	Course Outcomes with *Action verbs* for the Course topics	Bloom's Taxonomy Level	Program Outcome Addressed (PO #) with BTL
CO1	**Apply** the principles of testability in Integrated Circuits to categorize the faults in Integrated circuits.	**Apply**	PO1 (L3)
CO2	**Analyze** the methodologies and structures of built-in self-test (BIST), boundary scan testing, memory testing, and algorithms related to Test Pattern Generation for Combinational and Sequential Circuits.	**Apply**	PO1 (L2), PO2 (L3)
CO3	**Analyze** the circuits and device test pattern generators for the circuits.	**Analyze**	PO2 (L4)
CO4	**Investigate** the circuit for faults using modern tools.	**Analyze**	PO5(L3), PO10(L3)

Text Book(s):

1. Essentials Of Electronic Testing For Digital, Memory And Mixed-Signal VLSI Circuits, by Michael L. Bushnell, Vishwani D. Agrawal**,** KLUWER ACADEMIC PUBLISHERS, 2016**,** ISBN 13: 978-0-12-408082-9.

Reference Book(s):

1. Digital Systems and Testable Design, by Abramovici, Breuer and Friedman, Jaico Publishing House.
2. Digital Circuits Testing and Testability, by P.K. Lala, Academic Press.

Web and Video link(s):

1. https://www.youtube.com/watch?v=MEaMm423t0w&list=PLzkO3QQCXjbVIEsRgNkolAvs-SFXPUjpb

Course Articulation Matrix (CAM)

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2
# 1	3												3	
# 2	2	3											2	3
# 3		3												3
# 4					1					1				

*****

Artificial Intelligence and Machine Learning In VLSI [As per Choice Based Credit System (CBCS) & OBE Scheme] **SEMESTER – VI**			
Course Code:	**P22EC6034**	**Credits:**	**03**
Teaching Hours/Week (L:T:P):	**3**:0:0	**CIE Marks:**	**50**
Total Number of Teaching Hours:	**40**	**SEE Marks:**	**50**

Course Learning Objectives: This course will enable the students to:

- Understand structure of Neural Network and Deep Learning.
- Analyze the architecture of processors for deep learning.
- Learn streaming graph theory.
- Study applications of Machine learning in physical verification.
- Understand statistical analysis using Machine learning.

UNIT - I	**8 Hours**

Introduction: Development History, Development History, Neural Network Classification, Neural Network Framework.

Deep Learning: Neural Network Layer, Deep Learning Challenges.

Text 1: Chapter 1 and Chapter 2

Self-Study Component:	**1.** Study introduction to AI and ML **2.** Write a sample code in python for a neural network application

UNIT – II	**8 Hours**

Parallel Architecture: Intel Central Processing Unit (CPU), NVIDIA Graphics Processing Unit (GPU), NVIDIA Deep Learning Accelerator (NVDLA), GoogleTensor Processing Unit (TPU).

Microsoft Catapult Fabric Accelerator

Streaming Graph Theory: Blaize Graph Streaming Processor, Graph core Intelligence Processing Unit

Text 1: Chapter 3 and Chapter 4

Self-Study Component:	**1.** Study the introduction to NVIDIA GPU applications, Tensor flow.

UNIT - III	**8 Hours**

In-Memory Computation: Neurocube Architecture, Tetris Accelerator, NeuroStream Accelerator

Near-MemoryArchitecture: DaDianNao Supercomputer, Cnvlutin Accelerator.

Text 1: Chapter 6 and Chapter 7

Self-Study Component:	**1.** Study the supercomputer architectures

UNIT - IV	**8 Hours**

Machine Learning in Physical Verification, Mask Synthesis, and Physical Design: Introduction, Machine Learning in Physical Verification, Machine Learning in Physical Design

Machine Learning-Based Aging Analysis: Introduction, Negative Bias Temperature Instability, Related Prior Work, Proposed Technique, Offline Correlation Analysis and Prediction Model, Runtime Stress Monitoring, Results, Conclusions

Text 2: 4.1, 4.2, 4.4 and Chapter 9

Self-Study Component:	**1.** Study the Machine Learning Applications in VLSI routing.

UNIT - V			8 Hours
Extreme Statistics in Memories: Cell Failure Probability: An Extreme Statistic, Extremes: Tails and maxima **Fast Statistical Analysis Using MachineLearning:** Introduction: Logistic Regression-Based ImportanceSampling Methodology for Statistical Analysis ofMemory Design, Application to State-of-the-Art FinFET SRAM Design **Text 2:** 10.1, 10.2, 10.4, 11.1,11.5			
Self-Study Component:	**1.** Study the Machine Learning regression techniques and sampling algorithms.		
Course Outcomes: On completion of this course, students are able to:			
COs	**Course Outcomes** with ***Action verbs*** for the Course topics	**Bloom's Taxonomy Level**	**Program Outcome Addressed (PO #) with BTL**
CO1	Apply the concepts of Neural Network and Deep learning in verification and physical design	L3	PO1
CO2	Able to Analyze the functionality of Hardware architecture for newralnets.	L2	PO2
CO3	Use appropriate architecture like Accelerator for Neutral Network Implementation and for Hardware design.	L2	PO3
CO4	Investigate physical design problems.	L2	PO4
CO5	Implementation of neural network application using Python for Analysis of Memory Design.	L1	PO5

Text Book(s):

1. Artificial Intelligence Hardware Design: Challenges and Solutions, Albert Chun Chen Liu, Oscar Ming Kin Law, IEEE Press, Wiley, ISBN: 9781119810452
2. Machine Learning in VLSI Computer - Aided Design, Ibrahim (Abe) M.Elfadel, Duane S.Boning, Xin_Li, Springer ISBN 978-3-030-04665-1

Reference Book(s):

1. Artificial Intelligence: A Modern Approach , Stuart J. Russell and Peter Norvig, Prentice Hall, 4th Edition, 1995.
2. VLSI And Hardware Implementations Using Modern Machine Learning Methods Sandeep Saini, Kusum Lata, and G.R. Sinha, CRC Press 2022, ISBN: 978-1-032-06172-6

Web and Video link(s):

1. https://www.youtube.com/watch?v=aircAruvnKk
2. https://www.youtube.com/watch?v=aircAruvnKk
3. https://www.youtube.com/watch?v=pMKuULBKxXY

E-Books/Resources:

