Er. PERUMAL MANIMEKALAI COLLEGE OF ENGINEERING

(An Autonomous Institution–Affiliated to Anna University, Chennai)

Koneripalli, Hosur - 635117.

PMC TECH

INSPIRE TO INNOVATE

ACADEMIC REGULATIONS 2023 (R23)

Curriculum & Syllabi

(Version 1)

M.E. APPLIED ELECTRONICS

(Applicable from 2023 -24 onwards)

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

PEO1: The M.E. in Applied Electronics is a multidisciplinary program focused on enhancing skills in applying advanced electronics techniques to both contemporary and emerging fields.

PEO2: Develop the skills and mindset to adapt to changing technological and societal challenges.

PEO3: Leverage an intellectual environment through the Centre of Excellence in research-driven emerging technologies and intensive training to become scientists, technocrats, and business leaders.

PEO4: Strive to be a good human being and a responsible citizen, contributing to the overall welfare of society.

PROGRAM OUTCOMES (POs)

PO1: An ability to independently carry out research/investigation and development work to solve practical problems.

PO2: An ability to write and present a substantial technical report/document.

PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program

PO4: To critically evaluate the design and provide optimal solutions to problem areas in advanced signal processing, Consumer and automotive systems, embedded systems and VLSI design.

PO5: To enhance and develop electronic systems, protocols between circuits using modern engineering hardware and software tools.

PO6: To acquire knowledge of fundamentals of power electronics, power management, wireless, power supply circuits, RF circuits and FPGA circuits.

PROGRAM SPECIFIC OUTCOMES (PSOs):

PSO1: An ability to provide innovative solutions through the knowledge in Electronics Engineering domains namely Embedded, VLSI, Signal Processing and Networking.

PSO2: The capacity to ascertain the kind of tools and equipment required to Carry out challenges associated with implementations of Communication technologies to meet out societal and industrial Requirements of society.

PEOs	PROGRAM OUTCOMES (POs)							
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
PEO1	3	2	3	3	3	3	3	3
PEO2	3	2	3	3	2	3	2	1
PEO3	1	3	1	2	1	2	1	1
PEO4	1	2	1	-	-	-	1	-

REGULATIONS –2023

CHOICE BASED CREDIT SYSTEM

ME-APPLIED ELECTRONICS

CURRICULUM FOR I TO IV SEMESTERS

SEMESTER I

Sl. No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
THEORY								
1	PPAP1FC01	Applied Mathematics for Electronics Engineers	FC	4	3	1		4
2	PPAP1RM01	Research Methodology and IPR	RM	2	2	0		2
3	PPAP1PC01	Embedded System Design	PC	3	3	0		3
4	PPAP1PC02	Advanced Digital Signal Processing	PC	3	3	0		3
5	PPAP1TL01	Advanced Digital System Design	PC	5	3	0	2	4
6	PPAP1PC03	Semiconductor Devices and Modeling	PC	3	3	0		3
7	PPAP1ACXX	Audit Course – I*	AC	2	2			0
PRACTICALS								
8	PPAP1PL01	Advanced Digital Signal Processing	PL	4	0	0	4	2
9	PPAP1PL02	Embedded System Design Laboratory	PL	4	0	0	4	2
Total				**30**	**19**	**1**	**10**	**23**

***Registration for this course is optional to students**

SEMESTER II

Sl. No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
THEORY								
1	PPAP2PC04	ASIC and FPGA Design	PC	3	3	0	0	3
2	PPAP2PC05	Advanced Digital Image Processing	PC	3	3	0	0	3
3	PPAP2PC06	Analog and Mixed Signal IC Design	PC	3	3	0	0	3
4	PPAP2PEXX	Professional Elective-1	PE	3	3	0	0	3
5	PPAP2PEXX	Professional Elective-2	PE	3	3	0	0	3
6	PPAP2PEXX	Professional Elective-3	PE	3	3	0	0	3
7	PPAP2ACXX	**Audit Course-II***	AC	2	2	0	0	0
PRACTICALS								
7	PPAP2PL03	VLSI Design Laboratory	PL	4	0	0	4	2
8	PPAP2PL04	Advanced Digital Image Processing Laboratory	PL	4	0	0	4	2
9	PPAP2PL05	Term Paper Writing and seminar	PL	2	0	0	2	1
Total				**30**	**20**	**0**	**10**	**23**

***Registration for this course is optional to students**

SEMESTER III

Sl. No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
THEORY								
1	PPAP3PC07	IoT System Design and Security	PC	3	3	0	0	3
2	PPAP3PEXX	Professional Elective-4	PE	3	3	0	0	3
3	PPAP3PEXX	Professional Elective-5	PE	3	3	0	0	3
4	PPAP3OEXX	Open Elective-1	OE	3	3	0	0	3
PRACTICALS								
4	PPAP3PR01	Project Work Phase-I	PR	12	0	0	12	6
Total				**24**	**12**	**0**	**12**	**18**

SEMESTER IV

Sl. No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
PRACTICALS								
1	PPAP4PR02	Project Work Phase-II	PR	24	0	0	24	12
Total				**24**	**0**	**0**	**24**	**12**

TOTAL NO. OF CREDITS: 76

PROFESSIONAL ELECTIVES (PE)

SEMESTER II

ELECTIVE I

Sl. No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
1	PPAP2PE01	Digital Control Engineering	PE	3	3	0	0	3
2	PPAP2PE02	Sensors, Actuators & Interface Electronics	PE	3	3	0	0	3
3	PPAP2PE03	CAD for VLSI	PE	3	3	0	0	3
4	PPAP2PE04	Electromagnetic Interference and Compatibility	PE	3	3	0	0	3

ELECTIVE–II

Sl. No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
1	PPAP2PE05	VLSI Design Techniques	PE	3	3	0	0	3
2	PPAP2PE06	RF System Design	PE	3	3	0	0	3
3	PPAP2PE07	Wireless Ad-hoc and Sensor Networks	PE	3	3	0	0	3
4	PPAP2PE08	High Performance Networks	PE	3	3	0	0	3

ELECTIVE–III

Sl. No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
1	PPAP2PE09	DSP Architectures and Programming	PE	3	3	0	0	3
2	PPAP2PE10	Hardware–Software Co-design	PE	3	3	0	0	3
3	PPAP2PE11	Speech and Audio Signal Processing	PE	3	3	0	0	3
4	PPAP2PE12	Artificial Intelligence and Optimization Techniques	PE	3	3	0	0	3

SEMESTER-III

ELECTIVE–IV

Sl. No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
1	PPAP3PE13	Biomedical Signal Processing	PE	3	3	0	0	3
2	PPAP3PE14	Signal Integrity for High Speed Design	PE	3	3	0	0	3
3	PPAP3PE15	Consumer Electronics	PE	3	3	0	0	3
4	PPAP3PE16	Advanced Microprocessors and Microcontrollers Architectures	PE	3	3	0	0	3

ELECTIVE – V

Sl. No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
1	PPAP3PE17	Modeling and Synthesis with HDL	PE	3	3	0	0	3
2	PPAP3PE18	Artificial Intelligence and Machine Learning	PE	3	3	0	0	3
3	PPAP3PE19	Pattern Recognition	PE	3	3	0	0	3
4	PPAP3PE20	PCB Design	PE	3	3	0	0	3

AUDIT COURSE

Sl. No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
1	PPAP1ACXX	Audit Course – I*	AC	2	2	0	0	0
2	PPAP2ACXX	Audit Course-II*	AC	2	2	0	0	0

DISTRIBUTION OF CREDITS

Sl. No.	Category	Credits as per Semester				Total Credits
		I	II	III	IV	
1	FC	4	-	-	-	**4**
2	PC	17	14	3	-	**34**
3	PR	-	0	6	12	**18**
4	PE	-	9	6	-	**15**
5	OE	-	-	3	-	**3**
6	RM	2	-	-	-	**2**
7	AC	-	0	-	-	**0**
Total Credits		**23**	**23**	**18**	**12**	**76**

SEMESTER I

Sl. No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
THEORY								
1	PPAP1FC01	Applied Mathematics for Electronics Engineers	FC	4	3	1		4
2	PPAP1RM01	Research Methodology and IPR	RM	2	2	0		2
3	PPAP1PC01	Embedded System Design	PC	3	3	0		3
4	PPAP1PC02	Advanced Digital Signal Processing	PC	3	3	0		3
5	PPAP1TL01	Advanced Digital System Design	PC	5	3	0	2	4
6	PPAP1PC03	Semiconductor Devices and Modeling	PC	3	3	0		3
7	PPAP1ACXX	Audit Course – I*	AC	2	2			0
PRACTICALS								
8	PPAP1PL01	Advanced Digital Signal Processing	PL	4	0	0	4	2
9	PPAP1PL02	Embedded System Design Laboratory	PL	4	0	0	4	2
Total				**30**	**19**	**1**	**10**	**23**

***Registration for this course is optional to students**

PPAP1FC01	APPLIED MATHEMATICS FOR ELECTRONICS ENGINEERS	L T P C
		3 1 0 4

COURSE OBJECTIVE

The main objective of this course is to demonstrate various analytical skills in applied mathematics and extensive experience with the tactics of problem solving and logical thinking applicable in electronics engineering. This course also will help the students to identify, formulate, abstract, and solve problems in electrical engineering using mathematical tools from a variety of mathematical areas, including fuzzy logic, matrix theory, probability, dynamic programming and queuing theory

UNIT I FUZZY LOGIC 12

Introduction to fuzzy logic – Classical logic–Multi-valued logics –Fuzzy propositions –Fuzzy quantifiers

UNIT II MATRIX THEORY 12

Cholesky decomposition- Generalized Eigen vectors- Canonical basis- QR factorization-Least squares method -Singular value decomposition.

UNIT III PROBABILITY AND RANDOM VARIABLES 12

Probability–Axioms of probability–Conditional probability–Baye's theorem-Random variables – Probability function – Moments – Moment generating functions and their properties –Binomial, Poisson, Geometric, Uniform, Exponential, Gamma and Normal distributions – Function of a Random variable

UNIT IV DYNAMIC PROGRAMMING 12

Dynamic programming – Principle of optimality – Forward and backward recursion–Applications of dynamic programming– Problem of dimensionality.

UNIT V QUEUEING MODELS 12

Poisson Process – Markova an queues – Single and multi-server models – Little's formula – Machine interference model– Steady state analysis– Self-service queue.

TOTAL: 60 PERIODS

Cos	At the end of the course the student will be able to	Blooms Taxonomy
CO-1	Concepts of fuzzy sets, knowledge representation using fuzzy rules, fuzzy logic, fuzzy Prepositions and fuzzy quantifiers and applications of fuzzy logic.	Understand
CO-2	Apply various methods in matrix theory to solve system of linear equations	Analyze
CO-3	Computation of probability and moments, standard distributions of discrete and continuous random variables and functions of a random variable	Understand
CO-4	Conceptualize the principle of optimality and sub-optimization, formulation and computational procedure of dynamic programming	Understand
CO-5	Exposing the basic characteristic features of a queuing system and models	Understand

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	3	3	2	-	-	-
2	3	3	2	-	-	-
3	3	3	2	-	-	-
4	3	3	2	-	-	-
5	3	3	2	-	-	-

TEXTBOOKS:

1. Richard C, "Applied Mathematics for Electronics Engineers", Pocket Book of Electrical Engineering, 2018.
2. R S Salaria, "A Textbook of Engineering Mathematics (PTU-II)", Big Book, 2016.

REFERENCES:

1. J Sakthivel and Anbarasan R, "Applied Mathematics for Electronics Engineers, Suchitra Publications, 2016.
2. A Louis Pipes and Lawerence R. Harvill," Applied Mathematics for Engineers and Physicists: Third Edition (Dover Books on Mathematics) Third Edition, Kindle Edition, Dover Publications, and June 2014.
3. Gross, D., Shortle J. F., Thompson, J.M., and Harris, C. M., "Fundamentals of QueueingTheory",4th Edition, John Wiley, 2014.
4. Johnson, R.A., Miller, I and Freund J., "Miller and Freund "s Probability and Statistics for Engineers", Pearson Education,Asia,8th Edition,2015
5. Taha, H.A., "Operations Research: An Introduction", 9th Edition, Pearson Education, Asia, New Delhi, 2016

WEBSITE REFERENCES:

1. **Introduction to Fuzzy Logic:** https://www.geeksforgeeks.org/fuzzy-logic-introduction/
2. **Matrix Theory:** https://www.maths.ed.ac.uk/~v1ranick/papers/gantmacher1.pdf
3. **Probability and Random Variables:** https://www.britannica.com/science/statistics/Random- variables-and-probability-distributions
4. **Dynamic Programming:** https://medium.com/analytics-vidhya/dynamic-programming- mathematical-optimization-model-85c7f702216a
5. **Queuing Theory:** https://queue-it.com/blog/queuing-theory/

NPTEL/ SWAYAM/ MOOC REFERENCES:

1. NPTEL: Fuzzy Logic and Neural Network, IIT Kharagpur.
2. NPTEL: Dynamic Programming, IIT Kharagpur.

PPAP1RM01	RESEARCH METHODOLOGY AND IPR	L T P C
		2 0 0 2

COURSE OBJECTIVES

- To impart knowledge and skills required for research and IPR.
- Problem formulation, analysis and solutions.
- Technical paper writing/presentation without violating professional ethics
- Patent drafting and filing patents.

UNIT I: RESEARCH PROBLEM FORMULATION **6**

Meaning of research problem- Sources of research problem, criteria characteristics of a good research problem, errors in selecting a research problem, scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, necessary instrumentations

UNIT II: LITERATURE REVIEW **6**

Effective literature studies approaches, analysis, plagiarism, and research ethics.

UNIT III :TECHNICAL WRITING/PRESENTATION **6**

Effective technical writing, how to write report, paper, developing a research proposal, format of research proposal, a presentation and assessment by are view committee.

UNIT VI: INTRODUCTION TO INTELLECTUAL PROPERTY RIGHTS (IPR) **6**

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International co-operation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

UNIT V:INTELLECTUALPROPERTYRIGHTS (IPR) **6**

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. New Developments in IPR: Administration of Patent System, IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

TOTAL: 30 PERIODS

COs	At the end of the course the student will be able to	Blooms Taxonomy
CO-1	Concepts of fuzzy sets, knowledge representation using fuzzy rules, fuzzy logic, fuzzy Prepositions and fuzzy quantifiers and applications of fuzzy logic.	Understand
CO-2	Apply various methods in matrix theory to solve system of linear equations	Analyze
CO-3	Computation of probability and moments, standard distributions of discrete and continuous random variables and functions of a random variable	Understand
CO-4	Conceptualize the principle of optimality and sub-optimization, formulation and computational procedure of dynamic programming	Understand
CO-5	Exposing the basic characteristic features of a queuing system and acquire skills in analyzing queuing models	Understand

COs	POs					
	PO1	PO2	PO3	PO4	PO 5	PO6
1	1	-	-	-	3	2
2	2	-	-	-	2	3
3	3	-	-	-	3	2
4	4	-	-	-	3	2
5	5	-	-	-	3	3

TEXTBOOKS:

1. Ellapu Venkatesh Palagati Anusha, Savuturu Sujith Kumar, Syed Mastan Basha, "Fundamentals of Research Methodology and Intellectual Property Rights", Redshine Publication, 2023.
2. Dr. R. K. Prasad, Dr. V. K. Bhojwani," Research Methodology and IPR", Nirali Prakashan Publications, Edition 1, 2021.

REFERENCES:

1. Kompal Bansal & Parshit Bansal,"Fundamentals of IPR for Beginner"s", 1st Edition, BS Publications, 2016.
2. Ranjith Kumar, "Research Methodology – A Step by Step for Beginner"s", 2nd Edition, Pearson, Education, 2016.

3. Robert P. Merges, Peter S. Menell and Mark A. Lemley, "Intellectual Property in New Technological Age", Aspen Publishers, 2016.
4. C.R.Kothari, "Research Methodology", 3rd Edition, New Age International, 2017.

T. Ramappa, " Intellectual Property Rights Under WTO" , 2 nd Edition, S Chand, 2015.

WEBSITE REFERENCES:

1. **Research-Problem-Formulation:**https://www.indeed.com/career-advice/career development/research-problem.
2. **Literature Review:** https://writingcenter.unc.edu/tips-and-tools/**literat**ure-reviews/
3. **Technical-Writing-Presentation:** http://www.eiti.uottawa.ca/~rhabash/ELG2911TechnicalWritingandPresentation.pdf

Intellectual Property Rights (IPR): https://blog.ipleaders.in/all-about-intellectual-property-rights-ipr/

NPTEL/SWAYAM/MOOC REFERENCES:

1. Introduction to Research, IIT Madras, Prathap Haridoss
2. Literature and Coping Skills, IIT (BHU) Varangasi, Prof. Ajit K Mishra
3. Academic & Research Report Writing, ITTR, Kokata, Dr. Samir Roy

Intellectual Property, IIT Madras, Prof. Feroz Ali

PPAP1PC01	EMBEDDED SYSTEM DESIGN	L T P C 3 0 0 3

COURSE OBJECTIVES:

- To Understand the concepts of Embedded design challenges and design methodologies
- To Study general and single purpose processor
- To Understand bus structures and protocols
- To Design a state machine and concurrent process models
- To Describe the Embedded software development tools and RTOS.

UNIT I EMBEDDED SYSTEM OVER VIEW **9**

Embedded System Overview, Design Challenges–Optimizing Design Metrics, Design Methodology, RT- Level Combinational and Sequential Components, Optimizing Custom Single-Purpose Processors.

UNIT II GENERAL AND SINGLE PURPOSE PROCESSOR **9**

Basic Architecture, Pipelining, Super scalar and VLIW architectures, Program's view, Development Environment, Application-Specific Instruction-Set Processors (ASIPs) Microcontrollers, Timers, Counters and watchdog Timer, UART, LCD Controllers and Analog-to-Digital Converters, Memory Concepts.

