ANNA UNIVERSITY, CHENNAI
UNIVERSITY DEPARTMENTS
REGULATIONS - 2019
M.E. APPLIED ELECTRONICS
CHOICE BASED CREDIT SYSTEM

VISION

The Department of ECE shall strive continuously to create highly motivated, technologically competent engineers, be a benchmark and a trend setter in Electronics and Communication Engineering by imparting quality education with interwoven input from academic institutions, research organizations and industries, keeping in phase with rapidly changing technologies imbibing ethical values.

MISSION

- Imparting quality technical education through flexible student centric curriculum evolved continuously for students of ECE with diverse backgrounds.
- Providing good academic ambience by adopting best teaching and learning practices.
- Providing congenial ambience in inculcating critical thinking with a quest for creativity, innovation, research and development activities.
- Enhancing collaborative activities with academia, research institutions and industries by nurturing ethical entrepreneurship and leadership qualities.
- Nurturing continuous learning in the stat-of-the-art technologies and global outreach programmes resulting in competent world class engineers.

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PROGRAMME EDUCATIONAL OBJECTIVES:

1. Teach students to understand the principles involved in the latest hardware and software required for designing and critically analyzing electronic circuits relevant to industry and society
2. Blend theory and laboratory to make students appreciate the concepts in the working of electronic circuits
3. Mould students to progress and develop with ethics and to communicate effectively
4. Motivate students to take up socially relevant and challenging projects and propose innovative solutions to problems for the benefit of the society
5. To motivate students to become entrepreneurs to develop indigenous solutions.

PROGRAM OUTCOMES:

PO#	Graduate Attribute	Programme Outcome
1.	Research aptitude	An ability to independently carry out research /investigation and development work to solve practical problems
2.	Technical documentation	An ability to write and present a substantial technical report/document
3.	Technical competence	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
4.	Engineering Design	An ability to apply various advanced tools and techniques to develop efficient Hardware solutions
5.	The engineer and society	Apply technical knowledge towards the development of socially relevant products
6.	Environment and sustainability	Ensure development of eco-friendly indigenous products.

MAPPING OF PROGRAMME EDUCATIONAL OBJECTIVES WITH PROGRAMME OUTCOMES:

A broad relation between the programme objective and the outcomes is given in the following table:

PEOs	Programme Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
I.	✓	✓	✓	✓		
II.	✓	✓	✓	✓		
III.		✓				
IV.					✓	✓
V.	✓	✓	✓	✓	✓	✓

		COURSE NAME	PO1	PO2	PO3	PO4	PO5	PO6
YEAR 1	Semester 1	Advanced Applied Mathematics				✓	✓	
		Analog Integrated Circuit Design	✓		✓	✓		✓
		Embedded Systems Design	1	2	1	2	3	3
		Statistical Signal Processing	✓		✓	✓		✓
		Research Methodology and IPR						
		Audit Course - I						
		Embedded Systems and Robotics Lab	1		2	3	1	3
		Signal Processing and RTL Synthesis Laboratory	✓	✓	✓	✓	✓	✓
	Semester 2	Advanced Digital System Design	✓		✓	✓		✓
		Digital CMOS VLSI Design	3		3	2	1	1
		Program Elective I	✓		✓	✓		✓
		Program Elective II	✓		✓	✓		✓
		Program Elective III	✓		✓	✓		✓
		Audit Course - II						
		Analog and Digital CMOS VLSI Design Laboratory	3	1	3	3	2	2
		Printed Circuit Board Design and Component Assembling Laboratory		1	3	3	2	1
		Mini Project with Seminar	✓	✓	✓	✓	✓	✓
YEAR 2	Semester 3	Program Elective IV	✓		✓	✓		✓
		Program Elective V	✓		✓	✓		✓
		Program Elective VI	✓		✓	✓		✓
		Open Elective	✓		✓	✓		✓
		Dissertation – I	✓	✓	✓	✓	✓	✓
	Semester 4	Dissertation – II	✓	✓	✓	✓	✓	✓