1. https://www.google.co.in/books/edition/AI_and_Machine_Learning_for_Coders/gw4CEAAAQBAJ?hl=en&gbpv=1&dq=books+on+ai+and+ml&printsec=frontcover
2. https://www.google.co.in/books/edition/Machine_Learning_and_Artificial_Intellig/ybyxDwAAQBAJ?hl=en&gbpv=1&dq=books+on+ai+and+ml&printsec=frontcover
3. https://www.google.co.in/books/edition/Artificial_Intelligence_and_Machine_Lear/lW5_DwAAQBAJ?hl=en&gbpv=1&dq=books+on+ai+and+ml&printsec=frontcover
4. https://www.google.co.in/books/edition/Deep_Learning/omivDQAAQBAJ?hl=en&gbpv=1&dq=books+on+deep+learning&printsec=frontcover
5. https://www.google.co.in/books/edition/Neural_Networks_and_Deep_Learning/achqDwAAQBAJ?hl=en&gbpv=1&dq=books+on+deep+learning&printsec=frontcover

Course Articulation Matrix (CAM)

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2
# 1	3												3	
# 2		2												2
# 3			2											
# 4				2										
# 5					1									

*****

<table>
<tr><td colspan="4">Microwaves and Antenna (Integrated)
[As per Choice Based Credit System (CBCS) & OBE Scheme]
SEMESTER – VI</td></tr>
<tr><td>Course Code:</td><td>P22EC604</td><td>Credits:</td><td>04</td></tr>
<tr><td>Teaching Hours/Week (L:T:P):</td><td>3:0:2</td><td>CIE Marks:</td><td>50</td></tr>
<tr><td>Total Number of Teaching Hours:</td><td>40</td><td>SEE Marks:</td><td>50</td></tr>
<tr><td colspan="4">Course Learning Objectives: This course will enable the students to:
Provide the basic knowledge of Microwave transmission lines, rectangular waveguides and planar transmission lines.
Discuss the working of Microwave active and passive devices.
Explain the concepts of types of antenna and parameters of antenna.
Discuss the field due to dipole antenna and array of antenna.
Describe the structure and working of helical, log-periodic and micro strip antennas and its Design procedure.</td></tr>
<tr><td colspan="3">UNIT - I</td><td>8 Hours</td></tr>
<tr><td colspan="4">Microwave Transmission Lines: Introduction, Transmission lines equations, Characteristic and input impedances, Reflection and transmission coefficients, Standing waves, Planar transmission lines, Strip lines, rectangular waveguides, TE and TM wave solutions, dominant and degenerate modes.
Text 1: 3.1- 3.5, 3.10, 3.10.1, 3.11 - 3.11.4.</td></tr>
<tr><td>Self-Study Component:</td><td colspan="3">1. Study the properties of Microwave Transmission lines using Smith chart.
2. Understand the concepts of MIC Manufacturing Process.</td></tr>
<tr><td>Practical Topics: (2 Hours)</td><td colspan="3">1. Measurement of frequency, guide wavelength, power, VSWR and attenuation in a microwave test bench.</td></tr>
<tr><td colspan="3">UNIT – II</td><td>8 Hours</td></tr>
<tr><td colspan="4">Microwave Passive Devices: Attenuators, phase shifters - Precision phase shifter, MIC Phase shifter, reciprocal and non-reciprocal phase shifter, Hybrid or magic Tee, Application of Magic –T (excluding E-Plane Tee & H-Plane Tee).
Microwave Solid State Devices: Transferred electron devices (TED) - Gunn diodes, modes of operation, Gunn diode oscillator, TRAPATT diodes and Tunnel diodes- equivalent circuit, Tunnel diode Amplifiers, and Tunnel diode oscillator.
Text 1: 6.4.14, 6.4.15, 6.4.16, 10.3-(10.3.1, 10.3.2), 10.4.3, 10.5, 10.5.1, 10.5.2, 10.5.3.</td></tr>
<tr><td>Self-Study Component:</td><td colspan="3">1. Understand the working principle of Avalanche transit time devices, Directional couplers, Power Dividers and Microstrip Ring Resonator.
2. Study the Microwave Radiation hazards in Industries.</td></tr>
<tr><td>Practical Topics: (2 Hours)</td><td colspan="3">1. Determination of coupling and isolation characteristics of a micro–strip directional coupler.
2. Measurement of power division and isolation characteristics of a micro–strip 3dB power divider.
3. Measurement of resonance characteristics of a micro–strip ring resonator and determination of dielectric constant of the substrate.</td></tr>
</table>

UNIT - III		8 Hours
Introduction: Types of Antennas – Wire, Aperture, Micro-strip, Array, Reflector and Lens antennas, Radiation Mechanism – Single wire, Two-Wires and Dipole. **Fundamental Parameters of Antennas:** Introduction, Radiation Pattern – Isotropic, Directional, and Omnidirectional Patterns, Principal Patterns, Radiation Pattern Lobes, Field Regions, Radian and Steradian, Radiation Power Density, Radiation Intensity, Directivity, Gain, Antenna Efficiency, Half-Power Beamwidth, Beam Efficiency. **Text 2: 1.1, 1.2, 1.3 – (1.3.1, 1.3.2, 1.3.3), 2.1 to 2.5, 2.7 to 2.10.**		
Self-Study Component:	**1.** Understand the concepts of Friis Transmission Equation and Radar Range Equation.	
Practical Topics: (2 Hours)	**1.** Plot the Radiation pattern and measure the Directivity of Dipole antenna.	
UNIT - IV		**8 Hours**
Linear Wire Antennas: Introduction, Infinitesimal Dipole – Radiated Fields, Power density and Radiation resistance, Radian Distance and Sphere, Near-field, Intermediate and Far – field region, Directivity. **Antenna Arrays:** Introduction, Two- Element Array**,** N-Element Linear Array **–** Uniform Amplitude and Spacing-Broadside array, ordinary End fire array and Phased array. **Text 2: 4.1, 4.2, 6.1, 6.2, 6.3, 6.3.1 to 6.3.3.**		
Self-Study Component:	**1.** Study theproperties of N element linear array and Planar Array.	
Practical Topics: (2 Hours)	**1.** Design and Simulate Dipole antenna using Matlab and Plot the Radiation pattern, Directivity and Impedance graph.	
UNIT - V		**8 Hours**
Broadband Antennas: Helical Antenna - Design Concepts, Log-periodic Antennas – planar and wire surfaces and dipole array. **Micro strip Antennas:** Introduction - Basic Characteristics, Feeding Methods, Rectangular Patch - Transmission line model. **Text 2: 10.3, 10.3.1, 11.4, 11.4.1, 11.4.2, 14.1, 14.2, 14.2.1.**		
Self-Study Component:	**1.** Explore the design concepts of Log periodic dipole array, Yagi-Uda and circular patch Antenna.	
Practical Topics: (2 Hours)	**1.** Plot the Radiation pattern and measure the Directivity of Micro Strip-Rectangular Patch antenna. **2.** Design and Simulate Microstrip rectangular patch antenna using Matlab and Plot the Radiation pattern, Directivity and Impedance graph. **3.** Measurement of Pitch angle alpha (in degrees), Axial ratio (AR), HPBW (in degrees) and Directivity (dimensionless and in dB) of Helical Antenna using Matlab.	