UNIT III BUS STRUCTURES **9**

Basic Protocol Concepts, Microprocessor Interfacing – I/O Addressing, Port and Bus-Based I/O, Arbitration, Serial Protocols, I2C, CAN and USB, Parallel Protocols – PCI and ARM Bus, Wireless Protocols –IrDA, Bluetooth, IEEE 802.11.

UNIT IV STATE MACHINE AND CONCURRENT PROCESS MODELS **9**

Basic State Machine Model, Finite-State Machine with Data path Model, Capturing State Machine in Sequential Programming Language, Program-State Machine Model, Concurrent Process Model, Communication among Processes, Synchronization among processes, Dataflow Model, Real-time Systems, Automation: Synthesis, Verification: Hardware/Software Co-Simulation, Reuse: Intellectual Property Cores, Design Process Models

UNIT V EMBEDDED SOFTWARE DEVELOPMENT TOOLS AND RTOS **9**

Compilation Process–Libraries–Porting kernels–C extensions for embedded systems–emulation and debugging techniques– RTOS –System design using RTOS.

TOTAL: 45 PERIODS

COs	At the end of the course the student will be able to	Blooms Taxonomy
CO-1	Understand the concepts to design an Embedded system	Understand
CO-2	Understand a general and single purpose processor	Understand
CO-3	Explain the various methods of structures and protocols	Understand
CO-4	Describe the state machine and design process models	Understand
CO-5	Analyze the embedded software development tools and RTOS	Apply

COs	POs					
	PO1	PO2	PO3	PO4	PO 5	PO6
1	2	-	-	3	-	-
2	1	-	2	3	-	-
3	-	-	-	3	2	-
4	-	-	2	3	1	-
5	2	-	-	3	2	1

TEXT BOOKS:

1. Peter Marwedel," Embedded System Design", Springer Publication, Fourth Edition, 2021
2. Richard Z, "Embedded System Design and Verification, CRC Press, 2016.

REFERENCES:

1.Mohit Arora, "Embedded System Design: Introduction to SoC System Architecture", Learning Bytes Publishing; 1st edition, 2016.

2. Frank Vahid and Tony Gwargie, "Embedded System Design",John Wiley & sons, 2012.

3. Steve Heath,"Embedded System Design", Elsevier, Second Edition, 2014.

WEBSITE REFERENCE:

1. Introduction-to-Embedded-Systems:

https://ptolemy.berkeley.edu/books/leeseshia/releases/LeeSeshia_DigitalV2_2.pdf

2. **Embedded-Systems:**

https://www.iitg.ac.in/pbhaduri/cs52213/Introduction%20to%20Embedded%20Systems%20(ver%200.5,%20Aug%202010).pdf.

NPTEL/SWAYAM/MOOC REFERENCES:

1.NPTEL: Embedded System Design Prof. Anupam Basu, IIT Kharagpur.

2. NPTEL: Embedded System Design with ARM Prof Indranil Sungupta, IIT, Kharagpur.

PPAP1PC02	ADVANCED DIGITAL SIGNAL PROCESSING	L T P C
		3 0 0 3

COURSE OBJECTIVES

- To describe fundamental concepts of DSP and Discrete Transforms .
- To design digital filters design.
- To estimate power spectrum using non- parametric and parametric methods.
- To analyze the Multi-rate Signal processing by decimation and interpolation.
- To apply the concept of Multi-rate signal processing for various applications.

UNIT I: DIGITAL SIGNAL PROCESSING 9

Sampling of analog signals - Selection of sampling frequency - Frequency response - Transfer Functions - Filter structures - Fast Fourier Transform (FFT) Algorithms - Image coding - DCT.

UNIT II: DIGITAL FILTER DESIGN 9

IIR and FIR Filters: Filter structures, Implementation of Digital Filters - 2nd Order Narrow Band Filter and 1st Order All Pass Filter, Frequency sampling structures of FIR, Lattice structures, Forward and Backward prediction error filters, Reflection coefficients for lattice realization, Implementation of lattice structures for IIR filters, Advantages of lattice structures.

UNIT III : ESTIMATION OF POWER SPECTRUM 9

Non-Parametric Methods: Estimation of spectra from finite duration observation of signals,: Bartlett, Welch & Blackman-Tukey methods, Performance Comparison. Parametric Methods: Autocorrelation & Its Properties, Relation between auto correlation & model parameters, AR Models - Yule-Walker & Burg
Methods, MA & ARMA models for power spectrum estimation.

UNITIV: MULTI RATE SIGNAL PROCESSING 9

Decimation by a factor D - Interpolation by a factor I - Sampling rate conversion by rational factor I/D, Multistage Implementation of Sampling Rate Conversion, Filter design and Implementation for sampling
rate conversion. Up-sampling using All Pass Filter.

UNIT V : APPLICATIONS OF MULTI RATE SIGNAL PROCESSING AND DSP INTEGRATED CIRCUIT 9

Design of Phase Shifters, Interfacing of Digital Systems with Different Sampling Rates, Implementation of Narrow Band Low Pass Filters, Implementation of Digital Filter Banks, Sub band Coding of Speech Signals, Quadrature Mirror Filters, Over Sampling A/D and D/A Conversion.

TOTAL:45 PERIODS

COs	At the end of the course the student will be able to	Blooms Taxonomy
CO-1	Understand the concepts to design an Embedded system	Understand
CO-2	Understand a general and single purpose processor	Understand
CO-3	Explain the various methods of structures and protocols	Understand
CO-4	Describe the state machine and design process models	Understand
CO-5	Analyze the embedded software development tools and RTOS	Apply

COs	POs					
	PO1	PO2	PO3	PO4	PO 5	PO6
1	2	-	-	3	-	-
2	1	-	2	3	-	-
3	-	-	-	3	2	-
4	-	-	2	3	1	-
5	2	-	-	3	2	1

TEXT BOOKS:

1. J.G.Proakis & D. G.Manolakis Digital Signal Processing: Principles, Algorithms & Applications -
   , 4th Ed., Pearson Education, 2016.
2. Alan V Oppenheim & Ronald W Schaffer Discrete Time signal processing, Pearson Education, 2017.

REFERENCES:

1. Keshab K. Parhi, „VLSI Digital Signal Processing Systems Design and Implementation", John Wiley& Sons, 2016.
2. Steven. M .Kay, Modern Spectral Estimation: Theory & Application –PHI, 2016.

WEBSITEREFERENCES:

1. **Advanced Digital Signal Processing:** https://www.cse.iitd.ac.in/~sumantra/courses/adsp/adsp.html
2. **Advanced Digital Signal Processing:** https://web.iitd.ac.in/~seshan/teaching/ell720.html

NPTEL/SWAYAM/MOOC REFERENCES:

1. DSP and its Applications, Prof. V. M. Gadre, IIT Bombay.
2. ADSP-Multi-Rate and Wave-let, Prof. V M Gadre, IIT Bombay.

PPAP1TL01	ADVANCED DIGITAL SYSTEM DESIGN	L	T	P	C
		3	0	2	4

COURSE OBJECTIVES:

- To introduce methods to analyze and design synchronous and asynchronous sequential circuits.
- To introduce the architectures of programmable devices.
- To introduce design and implementation of digital circuits using programming tools.

UNIT I: SEQUENTIAL CIRCUIT DESIGN 9

Analysis of clocked synchronous sequential circuits and modeling- State diagram, state table, state table assignment and reduction-Design of synchronous sequential circuits design of iterative circuits-ASM chart and realization using ASM

UNIT II: ASYNCHRONOUS SEQUENTIAL CIRCUIT DESIGN 9

Analysis of asynchronous sequential circuit – flow table reduction-races-state assignment-transition table and problems in transition table- design of asynchronous sequential circuit-Static, dynamic and essential hazards – data synchronizers – mixed operating mode asynchronous circuits – designing vending machine controller

UNIT III: FAULT DIAGNOSIS AND TEST ABILITY ALGORITHMS 9

Fault table method-path sensitization method – Boolean difference method-D algorithm – Tolerance techniques–The compact algorithm–Fault in PLA–Test generation-DFT schemes–Built in self-test.

UNIT IV: SYNCHRONOUS DESIGN USING PROGRAMMABLE DEVICES 9

Programming logic device families–Designing asynchronous sequential circuit using PLA/PAL– Realization of finite state machine using PLD –FPGA–XilinxFPGA-Xilinx4000

UNIT V: SYSTEM DESIGN USING VERILOG 9

Hardware Modeling with Verilog HDL – Logic System, Data Types and Operators For Modeling in Verilog HDL - Behavioral Descriptions in Verilog HDL– HDL Based Synthesis – Synthesis of Finite State Machines–structural modeling–compilation and simulation of Verilog code–Test bench-Realization of combinational and sequential circuits using Verilog–Registers–counters– Sequential machine–serial adder–Multiplier-Divider–Design of simple microprocessor.

TOTAL:45 PERIODS

COs	At the end of the course the student will be able to	Blooms Taxonomy
CO-1	Understand the concepts to design an Embedded system	Understand
CO-2	Understand a general and single purpose processor	Understand
CO-3	Explain the various methods of structures and protocols	Understand
CO-4	Describe the state machine and design process models	Understand
CO-5	Analyze the embedded software development tools and RTOS	Apply

COs	POs					
	PO1	PO2	PO3	PO4	PO 5	PO6
1	2	-	2	-	-	-
2	2	-	-	3	-	-
3	-	-	-	-	2	1
4	-	-	3	-	-	2
5	-	-	-	2	3	-

TEXT BOOKS:

1. Charles H.RothJ "Fundamentals of Logic Design" Thomson Learning, Third Edition, 2017

2. M.D.Ciletti, Modeling, Synthesis and Rapid Prototyping with the Verilog HDL, Prentice Hall, Fourth Edition, 2018.

REFERENCES:

1. M.G. Arnold, Verilog Digital–Computer Design, Prentice Hall (PTR), Third Edition, 2016.
2. Nripendra N Biswas" Logic Design Theory" Prentice Hall of India, Fifth Edition, 2017
3. Parag K. Lala" Digital system Design using PLD" BS Publications, Third Edition, 2016
4. Parag K.Lala" Fault To leant and Fault Test able Hardware Design "BS Publications, Fourth edition, 2017

S.Palnitkar, Verilog HDL –A Guide to Digital Design and Synthesis, Pearson, Third Edition,2016.

WEBSITE REFERENCE:

1. **Advanced Digital System Design:** https://www.scribd.com/document/396180099/Ap5151-Advanced-Digital-System-Design#

NPTEL/SWAYAM/MOOC REFERENCE:

1.ADSP, Prof. Neeraj Goel, IIT Ropar.

PRACTICAL PERIODS:

1. Design of Registers by Verilog HDL.
2. Design of Counters by Verilog HDL.
3. Design of Sequential Machines by Verilog HDL.
4. Design of Serial Adders , Multiplier and Divider by Verilog HDL.
5. Design of a simple Microprocessor by Verilog HDL.

PPAP1PC03	SEMICONDUCTOR DEVICES AND MODELING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To acquire the fundamental knowledge and to expose to the field of semiconductor and devices and their applications.
- To gain adequate understanding of semiconductor device modeling aspects, designing devices for electronic applications
- To acquire the fundamental knowledge of different semiconductor device modeling aspects.

UNIT I: MOS CAPACITORS 9

Surface Potential: Accumulation, Depletion, and Inversion, Electrostatic Potential and Charge Distribution in Silicon, Capacitances in an MOS Structure, Poly-silicon-Gate Work Function and Depletion Effects, MOS under Non-equilibrium and Gated Diodes, Charge in Silicon Dioxide and at the Silicon–Oxide Interface, Effect of Interface Traps and Oxide Charge on Device Characteristics, High- Field Effects,ImpactIonizationandAvalancheBreakdown,Band-to-BandTunneling,Tunneling into and through Silicon Dioxide, Injection of Hot Carriers from Silicon into Silicon Dioxide, High-Field Effects in Gated Diodes, Dielectric Breakdown

UNIT II: MOSFET DEVICES 9

Long-Channel MOSFETs, Drain-Current Model, MOSFET I–V Characteristics, Sub threshold Characteristics, Substrate Bias and Temperature Dependence of Threshold Voltage, MOSFET Channel Mobility, MOSFET Capacitances and Inversion-Layer Capacitance Effect, Short-Channel MOSFETs, Short- Channel Effect, Velocity Saturation and High-Field Transport Channel Length Modulation, Source–Drain Series Resistance, MOSFET Degradation and Breakdown at High Fields

UNIT III: LINEAR ESTIMATION AND PREDICTION 9

CMOS scaling, constant field scaling, Generalized scaling , Non scaling effects, Threshold voltage, Threshold voltage Requirement, Channel profile design, Non uniform doping, Quantum effect on threshold voltage, Discrete dopant effects on threshold voltage, MOSFET channel length, Various definitions of channel length, Extraction of the effective channel length, Physical meaning of effective channel length, Extraction of the channel length by C-V measurements.

UNIT IV: BIPOLAR DEVICES	9
n–p–n Transistors, Basic Operation of a Bipolar Transistor, Modifying the Simple Diode Theory for Describing Bipolar Transistors, Ideal Current Voltage Characteristics, Collector Current, Base Current, Current Gains, Ideal IC–VCE Characteristics, Characteristics of a Typical n–p–n Transistor, Effect of Emitter and Base Series Resistances, Effect of Base–Collector Voltage on Collector Current, Collector Current Fall of fat High Currents, Non-ideal Base Current at Low Currents, Bipolar Device Models for Circuit and Time- Dependent Analyses Basic dc Model, Basic ac Model, Small-Signal Equivalent-Circuit Model, Emitter Diffusion Capacitance, Charge-Control Analysis, Breakdown Voltages, Common-Base Current Gain in the Presence of Base–Collector Junction Avalanche, Saturation Currents in a Transistor.	

UNIT V: MATHEMATICAL TECHNIQUES FOR DEVICE SIMULATIONS	9
Poisson equation, continuity equation, drift-diffusion equation, Schrodinger equation, hydro dynamic equations, trap rate, finite difference solutions to these equations in 1D and 2D space, grid generation.	

COs	At the end of the course the student will be able to	Blooms Taxonomy
CO-1	Understand the concepts to design an Embedded system	Understand
CO-2	Understand a general and single purpose processor	Understand
CO-3	Explain the various methods of structures and protocols	Understand
CO-4	Describe the state machine and design process models	Understand
CO-5	Analyze the embedded software development tools and RTOS	Apply

COs	POs					
	PO1	PO2	PO3	PO4	PO 5	PO6
1	2	1	-	-	-	-
2	1	-	2	-	-	-
3	2	-	1	-	-	-
4	-	-	2	1	-	-
5	2	-	-	-	1	-

TEXT BOOKS

1. Yuan Taur and TakH.Ning, "Fundamentals of Modern VLSI Devices", Cambridge University Press, 2016.
2. A.B. Bhattacharyya "Compact MOSFET Models for VLSI Design", John Wiley & Sons Ltd, Third Edition, 2017.

REFERENCES:

1. Ansgar Jungel, "Transport Equations for Semiconductors", Springer, Second Edition, 2016
2. Trond Ytterdal, Yuhua Cheng and Tor A. Fjeldly Wayne Wolf, "Device Modelling for

Analog and RF CMOS Circuit Design", John Wiley & Sons Ltd, Fourth Edition, 2017

3. Selberherr, S., "Analysis and Simulation of Semiconductor Devices", Springer-Verilog., Fifth Edition, 2016
4. Behzad Razavi, "Fundamentals of Microelectronics" Wiley Student Edition, 3rd Edition, 2016.
5. J P Collinge, C A Collinge, "Physics of Semiconductor devices" Springer, 4th Edition, 2016.

NPTEL/SWAYAM/MOOC REFERENCES:

1. CMOD Digital VLSI Design, Prof. Sudeb Dasgupta, IIT Roorkee
2. Micro Electronics Device to Circuits, Prof. Sudeb Dasgupta, IIT Roorkee.
3. Mathematical-Modelling-Analysis-and-Applications, Prof. Ameeya Kumar Nayak, IIT Roorkee.

WEBSITE REFERENCES:

1. **Semiconductor Device Modelling and Simulation for Electronic Circuit Design:** https://www.intechopen.com/chapters/71973
2. **Concept-of-Modelling-Semiconductor-Devices:** https://nanohub.org/resources/11494/download/General_Concepts_of_Modeling_Semiconductor_Devices.pdf

AUDIT COURSE-I (AC)

PPAP1ACXX	ENGLISH FOR RESEARCH PAPER WRITING	L	T	P	C
		2	0	0	0

COURSE OBJECTIVES:

- Teach how to improve writing skills and level of readability
- Tell about what to write in each section
- Summarize the skills needed when writing a Title
- Infer the skills needed when writing the Conclusion
- Ensure the quality of paper at very first-time submission

UNIT I INTRODUCTION TO RESEARCH PAPER WRITING 6

Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

UNIT II PRESENTATION SKILLS 6

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Introduction

UNIT III TITLE WRITING SKILLS 6

Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check

UNIT IV RESULT WRITING SKILLS 6

Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions

UNIT V VERIFICATIONSKILLS 6

Useful phrases, checking Plagiarism, how to ensure paper is as good as it could possibly be the first-time submission

TOTAL:30 PERIODS

COs	At the end of the course the student will be able to	Blooms Taxonomy
CO-1	Understand that how to improve your writing skills and level of readability	Understand
CO-2	Learn about what to write in each section	Understand
CO-3	Understand the skills needed when writing a Title	Understand
CO-4	Understand the skills needed when writing the Conclusion	Understand
CO-5	Ensure the good quality of paper at very first-time submission	Understand

COs	POs					
	PO1	PO2	PO3	PO4	PO 5	PO6
1	-	3	-	-	-	-
2	-	3	-	-	-	-
3	-	3	-	-	-	-
4	-	3	-	-	-	-
5	-	3	-	-	-	-

TEXT BOOKS:

1. Adrian Wall work , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, Third Edition, 2016.
2. Day R How to Write and Publish a Scientific Paper, Cambridge University Press, Fourth Edition, 2016.