ANNA UNIVERSITY, CHENNAI
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M.E. APPLIED ELECTRONICS
REGULATIONS - 2019
CHOICE BASED CREDIT SYSTEM
I - IV SEMESTERS CURRICULA AND SYLLABI

SEMESTER I

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	MA5159	Advanced Applied Mathematics	FC	3	1	0	4	4
2.	AP5151	Analog Integrated Circuit Design	PCC	3	0	0	3	3
3.	AP5152	Embedded System Design	PCC	3	0	0	3	3
4.	AP5153	Statistical Signal Processing	PCC	3	0	0	3	3
5.	RM5151	Research Methodology and IPR	RMC	2	0	0	2	2
6.		Audit Course – I *	AC	2	0	0	2	0
PRACTICALS								
7.	AP5161	Embedded Systems and Robotics Laboratory	PCC	0	0	4	4	2
8.	VL5261	Signal Processing and RTL Synthesis Laboratory	PCC	0	0	4	4	2
			TOTAL	**16**	**1**	**8**	**25**	**19**

*Audit Course is optional

SEMESTER II

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	AP5251	Advanced Digital System Design	PCC	3	0	0	3	3
2.	VL5152	Digital CMOS VLSI Design	PCC	3	0	0	3	3
3.		Program Elective I	PEC	3	0	0	3	3
4.		Program Elective II	PEC	3	0	0	3	3
5.		Program Elective III	PEC	3	0	0	3	3
6.		Audit Course – II*	AC	2	0	0	2	0
PRACTICALS								
7.	VL5161	Analog and Digital CMOS VLSI Design Laboratory	PCC	0	0	4	4	2
8.	AP5261	Printed Circuit Board Design and Component Assembling Laboratory	PCC	0	0	4	4	2
9.	AP5111	Mini Project with Seminar	EEC	0	1	2	3	2
			TOTAL	**17**	**1**	**10**	**28**	**21**

*Audit Course is optional

SEMESTER III

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.		Program Elective IV	PEC	3	0	0	3	3
2.		Program Elective V	PEC	3	0	0	3	3
3.		Program Elective VI	PEC	3	0	0	3	3
4.		Open Elective	OEC	3	0	0	3	3
PRACTICALS								
5.	AP5311	Dissertation – I	EEC	0	0	12	12	6
			TOTAL	**12**	**0**	**12**	**24**	**18**

SEMESTER IV

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			CONTACT PERIODS	CREDITS
				L	T	P		
PRACTICALS								
1.	AP5411	Dissertation – II	EEC	0	0	24	24	12
			TOTAL	**0**	**0**	**24**	**24**	**12**

TOTAL NO. OF CREDITS: 70

FOUNDATION COURSE (FC)

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	MA5159	Advanced Applied Mathematics	FC	3	1	0	4	4

PROGRAM CORE COURSES (PCC)

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			CONTACT PERIODS	CREDITS
				L	T	P		
1.	AP5151	Analog Integrated Circuit Design	PCC	3	0	0	3	3
2.	AP5152	Embedded System Design	PCC	3	0	0	3	3
3.	AP5153	Statistical Signal Processing	PCC	3	0	0	3	3
4.	AP5161	Embedded Systems and Robotics Laboratory	PCC	0	0	4	4	2
5.	VL5261	Signal Processing and RTL Synthesis Laboratory	PCC	0	0	4	4	2
6.	AP5251	Advanced Digital System Design	PCC	3	0	0	3	3

7.	VL5152	Digital CMOS VLSI Design	PCC	3	0	0	3	3
8.	VL5161	Analog and Digital CMOS VLSI Design Laboratory	PCC	0	0	4	4	2
9.	AP5261	Printed Circuit Board Design and Component Assembling Laboratory	PCC	0	0	4	4	2