Course Outcomes: On completion of this course, students are able to:

COs	**Course Outcomes** with ***Action verbs*** for the Course topics	**Bloom's Taxonomy Level**	**Program Outcome Addressed (PO #) with BTL**
CO1	**Apply** the knowledge of electromagnetic field theory and network analysis to understand the properties of transmission lines, microwave devices, the parameters of antennas and field due to antennas.	L3	PO1

CO2	**Analyze** the working and performance of microwave devices, microwave transmission lines.	L4	PO2
CO3	Develop an understanding of antenna theory, including radiation patterns, directivity, gain, and polarization, and will apply these principles to the **design** of various types of antennas.	L5	PO3
CO4	**Analyze and design** microwave components, such as attenuators, power dividers, and directional couplers, and understand their applications by conducting experiments in microwave communication systems.	L5	PO3
CO5	Simulate and analyze the performance and characteristics of various types of antennas, such as helical antennas, dipole and rectangular patch antennas, using MATLAB.	L6	PO5,PO9,PO10

Text Book(s):

1. Microwave Engineering, Annapurna Das, Sisir K Das, 2nd edition-2009, T.M.H, ISBN (13): 978-0-07-066738-9. ISBN (10): 0-07-066738-1.
2. Antenna Theory Analysis and Design, C. A. Balanis, 2nd edition – 2001, John Wiley, ISBN: 9971-51-233-5.

Reference Book(s):

1. Microwave engineering, David M Pozar, 2nd edition – 2004, John Wiley, ISBN: 9780470631553.
2. Foundations for Microwave Engineering, Robert E Collin, 2nd edition – 2009, John Wiley & Sons Inc (Sea) Pte Ltd, ISBN: 9788126515288.
3. Microwave Devices and Circuits, Samuel Y Liao, 3rd edition – 2004, ISBN: 9780135846810. PHI
4. Antennas for all Applications, John D Kraus, Ronald J Marheka, Ahmad s Khan, 3rd edition- 2006, T.M.H, ISBN:9780070601857.

Web and Video link(s):

1. Introduction to Microwave engineering, IIT Guwhati. https://youtu.be/F07ApLj12sE?si=3pGcsPyljNbH0Emv
2. https://youtu.be/bi1nDg9CqRo?si=dfUJABg2SIVua4Uh
3. NPTEL course: Antennas, by Prof. Girish Kumar, IIT Bombay. https://nptel.ac.in/noc/courses/noc17/SEM1/noc17-ee03/

E-Books/Resources:

1. https://www.studocu.com/in/document/dr-ambedkar-institute-of technology/mobile-adhoc-network/annapurna-das-sisir-k-das-microwave-engineering-mc-graw-hill-india-2014/32304541

Course Articulation Matrix (CAM)

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2
# 1	2												2	
# 2		3												3
# 3			2											
# 4														
# 5					2				2	2				

*****

Electronic Instrumentation [As per Choice Based Credit System (CBCS) & OBE Scheme] **SEMESTER – VI**			
Course Code:	**P22ECO6051**	**Credits:**	**03**
Teaching Hours/Week (L:T:P):	**3 : 0 : 0**	**CIE Marks:**	**50**
Total Number of Teaching Hours:	**40**	**SEE Marks:**	**50**

Course Learning Objectives: This course will enable the students to:

- Discuss the concepts of signal conditioning and data acquisition system
- Explain the different types of transducers and measurement errors
- Differentiate between the DC and AC voltmeters
- Analyze different types of digital voltmeter
- Analyze the operation of ADC and different types of digital instruments.
- Describe the operation of instrumentation amplifier and its applications.

UNIT - I	**8 Hours**

Qualities of Measurements: Introduction, Performance Characteristics, Static Characteristics, Error in Measurement, Types of Static Error, Sources of Error, Dynamic Characteristics.

Voltmeters and Multimeters: Introduction, Basic Meter as a DC Voltmeter, DC Voltmeter, Multirange Voltmeter , Extending Voltmeter Ranges, Loading , AC Voltmeter Using Rectifiers, AC Voltmeter Using Half Wave Rectifier, AC Voltmeter Using Full Wave Rectifier, Peak Responding Voltmeter, True RMS Voltmeter.

Text 1: 1.1 to 1.7, 4.1 to 4.6, 4.12 to 4.14, 4.17, 4.18

Self-Study Component:	**1.** Learn about the companies that manufacture standard voltmeters and ammeters, range of operation and their salient features.

UNIT – II	**8 Hours**

Digital Voltmeters: Introduction, RAMP Technique, Dual Slope Integrating Type DVM, Integrating Type DVM, Most Commonly Used Principles of ADC, Successive Approximations, **Digital Instruments:** Introduction, Digital Multimeters, Digital Frequency Meter, Digital Measurement of Time , Universal Counter, Decade Counter, Electronic Counter.

Text 1: 5.1 to 5.6, 5.11, 6.1 – 6.7

Self-Study Component:	**1.** List few practical applications of digital Instruments. **2.** Design a digital meter to measure light intensity (Block diagram approach)

UNIT - III	**8 Hours**

Transducers: Introduction, Electrical Transducer, Selecting a Transducer, Resistive Transducer, Resistive Position Transducer, Strain Gauges, Resistance Thermometer, Thermistor, Inductive Transducer, Differential Output Transducers, Linear Variable Differential Transducer, Piezo Electrical Transducer.

Text 1: 13.1 to 13.11 and 13.15.

Self-Study Component:	**1.** Analyze few electronic and fiber optic sensors which work on the principal of Transducers. **2.** Design a weighing machine using single strain gage (Block diagram approach)

UNIT - IV	**8 Hours**

Signal Conditioning: Introduction, operational amplifier, basic instrumentation amplifier, Applications of instrumentation amplifiers, chopped and modulated DC amplifier. **Recorders:** Introduction, strip chart recorder, galvanometer type recorder, null type recorder, circular chart recorder, X-Y recorder.

Text 1: 14.1 to 14.5, 12.1 to 12.6.	
Self-Study Component:	**1.** Design an op-amp which amplifies every signal by a factor of 2.5 using any simulator tool ((Multisim, Ltspice etc.)

UNIT - V	**8 Hours**

Data Acquisition System (DAS): Introduction, Objective of a DAS, Signal Conditioning of the Inputs, Single Channel Data Acquisition System, Multi-Channel DAS, Computer Based DAS, Digital to Analog and Analog to Digital Converters, Data Loggers, Sensors Based Computer Data Systems.

Text 1: 17.1 to 17.9

Self-Study Component:	**1.** Gather information about data acquisition systems and its uses in fiber optic receivers. **2.** Simulate an ADC and DAC using any simulator (Multisim, Ltspice etc.)