REFERENCES:

3. Goldbort R Writing for Science, Yale University Press (available on Google Books), Third Edition, 2016
4. High man N, Handbook of Writing for the Mathematical Sciences, SIAM. High man's book, Fifth Edition, 2017.

PPAP1PL01	ADVANCED DIGITAL SIGNAL PROCESSING LABORATORY	L T P C
		0 0 4 2

COURSE OBJECTIVES

- To provide the student with the basic understanding of audio signal analysis using filters
- To provide the students with the understanding of the working of statistical method based approaches
- To impart the students with the design of filters
- To demonstrate the working of algorithms for different applications
- To provide knowledge of analyzing the images and video

LISTOFEXPERIMENTS:

1. Design of Adaptive channel equalizer
2. Realization of sub band filter using linear convolution
3. Realization of STFT using FFT
4. Demonstration of Bayes technique
5. Demonstration of Min-max technique
6. Realization of FIR Wiener filter
7. Generation of Multivariate Gaussian generated data with desired mean vector and the required co-variance matrix.
8. Design and Realization of the adaptive filter using LMS algorithm (solved using steepest descent algorithm)
9. Representation of the 2D image signal as the linear combinations of PCA (Eigen faces)
10. Image compression using Discrete cosine transformation (DCT).
11. Multiple-input Multiple output (MIMO)
12. Speech recognition using Support Vector Machine (SVM)
13. LMS filtering implementation using TMS320C6x processor
14. Face detection and tracking in video using Open CV

60 PERIODS

COs	At the end of the course the student will be able to	Blooms Taxonomy
CO-1	Understand that how to improve your writing skills and level of readability	Understand
CO-2	Learn about what to write in each section	Understand
CO-3	Understand the skills needed when writing a Title	Understand
CO-4	Understand the skills needed when writing the Conclusion	Understand
CO-5	Ensure the good quality of paper at very first-time submission	Understand

COs	POs					
	PO1	PO2	PO3	PO4	PO 5	PO6
1	3	3	2	-	-	-
2	3	3	2	-	-	-
3	3	3	2	-	-	-
4	3	3	2	-	-	-
5	3	3	2	-	-	-

PPAP1PL02	EMBEDDED SYSTEMS DESIGN LABORATORY	L T P C
		0 0 4 2

COURSE OBJECTIVES

- To develop a knowledge about ARM processor in practical manner
- To enhance the application of embedded system using ARM processor in hands-on session
- To develop a knowledge about embedded system using TMS320C54X with CCS

1. Data Operations:

a) Arithmetic Operations
b) Block Transfers

2. I/O Interface

a) LCD Display
b) Matrix Keyboard
c) A/D Conversion
d) D/A conversion

3. Timer Operation – Real Time Clock

4. Experiments on TMS320C54X using CCS

1. Advanced addressing modes
2. Convolution/Correlation of Signals
3. Computation of FFT
4. Audio Capture and Processing
5. Implementation of LMS Algorithm

TOTAL:60 PERIODS

COs	At the end of the course the student will be able to	Blooms Taxonomy
CO-1	Experiment algorithm and programming with ARM Processor for arithmetic operations and block transfers	Understand
CO-2	Demonstrate the use of various I/O interfaces with ARM Processor	Create
CO-3	Develop algorithms and code for different applications for implementation on TMS320C54X processor	Create

COs	POs					
	PO1	PO2	PO3	PO4	PO 5	PO6
1	-	-	1	-	-	3
2	-	-	1	-	-	2
3	-	-	1	-	-	3

SEMESTER II

Sl. No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
THEORY								
1	PPAP2PC04	ASIC and FPGA Design	PC	3	3	0	0	3
2	PPAP2PC05	Advanced Digital Image Processing	PC	3	3	0	0	3
3	PPAP2PC06	Analog and Mixed Signal IC Design	PC	3	3	0	0	3
4	PPAP2PEXX	Professional Elective-1	PE	3	3	0	0	3
5	PPAP2PEXX	Professional Elective-2	PE	3	3	0	0	3
6	PPAP2PEXX	Professional Elective-3	PE	3	3	0	0	3
7	PPAP2ACXX	**Audit Course-II***	AC	2	2	0	0	0
PRACTICALS								
7	PPAP2PL03	VLSI Design Laboratory	PL	4	0	0	4	2
8	PPAP2PL04	Advanced Digital Image Processing Laboratory	PL	4	0	0	4	2
9	PPAP2PL05	Term Paper Writing and seminar	PL	2	0	0	2	1
Total				**30**	**20**	**0**	**10**	**23**

***Registration for this course is optional to students**

PROFESSIONAL ELECTIVES (PE)

SEMESTER II

ELECTIVE I

Sl. No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
1	PPAP2PE01	Digital Control Engineering	PE	3	3	0	0	3
2	PPAP2PE02	Sensors, Actuators & Interface Electronics	PE	3	3	0	0	3
3	PPAP2PE03	CAD for VLSI	PE	3	3	0	0	3
4	PPAP2PE04	Electromagnetic Interference and Compatibility	PE	3	3	0	0	3

ELECTIVE–II

Sl. No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
1	PPAP2PE05	VLSI Design Techniques	PE	3	3	0	0	3
2	PPAP2PE06	RF System Design	PE	3	3	0	0	3
3	PPAP2PE07	Wireless Ad-hoc and Sensor Networks	PE	3	3	0	0	3
4	PPAP2PE08	High Performance Networks	PE	3	3	0	0	3

ELECTIVE–III

Sl. No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
1	PPAP2PE09	DSP Architectures and Programming	PE	3	3	0	0	3
2	PPAP2PE10	Hardware–Software Co-design	PE	3	3	0	0	3
3	PPAP2PE11	Speech and Audio Signal Processing	PE	3	3	0	0	3
4	PPAP2PE12	Artificial Intelligence and Optimization Techniques	PE	3	3	0	0	3

PPAP2PC04	ASIC AND FPGA DESIGN	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To study the design flow of different types of ASIC.
- To familiarize the different types of programming technologies and logic devices.
- To learn the architecture of different types of FPGA.
- To gain knowledge about partitioning, floor planning, placement and routing including circuit extraction of ASIC

UNIT I: OVERVIEW OF ASIC AND PLD 9

Types of ASICs - Design flow – CAD tools used in ASIC Design – Programming Technologies: Anti-fuse – static RAM – EPROM and EEPROM technology, Programmable Logic Devices: ROMs and EPROMs – PLA–PAL. Gate Arrays– CPLDs and FPGAs

UNIT II: ASIC PHYSICAL DESIGN 9

System partition -partitioning - partitioning methods – interconnect delay models and measurement of delay - floor planning -placement – Routing: global routing- detailed routing - special routing –circuit extraction- DRC

UNIT III: LOGIC SYNTHESIS, SIMULATION AND TESTING 9

Design systems - Logic Synthesis - Half gate ASIC -Schematic entry - Low level design language -PLA tools -EDIF- CFI design representation. Verilog and logic synthesis -VHDL and logic synthesis –types of simulation-boundary scan test –fault simulation –automatic test pattern generation

UNIT IV: FIELD PROGRAMMABLE GATE ARRAYS 9

FPGA Design: FPGA Physical Design Tools-Technology mapping-Placement & routing-Register transfer (RT)/Logic Synthesis-Controller/Data path synthesis –Logic minimization.

UNIT V : SOC DESIGN 9

System-On-Chip Design-SoC Design Flow, Platform – based and IP based SoC Designs, Basic Concepts of Bus-Based Communication Architectures. High performance algorithms for ASICs/ SoCs as case studies: Canonical Signed Digit Arithmetic, Knowledge Crunching Machine, Distributed Arithmetic, High performance digital filters for sigma-delta ADC.

TOTAL:45 PERIODS

COs	At the end of the course the student will be able to	Blooms Taxonomy
CO-1	To analyze the synthesis, Simulation and testing of systems	Analyze
CO-2	To apply different high performance algorithms in ASICs	Apply
CO-3	To discuss the design issues of SOC	Understand
CO-4	To design a FPGA Physical	Create
CO-5	Design System on Chip	Create

COs	POs					
	PO1	PO2	PO3	PO4	PO 5	PO6
1	-	-	-	-	-	-
2	1	-	1	2	2	2
3	2	-	1	3	3	2
4	-	-	2	3	3	2
5	1	-	3	3	3	1

TEXT BOOKS:

1. David A. Hodges, Analysis and Design of Digital Integrated Circuits(3/e),MGH, Fifth Edition, 2016
2. H. Gerez, Algorithms for VLSI Design Automation, John Wiley, Fourth Edition, 2017

REFERENCES:

1. Jan.M. Rabaeyetal, Digital Integrated Circuit Design Perspective(2/e), PHI, Third Edition, 2016
2. M.J.S.Smith: Application Specific Integrated Circuits, Pearson, Fourth Edition, 2016
3. J.Old Field, R.Dorf, Field Programmable Gate Arrays, John Wiley & Sons, New york, 2nd edition, 2016.
4. P.K.Chan & S.Mourad, Digital Design using Field Programmable Gate Array, Prentice Hall, 3rd Edition, 2017.

WEB SITE REFERENCE:

1. **ASIC and FPGA Design:** https://www.wevolver.com/article/asic-vs-fpga-in-chip-design

NPTEL/SWAYAM/MOOC REFERENCE:

1. DSD and FPGA, Kuruvilla Varghese, IISc, Banguru.

PPAP2PC05	ADVANCED DIGITAL IMAGE PROCESSING	L T P C
		3 0 0 3

COURSE OBJECTIVES

- To understand the image fundamentals and mathematical transforms necessary for image processing and to study the image enhancement techniques.
- To understand the image segmentation and representation techniques.
- To understand how image are analyzed to extract features of interest.
- To introduce the concepts of image registration and image fusion.
- To analyze the constraints in image processing when dealing with 3D data sets.

UNIT I: FUNDAMENTALS OF DIGITAL IMAGE PROCESSING **9**

Elements of visual perception, brightness, contrast, hue, saturation, match band effect, 2D image transform- DFT, DCT, KLT, and SVD. Image enhancement in spatial and frequency domain, Morphological image processing

UNIT II : SEGMENTATION **9**

Edge detection, Thresholding, Region growing, Fuzzy clustering, Watershed algorithm, Active contour methods, Texture feature-based segmentation, Model based segmentation, Atlas based segmentation, Wavelet based Segmentation methods.

UNITIII : FEATURE EXTRACTION **9**

First and second order edge detection operators, Phase congruency, Localized feature extraction detecting image curvature, shape features Hough transform, shape skelet ionization, Boundary descriptors, Moments, Texture descriptors- Autocorrelation, Co-occurrence features, Run length features, Fractal model-based features, Gabor filter, wavelet features.

UNITIV:REGISTRATION AND IMAGE FUSION **9**

Decimation by a factor D - Interpolation by a factor I - Sampling rate conversion by rational factor I/D, Implementation of Sampling Rate Conversion, Filter design and Implementation for sampling rate conv sampling using All Pass Filter.

UNITV : 3D IMAGE VISUALIZATION **9**

Sources of 3D Data sets, Slicing the Data set, Arbitrary section planes, The use of color, Volumetric display, Stereo Viewing, Ray tracing, Reflection, Surfaces, multiply connected surfaces, Image processing in 3D, Measurements on 3D images.

TOTAL:45 PERIODS

Cos	At the end of the course the student will be able to	Blooms Taxonomy
CO-1	To understand image formation and the role of human visual system plays in perception of gray and color image data	Understand
CO-2	To apply image processing techniques in both the spatial and frequency (Fourier) domains	Apply
CO-3	To design image analysis techniques in the form of image segmentation and to evaluate the methodologies for segmentation	Create
CO-4	To conduct independent study and analysis of feature extraction techniques	Understand
CO-5	To understand the concepts of image registration and image fusion	Understand

COs	POs					
	PO1	PO2	PO3	PO4	PO 5	PO6
1	-	-	-	-	-	-
2	1	-	1	2	2	2
3	2	-	1	3	3	2
4	-	-	2	3	3	2
5	1	-	3	3	3	1

TEXT BOOKS:

1. John C.Russ, "The Image Processing Handbook", CRC Press, 2nd edition, 2016.
2. Mark Nixon, Alberto Aguado, "Feature Extraction and Image Processing" Academic Press, 3rd edition, 2017.

REFERENCES:

1. Ardeshir Goshtasby, "2D and 3D Image registration for Medical, 2n edition, 2016.
2. Sensing and Industrial Applications", John Wiley and Sons, Third Edition, 2017
3. Gonzalez, Richard E. Woods, , Digital Image Processing", Pearson, Education, Inc., Second Edition, 2nd Edition, 2016.
4. Anil K. Jain, Fundamentals of Digital Image Processing", Pearson Education, Inc., Third edition, 2016.
5. Rick S.Blum, Zheng Liu, "Multi-sensor image fusion and its Applications", Taylor & Francis, 3rd edition, 2016.

WEBSITE REFERENCES:

1. **Image Processing Basics**: https://www.v7labs.com/blog/image-processing-guide.

NPTEL/SWAYAM/MOOC REFERENCE:

1. DIP, Prof. Prabir Kumar Biswas, IIT Kharagpur.

PPAP2PC06	ANALOG AND MIXED SIGNAL IC DESIGN	L T P C
		3 0 0 3

COURSE OBJECTIVES

- To study the concepts of MOS large signal model and small signal model
- To provide in-depth understanding of the analog integrated circuit and building blocks
- To learn the Analog and Digital layout design for mixed signal circuits
- To understand the methodologies for analysis and design of fundamental CMOS Analog and Mixed signal Circuits like Data Converters and filters.
- To study the integrated circuits like oscillators and PLLs.

UNIT I: INTRODUCTION AND BASIC MOS DEVICES 9

Challenges in analog design-Mixed signal layout issues- MOS FET structures and characteristics- large signal model – small signal model- single stage Amplifier-Source follower- Common gate stage – Cascode Stage

UNIT II SUBMICRON CIRCUIT DESIGN 9

Submicron CMOS process flow, Capacitors and resistors, Current mirrors, The MOSFET Switch, Analog Circuit Design: Biasing, Op-Amp Design, Circuit Noise - OP Amp parameters

UNIT III - DATA CONVERTERS 9

Characteristics of Sample and Hold- Digital to Analog Converters- architecture-Differential Non linearity-Integral Non linearity- Voltage Scaling-Cyclic DAC-Pipeline DAC-Analog to Digital Converters-architecture – Flash ADC-Pipeline ADC-Differential Non linearity-Integral Non linearity. Overview of SNR of Data Converters- Clock Jitters- Improving Using Averaging Decimating Filters for ADC- Band pass and High Pass Sinc Filters- Interpolating Filters for DAC

UNIT IV - ANALOG AND DIGITAL CMOS DESIGN FOR MIXED SIGNAL 9

Layout introduction: Introduction, MOS transistor layers, stick diagram, symbolic diagram. Digital layout design: Introduction, guide line of transistor layout, PMOS and NMOS transistor layout, CMOS transistor layout. Introduction to analog layout techniques and Passive component layout - capacitor, resistor and inductor, Floor planning of analog and digital components, power supply and ground pin issues, matching, shielding, interconnection issues.

UNIT V: OSCILLATORS AND PLL 9

LC oscillators, Voltage Controlled Oscillators. Simple PLL, Charge pumps PLLs, Non ideal effects in PLLs, Delay Locked Loops. Applications of PLL. frequency multiplication and synthesis. Introduction to RF IC Design, building blocks, applications.

TOTAL: 45 PERIODS

COs	At the end of the course the student will be able to	Blooms Taxonomy
CO-1	Carry out research and development in the area of analog and mixed signal IC design	Understand
CO-2	Well versed with the MOS fundamentals, small signal models and analysis of MOSFETbased circuits	Understand
CO-3	Analyze and model data converters architecture	Analyze
CO-4	Understand and Design different mixed signal circuits for various applications as per the user specifications	Understand
CO-5	Analyze and design mixed signal circuits such as Comparator, ADCs, DACs, PLL	Analyze

COs	POs					
	PO1	PO2	PO3	PO4	PO 5	PO6
1	3	-	-	-	-	-
2	-	-	3	1	-	-
3	-	-	2	2	-	-
4	-	-	-	2	2	-
5	-	-	-	2		2

TEXT BOOKS:

1. P.AllenandD.Holberg,"CMOS Analog Circuit Design", Oxford University Press, 4th Edition, 2016.
2. B.Razavi, "Design of Analog CMOS Integrated Circuits", McGrawHill, 5th edition2017.

REFERENCES:

1. R. Jacob Baker, H. W. Li, and D. E. Boyce CMOS Circuit Design, Layout and Simulation, Prentice- Hall of India, 2016.
2. Paul R. Gray, Paul J. Hurst, Stephen H. Lewis, Robert G. Meyer, "Analysis and Design of Analog Integrated Circuits", Wiley Publishers, Fifth Edition, 2017.

WEBSITE REFERENCES:

1. **Analog-and-Digital-VLSI-Design**: https://www.scribd.com/document/169431345/
2. **Data Converters:** https://picture.iczhiku.com/resource/eetop/wykfLZHltIzPSnNB.pdf

NPTEL/ SWAYAM/ MOOC REFERENCES:

1. NPTEL: Analog IC Design, Prof. Aniruddhan.S, IIT Madras.
2. NPTEL: CMOS Analog VLSI Design, Prof. A.N. Chandorkar, IIT Bombay.