PROGRAM ELECTIVE COURSES (PEC)

S. NO	COURSE CODE	SUBJECTS	CATEGORY	PERIODS PER WEEK			CONTACT PERIODS	CREDITS
				L	T	P		
1.	AP5001	Digital Image Processing	PEC	3	0	0	3	3
2.	AP5002	DSP Integrated Circuits	PEC	3	0	0	3	3
3.	AP5003	Nonlinear Signal Processing	PEC	3	0	0	3	3
4.	AP5004	Digital Control Engineering	PEC	3	0	0	3	3
5.	AP5005	Programming Languages for Embedded Software	PEC	2	1	0	3	3
6.	AP5006	Advanced Computer Architecture Design	PEC	3	0	0	3	3
7.	AP5007	Design and Analysis of Computer Algorithms	PEC	3	0	0	3	3
8.	AP5078	Wireless Sensor Networks	PEC	3	0	0	3	3
9.	AP5008	IOT System Design and Security	PEC	3	0	0	3	3
10.	AP5074	PCB Design And Fabrication	PEC	3	0	0	3	3
11.	AP5071	Advanced Microprocessors and Microcontrollers	PEC	3	0	0	3	3
12.	AP5072	Electronics for Solar Power	PEC	3	0	0	3	3
13.	AP5076	Robotics and Intelligent Systems	PEC	3	0	0	3	3
14.	AP5075	RF System Design	PEC	3	0	0	3	3
15.	AP5077	Signal Integrity for High Speed Design	PEC	3	0	0	3	3
16.	AP5073	EMI and EMC in System Design	PEC	3	0	0	3	3
17.	AP5009	MEMS Based Devices	PEC	3	0	0	3	3
18.	AP5010	Artificial intelligence and Optimization Techniques	PEC	3	0	0	3	3

OPEN ELECTIVE COURSES (OEC)

*(out of 6 courses one course must be selected)

SI. NO	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			CONTACT PERIODS	CREDITS
				L	T	P		
1.	OE5091	Business Data Analytics	OEC	3	0	0	3	3
2.	OE5092	Industrial Safety	OEC	3	0	0	3	3
3.	OE5093	Operations Research	OEC	3	0	0	3	3
4.	OE5094	Cost Management of Engineering Projects	OEC	3	0	0	3	3
5.	OE5095	Composite Materials	OEC	3	0	0	3	3
6.	OE5096	Waste to Energy	OEC	3	0	0	3	3

AUDIT COURSES (AC)

Registration for any of these courses is optional to students

SL. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS
			Lecture	Tutorial	Practical	
1.	AX5091	English for Research Paper Writing	2	0	0	0
2.	AX5092	Disaster Management	2	0	0	0
3.	AX5093	Sanskrit for Technical Knowledge	2	0	0	0
4.	AX5094	Value Education	2	0	0	0
5.	AX5095	Constitution of India	2	0	0	0
6.	AX5096	Pedagogy Studies	2	0	0	0
7.	AX5097	Stress Management by Yoga	2	0	0	0
8.	AX5098	Personality Development Through Life Enlightenment Skills	2	0	0	0
9.	AX5099	Unnat Bharat Abhiyan	2	0	0	0
Total Credits						**0**

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

SI. NO	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			CONTACT PERIODS	CREDITS
				L	T	P		
1.	AP5111	Mini Project with Seminar	EEC	0	1	2	3	2
2.	AP5311	Dissertation – I	EEC	0	0	12	12	6
3.	AP5411	Dissertation – II	EEC	0	0	24	24	12

	M.E APPLIED ELECTRONICS					
	SUBJECT AREA	**CREDITS PER SEMESTER**				**CREDITS TOTAL**
		I	II	III	IV	
1.	FC	4	-	-	-	4
2.	PCC	13	10	-	-	23
3.	PEC	-	9	9	-	18
4.	RMC	2	-	-	-	2
5.	OEC	-	-	3	-	3
6.	EEC	-	2	6	12	20
7.	Non Credit & Audit Course	✓	✓	-	-	-
	TOTAL CREDITS	**19**	**21**	**18**	**12**	**70**