Course Outcomes: On completion of this course, students are able to:

COs	**Course Outcomes** with ***Action verbs*** for the Course topics	**Bloom's Taxonomy Level**	**Program Outcome Addressed (PO #) with BTL**
CO1	**Apply** the knowledge of basic electrical engineering in understanding basic principles of data acquisition system and electronic instrumentation.	**L3**	**PO1**
CO2	**Describe** various measuring instruments.	**L3**	**PO1**
CO3	**Analyze** the working principle of various electronic measuring instruments.	**L4**	**PO2**
CO4	**Design** simple electronic instrumentation systems for given specifications.	**L4**	**PO3**

Text Book(s):

1. Electronic Instrumentation, H. S. Kalsi, 3rd edition, McGraw Hill, 2010, ISBN-13: 9780-07-070206-6

Reference Book(s):

1. Electronic Instrumentation and Measurements, David A. Bell, 3rd edition, Oxford University Press, 2015. ISBN-13 : 978-0195696141
2. Modern Electronic Instrumentation and Measuring Techniques, Cooper, Helfrick, Prentice Hall of India. ISBN-13 : 978-9332556065

Web and Video link(s):

1. Electrical Measurement and Electronic Instruments
   by Prof. AvishekChatterjee, IIT Kharagpur
   https://archive.nptel.ac.in/courses/108/105/108105153/

Course Articulation Matrix (CAM)

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2
# 1	3												2	
# 2	3												2	
# 3		2												2
# 4			1											2

*****

Introduction to Embedded Systems [As per Choice Based Credit System (CBCS) & OBE Scheme] SEMESTER – VI			
Course Code:	**P22ECO6052**	**Credits:**	**03**
Teaching Hours/Week (L:T:P):	**3 : 0 : 0**	**CIE Marks:**	**50**
Total Number of Teaching Hours:	**40**	**SEE Marks:**	**50**

Course Learning Objectives: This course will enable the students to:

- Provide the knowledge about basic concepts of embedded systems.
- Outline the concepts of typical embedded systems and its applications.
- Describe the characteristics and quality attributes of embedded systems.
- Provide the knowledge of software hardware co–design and EDLC.
- Describe the concepts of real time operating system based embedded systems.

UNIT - I	**8 Hours**

Introduction to Embedded Systems: What is an Embedded system? Embedded System vs. General Computing Systems, History of Embedded Systems, Classification of Embedded Systems, Major Application Areas of Embedded Systems, Purpose of Embedded Systems, Wearable Devices-The Innovative Bonding of Lifestyle with Embedded Technologies.
The Typical Embedded System: Core of the Embedded System, Memory, Sensors and Actuators, Communication Interface, Embedded Firmware, Other System Components.
Text 1: 1.1 to 1.7, 2.1 to 2.6

Self-Study Component:	**1.** Study and understand the working operation of the following input devices: (i) IR proximity sensor (ii) Temperature sensor (iii) Humidity sensor. **2.** Study the working of Hydraulic and Rotatory Actuators to understand the operation of output devices.

UNIT – II	**8 Hours**

Characteristics and Quality Attributes of Embedded Systems: Characteristics of an embedded system, Quality attributes of embedded systems.
Embedded Systems- Application and Domain Specific: Washing Machine – Application-Specific Embedded System, Automotive – Domain Specific Examples of Embedded System
Hardware Software Co-Design and Program Modeling: Fundamental Issues in Hardware Software Co-Design, Computational Models in Embedded Design, Introduction to Unified modeling Language (UML), Hardware Software Trade-offs.
Text 1:3.1, 3.2, 4.1, 4.2, 7.1 to 7.4

Self-Study Component:	**1.** Illustrate the different areas that UML has been used in various domains. **2.** Interpret how UML can be used for designing a door system. (that can only be opened and closed) also note down the state diagram.

UNIT - III	**8 Hours**

Real-Time Operating System (RTOS) based Embedded System Design: Operating System Basics, Types of Operating Systems, Tasks, Process and Threads, Multiprocessing and Multitasking, Task Scheduling, Task Communication (Excluding Programs), Device Drivers.
Text 1: 10.1 to 10.5, 10.7, 10.9

Self-Study Component:	**1.** Understand the basics of Real time operating systems. **2.** Implement the multithread application to satisfy i) Two child threads are created with normal priority ii) Thread 1 receives and prints its priority, sleeps for 50 m sec and then quits.

<table>
<tr><td colspan="3">UNIT - IV</td><td>8 Hours</td></tr>
<tr><td colspan="4">Embedded Firmware Design and Development: Embedded Firmware Design Approaches, Embedded Firmware Development Languages
The Embedded System Development Environment: The Integrated Development Environment(IDE), Types of Files Generated on Cross compilation, Disassembler/ Decompiler, Simulators, Emulators and Debugging, Target Hardware Debugging, Boundary Scan.
Text 1: 9.1, 9.2, 13.1 (excluding sub articles), 13.2 to13.6</td></tr>
<tr><td>Self-Study Component:</td><td colspan="3">1. Tabulate the different IDE tools used for the development of embedded systems with proper examples.
2. Distinguish the concept of software for Embedded Systems.</td></tr>
<tr><td colspan="3">UNIT - V</td><td>8 Hours</td></tr>
<tr><td colspan="4">The Embedded Product Development Life Cycle (EDLC): What is EDLC, Why EDLC, Objectives of EDLC, Different phases of EDLC, EDLC Approaches.
Trends in the Embedded Industry: Processor Trends in Embedded System Embedded OSTrends, Development Language Trends, Open Standards, Frameworks and Alliances, Bottlenecks.
Text 1:15.1 to 15.5, 16.1 to 16.5</td></tr>
<tr><td>Self-Study Component:</td><td colspan="3">1. Discuss the recent key trends used in embedded systems market.
2. Illustrate the different categories of EDLC.</td></tr>
<tr><td colspan="4">Course Outcomes: On completion of this course, students are able to:</td></tr>
<tr><td>COs</td><td>Course Outcomes with Action verbs for the Course topics</td><td>Bloom's Taxonomy Level</td><td>Program Outcome Addressed (PO #) with BTL</td></tr>
<tr><td>CO1</td><td>Apply the knowledge of Microcontrollers to demonstrate various concepts of Embedded systems</td><td>Apply</td><td>PO1 (L2)</td></tr>
<tr><td>CO2</td><td>Examine the different issues involved in embedded system development using real time operating systems.</td><td>Analyze</td><td>PO1, PO2 (L2, L3)</td></tr>
<tr><td>CO3</td><td>Illustrate the recent trends and overview in the Design of Embedded systems.</td><td>Analyze</td><td>PO2 (L3)</td></tr>
<tr><td>CO4</td><td>Develop an embedded systems applications for a given specification using high level and assembly level language.</td><td>Create</td><td>PO3 (L4, L6)</td></tr>
<tr><td>CO5</td><td>Design an embedded system applications using modern tools.</td><td>Create</td><td>PO5,PO9,PO10(L4,L6)</td></tr>
<tr><td colspan="4">Text Book(s):
1. Introduction to Embedded Systems, Shibu K V, Second edition, Tata McGraw Hill Education Private Limited, 2009, 2nd Edition, ISBN (13): 978-0-07-014589-4.</td></tr>
<tr><td colspan="4">Reference Book(s):
1. Embedded Systems: A Contemporary Design Tool, James K Peckol, Wiley, 2008.
2. Embedded Systems Design: An Introduction to Processes, Tools, and Techniques Arnold S. Berger, ISBN: 1578200733 CMP Books © 2002</td></tr>
<tr><td colspan="4">Web and Video link(s):
1. https://www.edx.org/learn/embedded-systems
2. https://www.youtube.com/watch?v=KfFBEBN5UHU</td></tr>
</table>