ELECTIVE I

Sl. No.	Course code	Course Title	Category	Contact Periods	L	T	P	C
1	PPAP2PE01	Digital Control Engineering	PE	3	3	0	0	3
2	PPAP2PE02	Sensors, Actuators & Interface Electronics	PE	3	3	0	0	3
3	PPAP2PE03	CAD for VLSI	PE	3	3	0	0	3
4	PPAP2PE04	Electromagnetic Interference and Compatibility	PE	3	3	0	0	3

PPAP2PE01	DIGITAL CONTROL ENGINEERING	L T P C
		3 0 0 3

COURSE OBJECTIVES

- To explain the principles of PI, PD, PID controllers.
- To understand the concepts of digitizing the signals related to control systems
- To analyze the time and frequency response of discrete time control systems
- To understand the design of compensator and development of digital PID controller
- To obtain knowledge on the implementation of PID control algorithms on various applications

UNIT I CONTROLLERS IN FEED BACK SYSTEMS 9

Review of frequency and time response analysis and specifications of first order and second order feedback control systems, need for controllers, continuous time compensations, continuous time PI, PD, PID controllers, digital PID controllers.

UNIT II BASIC DIGITAL SIGNAL PROCESSING IN CONTROL SYSTEMS 9

Sampling theorem, quantization, aliasing and quantization error, hold operation, mathematical model Of sample and hold, zero and first order hold, factors limiting the choice of sampling rate, reconstruction.

UNIT III MODELING OF SAMPLED DATA CONTROL SYSTEM 9

Difference equation description, Z-transform method of description, pulse transfer function, time and frequency response of discrete time control systems, stability of digital control systems, Jury's stability test, state space description, first companion, second companion, Jordan canonical models, discrete state variable models(elementary principles only).

UNIT IV-DESIGN OF DIGITAL CONTROL ALGORITHMS 9

Review of principle of compensator design, Z-plane specifications, digital compensator design using Frequency response plots, discrete integrator, discrete differentiator, development of digital PID controller, transfer function, design in the Z-plane.

UNIT V: PRACTICAL ASPECTS OF DIGITAL CONTROL ALGORITHMS 9

Algorithm development of PID control algorithms, standard programmers for microcontroller implementation, finite word length effects, choice of data acquisition systems, microcontroller based temperature control systems, microcontroller based motor speed control systems, DSP implementation of motor control system.

TOTAL: 45 PERIODS

COs	At the end of the course the student will be able to	Blooms Taxonomy
CO-1	Summarize the need for PI, PD, PID controllers	Understand
CO-2	Describe the steps in digitizing signals and reconstruction of signals	Understand
CO-3	Explain various methods of modeling control systems	Understand
CO-4	Design digital compensators using frequency response plots	Create
CO-5	Apply digital control algorithms on various control systems	Apply

COs	POs					
	PO1	PO2	PO3	PO4	PO 5	PO6
1	1	-	2	2	1	3
2	1	-	2	3	-	2
3	1	-	2	3	-	2
4	1	-	2	2	1	3
5	1	-	2	2	1	3

TEXT BOOKS:

1. John J. D'Azzo, "Constantive Houpios, Linear Control System Analysis and Design", McGraw Hill,2016.
2. Kenneth J. Ayala, "The 8051 Microcontroller- Architecture, Programming and Applications", Penram International, 4th Edition, 2017.

REFERENCES:

1. M.Gopal, "Digital Control and Static Variable Methods", Tata McGraw Hill, New Delhi, 2016.
2. M Sami Fadali,"Digital Control Engineering: Analysis and Design, 3rd edition, Academic Press, 2019.
3. M Gopal, "Digital Control Engineering", New Age International Publisher, 2016.
4. M Gopal," Digital Control and Static Variable Methods",4th edition, 2017.

NPTEL/SWAYAM/MOOC REFERENCE:

1. DCEAD, Prof. C S Shankar Ram, IIT Madras.

WEB SITE REFERENCES:

1. **Digital-Control-Engineering:** https://www.sciencedirect.com/book/9780123744982/
2. **DCEAD:** https://www.amazon.in/Digital-Control-Engineering-analysis-Design/dp/0128144335

PPAP2PE02	SENSORS, ACTUATORS & INTERFACE ELECTRONICS	L T P C
		3 0 0 3

COURSE OBJECTIVES

- Understand static and dynamic characteristics of measurement systems.
- Study various types of sensors.
- Study different types of actuators and their usage.
- Study State-of-the-art digital and semiconductor sensors.

UNIT I: INTRODUCTION TO MEASUREMENT SYSTEMS 9

Introduction to measurement systems: general concepts and terminology, measurement systems, sensor classification, general input-output configuration, methods of correction, performance characteristics: static characteristics of measurement systems, accuracy, precision, sensitivity, other characteristics: linearity, resolution, systematic errors, random errors, dynamic characteristics of measurement systems: zero-order, first-order, and second-order measurement systems and response.

UNIT II RESISTIVE AND REACTIVE SENSORS 9

Resistive sensors: potentiometers, strain gages, resistive temperature detectors, magneto resistors, light- dependent resistors, Signal conditioning for resistive sensors: Wheatstone bridge, sensor bridge calibration and compensation, Instrumentation amplifiers, sources of interference and interference reduction, Reactance variation and electromagnetic sensors, capacitive sensors, differential, inductive sensors, linear variable differential transformers (LVDT), magneto elastic sensors, hall effect sensors, Signal conditioning for reactance-based sensors & application to the LVDT.

UNIT III SELF-GENERATING SENSORS 9

Self-generating sensors: thermoelectric sensors, piezoelectric sensors, pyro electric sensors, photovoltaic sensors, electrochemical sensors, Signal conditioning for self-generating sensors: chopper and low-drift amplifiers, offset and drifts amplifiers, electrometer amplifiers, charge amplifiers, noise in amplifiers.

UNIT IV ACTUATORS DRIVE CHARACTERISTICS AND APPLICATIONS 9

Relays, Solenoid drive, Stepper Motors, Voice-Coil actuators, Servo Motors, DC motors and motor control, 4-to-20 mA Drive, Hydraulic actuators, variable transformers: synchro's, resolvers, Inductor syn, resolver-to-digital and digital-to-resolver converters.

UNIT V DIGITAL SENSORS AND SEMICONDUCTOR DEVICE SENSORS 9

Digital sensors: position encoders, variable frequency sensors – quartz digital thermometer, vibrating wire strain gages, vibrating cylinder sensors, saw sensors, digital flow meters, Sensors based on semiconductor junctions: thermometers based on semiconductor junctions, magneto diodes and magneto transistors, photodiodes and phototransistors, sensors based on MOSFET transistors, CCD imaging sensors , ultrasonic sensors, fiber-optic sensors

TOTAL:45 PERIODS

COs	At the end of the course the student will be able to	Blooms Taxonomy
CO-1	Compare Actuators	Understand
CO-2	Evaluate digital sensors and semiconductor device sensors	Understand
CO-3	Discuss Self-generating sensors	Understand
CO-4	Learn about actuators and its applications	Understand
CO-5	Outline about Sensors and semiconductor devices	Understand

COs	POs					
	PO1	PO2	PO3	PO4	PO 5	PO6
1	1	-	2	2	1	3
2	1	-	2	3	-	2
3	1	-	2	3	-	2
4	1	-	2	2	1	3
5	1	-	2	2	1	3

TEXT BOOKS:

1. Ian Sinclair, Sensors and Transducers, Elsevier, 4TH Edition, 2016.
2. Jon Wilson , "Sensor Technology Handbook",3rd edition, 2016.

REFERENCES:

1. Kevin James, PC Interfacing and Data acquisition, Elsevier, 2016.
2. Ramon Pallás Areny, John G. Webster, "Sensors and Signal conditioning", 2nd edition, John Wiley and Sons, 2015.
3. Sensors and Actuators: Control System Instrumentation, Clarence W. de Silva CRC Press, 2016.
4. Andrzej M. Pawlak Sensors and Actuators in Mechatronics Design and Applications, 2017.

WEBSITEREFERENCES:

1. **Sensors and Actuators**: https://www.scribd.com/document/455085708/Nathan-Ida-Sensors-Actuators- and-Their-Interfa-pdf

Sensors Basics: https://www.engineersgarage.com/what-is-an-actuator-sensor-interface-as-i/

NPTEL/SWAYAM/MOOC REFERENCE:

1. Sensors and Actuators, Dr. Hardik J Pandya, IISc, Bangalore.

PPAP2PE03	CAD FOR VLSI CIRCUITS	L T P C
		3 0 0 3

COURSE OBJECTIVES

- To study various physical design methods in VLSI.
- To understand the concepts behind the VLSI design rules and routing techniques.
- To understand the concepts of various algorithms used for floor planning and routing techniques.

UNIT I INTRODUCTION TO VLSI DESIGN FLOW 9

Introduction to VLSI Design methodologies, Basics of VLSI design automation tools, Algorithmic Graph Theory and Computational Complexity, Tractable and Intractable problems, General purpose methods for combinatorial optimization.

UNIT II LAYOUT, PLACEMENT AND PARTITIONING 9

System partition -partitioning - partitioning methods – interconnect delay models and measurement of delay - floor planning -placement – Routing: global routing- detailed routing - special routing –circuit extraction- DRC

UNIT III FLOOR PLANNING AND ROUTING 9

Floor planning concepts, Shape functions and floor plan sizing, Types of local routing problems, Area routing, Channel routing, Global routing, Algorithms for global routing.

UNIT IV SIMULATION AND LOGIC SYNTHESIS 9

Simulation, Gate-level modeling and simulation, Switch-level modeling and simulation, Combinational Logic Synthesis, Binary Decision Diagrams, Two Level Logic Synthesis.

UNIT V HIGH LEVEL SYNTHESIS 9

Hardware models for high level synthesis, internal representation, allocation, assignment and scheduling, scheduling algorithms, Assignment problem, High level transformations.

TOTAL: 45 PERIODS

COs	At the end of the course the student will be able to	Blooms Taxonomy
CO-1	To use the simulation techniques at various levels in VLSI flow	Understand
CO-2	Discuss the concepts of floor planning and routing	Understand
CO-3	Outline high level synthesis	Understand
CO-4	To learn the simulation of Logic Synthesis	Understand
CO-5	To outline the high level synthesis for hardware models	Understand

COs	POs					
	PO1	PO2	PO3	PO4	PO 5	PO6
1	3	2	2	2	1	-
2	3	2	2	2	1	-
3	3	2	2	2	1	-
4	3	2	2	2	1	-
5	3	2	2	2	1	-

TEXT BOOKS:

1. N.A. Sherwani, "Algorithms for VLSI Physical Design Automation", Kluwer Academic Publishers, 2016.
2. S.H. Gerez, "Algorithms for VLSI Design Automation", John Wiley & Sons, 2017.

REFERENCES:

1. Sadiq M. Sait, Habib Youssef, "VLSI Physical Design automation: Theory and Practice", World scientific 2016.
2. Steven M.Rubin, "Computer Aids for VLSI Design", Addison Wesley Publishing 2015.
3. CAD for VLSI Circuits, Wiley Publisher, 2016
4. Steven M.Rubin, "Computer Aids for VLSI Design", Addison Wesley Publishing, 4th edition, 2016.

WEBSITE REFERENCES:

1. Analog-VLSI-And-Cad: https://freevideolectures.com/course/3175/
2. Analog-VLSI-And-Cad in Details: https://www.youtube.com/watch?v=oeF8bUUqSgE

NPTEL/ SWAYAM/ MOOC REFERENCE:

1. NPTEL: CAD for VLSI Design, Prof.V.Kamakoti and Shankar Balachandran, IIT Madras.

PPAP2PE04	ELECTROMAGNETIC INTERFERENCE AND COMPATIBILITY	L T P C
		3 0 03

COURSE OBJECTIVES

- To gain broad conceptual understanding of the various aspects of electromagnetic (EM) interference and compatibility
- To develop a theoretical understanding of electromagnetic shielding effectiveness
- To understand ways of mitigating EMI by using shielding, grounding and filtering
- To understand the need for standards and to appreciate measurement methods
- To understand how EMI impacts wireless and broadband technologies

UNIT I: INTRODUCTION & SOURCES OF EM INTERFERENCE 9

Introduction - Classification of sources - Natural sources - Man-made sources - Survey of the electromagnetic environment.

UNIT II: EM SHIELDING 9

Introduction - Shielding effectiveness - Far-field sources - Near-field sources - Low-frequency, magnetic field shielding - Effects of apertures.

UNIT III: INTERFERENCE CONTROL TECHNIQUES 9

Equipment screening - Cable screening - grounding - Power-line filters - Isolation - Balancing - Signal-line filters - Nonlinear protective devices.

UNIT IV: EMC STANDARDS, MEASUREMENTS AND TESTING 9

Need for standards - The international framework - Human exposure limits to EM fields -EMC measurement

techniques - Measurement tools - Test environments.

UNIT V: EMC CONSIDERATIONS IN WIRELESS AND BROADB AND TECHNOLOGIES 9

Efficient use of frequency spectrum - EMC, interoperability and coexistence - Specifications and alliances - Transmission of high-frequency signals over telephone and power networks – EMC and digital subscriber lines - EMC and power line telecommunications.

TOTAL:45 PERIODS

COs	At the end of the course the student will be able to	Blooms Taxonomy
CO-1	Demonstrate knowledge of the various sources of electromagnetic interference	Understand
CO-2	Display an understanding of the effect of how electromagnetic fields couple through apertures, and solve simple problems based on that understanding	Understand
CO-3	Explain the EMI mitigation techniques of shielding	Understand
CO-4	Explain the need for standards and EMIC measurement	Understand
CO-5	Discuss the impact of EMC on wireless and broadband technologies	Understand

COs	POs					
	PO1	PO2	PO3	PO4	PO 5	PO6
1	3	2	2	2	1	-
2	3	2	2	2	1	-
3	3	2	2	2	1	-
4	3	2	2	2	1	-
5	3	2	2	2	1	-

TEXT BOOKS:

1. Christopoulos C, Principles and Techniques of Electromagnetic Compatibility, CRC Press, 4th Edition, Indian Edition, 2016.
2. Paul C R, Introduction to Electromagnetic Compatibility, Wiley India, 4th Edition, 2017.

REFERENCES:

1. Kodali V P, Engineering Electromagnetic Compatibility, Wiley India, 5th Edition, 2016.
2. Henry W Ott, Electromagnetic Compatibility Engineering, John Wiley & Sons Inc, Newyork, 2016.
3. Scott Bennett W, Control and Measurement of Unintentional Electromagnetic Radiation, John Wiley& Sons Inc., Wiley Inter-science Series,4th edition, 2016.
4. Henry W Ott, Electromagnetic Compatibility Engineering, John Wiley & Sons Inc, New-york, 4th edition, 2016.
5. Scott Bennett W, Control and Measurement of Unintentional Electromagnetic Radiation, John Wiley& Sons Inc., Wiley Inter-science Series, 5th edition, 2017.

4. Henry W Ott, Electromagnetic Compatibility Engineering, John Wiley & Sons Inc, New-york, 4th edition, 2016.
5. Scott Bennett W, Control and Measurement of Unintentional Electromagnetic Radiation, John Wiley& Sons Inc., Wiley Inter-science Series, 5th edition, 2017.

NPTEL/SWAYAM/MOOC REFERENCES:

1. Introduction to EM, Rajeev. Thottappilli, Daniel Mansson,KTH Royal IT, Sweden.
2. EM and Compatibility in Details, Thottappilli, Daniel Mansson,KTH Royal IT, Sweden.

WEB SITE REFERENCES:

1. **EM-Interference-and-Compatibility:** https://onlinelibrary.wiley.com/doi/abs/10.1002/9780471740360.ebs0422
2. **EM-Interference in details:** https://ieeexplore.ieee.org/abstract/document/4201325

ELECTIVE–II

Sl. No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
1	PPAP2PE05	VLSI Design Techniques	PE	3	3	0	0	3
2	PPAP2PE06	RF System Design	PE	3	3	0	0	3
3	PPAP2PE07	Wireless Ad-hoc and Sensor Networks	PE	3	3	0	0	3
4	PPAP2PE08	High Performance Networks	PE	3	3	0	0	3

PPAP2PE05	VLSI DESIGN TECHNIQUES	L T P C
		3 0 0 3

COURSE OBJECTIVES

- To understand the basics I-V characteristics of MOS transistor
- To introduce the VLSI design flow
- To Design combinational and sequential circuits
- To introduce testing of VLSI circuits
- To explore system design using Verilog HDL

UNIT I:CMOS TECHNOLOGY 9

MOS transistor, Ideal I–V characteristics, C–V characteristics, non-ideal I–V effects – CMOS Inverter and Pass transistor DC transfer characteristics – CMOS technologies, Layout design Rules – Stick Diagram – CMOS process enhancements– VLSI design Flow.

UNIT II CIRCUIT DELAY, POWER, INTER CONNECT AND VERILOG HDL 9

Delay estimation – Logical effort and Transistor sizing – Power dissipation – Interconnect – Design margin –Reliability – Scaling – SPICE – Device models. Verilog: Procedural assignments –conditional statements – Design of combinational and sequential circuits using different types of modeling –Test benches.

UNIT III COMBINATIONAL AND SEQUENTIAL CIRCUIT DESIGN 9

Circuit families –Circuit Pitfalls – Sequencing static circuits, Max-min delay constraints, Time borrowing, Clock Skew – circuit design of latches and flip flops – synchronizers, Meta-stability, communication between asynchronous clock domains.

UNIT IV CMOS TESTING 9

Need for testing – Testers, Text fixtures and test programs – Logic verification – Silicon debug principles –Manufacturing test – Design for testability – Boundary scan test.

UNIT V SYSTEM DESIGN USING VERILOG HDL 9

Basic concepts- identifiers- gate primitives- gate delays- operators timing controls- procedural assignments- conditional statements- Design of combinational and sequential circuits using Data flow- structural gate level- switch level modeling and Behavioral modeling-Test benches.