MA5159 **ADVANCED APPLIED MATHEMATICS** **L T P C**
3 1 0 4

OBJECTIVES:

- To encourage students to develop a working knowledge of the central ideas of linear algebra.
- To enable students to understand the concepts of probability and random variables.
- To make students understand the notion of a Markov chain, and how simple ideas of conditional probability and matrices can be used to give a thorough and effective account of discrete-time Markov chains.
- To familiarize the students with the formulation and construction of a mathematical model for a linear programming problem in real life situation.
- To introduce the Fourier Transform as an extension of Fourier techniques on periodic functions and to solve partial differential equations.

UNIT I LINEAR ALGEBRA 12

Vector spaces – norms – Inner Products – Eigenvalues using QR transformations – QR factorization - generalized eigenvectors – Canonical forms – singular value decomposition and applications - pseudo inverse – least square approximations --Toeplitz matrices and some applications.

UNIT II ONE DIMENSIONAL RANDOM VARIABLES 12

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 III RANDOM PROCESSES 12

Classification – Auto correlation - Cross correlation - Stationary random process – Markov process –- Markov chain - Poisson process – Gaussian process.

UNIT IV LINEAR PROGRAMMING 12

Formulation – Graphical solution – Simplex method – Two phase method - Transportation and Assignment Models

UNIT V FOURIER TRANSFORM FOR PARTIAL DIFFERENTIAL EQUATIONS 12

Fourier transforms: Definitions, properties-Transform of elementary functions, Dirac Delta functions – Convolution theorem – Parseval‘s identity – Solutions to partial differential equations: Heat equations, Wave equations, Laplace and Poisson‘s equations.

TOTAL: 45+15=60 PERIODS

COURSE OUTCOMES:

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

CO1: Apply the concepts of linear algebra to solve practical problems.
CO2: Use the ideas of probability and random variables in solving engineering problems.
CO3: Classify various random processes and solve problems involving stochastic processes.
CO4: Formulate and construct mathematical models for linear programming problems and solve the transportation and assignment problems.
CO5: Apply the Fourier transform methods of solving standard partial differential equations.

REFERENCES:

1. Andrews, L.C. and Philips.R.L., “Mathematical Techniques for engineering and scientists”, Printice Hall of India, New Delhi, 2006.
2. Bronson, R., “Matrix Operation”, Schaum‘s outline series, Tata McGrawHill, New York, 2011.
3. O‘Neil P.V., “Advanced Engineering Mathematics”, Cengage Learning, 8th Edition, India, 2017.
4. Oliver C. Ibe, “Fundamentals of Applied Probability and Random Processes”, Academic Press, Boston, 2014.

5. Sankara Rao, K., “Introduction to partial differential equations”, Prentice Hall of India, pvt, Ltd, 3rd Edition, New Delhi, 2010.
6. Taha H.A., “Operations Research: An introduction”, Ninth Edition, Pearson Education, Asia, 10th Edition, New Delhi, 2017.

AP5151 ANALOG INTEGRATED CIRCUIT DESIGN L T P C
3 0 0 3

OBJECTIVES:

- Analog circuits play a very crucial role in all electronic systems and due to continued miniaturization, many of the analog blocks are not getting realized in CMOS technology. The most important building blocks of all CMOS analog ICs will be the topic of study in this course.
- The basic principle of operation, the circuit choices and the tradeoffs involved in the MOS transistor level design common to all analog CMOS ICs will be discussed in this course.
- The specific design issues related to single and multistage voltage, current and differential amplifiers, their output and impedance issues, bandwidth, feedback and stability will be dealt with in detail.