E-Books/Resources:

1. https://www.electronicsforu.com/special/cool-stuff-misc/eight-free-ebooks-embedded-systems
2. https://link.springer.com/book/10.1007/978-3-030-60910-8

Course Articulation Matrix (CAM)

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2
# 1	3												3	
# 2	3	3											3	3
# 3		3												
# 4			2											
# 5					1				1	1				

*****

Introduction to Image Processing [As per Choice Based Credit System (CBCS) & OBE Scheme] **SEMESTER – VI**			
Course Code:	**P22ECO6053**	**Credits:**	**03**
Teaching Hours/Week (L:T:P):	**3** : 0 : 0	**CIE Marks:**	**50**
Total Number of Teaching Hours:	**40**	**SEE Marks:**	**50**

Course Learning Objectives: This course will enable the students to:

- Understand the fundamentals of digital image processing.
- Understand the image enhancement techniques used in digital image processing.
- Understand the image restoration techniques and methods used in digital image processing.
- Understand the morphological operations and algorithms.
- Understand various segmentation methods used in digital image processing

UNIT - I	**8 Hours**

Digital Image Fundamentals: What is Digital Image Processing?, Fundamental Steps in Digital Image Processing, Components of an Image Processing System, Elements of Visual Perception, Image Sampling and Quantization.
Text 1: 1.1, 1.4, 1.5, 2.1, 2.2, 2.4

Self-Study Component:	**1.** Prepare a report on basic relationships between pixels of an image

UNIT – II	**8 Hours**

Spatial Domain: Some Basic Intensity Transformation Functions, Histogram Processing.
Text 1: 3.1-3.3

Self-Study Component:	**1.** Comprehend the local Histogram Processing techniques

UNIT - III	**8 Hours**

Spatial Filters: Fundamentals of Spatial Filtering, Smoothing Spatial Filters.
Restoration: A model of the image Degradation/Restoration Process, Noise models.
Text 1: 3.4 - 3.5, 5.1- 5.2.

Self-Study Component:	**1.** Develop an algorithm to add various intensity levels of salt and pepper noise to an image and remove.

UNIT - IV	**8 Hours**

Segmentation: Fundamentals, Point, Line, and Edge Detection, Thresholding, Region Based Segmentation.
A case study on impulse noise and Morphological Image Processing. (Refer, Ref1 and Ref2)
Text 1: 10.1, 10.2.1 - 10.2.5, 10.3-10.3.2, 10.4.

Self-Study Component:	**1.** Develop an algorithm to show dilation and erosion of an image.

UNIT - V	**8 Hours**

Morphological Image Processing: Preliminaries, Erosion and Dilation, Opening and Closing, the Hit-or-Miss Transforms, Some Basic Morphological Algorithms.
Color Image Processing: Color Fundamentals, Color Models.
A case study on Enhancement of Images using image processing methods.(Refer: Ref-3).
Text 1:9.5.1, 9.5.5, 9.5.6, 6.1-6.2.

Self-Study Component:	**1.** Develop an algorithm to convert colors of an image from RGB to HIS and vice versa.

Course Outcomes: On completion of this course, students are able to:			
COs	**Course Outcomes** with ***Action verbs*** for the Course topics	**Bloom's Taxonomy Level**	**Program Outcome Addressed (PO #) with BTL**
CO1	**Apply** basic mathematical and signal processing knowledge to understand different image processing stages/components.	L3	PO1
CO2	**Describe** different types of image processing techniques (e.g., image enhancement, restoration, segmentation etc) for different applications.	L3	PO1
CO3	**Evaluate** the techniques for image enhancement, segmentation and image restoration in the spatial domain.	L4	PO2
CO4	**Analyze the** various image processing techniques in spatial domain.	L4	PO2

Text Book(s):

1. Digital Image Processing- Rafael C Gonzalez and Richard E. Woods, PHI, 3e, 2010.

Reference-1: A Case Study of Impulse Noise Reduction Using Morphological Image Processing with Structuring Elements by V. Elamara et.al., Asian Journal of Scientific Research / DOI: 10.3923/ ajsr.2015.291.303

Reference-2: Image Analysis Using Mathematical Morphology by Robert M. Haralicket. al., IEEE Transactions on Pattern Analysis and Machine Intelligence, Volume: PAMI-9, Issue: 4, July 1987, DOI: 10.1109/TPAMI.1987.4767941.

Reference-3: Enhancement of Images using Morphological Transformations by K.Sreedhar and B.Panlal, International Journal of Computer Science & Information Technology (IJCSIT) Vol 4, No 1, Feb 2012.

Reference Book(s):

1. Digital Image Processing, S.Jayaraman, S.Esakkirajan, T.Veerakumar, TMH 2014.
2. Fundamentals of Digital Image Processing, A. K. Jain, Pearson 2004.

Web and Video link(s):

1. https://youtu.be/ArKe6zMkXnk
2. https://youtu.be/iZmHHVwp0Ow

E-Books/Resources:

1. https://sde.uoc.ac.in/sites/default/files/sde_videos/Digital%20Image%20Processing%203rd%20ed.%20-%20R.%20Gonzalez,%20R.%20Woods-ilovepdf-compressed.pdf

Course Articulation Matrix (CAM)

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2
# 1	3												3	
# 2	3												3	
# 3		2												2
# 4		2												2

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AUTOMOTIVE ELECTRONICS [As per Choice Based Credit System (CBCS) & OBE Scheme] **SEMESTER – VI**			
Course Code:	**P22EC6054**	**Credits:**	**03**
Teaching Hours/Week (L:T:P):	**3 : 0 : 0**	**CIE Marks:**	**50**
Total Number of Teaching Hours:	**40**	**SEE Marks:**	**50**

Course Learning Objectives: This course will enable the students to:

- Understand the concepts of Automotive Electronics and its evolution and trends.
- Discuss the various application of electronics systems and ECU in automotive.
- Illustrate the basic principles and applications of sensors and actuators in automotive electronics systems.
- Analyze various control systems and communication protocols in automotive.
- Compare and contrast different automotive technologies, analyzing their advantages, disadvantages and applications in various vehicle types and scenarios.