TOTAL:45 PERIODS

COs	At the end of the course the student will be able to	Blooms Taxonomy
CO-1	Analyze the characteristics of CMOS transistor	Analyze
CO-2	Identify the methods to distribute clock and reduce power in CMOS circuits	Understand
CO-3	Design combinational and sequential circuits	Create
CO-4	Analyze the methods to test the CMOS circuits	Analyze
CO-5	Synthesize the combinational and sequential circuits using HDL	Understand

COs	POs					
	PO1	PO2	PO3	PO4	PO 5	PO6
1	-	-	1	2	-	3
2	1	-	2	1	-	2
3	2	-	1	2	1	3
4	-	-	1	2	1	2
5	1	-	1	2	3	3

TEXT BOOKS:

1. Weste and Harris: "CMOS VLSI DESIGN" 4th Edition, Pearson Education, 2016.
2. Uyemura J.P: "Introduction to VLSI circuits and systems", Wiley 2016.

REFERENCES:

1. D.APucknell & K.Eshraghian, "Basic VLSI Design", 3rd Edition, PHI, 2016
2. Wayne Wolf, "Modern VLSI design", 4th edition Pearson Education, 2016
3. M.J.S.Smith, "Application specific integrated circuits", 1st edition, Addison-Wesley Professional, 2017
4. Ciletti, "Advanced Digital Design with the Verilog HDL", 2nd edition, Pearson Education, 2016

Samir Palnitkar "Verilog HDL a guide to digital design and Synthesis", Prentice Hall, 3rd edition, 2016

WEBSITE REFERENCE:

1. VLSI Design Techniques: https://cselectricalandelectronics.com/materials-used-to-design-the-chip-vlsi-design-materials/

NPTEL/SWAYAM/MOOC REFERENCE:

1. VLSI Design Techniques, Prof. S. Srinivasan, IIT Madras.

PPAP2PE06	RF SYSTEM DESIGN	L T P C 3 0 0 3

COURSEOBJECTIVES:

- Understand the RF transceiver system design for wireless communications
- Understand the design methods of receivers and transmitters in communication systems.
- Design RF circuits and systems using an advanced design tool.
- Analyze various synchronization methods circuits and describe their block schematic and design criteria
- To Measure the concepts of RF circuits and systems with a spectrum analyzer.

UNIT I: BASICS OF RADIO FREQUENCY SYSTEM DESIGN **9**

Definitions and models of Linear systems and Non-linear system. Specification parameters: Gain, noise figure, SNR, Characteristic impedance, S-parameters, Impedance matching and Decibels.Elementsofdigitalbasebandsignaling:complexenvelopeofbandpasssignals,Averagevalue, RMS value, Crest factor, Sampling, jitter, modulation techniques, filters, pulse shaping, EVM,BER, sensitivity,selectivity,dynamicrangeand,adjacentandalternatechannelpowerleakages

UNIT II: RADIO ARCHITECTURES AND DESIGN CONSIDERATIONS **9**

Super heterodyne architecture, direct conversion architecture, Low IF architecture, band-pass sampling radio architecture, System Design Considerations for an Analog Frontend Receiver in Cognitive Radio Applications, Interference, Near, In-band &wide-band considerations.

UNIT III: AMPLIFIER MODELING AND ANALYSIS **9**

Noise: Noise equivalent model for Radio frequency device, amplifier noise model, cascade performance, minimum detectable signal, performance of noisy systems in cascade. Non- Linearity: Amplifier power transfer curve, gain compression, AM-AM, AM-PM, polynomial approximations, Saleh model, Wiener model and Hammerstein model, inter modulation, Single and two tone analyses, second and third order distortions and measurements, SOI and TOI points, cascade performance of non-linear systems.

UNIT IV: MIXER AND OSCILLATOR MODELING AND ANALYSIS **9**

Mixers: Frequency translation mechanisms, frequency inversion, image frequencies, spurious scale calculations, principles of mixer realizations. Oscillators: phase noise and its effects, effects of oscillator spurious components, frequency accuracy, oscillator realizations: Frequency synthesizers, NCO

UNIT V: APPLICATIONS OF SYSTEMS DESIGN **9**

Multi-mode and multi-band Super-heterodyne transceiver: selection of frequency plan, receiver System and transmitter system design–Direct conversion transceiver: receiver system and transmitter system design.

TOTAL: 45 PERIODS

COs	At the end of the course the student will be able to	Blooms Taxonomy
CO-1	Describe the specifications of transceiver modules	Understand
CO-2	Summarize pros and soft-transceiver architectures	Create
CO-3	Understand the impact of noise and amplifier modules	Understand
CO-4	Explain about spurs and generation principles during sign AL	Understand
CO-5	Understand the case study of transceiver systems	Understand

COs	POs					
	PO1	PO2	PO3	PO4	PO 5	PO6
1	-	-	2	1	-	3
2	3	-	2	2	-	3
3	-	-	2	2	-	3
4	-	-	3	1	-	3
5	3	-	3	1	-	3

TEXT BOOKS:

1.The design of CMOS Radio Frequency Integrated Circuits by Thomas HLee. Cambridge University Press, 4TH Edition, 2016.

2. QizhengGu,"RFSystemDesignofTransceiversforWirelessCommunications",Springer, 5th edition, 2017.

REFER:

1. W. F. Egan, "Practical RF System Design", 3rd edition, 2016.
2. S. Sengupta, "RF System Design of an RFIC Receiver for IoT," ,IEEE, Kolkata, India, 2016,
3. QizhengGu,"RFSystemDesignofTransceiversforWirelessCommunications",Springer, 3rd edition, 2016.
4. W. F. Egan, "Practical RF System Design", 4th edition, 2017
5. The Design of CMOSRadio-Frequency Integrated Circuits by Thomas H.Lee. Cambridge University Press, 5th Edition, 2017.

WEB SITE REFERENCE:

1. SDTWC:https://dokumen.tips/documents/rf-system-design-of-transceivers-for-wireless-communications-586e0ed81317a.html?page=2

NPTEL/SWAYAM/MOOC REFERENCES:

1. NPTEL: Design Principles of RF and Microwave Filters and Amplifiers Prof. A. Bhattacharya, IIT Kharagpur.
2. NPTEL: RF Integrated Circuits Dr. Shouribrata Chatterjee, IIT Delhi.

PPAP2PE07	WIRELESS AD-HOC AND SENSOR NETWORKS	L T P C
		3 0 0 3

COURSE OBJECTIVES

- To understand the basic architecture and protocols followed in Ad-hoc Networks
- To gain knowledge on various routing techniques in Ad-hoc networks
- To analyze various issues related to the efficient management of Ad-hoc and sensor networks.
- To understand the concepts of sensor network programming and simulators in Ad-hoc networks
- To explain various security practices and protocols of Ad-hoc and Sensor Networks.

UNIT I:MAC & TCP IN AD HOC NETWORKS 9

Fundamentals of WLANs – IEEE 802.11 Architecture - Self configuration and Auto configuration-Issues in Ad-Hoc Wireless Networks – MAC Protocols for Ad-Hoc Wireless Networks – ContentionBasedProtocols-TCPoverAd-Hocnetworks-TCPprotocoloverview-TCPandMANETs– Solutions for TCP over Ad-Hoc Networks

UNIT II ROUTING IN ADHOC NETWORKS 9

RoutinginAd-HocNetworks-Introduction-TopologybasedversusPositionbasedApproaches-Proactive, Reactive, Hybrid Routing Approach-Principles and issues – Location services - DREAM – Quorumsbasedlocationservice–Grid–Forwardingstrategies–Greedypacketforwarding– Restricted directional flooding-Hierarchical Routing-Issues and Challenges improving QoS.

UNIT III MAC, ROUTING & QOS IN WIRELESS SENSOR NETWORKS 9

Introduction – Architecture - Single node architecture – Sensor network design considerations – Energy Efficient Design principles for WSNs – Protocols for WSN – Physical Layer : Transceiver Design considerations – MAC Layer Protocols – IEEE 802.15.4 Zigbee – Link Layer and Error Control issues – Routing Protocols–Mobile Nodes and Mobile Robots-Data Centric & Contention Based Networking–Transport Protocols & QOS –Congestion Control issues –Application Layer support

UNIT IV SENSOR MANAGEMENT 9

Sensor Management-Topology Control Protocols and Sensing Mode Selection Protocols-Time synchronization-Localization and positioning–Operating systems and Sensor Network programming–Sensor
Network Simulators

UNIT V SECURITY IN ADHOC AND SENSOR NETWORKS 9

Security in Ad-Hoc and Sensor networks – Key Distribution and Management – Software based Anti-tamper techniques – water marking techniques – Defense against routing attacks - Secure Ad-hoc routing protocols– Broadcast authentication WSN protocols–TESLA–Biba–Sensor Network Security Protocols– SPINS.

TOTAL:45 PERIODS

COs	At the end of the course the student will be able to	Blooms Taxonomy
CO-1	Identify different issues and types of protocol in Ad-hoc	Understand
CO-2	Describe various routing approaches in Ad-hoc networks	Understand
CO-3	Explain the network design considerations and routing in wireless sensor networks	Understand
CO-4	Analyze the issues in the deployment of sensor network	Analyze
CO-5	Interpret various techniques to ensure security in Ad-hoc sensor networks	Understand

COs	POs					
	PO1	PO2	PO3	PO4	PO 5	PO6
1	-	-	2	1	-	3
2	3	-	2	2	-	3
3	-	-	2	2	-	3
4	-	-	3	1	-	3
5	3	-	3	1	-	3

TEXT BOOKS:

1. J Sarangapani,"Wireless Ad hoc and Sensor Networks", T and F Publisher, 2017
2. Raja Jurdak," Wireless Ad Hoc and Sensor Networks: A Cross-Layer Design Perspective", Springer Publisher, 2017.

REFERENCES:

1. Grafiati," Wireless ad hoc and sensor networks", 2021
2. Jing (Selina) He, Mr. ShoulingJi, Yingshu Li, Yi Pan Wireless Ad Hoc and Sensor Networks Management, Performance, and Applications, CRC Press, 2019
3. Hai Liu, Yiu-Wing Leung, Xiaowen Chu ,Ad Hoc and Sensor Wireless Networks: Architectures, Algorithms and Protocols, Bentham Books, 2016
4. AnuragKumar ,Wireless Networks (Cellular Systems, Ad-Hoc Networks, Sensor Networks, TCP over Wireless, Power Control), 2017.

WEB SITE REFERENCE:

1. Wireless ad hoc and sensor networks: https://www.sciencedirect.com/topics/computer-science/ad-hoc- wireless-network

NPTEL/SWAYAM/MOOC REFERENCE:

1. Wireless ad hoc and sensor networks, Prof. Sudip Misra, IITKGP

PPAP2PE08	HIGH PERFORMANCE NETWORKS	L T P C
		3 0 0 3

COURSE OBJECTIVES

- To develop a comprehensive understanding of multimedia networking.
- To study the types of VPN and tunnelling protocols for security.
- To learn about network security in many layers and network management.

UNIT I: INTRODUCTION **9**

Review of OSI, TCP/IP; Multiplexing, Modes of Communication, Switching, Routing. SONET – DWDM – DSL – ISDN – BISDN,ATM.

UNIT II MULTIMEDIA NETWORKING APPLICATIONS **9**

Streaming stored Audio and Video – Best effort service – protocols for real time interactive applications – Beyond best effort – scheduling and policing mechanism – integrated services – RSVP- differentiated services.

UNIT III -ADVANCED NETWORKS CONCEPTS **9**

VPN-Remote-Access VPN, site-to-site VPN, Tunnelling to PPP, Security in VPN.MPLS- operation, Routing, Tunnelling and use of FEC, Traffic Engineering, and MPLS based VPN, overlay networks-P2P connections.

UNIT IV-TRAFFIC MODELLING **9**

Little"s theorem, Need for modelling, Poisson modelling and its failure, Non- Poisson models, Network performance evaluation.

UNIT-V:NETWORK SECURITY AND MANAGEMENT **9**

Principles of cryptography – Authentication – integrity – key distribution and certification – Access control and: fire walls – attacks and counter measures – security in many layers. Infrastructure for network management – The internet standard management framework – SMI, MIB, SNMP, Security and administration – ASN.1

TOTAL:45 PERIODS

COs	At the end of the course the student will be able to	Blooms Taxonomy
CO-1	Discuss advanced networks concepts	Understand
CO-2	Outline traffic modelling	Understand
CO-3	Evaluate network security	Evaluate
CO-4	Outline about Traffic Modelling	Analyze
CO-5	Learn about Network Security and its management	Understand

COs	POs					
	PO1	PO2	PO3	PO4	PO 5	PO6
1	1	-	-	-	-	3
2	1	-	2	-	-	3
3	1	-	1	-	-	3
4	1	-	2	-	1	3
5	1	-	2	-	1	3

REFERENCES:

1. HersentGurle& Petit, "IP Telephony, packet Pored Multimedia communication Systems", Pearson education , 3rd edition, 2016
2. J.F. Kurose & K.W. Ross,"Computer Networking- A top down approach featuring the internet", Pearson, 4th edition, 2017
3. Larry l.Peterson& Bruce S.David, "Computer Networks: A System Approach"- 3rd edition, 2016
4. LEOM-GarCIA, WIDJAJA, "Communication networks", TMH seventh reprint 2016
5. Nader F.Mir ,Computer and Communication Networks, fifth edition 2016

NPTEL/SWAYAM/MOOC REFERENCES:

1. Introduction, Prof. Varsha Apte, IIT Bombay
2. Multimedia Networking Application, Prof. Somnath Sengupta, IIT Kharapur.
3. Advanced Network Concepts: Prof. Neminath Hubballi, Prof. Sameer G Kulkarni, IIT Indore, IIT Gandhi nagar

WEBSITE REFERENCES:

1. HPN:https://www.hpnetworks.net/

High-Performance-Networks :https://www.actuary.org/content/high-performance-networks-0

ELECTIVE–III

Sl. No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
1	PPAP2PE09	DSP Architectures and Programming	PE	3	3	0	0	3
2	PPAP2PE10	Hardware–Software Co-design	PE	3	3	0	0	3
3	PPAP2PE11	Speech and Audio Signal Processing	PE	3	3	0	0	3
4	PPAP2PE12	Artificial Intelligence and Optimization Techniques	PE	3	3	0	0	3

PPAP2PE09	DSP ARCHITECTURE AND PROGRAMMING	L T P C
		3 0 0 3

COURSE OBJECTIVES

- To understand the fundamental of Programmable DSPs
- To learn the architecture of TMS320C5X Processor
- To study the architecture of TMS3203X Processor
- To apply the advanced processor I in DSP
- To study the advanced processor II in DSP

UNIT I:FUNDAMENTALS OF PROGRAMMABLE DSPs **9**

Multiplier and Multiplier accumulator –Modified Bus Structures and Memory access in P-DSPs –Multiple access memory –Multi-port memory –VLIW architecture-Pipelining –Special Addressing modes in P-DSPs – On-chip Peripherals.

UNITIITMS320C5X PROCESSOR **9**

Architecture –Assembly language syntax -Addressing modes –Assembly language Instructions -Pipeline structure, Operation –Block Diagram of DSP starter kit –Application Programs for processing real time signals.

UNITIII -TMS320C3X PROCESSOR **9**

Architecture –Data formats -Addressing modes –Groups of addressing modes-Instruction sets -Operation – Block Diagram of DSP starter kit –Application Programs for processing real time signals –Generating and finding the sum of series, Convolution of two sequences, Filter design –Introduction to code composer studio.

UNITIV-ADVANCED PROCESSORS I **9**

Architecture of ADSP-21XX and ADSP-210XX series of DSP processors-Addressing modes and assembly language instructions –Application programs –Filter design, FFT calculation.

UNIT-V:ADVANCED PROCESSORS II **9**

Architecture of TMS320C54X: Pipe line operation, Code Composer studio -Architecture of TMS320C6X - Architecture of Motorola DSP563XX –Comparison of the features of DSP family processors.

TOTAL:45 PERIODS

COs	At the end of the course the student will be able to	Blooms Taxonomy
CO-1	Describe the fundamentals of Digital Signal Processors	Understand
CO-2	Explain the architecture, addressing modes and instruction set of generic DSP Devices	Understand
CO-3	Illustrate algorithms for implementation in Digital Signal Processors to solve real- time problems	Understand
CO-4	Compare the features and performance of DSP devices	Understand
CO-5	Identify salient features of advanced DSP devices	Understand

COs	POs					
	PO1	PO2	PO3	PO4	PO 5	PO6
1	-	-	1	-	-	3
2	-	-	1	-	-	2
3	-	-	1	-	-	3
4	-	-	1	-	2	3
5	-	-	1	-	-	3

TEXT BOOKS:

1. B.Venkataramani and M.Bhaskar, "Digital Signal Processors –Architecture, Programming and Applications", Tata McGraw –Hill Publishing Company Limited, New Delhi, 2nd edition, 2016.
2. "User guides"-Texas Instruments, Analog Devices, Motorola, 2017.

REFERENCES:

1. Lapsley et al, "DSP Processor Fundamentals, Architectures & Features", S. Chand & Co2000.
2. Phil Lapsley," DSP Processor Fundamentals: Architectures and Features", Wiley Publisher, 3rd edition, 2017

NPTEL/SWAYAM/MOOC REFERENCES:

1. Mapping Signal Processing Algorithms to Architectures, Prof.Nitin Chandrachoodan, IIT Madras
2. Real-Time Digital Signal Processing, Prof. Rathna G N, IISc Bangalore.

WEBSITE REFERENCE:

1. Multi-Media: https://multimed.org/student/zps/en/02-Architecture.pdf

PPAP2PE10	HARDWARE - SOFTWARE CO-DESIGN	L T P C
		3 0 0 3

COURSE OBJECTIVES

- To acquire the knowledge about system specification and modelling.
- To learn the formulation of partitioning
- To study the different technical aspects about prototyping and emulation

UNIT I: SYSTEM SPECIFICATION AND MODELLING 9

Embedded Systems, Hardware/Software Co-Design, Co-Design for System Specification and Modelling , Co-Design for Heterogeneous Implementation - Single-Processor Architectures with one ASIC and many ASICs, Multi-Processor Architectures, Comparison of Co- Design Approaches, Models of Computation, Requirements for Embedded System Specification.