UNIT I SINGLE STAGE AMPLIFIERS 9

Basic MOS physics and equivalent circuits and models, CS, CG and Source Follower differential with active load, Cascode and folded cascode configurations with active load, Design of differential and cascode amplifiers – to meet specified SR, noise, gain, BW, ICMR and power dissipation, voltage swing, High gain amplifier, structures.

UNIT II HIGH FREQUENCY AND NOISE OF CHARACTERISTICS AMPLIFIERS 9

Miller effect, association of poles with nodes, frequency response of CS, CG and source follower, cascode and differential pair stages, Statistical characteristics of noise, noise in single stage amplifiers, noise in differential amplifiers.

UNIT III FEEDBACK AND ONE STAGE OPERATIONAL AMPLIFIERS 9

Properties and types of negative feedback circuits, effect of loading in feedback networks, operational amplifier performance parameters, One-stage Op Amps, Two-stage Op Amps, Input range limitations, Gain boosting, slew rate, power supply rejection, noise in Op Amps.

UNIT IV STABILITY AND FREQUENCY COMPENSATION OF TWO STAGE AMPLIFIER 9

Analysis of two stage Op amp – two stage Op amp single stage CMOS Cs as second stage and using cascode second stage, multiple systems, Phase Margin, Frequency Compensation, and Compensation of two stage Op Amps, Slewing in two stage Op Amps, Other compensation techniques.

UNIT V BANDGAP REFERENCES 9

Current sinks and sources, Current mirrors, Wilson current source, Wildar current source, Cascode current source, Design of high swing cascode sink, current amplifiers, Supply independent biasing, temperature independent references, PTAT and CTAT current generation, Constant-Gm Biasing.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: Ability to design amplifiers to meet user specifications
CO2: Ability to analyse the frequency and noise performance of amplifiers
CO3: Ability to design and analyse feedback amplifiers and one stage op amps
CO4: Ability to design and analyse two stage op amps
CO5: Ability to design and use current mirrors and current sinks with MOS devices

REFERENCES:

1. Behzad Razavi, "Design of Analog CMOS Integrated Circuits", Tata McGraw Hill, 2001
2. Willey M.C. Sansen, "Analog Design Essentials", Springer, 2006.
3. Grebene, "Bipolar and MOS Analog Integrated Circuit Design", John Wiley & sons,Inc.,2003.
4. Phillip E.Allen, Douglas R.Holberg, "CMOS Analog Circuit Design", Oxford University Press, 2nd Edition, 2002.
5. Recorded lecture available at http://www.ee.iitm.ac.in/~ani/ee5390/index.html
6. Jacob Baker "CMOS: Circuit Design, Layout, and Simulation", Wiley IEEE Press, 3rd Edition, 2010.

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2		3			
CO2	2		3		1	
CO3	2		3		1	
CO4	2		3		1	
CO5	2		3		1	

AP5152 EMBEDDED SYSTEM DESIGN L T P C
3 0 0 3

OBJECTIVES:

- To expose the students to the fundamentals of embedded system design.
- To enable the students to understand and use embedded computing platform.
- To introduce networking principles in embedded devices.
- To learn real time characteristics in embedded system design.
- To explore system design techniques.

UNIT I EMBEDDED PROCESSORS 9

Embedded Computers, Characteristics of Embedded Computing Applications, Challenges in Embedded Computing system design, Embedded system design process- Requirements, Specification, Architectural Design, Designing Hardware and Software Components, System Integration, Formalism for System Design- Structural Description, Behavioural Description, Design Example: Model Train Controller, ARM processor- processor and memory organization.

UNIT II EMBEDDED COMPUTING PLATFORM 9

Data operations, Flow of Control, SHARC processor- Memory organization, Data operations, Flow of Control, parallelism with instructions, CPU Bus configuration, ARM Bus, SHARC Bus, Memory devices, Input/output devices, Component interfacing, designing with microprocessor development and debugging, Design Example : Alarm Clock.