UNIT - I	**8 Hours**

Architecture: Overview, Vehicle system architecture.
Electronic control unit: Operating conditions, Design, Data processing, Digital modules in the control unit Control unit software, Software Development**.**
Text 1

Self-Study Component:	**1.** Compare and contrast different automotive systems and components, analyzing their strengths, weaknesses, and applications in various vehicle types and scenarios. **2.** Explain how automotive networking enables communication between various vehicle systems, such as engine control, braking, and infotainment, and describe its importance in modern vehicles.

UNIT – II	**8 Hours**

Basic principles of networking: Network topology, Network organization, OSI reference model, Control mechanisms.
Automotive networking: Cross-system functions, Requirements for bus systems, Classification of bus systems, Applications in the vehicle, Coupling of networks, Examples of networked vehicles.
Bus systems: Controller Area Network.
Text 1

Self-Study Component:	**1.** Design a simple electronic engine control system, using basic components and principles, to achieve specific performance or efficiency goals. **2.** Compare and contrast different types of electronic ignition systems, analyzing their advantages, disadvantages, and applications in various engines and scenarios.

UNIT - III	**8 Hours**

Bus systems: LIN bus, Bluetooth, MOST bus, TTP/C, FlexRay, Diagnosis interfaces.
Automotive sensors: Basics and overview, Automotive applications, Features of vehicle sensors, Sensor classification, Main requirements, trends, Overview of the physical effects for sensors, Overview and selection of sensor technologies.
Vehicle security systems: Acoustic signaling devices, Central locking system, Locking systems, Biometric systems
Text 1

Self-Study	**1.** Illustrate and present the basic principles and applications of

Component:	Angular Rate Sensors (ARS) in automotive and aerospace industries. **2.** Assess the performance, reliability, and durability of different actuators in various engine applications, considering factors like fuel type, engine load, and environmental conditions.

UNIT - IV	**8 Hours**

Electronic Transmission Control: Drive train Management, Market Trends, Control of Automated Shift Transmission AST, Control of Automatic Transmissions, Control of Continuously Variable Transmission, ECUs for Electronic Transmission Control, Thermo-Management, Processes and Tools Used in ECU Development.

Antilock Braking System (ABS): System overview, Requirements placed on ABS, Dynamics of a braked wheel, ABS control loop, Typical control cycles.

Text 1

Self-Study Component:	**1.** Discuss how the ECS integrates with various engine systems, describing its principles, components, and functions in controlling engine performance, efficiency, and emissions. **2.** Demonstrate a Program control units(PCU) -based system for a specific engine control application, selecting appropriate hardware and software components to meet performance, efficiency, and emissions goals.

UNIT - V	**8 Hours**

Electronic Diesel Control (EDC): System overview, Common-rail system for passenger cars, Common-rail system for commercial vehicles, Data processing, Fuel-injection control, Lambda closed-loop control for passenger-car diesel engines, Torque-controlled EDC systems, Data exchange with other systems, Serial data transmission (CAN)

Automatic brake functions, Sensotronic brake control (SBC): Overview, Standard function, Additional functions, Purpose and function, Design, Method of operation.

Active steering: Purpose, Design, Method of operation, Safety concept, Benefits of active steering for the driver.

Text 1

Self-Study Component:	**1.** Analyze and present the Design of diagnostic system for a specific Electronic Control System (ECS) application, selecting appropriate tools and techniques to detect and troubleshoot faults. **2.** Compare and contrast different Lane Departure Monitor and Tyre Pressure Monitoring System, analyzing their accuracy, reliability and performance in various driving scenarios.

Course Outcomes: On completion of this course, students are able to:

COs	**Course Outcomes** with ***Action verbs*** for the Course topics	**Bloom's Taxonomy Level**	**Program Outcome Addressed (PO #) with BTL**
CO1	**Illustrate** the use of automotive components, subsystems and basics of Electronic Engine Control in automotive industry.	L2	PO1(L2)
CO2	**Apply** the concept of automotive sensors and actuators to design automotive system	L3	PO1(L3)

CO3	Analyze the networking of various modules in automotive systems and communication protocols that interface the different electronics components, systems and mechanical counterparts.	L4	PO2 (L4)
CO4	Analyze the different automotive control systems and safety-Related Systems.	L3	PO1 (L3)

Text Book(s)

1. Automotive Mechatronics, Editor: Konrad Reif, ISBN 978-3-658-03974-5, ISBN 978-3-658-03975-2(eBook), Springer Vieweg, 2015

Reference Book(s)

1. Automotive Electronics Design Fundamentals, Nazamuz Zaman, 2015, Springer Publications. ISBN: 978-3-319-17584-3.

Web and Video link(s):

1. hp-laserjet-1022-basic-driver-eng
2. https://youtu.be/zzpOtJA-Rqw

E-Books/Resources:

1. https://www.elsevier.com/books/understanding-automotive-electronics/ribbens/978-0-12-810434-7
2. https://www.academia.edu/42742205/Bosch_Professional_Automotive_Information

Course Articulation Matrix (CAM)

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2
# 1	3													
# 2	3													
# 3		3												1
# 4	3												1	

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VLSI Laboratory
[As per Choice Based Credit System (CBCS) & OBE Scheme]
SEMESTER – VI

Course Code:	**P22ECL606**	**Credits:**	**01**
Teaching Hours/Week (L:T:P):	**0: 0 : 2**	**CIE Marks:**	**50**
Total Number of Teaching Hours:	**Lab: 2 Hrs, Exam: 2Hrs**	**SEE Marks:**	**50**

Course Learning Objectives: This course will enable the students to:

- Understand simulation and synthesis of digital design.
- Design and simulate the various basic CMOS digital circuits and use them in higher circuits like adders and shift registers using design abstraction concepts
- Explore the CAD tool and understand the flow of the Full Custom IC design cycle.
- Learn DRC, LVS and Parasitic Extraction of the various designs.
- Design and simulate the various basic CMOS analog circuits and use them in higher circuits like operational amplifiers using design abstraction concepts.

Course Content

Part A:

ASIC-Digital Design / FPGA Digital Design:

The following experiments involve synthesis and verification for logical equivalence.

1. Develop Verilog Code for ALU.
2. Develop Verilog code for Universal Shift Register.
3. Develop Verilog Code for Serial adder.
4. Develop Verilog Code for Radix-4 Booth Multiplier.
5. Develop Verilog Code for Parallel adder.
6. Develop Verilog code for State Machine.