UNIT II HARDWARE / SOFTWARE PARTITIONING 9

The Hardware/Software Partitioning Problem, Hardware-Software Cost Estimation, Generation of the Partitioning Graph, Formulation of the HW/SW Partitioning Problem, Optimization , HW/SW Partitioning based on Heuristic Scheduling, HW/SW Partitioning based on Genetic Algorithms .

UNIT III: HARDWARE / SOFTWARE CO-SYNTHESIS 9

The Co-Synthesis Problem, State-Transition Graph, Refinement and Controller Generation, Co-Synthesis Algorithm for Distributed System- Case Studies with any one application.

UNIT IV: PROTOTYPING AND EMULATION 9

Introduction, Prototyping and Emulation Techniques , Prototyping and Emulation Environments, Future Developments in Emulation and Prototyping ,Target Architecture- Architecture Specialization Techniques ,System Communication Infrastructure, Target Architectures and Application System Classes, Architectures for Control-Dominated Systems, Architectures for Data-Dominated Systems ,Mixed Systems and Less Specialized Systems

UNIT V: DESIGN SPECIFICATION AND VERIFICATION 9

Concurrency, Coordinating Concurrent Computations, Interfacing Components, Verification ,Languages for System-Level Specification and Design System-Level Specification ,Design Representation for System Level Synthesis, System Level Specification Languages, Heterogeneous Specification and Multi-Language Co- simulation.

TOTAL:45 PERIODS

COs	At the end of the course the student will be able to	Blooms Taxonomy
CO-1	To assess prototyping and emulation techniques	Create
CO-2	To compare hardware / software co-synthesis	Understand
CO-3	To formulate the design specification and validate its functionality by simulation Time problems	Understand
CO-4	To learn about Prototyping and Emulation	Understand
CO-5	To design the specification and its verification of System	Create

COs	POs					
	PO1	PO2	PO3	PO4	PO 5	PO6
1	-	-	1	-	-	3
2	-	-	1	-	-	2
3	-	-	1	-	-	3
4	-	-	1	-	2	3
5	-	-	1	-	-	3

TEXT BOOK:

1. Giovanni De Micheli , Rolf Ernst Morgon," Reading in Hardware/Software Co-Design "Kaufmann Publishers, 2016.

REFERENCES:

1. Jorgen Staunstrup, Wayne Wolf ,"Hardware/Software Co-Design: Principles and Practice" , Kluwer Academic Pub, 2015.
2. Ralf Niemann , "Hardware/Software Co-Design for Data Flow Dominated Embedded, 2017.

NPTEL REFERENCE:

1. Embedded Systems Design, Prof. Anupam Basu, IIT Karagpur.

WEB SITE REFERENCES:

1. Hardware Software Co-Design: https://resources.pcb.cadence.com/blog/2019-what-is-hardware-software-co-design-and-how-can-it-benefit-you-or-your-business.

2. EM Module: https://www.marian.ac.in/public/images/uploads/CS404_EM_Module_2_1.pdf

PPAP2PE11	SPEECH AND AUDIO SIGNAL PROCESSING	L T P C
		3 0 0 3

COURSE OBJECTIVES

- To study basic concepts of processing speech and audio signals
- To study and analyze various M-band filter-banks for audio coding
- To understand audio coding based on transform coders.
- To study time and frequency domain speech processing methods

UNIT I MECHANICS OF SPEECH AND AUDIO 9

Introduction - Review of Signal Processing Theory-Speech production mechanism – Nature of Speech signal – Discrete time modeling of Speech production – Classification of Speech sounds –Phones– Phonemes– PhoneticandPhonemicalphabets–Articulatoryfeatures.AbsoluteThresholdofHearing CriticalBands-SimultaneousMasking,Masking-Asymmetry,andtheSpreadofMasking-Non- simultaneous Masking-Perceptual Entropy-Basic measuring philosophy-Subjective versus objective perceptual testing - The perceptual audio quality measure (PAQM) –Cognitive effects in judging audio quality.

UNIT II TIME FREQUENCY ANALYSIS FILTER BANKS & TRNSFORMS 9

Introduction - Analysis-Synthesis Framework for M-band Filter Banks- Filter Banks for Audio Coding: Design Considerations - Quadrature Mirror and Conjugate Quadrature Filters – Tree Structured QMF and CQF M-band Banks - Cosine Modulated "Pseudo QMF" M-band Banks - Cosine Modulated Perfect Reconstruction (PR) M-band Banks and the Modified Discrete Cosine Transform (MDCT) - Discrete Fourier and Discrete Cosine Transform - Pre-echo Distortion- Preecho Control Strategies

UNIT III AUDIO CODING AND TRANSFORM CODERS 9

Lossless Audio Coding – Lossy Audio Coding - ISO-MPEG-1A, 2A, 2A-Advaned, 4A Audio Coding - Optimum Coding in the Frequency Domain - Perceptual Transform Coder –Brandenburg - Johnston Hybrid Coder - CNET Coders - Adaptive Spectral Entropy Coding –Differential Perceptual Audio Coder - DFT Noise Substitution -DCT with Vector Quantization -MDCT with Vector Quantization

UNIT IV TIME AND FREQUENCY DOMAIN METHODS FOR SPEECH PROCESSING 9

Time domain parameters of Speech signal – Methods for extracting the parameters :Energy, Average Magnitude – Zero crossing Rate – Silence Discrimination using ZCR and energy Short Time Fourier analysis – Formant extraction – Pitch Extraction using time and frequency domain methods Holomorphic Speech Analysis: Cepstral analysis of Speech – Formant and Pitch Estimation – Holomorphic Vocoders

UNIT V PREDICTIVE ANALYSIS OF SPEECH 9

Formulation of Linear Prediction problem in Time Domain – Basic Principle – Auto correlation method– Covariance method – Solution of LPC equations – Cholesky method – Durbin"s Recursive algorithm– lattice formation and solutions – Comparison of different methods – Application of LPC parameters– Pitch detection using LPC parameters – Formant analysis – VELP – CELP

TOTAL:45 PERIODS

COs	At the end of the course the student will be able to	Blooms Taxonomy
CO-1	Explain the audio and speech mechanics	Understand
CO-2	Analyze the filter banks and transforms	Analyze
CO-3	Evaluate audio coding and transform coders	Evaluate
CO-4	Discuss time and frequency domain methods	Understand
CO-5	Explain predictive analysis of speech	Understand

COs	POs					
	PO1	PO2	PO3	PO4	PO 5	PO6
1	3	3	3	2	2	2
2	3	3	3	3	3	2
3	3	3	3	3	3	3
4	3	3	3	3	3	2
5	2	2	2	2	2	2

TEXT BOOK:

1. Ben Gold and Nelson Morgan, Speech and Audio Signal Processing, John Wiley and Sons Inc. , Singapore, 2017.

REFERENCES:

1. B. Gold and N. Morgan, "Speech and Audio Signal Processing", Wiley and Sons, 2016
2. UdoZölzer, "Digital Audio Signal Processing", Third Edition A John Wiley& sons Ltd,2022
3. Applications of Digital Signal Processing to Audio And Acoustics Mark Kahrs, Karlheinz Brandenburg, Kluwer Academic Publishers New York, Boston, Dordrecht, London , Moscow,2016

WEBSITE REFERENCE:

1. Speech and Audio Signal Processing: https://link.springer.com/book/10.1007/b117882

NPTEL/SWAYAM/MOOC REFERENCE:

1. Speech and Audio Signal Processing, Prof. Shyamal Kumar Das Mandal, IIT Karagpur.

PPAP2PE12	ARTIFICIAL INTELLIGENCE AND OPTIMIZATION TECHNIQUES	L T P C
		3 0 0 3

COURSE OBJECTIVES

- To understand basic problem solving strategies.
- To outline game theory based search and constraint satisfaction
- To study knowledge representation techniques
- To explore reasoning and planning associated with AI.
- To study the techniques of knowledge representation
- . To understand probabilistic and other types of reasoning
- To discuss ethical and safety issues associated with AI

UNIT I INTRODUCTION AND PROBLEM SOLVING **9**

Artificial Intelligence -Introduction - Problem-solving -Solving Problems by Searching – Uninformed Search Strategies -Informed (Heuristic) Search Strategies - Local Search - Search in Partially Observable Environments

UNIT II ADVERSARIAL SEARCH AND CONSTRAINT SATISFACTION PROBLEMS **9**

Game Theory- Optimal Decisions in Games - Heuristic Alpha--Beta Tree Search- Monte Carlo Tree Search - Stochastic Games - Partially Observable Games - Limitations of Game Search Algorithms Constraint Satisfaction Problems (CSP)– Examples - Constraint Propagation Backtracking Search for CSPs - Local Search for CSPs

UNIT III KNOWLEDGE, REASONING AND PLANNING **9**

First Order Logic – Inference in First Order Logic -Using Predicate Logic - Knowledge Representation - Issues -Ontological Engineering - Categories and Objects – Reasoning Systems for Categories - Planning - Definition -Algorithms -Heuristics for Planning -Hierarchical Planning

UNIT IV UNCERTAIN KNOWLEDGE AND REASONING **9**

Quantifying Uncertainty - Probabilistic Reasoning - Probabilistic Reasoning over Time Probabilistic Programming -Making Simple Decisions - Making Complex Decisions - Case Based Reasoning – Explanation-Based Learning – Evolutionary Computation

UNIT V PHILOSOPHY, ETHICS AND SAFETY OF AI **9**

The Limits of AI – Knowledge in Learning –Statistical Learning Methods – Reinforcement Learning - Introduction to Machine Learning and Deep Learning -Can Machines Really Think? - Distributed AI Artificial Life-The Ethics of AI - Interpretable AI- Future of AI - AI Components -AI Architectures

TOTAL:45 PERIODS

COs	At the end of the course the student will be able to	Blooms Taxonomy
CO-1	Implement any three problem solving methods for a puzzle choice	Apply
CO-2	Understand Game playing and implement a two player game using AI techniques	Understand
CO-3	Design and Implement an example using predicate Logic	Create
CO-4	Implement a case based reasoning system	Apply
CO-5	Discuss some methodologies to design ethical and AI systems	Understand

COs	POs					
	PO1	PO2	PO3	PO4	PO 5	PO6
1	3	1	1	2	3	2
2	2	1	2	3	2	3
3	1	3	2	3	3	2
4	1	3	3	3	3	1
5	2	3	3	-	2	3

TEXT BOOKS:

1. Stuart Russell, Peter Norvig, "Artificial Intelligence: A Modern Approach", Pearson, 4th Edition, 2020.
2. Zhongzhi Shi "Advanced Artificial Intelligence", World Scientific; 2019.

REFERENCES:

1. Kevin Knight, Elaine Rich, Shivashankar B. Nair, "Artificial Intelligence", McGraw Hill Education; 3rd edition, 2017
2. Richard E. Neapolitan, Xia Jiang, "Artificial Intelligence with an Introduction to Machine Learning", Chapman and Hall/CRC; 2nd edition, 2018
3. Dheepak Khemani, "A first course in Artificial Intelligence", McGraw Hill Education Pvt Ltd., New Delhi, 2016.

NPTEL/SWAYAM/MOOC REFERENCE:

1. Artificial-Intelligence-and-Optimization-Techniques, Prof. Anupam Basu, Prof. S. Sarkar, IIT Karagpur.

WEB SITE REFERENCE:

1. Artificial-Intelligence-and-Optimization-Techniques:https://link.springer.com/chapter/10.1007/978-981-15-0214-9_12.

PPAP2ACXX	AUDIT COURSE-II DISASTER MANAGEMENT	L	T	P	C
		2	0	0	0

COURSE OBJECTIVES:

- Summarize basics of disaster
- Explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
- Illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
- Describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
- Develop the strengths and weaknesses of disaster management approaches

UNIT I: INTRODUCTION 6

Disaster: Definition, Factors and Significance; Difference between Hazard And Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

UNIT II : REPERCUSSIONS OF DISASTERS AND HAZARDS 6

Economic Damage, Loss of Human and Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.

UNIT III : DISASTER PRONE AREAS IN INDIA 6

Study of Seismic Zones; Areas Prone To Floods and Droughts, Landslides And Avalanches; Areas Prone To Cyclonic and Coastal Hazards with Special Reference To Tsunami; Post-Disaster Diseases and Epidemics

UNIT IV : DISASTER PREPAREDNESS AND MANAGEMENT 6

Preparedness: Monitoring Of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological And Other Agencies, Media Reports: Governmental and Community Preparedness.

UNIT V : RISK ASSESSMENT 6

Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, Peopl's Participation in Risk Assessment. Strategies for Survival.

TOTAL: 30 PERIODS

COs	At the end of the course the student will be to	Blooms Taxonomy
CO-1	Ability to summarize basics of disaster	Understand
CO-2	Ability to explain a critical understanding of key concepts in disaster risk reduction and humanitarian response	Understand
CO-3	Ability to illustrate disaster risk reduction and humanitarian response policy and practice from multiple Perspectives	Understand
CO-4	Ability to describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations	Understand
CO-5	Ability to develop the strengths and weaknesses of disaster management approaches	Create

COs	POs					
	PO1	PO2	PO3	PO4	PO 5	PO6
1	-	-	-	1	-	1
2	-	-	1	2	-	1
3	-	-	1	2	1	-
4	-	-	1	2	2	-
5	-	-	1	2	-	-

TEXT BOOKs:

1. Goel S. L., Disaster Administration And Management Text And Case Studies", Deep & Deep Publication Pvt. Ltd., New Delhi,2016.
2. Nishitha Rai, Singh AK, "Disaster Management in India: Perspectives, issues and strategies ""New-Royal book Company, 2016.
3. Sahni, Pardeep Et. Al. ," Disaster Mitigation Experiences and Reflections", Prentice Hall Of India, New Delhi, 2016.

PPAP2PL03	VLSI DESIGN LABORATORY	L T P C
		0 0 4 2

COURSE OBJECTIVES

- Familiarize with different FPGA boards
- Analyze digital design using Front end Tools
- Analyze the CMOS circuits using CAD tools
- Analyze the interfacing of I/O devices with Arduino Boards using Embedded

PRACTICAL EXPERIMENTS:

1. Synthesize and implement Combinational and Sequential Circuits in VERILOG / VHDL
2. Synthesize an implement MAC unit and GCD unit in Verilog /VHDL
3. Implementation of sampling of input signal and display in FPGA Synthesize and
4. implement FIR filter and IIR filter Verilog /VHDL
5. Synthesize and implement 8 bit general purpose processor in Verilog/VHDL
6. Synthesize and implement UART and USART
7. Simulation and Analysis of CMOS combinational and sequential logic circuits using CAD tools

60 PERIODS

COs	At the end of the course the student will be able to	Blooms Taxonomy
CO-1	Program in Verilog/VHDL for combinational and sequential circuits and implement the program in FPGA	Understand
CO-2	Implement FIR and IIR filters in FPGA	Apply
CO-3	Implement data path design and interfaces	Apply
CO-4	Handle CAD tools to draw/edit, and analyze the CMOS circuits	Analyze
CO-5	Program and interface the Arduino Boards using Embedded C	Apply

COs	POs					
	PO1	PO2	PO3	PO4	PO 5	PO6
1	1	-	-	3	-	-
2	2	-	-	2	-	-
3	-	-	-	1	-	-
4	2	-	-	-	-	-
5	-	-	-	1	1	2

PPAP2PL04	ADVANCED DIGITAL IMAGE PROCESSING LABORATORY	L T P C
		0 0 4 2

COURSE OBJECTIVES

- To understand the image fundamentals and mathematical transforms necessary for image processing and to study the image enhancement techniques.
- To understand the image segmentation and representation techniques.
- To understand how image are analyzed to extract features of interest.
- To introduce the concepts of image registration and image fusion.
- To analyze the constraints in image processing when dealing with 3D data sets.

LIST OF EXPERIMENTS:

1. Wavelet and DCT based Image Compression.
2. Geometrical transformations and Interpolation of Images.
3. Edge Detection using canny edge detector.
4. Region based, threshold based and Watershed Segmentation.
5. Image filtering using DFT..
6. Texture, Gabor and Wavelet Feature Extraction .
7. Image fusion using Wavelets .
8. Segmenting 3D Image volume using K-means clustering.
9. Segmentation of Lungs from 3D- Chest Scan

TOTAL: 60 PERIODS

COs	At the end of the course the student will be able to	Blooms Taxonomy
CO-1	To understand image formation and the role of human visual system plays in perception of gray and color Understand image data.	Understand
CO-2	To apply image processing techniques in both the spatial and frequency (Fourier) domains	Apply
CO-3	To design image analysis techniques in the form of Create image segmentation and to the Methodologies for segmentation	Create
CO-4	To conduct independent study and analysis of feature extraction techniques.	Analyze
CO-5	To understand the concepts of image registration and image fusion	Understand

COs	POs					
	PO1	PO2	PO3	PO4	PO 5	PO6
1	3	2	2	2	2	-
2	3	2	2	2	2	-
3	3	2	2	2	2	-
4	3	2	2	2	2	-
5	3	2	2	2	2	-

PAP2PL05	TERM PAPER WRITING AND SEMINAR	L	T	P	C
		0	0	2	1

COURSE OBJECTIVES

In this course, students will develop their scientific and technical reading and writing skills that they need to understand and constructer search articles. A term paper requires a student to obtain information from a variety of sources (i.e., Journals, dictionaries, reference books) and then place it in logically developed ideas.