UNIT III NETWORKS **9**

Distributed Embedded Architecture- Hardware and Software Architectures, Networks for embedded systems- I2C, CAN Bus, SHARC link supports, Ethernet, Myrinet, Internet, Network-Based design- Communication Analysis, system performance Analysis, Hardware platform design, Allocation and scheduling, Design Example: Elevator Controller.

UNIT IV REAL-TIME CHARACTERISTICS **9**

Clock driven Approach, weighted round robin Approach, Priority driven Approach, Dynamic Versus Static systems, effective release times and deadlines, Optimality of the Earliest deadline first (EDF) algorithm, challenges in validating timing constraints in priority driven systems, Off-line Versus On-line scheduling.

UNIT V SYSTEM DESIGN TECHNIQUES **9**

Design Methodologies, Requirement Analysis, Specification, System Analysis and Architecture Design, Quality Assurance, Design Example: Telephone PBX- System Architecture, Ink jet printer- Hardware Design and Software Design, Personal Digital Assistants, Set-top Boxes.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: To explore fundamentals of embedded system design.
CO2: To interpret and use embedded computing platform.
CO3: To apply networking principles in embedded devices.
CO4: To gain insight on the characteristics in embedded system design.
CO5: To select and design suitable embedded systems for real world applications.

REFERENCES:

1. Wayne Wolf, “Computers as Components: Principles of Embedded Computing System Design”, Morgan Kaufman Publishers, 3rd Edition, 2012.
2. Jane.W.S. Liu, “Real-Time systems”, Pearson Education Asia, 2001.
3. C. M. Krishna and K. G. Shin, “Real-Time Systems” , McGraw-Hill, 1997.
4. Frank Vahid and Tony Givargis, “Embedded System Design: A Unified Hardware/Software Introduction”, John Wiley & Sons, 2002.

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1					
CO2		2			1	
CO3			1	2		
CO4					3	1
CO5					2	3

AP5153 STATISTICAL SIGNAL PROCESSING **L T P C**
3 0 0 3

OBJECTIVES:

- To introduce the basics of random signal processing
- To learn the concept of estimation and prediction theory
- To know about adaptive filtering and its applications

UNIT I INTRODUCTION TO RANDOM SIGNAL PROCESSING 9

Discrete Random Processes- Ensemble Averages, Stationary processes, Bias and Estimation, Autocovariance, Autocorrelation, Parseval"s theorem, Wiener-Khintchine relation, White noise, Power Spectral Density, Spectral factorization, Filtering Random Processes.

UNIT II SIGNAL MODELING 9

ARMA (p,q) , AR (p), MA (q) models, Forward Linear Prediction, Backward Linear Prediction : – Yule-Walker Method, Solution to Prony's normal equation, Levinson Durbin Algorithm.

UNIT III SPECTRAL ESTIMATION 9

Estimation of spectra from finite duration signals, Nonparametric methods - Periodogram, Modified periodogram, Bartlett, Welch and Blackman-Tukey methods, Parametric method, AR (p) spectral estimation and detection of Harmonic signals.

UNIT IV LINEAR ESTIMATION 9

Linear Minimum Mean-Square Error (LMMSE) Filtering: Wiener Hopf Equation, FIR Wiener filter, Noise Cancellation, Causal IIR Wiener filter, Noncausal IIR Wiener filter.

UNIT V ADAPTIVE FILTERS 9

FIR adaptive filters – adaptive filter based on steepest descent method- Widrow-Hopf LMS algorithm, Normalized LMS algorithm, Adaptive channel equalization, Adaptive echo cancellation, Adaptive noise cancellation, RLS adaptive algorithm.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

CO1: Analyze discrete time random processes
CO2: Obtain models for prediction and Estimation
CO3: Analyze non-parametric methods and parametric methods for spectral estimation
CO4: Design different MMSE filters
CO5: Design adaptive filters for different applications

REFERENCES:

1. Monson H. Hayes, "Statistical Digital Signal Processing and Modeling", John Wiley and Sons, Inc, Singapore, 2002.
2. Dimitris G. Manolakis and Vinay K .Ingle,"Applied Digital Signal Processing", Cambridge University Press, 2011.
3. M. Kay's, "Fundamentals of Statistical Signal Processing: Estimation Theory (Vol 1), Detection Theory (Vol 2)", Prentice Hall Signal Processing Series, 1993.
4. Kailath, Sayed and Hassibi, "Linear Estimation, Information and Sciences Series", Prentice Hall, 1st Edition, 2000.

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3		2	1		
CO2	3		2	1		
CO3	3		3	1		
CO4	3		3	2	1	1
CO5	3		3	2	1	1

RM5151 RESEARCH METHODOLOGY AND IPR LT P C
2 0 0 2

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 TECHNICALWRITING /PRESENTATION 6

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

UNIT IV 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 cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

UNIT V INTELLECTUAL PROPERTY RIGHTS (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

COURSE OUTCOMES:

CO1: Ability to formulate research problem
CO2: Ability to carry out research analysis
CO3: Ability to follow research ethics
CO4: Ability to understand that today's world is controlled by Computer, Information CO5: Technology, but tomorrow world will be ruled by ideas, concept, and creativity
CO5: Ability to understand about IPR and filing patents in R & D.

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

REFERENCES:

1. Asimov, “Introduction to Design”, Prentice Hall, 1962.
2. Halbert, “Resisting Intellectual Property”, Taylor & Francis Ltd ,2007.
3. Mayall, “Industrial Design”, McGraw Hill, 1992.
4. Niebel, “Product Design”, McGraw Hill, 1974.
5. Ranjit Kumar, 2nd Edition, “Research Methodology: A Step by Step Guide for beginners” 2010.

AP5161 EMBEDDED SYSTEMS AND ROBOTICS LABORATORY L T P C
0 0 4 2

OBJECTIVES:

- To introduce microcontroller based system design concept.
- To learn concept on real time operating systems..
- To make learn EDA tools, sensors, high power devices and motors.
- To work with different Robots and its operating systems.

EMBEDDED SYSTEMS LAB EXPERIMENTS:

1. Microcontroller based system design of interfacing with RTC, LCD and I2C EPROM.
2. Design of microcontroller based RC5 remote control decoder.
3. Microcontroller based system design of Switching of high power device with SCR, MOSFET and Relay.
4. Microcontroller based system design with Touch screen interfacing.
5. Sensors and interfacing of ultrasound sensors, PIR, temperature and RFID with Microcontroller based system.
6. Microcontroller based system design with Matrix keyboard and LED interfacing.
7. Microcontroller based system design with Motor interfacing-DC, servo and stepper.
8. Design and implementation of different real time scheduling algorithms for embedded applications. RTOS- simple task creation, Round Robin Scheduling and Semaphores.

ROBOTICS LAB EXPERIMENTS:

1. Design and implementation of Line following Robot.
2. Design and implementation of Obstacle avoidance and navigation Robot.
3. Design and implementation of Robotic Arm manipulation with 6 DOF.
4. Design and implementation of Pick and Place robot.
5. Design and implementation of Colour guided material handling Robot.
6. Design and implementation of Self balancing robot.
7. Robot operating System (ROS) for Robot.

COURSE OUTCOMES:

CO1: Ability to design and develop microcontroller based systems.
CO2: Validate the design in microcontroller starting from assembler to compiler.
CO3: Ability to use EDA tools, sensors, high power devices and motors.
CO4: Ability to design and develop different real-time scheduling algorithms.
CO5: Ability to work with different Robot operating systems.