Part B:

Analog Design Flow:

Perform the following steps for experiments listed below:

Steps:

1. Draw the schematic and verify the following: DC Analysis, Transient Analysis.
2. Draw the Layout and verify the DRC, ERC, and check for LVS.
3. RC extraction

Experiments

1. Design a NOT gate with given specification.
2. Design the following amplifiers in different topologies, for the given specification
   - Common source amplifier
   - Common Drain amplifier.

Design an OPAMP for given specifications using Differential Amplifier.

Open Ended Experiments:

1. Design and simulate Gilbert cell for Analog multiplication

Course Outcomes: On completion of this course, students are able to:

COs	**Course Outcomes** with ***Action verbs*** for the Course topics	**Bloom's Taxonomy Level**	**Program Outcome Addressed (PO #) with BTL**
CO1	**Apply** the basic knowledge of Digital system and VLSI to design the schematic and Layout of CMOS Circuits	Applying	PO1,PO3(L2)

CO2	**Interpret the** concept of DC Analysis, AC Analysis and Transient Analysis in analog circuits	Analyze	PO2 (L3)
CO3	**Simulate** basic CMOS circuits like inverter, Common Source Amplifier and Differential Amplifier using Cadence tool.	Simulate	PO5 (L4)
CO4	**Develop** a Verilog code for digital system and verify its functionality in cadence tool	Creating	PO5,PO7,PO10,PO12 (L6)

Course Articulation Matrix (CAM)

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2
# 1	2												2	
# 2		3											3	
# 3	3				3									2
# 4					3		1			1		1		2

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Mini Project

[As per Choice Based Credit System (CBCS) & OBE Scheme]

SEMESTER – VI

Course Code:	**P22ECMP607**	**Credits:**	**02**
Teaching Hours/Week (L:T:P):	**0 : 0 : 2 : 2**	**CIE Marks:**	**50**
Total Number of Teaching Hours:	**40**	**SEE Marks:**	**50**

Course Learning Objectives: This course will enable the students to:

- Identify, discuss and justify the technical aspects of the chosen project with a comprehensive and systematic approach.
- Practice acquired knowledge within the chosen area of technology for project development.
- Reproduce, improve and refine technical aspects for engineering projects.
- Work as an individual or in a team in development of technical projects.
- Communicate and report effectively project related activities and findings.

Course Outcomes: On completion of this course, students are able to:

COs	**Course Outcomes** with ***Action verbs*** for the Course topics	**Bloom's Taxonomy Level**	**Program Outcome Addressed (PO #) with BTL**
CO1	**Apply** the knowledge to identify, gather information and analyze to formulate the problem definition for project through detailed investigation.	L3	PO1, PO2, PO4 (L3)
CO2	**Design** and formulate the solutions to real-world problems by applying the fundamental concepts of electronics learnt from previous and current semesters.	L6	PO2, PO3 (L6)
CO3	**Select** the open source tools and resources in solving the problems.	L3	PO5(L3)
CO4	**Adapt** effective communication by presentation of the work with professional ethics as an individual or a member of a team	L6	PO8, PO9, P10 (L6)
CO5	**Develop** sustainable system with scope for enhancement and continue life-long learning**.**	L6	P12(L6)

Course Articulation Matrix (CAM)

CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**
# 1	**3**	**3**		**2**									**3**	**3**
# 2		**2**	**3**											**2**
# 3					**3**									
# 4								**3**	**2**	**3**				
# 5												**3**		

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Employability Enhancement Skills (EES) - VI *[As per Choice Based Credit System (CBCS) & OBE Scheme]* **SEMESTER – VI**			
Course Code:	**P22HSMC608**	**Credits:**	**01**
Teaching Hours/Week (L:T:P):	**0:2:0**	**CIE Marks:**	**50**
Total Number of Teaching Hours:	**28**	**SEE Marks:**	**50**

Course Learning Objectives: This course will enable students to:

- Explain the basic concepts in Race and games, Linear equations, mensuration, height and distance.
- Apply the logical skills in decoding Number, letter series and Game based assessments.
- Calculations involving Time, Speed and distance, HCF & LCM, Averages and Partnerships

UNIT – I	**10 Hours**
Quantitative Aptitude: Race and games, Linear equations **Logical Reasoning:** Number and letter series	
Self-Study	Types of cryptarithm

UNIT – II	**10 Hours**
Quantitative Aptitude: Mensuration, Height & distance. **Logical Reasoning:** Game based assessments. **Self-Study:**	
Self-Study	Inferred meaning, Chain rule.

UNIT - III	**8 Hours**
Quantitative Aptitude: Time, Speed and distance, HCF & LCM, Averages and Partnerships	
Self-Study	Decimal fractions

Course Outcomes: On completion of this course, students are able to:

CO – 1:	Solve the problems based on Race and games, Linear equations, mensuration, height and distance.
CO – 2:	Solve logical reasoning problems based on Number, letter series and Game based assessments.
CO – 3:	Solve the problems based on HCF & LCM, averages and partnerships.

Text Book(s):

1. Quantitative aptitude by Dr. R. S Agarwal, published by S.Chand private limited.
2. Verbal reasoning by Dr. R. S Agarwal, published by S. Chand private limited.

Reference Book(s):

1. Quantitative Aptitude by Arun Sharma, McGraw Hill Education Pvt Ltd
2. A Modern Approach to Verbal & Non-Verbal Reasoning by R.S. Agarwal.
3. CAT Mathematics by Abhijith Guha, PHI learning private limited.

COURSE ARTICULATION MATRIX [Employability Enhancement Skills (EES) - VI**]**

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

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Universal Human Values and Professional Ethics
[As per Choice Based Credit System (CBCS) & OBE Scheme]
SEMESTER – VI

Course Code:	**P22UHV609**	**Credits:**	**01**
Teaching Hours/Week (L:T:P):	**1 : 0 : 0**	**CIE Marks:**	**50**
Total Number of Teaching Hours:	**25 + 5**	**SEE Marks:**	**50**

Course objectives:
This course is intended to:

1. To help the students appreciate the essential complementarity between 'VALUES' and 'SKILLS' to ensure sustained happiness and prosperity which are the core aspirations of all human beings.
2. To facilitate the development of a Holistic perspective among students towards life and profession as well as towards happiness and prosperity based on a correct understanding of the Human reality and the rest of existence. Such a holistic perspective forms the basis of Universal Human Values and movement towards value-based living in a natural way.
3. To highlight plausible implications of such a Holistic understanding in terms of ethical human conduct, trustful and mutually fulfilling human behaviour and mutually enriching interaction with Nature.
4. This course is intended to provide a much-needed orientation input in value education to the young enquiring minds.