The work involves the following steps:

1. Selecting a subject, narrowing the subject into a topic
2. Stating an objective.
3. Collecting the relevant bibliography (at least 15 journal papers)
4. Preparing a working outline.
5. Studying the papers and understanding the authors contributions and critically analyzing each paper.
6. Preparing a working outline
7. Linking the papers and preparing a draft of the paper.
8. Preparing conclusions based on the reading of all the papers.
9. Writing the Final Paper and giving final Presentation

Please keep a file where the work carried out by you is maintained. Activities to be carried Out

Activity	Instructions	Submission	Evaluation
Selection of area of interest and Topic Stating an objective	You are requested to select an area of interest, topic and state an objective	2nd week	3 % Based on clarity of thought, current relevance and clarity Stating an in writing
Collecting Information about your area & topic	1. List 1 Special Interest Groups or professional society 2. List2journals 3. List 2 conferences, symposia or workshops 4. 4.List1thesistitle 5.List3webpresences (mailing lists, forums, news sites) 6. List 3 authors who publish regularly in your area 7.Attach a call for papers (CFP) from your area. You have to provide a complete list of references you will be using-Based on your objective-Search various digital libraries and Google Scholar When picking papers to read -try to:	3rd week	3% (the selected information must be area specific and of international and national standard)
Collection of Journal papers in the topic in the context of the objective– collect20& Then filter	• Pick papers that are related to each other in some ways and/or that are in the same field so that you can write a meaning full survey out of them,	4th week	
	• Favor papers from well-known journals and conferences,		6% (the list of standard papers and reason for selection)

	• Favor "first" or "foundational" papers in the field (as indicated in other People's survey paper), Favor more recent papers • Pick are cent survey of the Fields you can quickly gain an overview, • Find relationships with respect to each other and to your topic area (classification scheme/categorization)		

SEMESTER III

Sl. No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
THEORY								
1	PPAP3PC07	IoT System Design and Security	PC	3	3	0	0	3
2	PPAP3PEXX	Professional Elective-4	PE	3	3	0	0	3
3	PPAP3PEXX	Professional Elective-5	PE	3	3	0	0	3
4	PPAP3OEXX	Open Elective-1	OE	3	3	0	0	3
PRACTICALS								
4	PPAP3PR01	Project Work Phase-I	PR	12	0	0	12	6
Total				**24**	**12**	**0**	**12**	**18**

PPAP3PC07	IoT SYSTEMS DESIGN AND SECURITY	L T P C
		3 0 0 3

COURSE OBJECTIVES

- The main objective of this course is to understand the Introduction about IoT
- This course also will help the students themselves about Middleware and IoT Protocols
- To understand the concept of Case Studies in IoT
- To understand the various IoT Securities and its practices

UNIT I INTRODUCTION TO INTERNET OF THINGS 9

IoT , Importance of IoT, Applications of IOT, IoT architecture, Understanding working of Sensors, Actuators, Sensor calibration, Study of Different sensors and their characteristics.

UNIT II MIDDLEWARE AND PROTOCOLS OF IOT 9

Middleware technologies for IOT system, Middleware architecture of RFID,WSN,SCADA,M2M – Interoperability challenges of IOT -Protocols for RFID,WSN,SCADA,M2M- Zigbee, KNX, BACNet, MODBUS - Challenges Introduced by 5G in IoT Middleware.

UNIT III CASE STUDIES IN IoT 9

Home automations - Smart cities – Environment – Energy – Retail – Logistics – Agriculture – Industry - Health and life style – Case study.

UNIT IV IOT INTRODUCTION TO IoT SECURITY 9

Overview of IoT ecosystems - Unique security challenges of IoT- Threat landscape in IoT Security analysis of MQTT, CoAP, HTTP, etc.-Transport layer security (TLS) in IoT - Secure bootstrapping and provisioning - Symmetric and asymmetric encryption -Key management in IoT -Message authentication codes (MACs)

UNIT V SECURITY PRACTICES 9

Firewalls and Intrusion Detection Systems: Intrusion Detection Password Management, Firewall Characteristics Types of Firewalls, Firewall Basing, Firewall Location and Configurations. Block-chains, Cloud Security and IoT security.

TOTAL:45 PERIODS

COs	At the end of the course the student will be able to	Blooms Taxonomy
CO-1	Discuss the introduction about IoT	Understand
CO-2	Identify the middle ware and Protocols of IoT	Understand
CO-3	Understand the concepts of case studies in IoT.	Understand
CO-4	Discuss the Introduction about IoT Security.	Understand
CO-5	Understand about security and its applications	Understand

COs	POs					
	PO1	PO2	PO3	PO4	PO 5	PO6
1	-	1	3	-	-	-
2	-	-	2	-	-	-
3	-	-	2	1	-	-
4	-	-	3	-	-	-
5	-	-	2	1	-	-

TEXTBOOKS:

1. Honbo Zhou, "Internet of Things in the cloud: A middleware perspective", CRC press, 2021.
2. Vijay Madisetti and Arshdeep Bahga, "Internet of Things (A Hands-on Approach)", VPT, 6th Edition, 2020.

REFERENCES:

1. Pethuru Raj and Anupama C. Raman, "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", CRC Press, 2019.
2. Constandinos X. Mavromoustakis, George Mastorakis, Jordi Mongay Batalla, "Internet of Things (IoT) in 5G Mobile Technologies" Springer International Publishing Switzerland 2020.
3. DieterUckelmann, Mark Harrison, Florian Michahelles, "Architecting the Internet of Things" Springer-Verlag Berlin Heidelberg, 2019.
4.

NPTEL/ SWAYAM/ MOOC REFERENCE:

1. NPTEL:Design for internet of things: https://onlinecourses.nptel.ac.in/noc21_ee85/preview, Prof. Probhakar T V, IISc Bangalore.

SEMESTER III

ELECTIVE IV

Sl. No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
1	PPAP3PE13	Biomedical Signal Processing	PE	3	3	0	0	3
2	PPAP3PE14	Signal Integrity for High Speed Design	PE	3	3	0	0	3
3	PPAP3PE15	Consumer Electronics	PE	3	3	0	0	3
4	PPAP3PE16	Advanced Microprocessors and Microcontrollers Architectures	PE	3	3	0	0	3

PPAP3PE13	BIOMEDICAL SIGNAL PROCESSING	L T P C
		3 0 0 3

COURSE OBJECTIVES

- The main objective of this course is to describe the properties and suitable models of biomedical signals.
- Introduce the basic signal processing techniques in analyzing biomedical signals.
- Developing computational skills in filtering of biomedical signals.
- This course also will help the students to understand on ECG signal compression algorithms
- Also on extraction of biomedical signals

UNIT I INTRODUCTION TO BIOMEDICAL SIGNALS 9

Introduction to Biomedical Signals: The nature of Biomedical Signals, Examples of Biomedical Signals, Objectives and difficulties in Biomedical analysis. Electrocardiography: Basic electrocardiography, ECG leads systems, ECG signal characteristics. Signal Conversion :Simple signal conversion systems, Conversion requirements for biomedical signals, Signal conversion circuits

UNIT II SIGNAL AVERAGING 9

Signal Averaging: Basics of signal averaging, signal averaging as a digital filter, a typical average, software for signal averaging, limitations of signal averaging. Adaptive Noise Cancelling: Principal noise canceller model, 60-Hz adaptive cancelling using a sine wave model, other applications of adaptive filtering

UNIT III DATA COMPRESSION TECHNIQUES 9

Data Compression Techniques: Turning point algorithm, AZTEC algorithm, Fan algorithm, Huffman coding, data reduction algorithms. The Fourier transform, Correlation, Convolution, Power spectrum estimation, Frequency domain analysis of the ECG

UNIT IV CARDIOLOGICAL SIGNAL PROCESSING 9

Cardiological signal processing: Basic Electrocardiography, ECG data acquisition, ECG lead system, ECG signal characteristics (parameters and their estimation), Analog filters, ECG amplifier, and QRS detector, Power spectrum of the ECG, Band pass filtering techniques, Differentiation techniques, Template matching techniques, A QRS detection algorithm, Real time ECG processing algorithm, ECG interpretation, ST segment analyzer, Portable arrhythmia monitor

UNIT V NEUROLOGICAL SIGNAL PROCESSING 9

Neurological signal processing: The brain and its potentials, The electro physiological origin of brain waves, The EEG signal and its characteristics (EEG rhythms, waves, and transients), Correlation. Analysis of EEG channels: Detection of EEG rhythms, Template matching for EEG, spike and wave detection.

TOTAL: 45 PERIODS

COs	At the end of the course the student will be able to	Blooms Taxonomy
CO-1	Possess kills necessary to analyze ECG and EEG Signals	Understand
CO-2	Apply classical and modern filtering techniques for ECG and EEG Signal	Apply
CO-3	Apply classical and modern compression techniques for ECG and EEG Signals	Apply
CO-4	Develop an understanding on ECG feature extraction	Understand
CO-5	Develop an understanding on EEG feature extraction	Understand

COs	POs					
	PO1	PO2	PO3	PO4	PO 5	PO6
1	-	1	2	-	3	-
2	-	2	1	-	2	1
3	-	1	2	1	3	2
4	-	1	2	1	2	-
5	-	1	2	3	3	1

TEXTBOOKS:

1. Rangaraj MR angayyan "Biomedical Signal Analysis –A case study approach "IEEE press series in biomedical engineering, 5th Edition, 2020
2. DCReddy"BiomedicalSignalProcessing:PrinciplesandTechniques",TataMcGraw-Hill Publishing Co. Ltd, 2019.

REFERENCES:

1. John GProakis, Dimitris and G.Manolakis, "Digital Signal Processing Principles algorithms, applications" PHI Third Edition. 2020.
2. WillisJ.Tompkins"BiomedicalDigitalSignalProcessing",EEE,PHI,2004Gross, D., Shortle J. F., Thompson, J.M., and Harris, C. M., "Fundamentals of QueueingTheory",6th Edition.

NPTEL/ SWAYAM/ MOOC REFERENCE:

1. NPTEL: Biomedical Signal Processing: https://onlinecourses.nptel.ac.in/noc20_ee41/preview,Prof. Sudipta Mukhopadhyay, IIT Kharagpur.

PPAP3PE14	SIGNAL INTEGRITY FOR HIGH SPEED DESIGN	L T P C
		3 0 0 3

COURSE OBJECTIVES

- To identify sources affecting the speed of digital circuits
- To improve the signal transmission characteristics

UNIT I SIGNAL PROPAGATION ON TRANSMISSION LINES 9

Transmission line equations, wave solution, wave vs. circuits ,initial wave, delay time, characteristic impedance , wave propagation, reflection, and bounce diagrams Reactive terminations – L, C , static field maps of micro strip and strip line cross-sections, per unit length parameters, PCB layer stickups and layer/Cu thicknesses, cross-sectional analysis tools, Zo and Td equations for micro strip and strip line Reflection and terminations for logic gates, fan-out, logic switching , input impedance into a transmission-line section, reflection coefficient, skin-effect, dispersion.

UNIT II MULTI-CONDUCTOR TRANSMISSION LINES AND CROSS-TALK 9

Multi-conductor transmission-lines, coupling physics, per unit length parameters ,Near and far-end cross-talk, minimizing cross-talk (strip line and micro strip) Differential signaling, termination, balanced circuits ,S-parameters, Lossy and Lossless models.

UNIT III NON-IDEALEFFECTS 9

Non-ideal signal return paths – gaps, BGA fields, via transitions , Parasitic inductance and capacitance , Transmission line losses – Rs, tanδ , routing parasitic, Common-mode current, differential-mode current , Connectors.

UNIT IV POWER CONSIDERATIONS AND SYSTEM DESIGN 9

SSN/SSO , DC power bus design , layer stack up, SMT decoupling ,, Logic families, power consumption, and system power delivery ,Logic families and speed Package types and parasitic,SPICE,IBISmodels,Bitstreams,PRBSandfilteringfunctionsoflink-athcomponents,Eye diagrams , jitter , inter-symbol interference Bit-error rate ,Timing analysis.

UNIT V CLOCK DISTRIBUTION AND CLOCK OSCILLATORS 9

Timingmargin,Clockslew,lowimpedancedrivers,terminations,DelayAdjustments,canceling parasitic capacitance, Clock jitter

TOTAL:45PERIODS

COs	At the end of the course the student will be able to	Blooms Taxonomy
CO-1	Identify sources affecting the speed of digital circuits.	Understad
CO-2	Identify methods to improve the signal transmission characteristics	Understand
CO-3	Characterize and model multi-conductor transmission line	Understand
CO-4	Analyses clock distribution system and understand its design parameters	Analyze
CO-5	Analyze non ideal effects of transmission line	Analyze

COs	POs					
	PO1	PO2	PO3	PO4	PO 5	PO6
1	-	-	3	-	-	-
2	-	-	3	-	-	-
3	-	-	2	1	-	-
4	-	-	-	2	2	-
5	-	-	2	1	-	-

TEXTBOOK:

1. H. W. Johnson and M. Graham, High-Speed Digital Design: A Handbook of Black Magic, Prentice Hall, 2020.

REFERENCES:

1. Douglas Brooks, Signal Integrity Issues and Printed Circuit Board Design, Prentice Hall PTR , 2019.
2. S. Hall, G. Hall, and J. McCall, High-Speed Digital System Design: A Handbook of Interconnect Theory and Design Practices, Wiley-Inter-science, 2018.
3. Eric Bogatin , Signal Integrity – Simplified , Prentice Hall PTR, 2019.

NPTEL/ SWAYAM/ MOOC REFERENCES:

1. **NPTEL:** R Ftransceiver Design: https://onlinecourses.nptel.ac.in/noc24_ee75/preview, Prof. Darshak Bhatt, IIT Kharagpur.
2. **NPTEL:** Signal Integrity : Principles, Techniques And Applications: https://onlinecourses.nptel.ac.in/noc24_ee67/preview, Prof. Amitabha Bhattacharya, IIT Kharagpur.

PPAP3PE15	CONSUMER ELECTRONICS	L T P C
		3 0 0 3

COURSE OBJECTIVES

- To acquaint the students with the construction, theory.
- Operation of the basic electronic devices such as PN junction diode, Bipolar and Field Effect Transistors, Power control devices etc.,
- The working principle of LED, LCD and other Opto-electronic devices., used to introduce the concept of Sensors and voice controls,
- It provide the knowledge on Smart home devices. on gain knowledge on current communication technology.

UNIT I CONSUMER ELECTRONICS FUNDAMENTALS 9

History of Electronic Devices- Vacuum Tubes, Transistors, Integrated Circuits- Moorse Law, SemiconductorDevices,Diodes,Rectifiers,Transistors,LogicGates,CombinationalCircuits,ADC, DAC and Microprocessors, Microprocessor Vs Microcontrollers, Microcontrollers in consumer electronics, Energy management, Intelligent Building Perspective

UNIT II ENTERTAINMENT ELECTRONICS 9

Audio systems: Construction and working principle of: Microphone, Loud speaker, AM and FM receiver, stereo, Home theatre. Display systems: CRT, LCD, LED and Graphics display Video Players: DVD and Blue RAY. Recording Systems: Digital Cameras and Camcorders

UNIT III SMART HOME-SENSORS 9

Technology involved in Smart home, Home Virtual Assistants- Alexa and Google Home. Home Security Systems - Intruder Detection, Automated blinds, Motion Sensors, Thermal Sensors and Image Sensors, PIR, IR and Water Level Sensors.

UNIT IV HOME APPLIANCE 9

Home Enablement Systems: RFID Home, Lighting control, Automatic Cleaning Robots, Washing Machines, Kitchen Electronics- Microwave, Dishwasher, Induction Stoves, Smart Refrigerators, Smart alarms, Smart toilet, Smart floor, Smart locks.

UNIT V INTRODUCTION TO SMART OS AND COMMUNICATION 9

Introduction to Smart OS- Android and iOS. Video Conferencing Systems- Web/IP Camera, Video security, Internet Enabled Systems, Wi-Fi, IoT, Li-Fi, GPS and Tracking Systems. Cordless Telephones, Fax Machines, PDAs- Tablets, Smart Phones and Smart Watches.

TOTAL: 45 PERIODS

COs	At the end of the course the student will be able to	Blooms Taxonomy
CO-1	Explain the V-I characteristic of diode, UJT and SCR. Describe the equivalence circuits of transistors.	Understand
CO-2	Operate the basic electronic devices such as PN junction diode, Bipolar and Field Effect Transistors, Power control devices, LED, LCD and other Opto-electronic devices.	Understand
CO-3	Gain knowledge on sensors and controls.	Understand
CO-4	Emphasize the need for communication systems.	Understand
CO-5	Explore the current technology and apply on home applications	Understand

COs	POs					
	PO1	PO2	PO3	PO4	PO 5	PO6
1	-	-	2	-	-	-
2	-	-	2	1	-	-
3	-	-	2	-	-	-
4	-	-	-	1	2	-
5	-	-	-	-	2	2

TEXTBOOKS:

1. ThomasLFloyd"ElectronicDevices"10th Edition Pearson Education Asia 2020.
2. Jordan Frith, "Smart phones as Locative Media", Wiley. 2021.
3.

REFERENCES:

1. DennisCBrewer,"HomeAutomation",QuePublishing2019.
2. ThomasM.Coughlin,"Digital Storagein Consumer Electronics", Elsevier and Newness, 2019.

Nickvandome, Smarthomes in easy steps,-Master smart technology for your home 2019.

NPTEL/ SWAYAM/ MOOC REFERENCES:

1. **NPTEL:** Sensors and actuators: https://onlinecourses.nptel.ac.in/noc21_ee32/preview, Prof. Hardik Jeetendra Pandya, IISc, bangalore.
2. **NPTEL:** Basic electronics: https://onlinecourses.nptel.ac.in/noc21_ee55/preview, Prof. M.B. Patil, IIT,bombay.

PPAP3PE16	ADVANCED MICROPROCESSORS AND MICROCONTROLLERS ARCHITECTURES	L T P C
		3 0 0 3

COURSE OBJECTIVES

- To expose the students to the fundamentals of microprocessor architecture.
- To explore the high performance features in CISC architecture.
- To familiarize the high performance features in RISC architecture.
- To introduce the basic features in Motorola microcontrollers.
- To enable the students to understand PIC Microcontroller

UNIT I MICROPROCESSOR ARCHITECTURE 9

Instruction Set – Data formats –Addressing modes – Memory hierarchy –register file – Cache – Virtual memory and paging – Segmentation- pipelining –the instruction pipeline – pipeline hazards – instruction level parallelism – reduced instruction set –Computer principles – RISC versus CISC.