Teaching-Learning Process (General Instructions)
These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. The methodology of this course is explorational and thus universally adaptable. It involves a systematic and rational study of the human being vis-à-vis the rest of existence.
2. In addition to the traditional lecture method, different types of innovative teaching methods may be adopted so that the activities will develop students' theoretical and applied skills.
3. State the need for UHV activities and its present relevance in the society and Provide real-life examples.
4. Support and guide the students for self-study activities.
5. You will also be responsible for assigning homework, grading assignments and quizzes, and documenting students' progress in real activities in the field.
6. This process of self-exploration takes the form of a dialogue between the teacher and the students to begin with, and then to continue within the student in every activity, leading to continuous selfevolution.
7. Encourage the students for group work to improve their creative and analytical skills.

Module - 1	**3 Hours**

Introduction to Value Education
Right Understanding, Relationship and Physical Facility (Holistic Development and the Role of Education) Understanding Value Education, Self-exploration as the Process for Value Education, Continuous Happiness and Prosperity – the Basic Human Aspirations, Happiness and Prosperity – Current Scenario, Method to Fulfil the Basic Human Aspirations

Module - 2	3 Hours
Harmony in the Human Being : Understanding Human being as the Co-existence of the Self and the Body, Distinguishing between the Needs of the Self and the Body, The Body as an Instrument of the Self, Understanding Harmony in the Self, Harmony of the Self with the Body, Programme to ensure self-regulation and Health	
Module - 3	**3 Hours**
Harmony in the Family and Society : Harmony in the Family – the Basic Unit of Human Interaction, 'Trust' – the Foundational Value in Relationship, 'Respect' – as the Right Evaluation, Other Feelings, Justice in Human-to-Human Relationship, Understanding Harmony in the Society, Vision for the Universal Human Order	
Module - 4	**3 Hours**
Harmony in the Nature/Existence : Understanding Harmony in the Nature, Interconnectedness, self-regulation and Mutual Fulfilment among the Four Orders of Nature, Realizing Existence as Co-existence at All Levels, The Holistic Perception of Harmony in Existence	
Module - 5	**3 Hours**
Implications of the Holistic Understanding – a Look at Professional Ethics : Natural Acceptance of Human Values, Definitiveness of (Ethical) Human Conduct, A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order, Competence in Professional Ethics Holistic Technologies, Production Systems and Management Models-Typical Case Studies, Strategies for Transition towards Value-based Life and Profession	
Course outcome (Course Skill Set) At the end of the course, students are expected to become more aware of themselves, and their surroundings (family, society, nature); • They would become more responsible in life, and in handling problems with sustainable solutions, while keeping human relationships and human nature in mind. • They would have better critical ability. • They would also become sensitive to their commitment towards what they have understood (human values, human relationship and human society). • It is hoped that they would be able to apply what they have learnt to their own self in different day-to-day settings in real life, at least a beginning would be made in this direction. Expected to positively impact common graduate attributes like: 1. Ethical human conduct 2. Socially responsible behaviour 3. Holistic vision of life 4. Environmentally responsible work 5. Having Competence and Capabilities for Maintaining Health and Hygiene 6. Appreciation and aspiration for excellence (merit) and gratitude for all	

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). The student is declared as a pass in the course if he/she secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous internal Examination (CIE)

- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.
- CIE paper shall be set for 25 questions, each of the 02 marks. The pattern of the question paper is MCQ (multiple choice question). The time allotted for SEE is 01 hour. The student has to secure a minimum of 35% of the maximum marks meant for SEE.

The sum of two tests, will be out of 100 marks and will be scaled down to 50 marks
Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examinations (SEE)

SEE paper shall be set for **50 questions,** each of the 01 marks. **The pattern of the question paper is MCQ (multiple choice questions). The time allotted for SEE is 01 hour.** The student has to secure a minimum of 35% of the maximum ma

Suggested Learning Resources:

Books for READING:

Text Book and Teachers Manual

- The Textbook A Foundation Course in Human Values and Professional Ethics, R R Gaur, R Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034- 47-1
- The Teacher‟s Manual for A Foundation Course in Human Values and Professional Ethics, R R Gaur, R Asthana, G

Reference Books

1. Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amar kantak, 1999.
2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3. The Story of Stuff (Book).
4. The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi
5. Small is Beautiful - E. F Schumacher.
6. Slow is Beautiful - Cecile Andrews
7. Economy of Permanence - J C Kumarappa
8. Bharat Mein Angreji Raj – Pandit Sunderlal
9. Rediscovering India - by Dharampal
10. Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi
11. India Wins Freedom - Maulana Abdul Kalam Azad
12. Vivekananda - Romain Rolland (English)
13. Gandhi - Romain Rolland (English)
14. Sussan George, 1976, How the Other Half Dies, Penguin Press. Reprinted 1986, 1991
15. Donella H. Meadows, Dennis L. Meadows, Jorgen Randers, William W. Behrens III, 1972, Limits to Growth – Club of Rome's report, Universe Books.

16. A Nagraj, 1998, Jeevan Vidya Ek Parichay, Divya Path Sansthan, Amarkantak.
17. P L Dhar, RR Gaur, 1990, Science and Humanism, Commonwealth Publishers.
18. A N Tripathy, 2003, Human Values, New Age International Publishers.
19. SubhasPalekar, 2000, How to practice Natural Farming, Pracheen (Vaidik) KrishiTantraShodh, Amravati.
20. E G Seebauer & Robert L. Berry, 2000, Fundamentals of Ethics for Scientists & Engineers , Oxford University Press
21. M Govindrajran, S Natrajan & V.S. Senthil Kumar, Engineering Ethics (including Human Values), Eastern Economy Edition, Prentice Hall of India Ltd.
22. B P Banerjee, 2005, Foundations of Ethics and Management, Excel Books.
23. B L Bajpai, 2004, Indian Ethos and Modern Management, New Royal Book Co., Lucknow. Reprinted 2008.

Web links and Video Lectures (e-Resources):

Value Education websites,

- https://www.uhv.org.in/uhv-ii,
- http://uhv.ac.in,
- http://www.uptu.ac.in
- Story of Stuff,
- http://www.storyofstuff.com
- Al Gore, An Inconvenient Truth, Paramount Classics, USA
- Charlie Chaplin, Modern Times, United Artists, USA
- IIT Delhi, Modern Technology – the Untold Story
- Gandhi A., Right Here Right Now, Cyclewala Productions
- https://www.youtube.com/channel/UCQxWr5QB_eZUnwxSwxXEkQw
- https://fdp-si.aicte-india.org/8dayUHV_download.php
- https://www.youtube.com/watch?v=8ovkLRYXIjE
- https://www.youtube.com/watch?v=OgdNx0X923I
- https://www.youtube.com/watch?v=nGRcbRpvGoU
- https://www.youtube.com/watch?v=sDxGXOgYEKM