UNIT II HIGH PERFORMANCE CISC ARCHITECTURE – PENTIUM 9

CPU Architecture- Bus Operations – Pipelining – Brach predication – floating point unit- Operating Modes –Paging – Multitasking – Exception and Interrupts – Instruction set – addressing modes – Programming the Pentium processor.

UNIT III HIGH PERFORMANCE RISC ARCHITECTURE – ARM 9

Organization of CPU – Bus architecture –Memory management unit - ARM instruction set- Thumb Instruction set- addressing modes – Programming the ARM processor.

UNIT IV MSP430 16 - BIT MICROCONTROLLER 9

The MSP430 Architecture- CPU Registers - Instruction Set, On-Chip Peripherals - MSP430 - Development Tools, ADC - PWM - UART - Timer Interrupts - System design using MSP430Microcontroller

UNIT V PIC MICROCONTROLLER 9

CPU Architecture – Instruction set – interrupts- Timers- I2C Interfacing –UART- A/D Converter – PWM and introduction to C-Compilers.

TOTAL:45 PERIODS

COs	At the end of the course the student will be able to	Blooms Taxonomy
CO-1	To understand the fundamentals of microprocessor architecture.	Understand
CO-2	To know and appreciate the high performance features in CISC architecture	Understand
CO-3	To know and appreciate the high performance features in RISC architecture	Understand
CO-4	To perceive the basic features in Motorola microcontrollers.	Apply
CO-5	To interpret and understand PIC Microcontroller.	Understand

COs	POs					
	PO1	PO2	PO3	PO4	PO 5	PO6
1	-	2	3	-	-	-
2	-	-	2	-	-	-
3	-	-	2	1	-	-
4	-	-	3		-	-
5	-	-	2	1	-	-

TEXT BOOKS:

1. Daniel Tabak , „" Advanced Microprocessors" McGraw Hill.Inc., 2020.
2. James L. Antonakos , " The Pentium Microprocessor", Pearson Education , 2021.

REFERENCES:

1. Steve Furber , " ARM System –On –Chip architecture", Addision Wesley , 2019.
2. Gene .H.Miller ." Micro Computer Engineering ", Pearson Education , 2020.
3. John .B.Peatman , " Design with PIC Microcontroller" , Prentice hall, 2018.
4. John H.Davis , "MSP 430 Micro controller basics", Eelsevier, 2019.
5. James L.Antonakos, "An Introduction to the Intel family of Microprocessors", Pearson Education 2018.
6. Barry.B.Breg, "The Intel Microprocessors Architecture , Programming and Interfacing ", PHI,2019.
7. Valvano "Embedded Microcomputer Systems" Thomson Asia PVT LTD first reprint 2020.

NPTEL/ SWAYAM/ MOOC REFERENCE:

1. NPTEL: Microprocessor and Microcontroller: https://archive.nptel.ac.in/courses/108/105/108105102/, Prof. SantanuChattopadhyay, IIT Kharagpur.

ELECTIVE–V

Sl. No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
1	PPAP3PE17	Modeling and Synthesis with HDL	PE	3	3	0	0	3
2	PPAP3PE18	Artificial Intelligence and Machine Learning	PE	3	3	0	0	3
3	PPAP3PE19	Pattern Recognition	PE	3	3	0	0	3
4	PPAP3PE20	PCB Design	PE	3	3	0	0	3

PPAP3PE17	MODELING AND SYNTHESIS WITH HDL	L T P C
		3 0 0 3

COURSE OBJECTIVES

- To know the basic language features of Verilog HDL.
- The role in digital logic design.
- To know the behavioral modeling of combinational and sequential circuits.
- To know the behavioral modeling of algorithmic state machines,
- To know the synthesis of combinational and sequential descriptions.
- To know the architectural features of programmable logic devices.

UNIT I INTRODUCTION TO LOGIC DESIGN WITH VERILOG 9

Overview of Digital Design with Verilog HDL - Hierarchical Modeling Concepts: Top-down and bottom-up design methodology, differences between modules and module instances, parts of a simulation, design block, stimulus block - Basic Concept- Modules and Ports: Module definition, port declaration, connecting ports, hierarchical name referencing. Tasks and Functions

UNIT II LEVELS OF MODELING 9

Gate-Level Modeling: Modeling using basic Verilog gate primitives, description of and/or and buf/not type gates, rise, fall and turn-off delays, min, max, and typical delays. Dataflow Modeling: Continuous assignments, delay specification, expressions, operators, operands, operator types. Behavioral Modeling: Structured procedures, initial and always, blocking and non-blocking statements, delay control, generate statement, event control, conditional statements, multi-way branching, loops, sequential and parallel blocks

UNIT III DESIGN OF DIGITAL LOGIC USING HDL 9

Design of combinational logic: adders, multiplexers, de-multiplexers, encoders and decoders, comparators, multipliers - Design of Sequential logic: Flip-flops, synchronous and Asynchronous counters, shift registers, Universal shift register, FSM and LFSR. (Using various Levels of Modeling)

UNIT IV LOGIC SYNTHESIS AND DESIGN FLOW 9

Logic Synthesis with Verilog HDL-Synthesis Design flow, RTL and Test Bench Modeling Techniques and Timing and Path Delay Modeling, Timing Checks, Switch Level Modeling

UNIT V PROGRAMMABLE LOGIC DEVICES 9

Programmable logic devices, storage devices, programmable logic array programmable array logic, programmability of PLDs CPLDs.

TOTAL:45 PERIODS

COs	At the end of the course the student will be able to	Blooms Taxonomy
CO-1	Demonstrate knowledge on HDL design flow and digital circuits design.	Understand
CO-2	Develop the combinational and sequential circuits using various modeling	Understand
CO-3	Solving algorithmic state machines using hardware description language	Understand
CO-4	Analyze the process of synthesizing the combinational and sequential descriptions	Apply
CO-5	Know the advantages of programmable logic devices and their description in Verilog	Understand

COs	POs					
	PO1	PO2	PO3	PO4	PO 5	PO6
1	3	-	2	-	2	-
2	1	-	-	2	3	-
3	3	-	2	-	3	-
4	-	-	2	1	3	2
5	2	-	1	2	-	1

TEXT BOOKS:

1. Samir Palnitkar - Verilog HDL, 6thedition, Pearson Education, 2021.
2. Michael D Ciletti - Advanced Digital Design with the VERILOG HDL, 5th Edition, PHI, 2020.

REFERENCES:

1. Z Navabi - Verilog Digital System Design, 5th Edition, McGraw Hill, 2020.
2. Stephen Brown and Zvonko Vranesic - Fundamentals of Digital Logic with Verilog, 4th Edition, TMH, 2020.

NPTEL/ SWAYAM/ MOOC REFERENCE:

1.**NPTEL:**Hardware modeling using Verilog: https://archive.nptel.ac.in/courses/106/105/106105165/, Prof IndranilSen Gupta, IIT Kharagpur.

PPAP3PE18	ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING	L T P C
		3 0 0 3

COURSE OBJECTIVES

- Study about uninformed and Heuristic search techniques
- Learn techniques for reasoning under uncertainty
- Introduce Machine Learning and supervised learning algorithms
- Study about ensemble and unsupervised learning algorithms
- Learn the basics of deep learning using neural networks

UNIT I INTRODUCTION TO AI AND PROBLEM SOLVING 9

Introduction to AI - AI Applications - Problem solving agents – search algorithms – uninformed search strategies – Heuristic search strategies – Local search and optimization problems – adversarial search – constraint satisfaction problems (CSP)

UNIT II PROBABILISTIC REASONING 9

Introduction to probabilistic programming languages (PPLs), acting under uncertainty – Bayesian inference – naïve bayes models. Probabilistic reasoning – Bayesian networks – exact inference in BN – approximate inference in BN – causal networks., Bayesian inference using PPLs, Ensemble methods in Bayesian inference

UNIT III SUPERVISED LEARNING 9

Introduction to machine learning – Linear Regression Models: Least squares, single & multiple variables, Bayesian linear regression, gradient descent, Linear Classification Models: Discriminant function – Probabilistic discriminative model - Logistic regression, Probabilistic generative model – Naive Bayes, Maximum margin classifier – Support vector machine, Decision Tree, Random forests

UNITIV ENSEMBLE TECHNIQUES AND UNSUPERVISED LEARNING 9

Combining multiple learners: Model combination schemes, Voting, Ensemble Learning - bagging, boosting, stacking, Unsupervised learning: K-means, Instance Based Learning: KNN, Gaussian mixture models and Expectation maximization

UNIT V NEURAL NETWORKS 9

Perceptron - Multilayer perceptron, activation functions, network training – gradient descent optimization – stochastic gradient descent, error backpropagation, from shallow networks to deep networks –Unit saturation (aka the vanishing gradient problem) – ReLU, hyperparameter tuning, batch normalization, regularization, dropout.

TOTAL:45 PERIODS

COs	At the end of the course the student will be able to	Blooms Taxonomy
CO-1	Use appropriate search algorithms for problem solving	Analyze
CO-2	Apply reasoning under uncertainty	Apply
CO-3	Analyze supervised learning models	Analyze
CO-4	Analyze ensemble and unsupervised models	Analyze
CO-5	Analyze deep learning neural network models	Analyze

COs	POs					
	PO1	PO2	PO3	PO4	PO 5	PO6
1	3	-	-	2	-	-
2	-	-	-	3	-	-
3	2	-	2	3	-	-
4	3	-	2	3	2	-
5	2	-	3	2	2	-

TEXT BOOKS:

1. Stuart Russell and Peter Norvig, "Artificial Intelligence – A Modern Approach", Fourth Edition, Pearson Education, 2021.
2. EthemAlpaydin, "Introduction to Machine Learning", MIT Press, Fourth Edition, 2020.

REFERENCES:

1. Charu C. Aggarwal, "Data Classification Algorithms and Applications", CRC Press, 2020
2. Ian Goodfellow, YoshuaBengio, Aaron Courville, "Deep Learning", MIT Press, 2019

Deepak Khemani, "Artificial Intelligence", Tata McGraw Hill Education, 2020.

NPTEL/ SWAYAM/ MOOC REFERENCE:

1. **NPTEL:** Artificial Intelligence and Machine Learning: https://archive.nptel.ac.in/courses/106/106/106106184/, Prof Mitesh M Khapra, IIT Ropar.

PPAP3PE19	PATTERN RECOGNITION	L T P C
		3 0 0 3

COURSE OBJECTIVES

- To learn about supervised and unsupervised pattern classifiers.
- To familiarize about different feature extraction techniques.
- To explore the role of Hidden Marko model and SVM in pattern recognition.
- To understand the application of Fuzzy logic and genetic algorithms for pattern classifier

UNITI PATTERN CLASSIFIER **9**

Overview of Pattern recognition – Discriminant functions – Supervised learning –Parametric estimation – Maximum Likelihood Estimation – Bayesian parameter Estimation – Problems with Bayes approach– Pattern classification by distance functions – Minimum distance pattern classifier.

UNIT II CLUSTERING **9**

Clustering for unsupervised learning and classification–Clustering concept – C Means algorithm – Hierarchical clustering – Graph theoretic approach to pattern Clustering – Validity of Clusters.

UNIT IIIFEATURE EXTRACTION AND STRUCTURAL PATTERN RECOGNITION **9**

Principle component analysis, Independent component analysis, Linear discriminant analysis, Feature selection through functional approximation – Elements of formal grammars, Syntactic description – Stochastic grammars – Structural Representation.

UNIT IV HIDDEN MARKOV MODELS AND SUPPORT VECTOR MACHINE **9**

State Machines – Hidden Markov Models – Training – Classification – Support vector Machine – Feature Selection.

UNIT V RECENT ADVANCEMENTS **9**

Fuzzy logic – Fuzzy Pattern Classifiers – Pattern Classification using Genetic Algorithms – Case Study Using Fuzzy Pattern Classifiers and Perception.

TOTAL:45PERIODS

COs	At the end of the course the student will be able to	Blooms Taxonomy
CO-1	Differentiate between supervised and unsupervised classifiers	Analyze
CO-2	Classify the data and identify the patterns.	Apply
CO-3	Extract feature set and select the features from given data set.	Apply
CO-4	Apply fuzzy logic and genetic algorithms for classification problems	Apply
CO-5	To understand recent advances in pattern recognition	Understand

COs	POs					
	PO1	PO2	PO3	PO4	PO 5	PO6
1	3	-	-	2	-	-
2	-	-	-	3	-	-
3	2	-	2	3	-	-
4	3	-	2	3	2	-
5	2	-	3	2	2	-

TEXT BOOKS:

1. M. Narasimha Murthy and V. Susheela Devi, "Pattern Recognition", Springer 2020
2. S.Theodoridis and K.Koutroumbas, "Pattern Recognition", 6th Ed., Academic Press. 2021.

REFERENCES:

1. C.M.Bishop, "Pattern Recognition and Machine Learning", Springer, 2020.
2. Menahem Friedman, Abraham Kandel, "Introduction to Pattern Recognition Statistical, Structural, Neural and Fuzzy Logic Approaches", World Scientific publishing Co. Ltd, 2020.
3. R.O.Duda, P.E.Hart and D.G.Stork, "Pattern Classification", John Wiley, 2020.

NPTEL/ SWAYAM/ MOOC REFERENCE:

1. **NPTEL:** Pattern Recognition and Application: https://archive.nptel.ac.in/courses/117/105/117105101/, Prof. P K Biswas, IIT Kharapur.

PPAP3PE20	PCB DESIGN	L T P C
		3 0 0 3

COURSE OBJECTIVES

- PCB Design and Fabrication process.
- Familiarize Schematic and layout design flow using Electronic Design Automation (EDA) Tools. Understand basic concepts of transmission line, crosstalk and thermal issues
- Design (schematic and layout) PCB for analog circuits, digital circuits and mixed circuits. Schematic creation & interpretation

UNIT I INTRODUCTION TO PRINTED CIRCUIT BOARD **9**

Introduction to Printed circuit board: fundamental of electronic components, basic electronic circuits, Basics of printed circuit board designing: Layout planning, general rules and parameters, ground conductor considerations, thermal issues, check and inspection of artwork.

UNIT II DESIGN RULES FOR PCB **9**

Design rules for PCB: Design rules for Digital circuit PCBs, Analog circuit PCBs, high frequency and fast pulse applications, Power electronic applications, Microwave applications, PCB Technology Trends: Multilayer PCBs. Multiwire PCB, Flexible PCBs, Surface mount PCBs, Reflow soldering, Introduction to High-Density Interconnection (HDI) Technology.

UNIT III INTRODUCTION TO ELECTRONIC DESIGN AUTOMATION (EDA) TOOLS FOR PCB DESIGNING **9**

Introduction to Electronic design automation(EDA) tools for PCB designing: Brief Introduction of various simulators, SPICE and PSPICE Environment, Selecting the Components Footprints as per design, Making New Footprints, Assigning Footprint to components, Net listing, PCB Layout Designing, Auto routing and manual routing. Assigning specific text (silkscreen) to design, Creating report of design, creating manufacturing data (GERBER) for design

UNIT IV INTRODUCTION PRINTED CIRCUIT BOARD PRODUCTION TECHNIQUES **9**

Introduction printed circuit board production techniques: Photo printing, film-master production, reprographic camera, basic process for double sided PCBs photo resists, Screen printing process, plating, relative performance and quality control, Etching machines, Solders alloys, fluxes, soldering techniques, Mechanical operations.

UNIT V PCB DESIGN FOR EMI/EMC **9**

PCB design for EMI/EMC: Subsystem/PCB Placement in an enclosure, Filtering circuit placement, decoupling and bypassing, Electronic discharge protection, Electronic waste; Printed circuit boards Recycling techniques, Introduction to Integrated Circuit Packaging and footprints, NEMA and IPC standards.

TOTAL:45PERIODS

Cos	At the end of the course the student will be able to	Blooms Taxonomy
CO-1	Appreciate the necessity and evolution of PCB, types and classes of PCB.	Understand
CO-2	Understand the steps involved in schematic, layout, fabrication and assembly process of PCB design	Understand
CO-3	Apply advanced techniques, skills and modern tools for designing and fabrication of PCBs.	Apply
CO-4	Apply the knowledge and techniques to fabricate Multilayer, SMT and HDI PCB.	Apply
CO-5	Design (schematic and layout) and fabricate PCB for simple circuits.	Analyze

COs	POs					
	PO1	PO2	PO3	PO4	PO 5	PO6
1	3	-	-	2	-	-
2	-	-	-	3	-	-
3	2	-	2	3	-	-
4	3	-	2	3	2	-
5	2	-	3	2	2	-

TEXT BOOKS:

1. Printed circuit board design ,fabrication assembly and testing By R. S. Khandpur, Tata McGraw Hill 2019.
2. Printed Circuits Handbook, Sixth Edition,by Clyde F. Coombs, Jr, Happy T. Holden,Publisher: McGraw-Hill Education Year: 2020

REFERENCES:

1. Complete PCB Design Using OrCAD Capture and PCB Editor,KraigMitzner Bob Doe Alexander Akulin Anton Suponin Dirk Müller, 5th Edition 2020.
2. Introduction to System-on-Package, RaoR ,Tummala,&MadhavanSwaminathan, McGraw Hill, 2021.
3. EMC and Printed circuit board ,Design theory and layout, Mark I Montrose IEEE compatibility society, 2019.

NPTEL/ SWAYAM/ MOOC REFERENCE:

1. NPTEL:Design of Power Electronic Converters: https://archive.nptel.ac.in/noc/courses/noc22/SEM1/noc22-ee33/, Prof ShabariNath, IIT Guwahati.

SEMESTER IV

Sl. No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
PRACTICALS								
1	PPAP4PR02	Project Work Phase-II	PR	24	0	0	24	12
Total				**24**	**0**	**0**	**24**	**12**