TOTAL: 60 PERIODS

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1				2	
CO2			3			
CO3			2	2	1	
CO4			1	1		
CO5				3	1	1

VL5261 SIGNAL PROCESSING AND RTL SYNTHESIS LABORATORY L T P C
0 0 4 2

OBJECTIVES:

- FPGAs are important platform used throughout the industry both in their own right in building complete systems. They are also used as validation/verification platforms prior to undertaking cost and time intensive design and fabrication of custom VLSI designs. Starting from high level design entry in the form VHDL/Verilog codes, the students will be carrying out complete hardware level FPGA validation of important digital algorithms.
- Understanding signal processing play a key role in the design and testing of circuit block in ICs. The experiments are structured to give an exposure to the design of basic signal processing modules and its realization in FPGA

LIST OF EXPERIMENTS:

1) HDL realization and timing analysis of
   i. Combinational circuits namely 8:1 Mux/Demux, Full Adder, 8-bit Magnitude comparator, Encoder/decoder, Priority encoder.
   ii. Sequential circuits namely D-FF, 4-bit Shift registers (SISO, SIPO, PISO, bidirectional), 3-bit Synchronous Counters.
2) FPGA implementation of PCI Bus & arbiter.
3) Realization of UART/ USART implementation in HDL and design validation using test vector generation.
4) FPGA realization of single port SRAM and capturing the signal in DSO.
5) Back annotation and timing analysis of Arithmetic circuits like serial adder/ subtractor, parallel adder/subtractor, serial/parallel multiplier.
6) Realization of Discrete Fourier transform/Fast Fourier Transform algorithm in HDL and observing the spectrum in simulation.
7) Implement different power spectrum
8) Design and implement FIR and IIR Weiner filters for smoothing and prediction
9) Design and implement adaptive filters
10) Perform image enhancement operations (spatial & transform domain analysis)
11) Perform morphological image analysis
12) Implement image segmentation algorithms

TOTAL: 60 PERIODS

COURSE OUTCOMES:

CO1: Identify, formulate, solve and implement problems in signal processing, communication systems etc using RTL design tools.
CO2: Validate the design in FPGA starting from design entry to back annotation.
CO3: Use EDA tools like Cadence/Mentor Graphics/ Xilinx/Quartus.
CO4: Implement image processing algorithms using MATLAB and HDL
CO5: Implement image processing algorithms using MATLAB and HDL

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	3	3	2	
CO2	1	1	3	3	2	
CO3	1	1	3	3	2	
CO4	1	1	3	2	2	
CO5	1	1	3	2	2	

AP5251 ADVANCED DIGITAL SYSTEM DESIGN L T P C
3 0 0 3

OBJECTIVES:

- To introduce methods to analyse and design synchronous sequential circuits
- To introduce methods to analyse and design asynchronous sequential circuits and to analyse hazards
- To introduce the fault testing procedure for combinational circuits and PLA 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 modelling- 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 – mixed operating mode asynchronous circuits – designing vending machine controller

UNIT III FAULT DIAGNOSIS AND TESTABILITY ALGORITHMS 9

Fault table method-path sensitization method – Boolean difference method - D algorithm – Kohavi 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 a synchronous sequential circuit using PLA/PAL – Designing ROM with PLA – Realization of finite state machine using PLD – FPGA – Xilinx FPGA-Xilinx 4000

UNIT V SYSTEM DESIGN USING VERILOG 9

Hardware Modelling with Verilog HDL – Logic System, Data Types and Operators For Modelling in Verilog HDL - Behavioural Descriptions in Verilog HDL – HDL Based Synthesis – Synthesis of Finite State Machines– structural modelling – 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

COURSE OUTCOMES:

CO1: Analyse and design synchronous sequential circuits
CO2: Analyse hazards and design asynchronous sequential circuits
CO3: Knowledge on the testing procedure for combinational circuit and PLA
CO4: Able to design PLD and ROM
CO5: Design and use programming tools for implementing digital circuits of industry standards

REFERENCES:

1. Charles H.Roth Jr, “Fundamentals of Logic Design”, Thomson Learning, 2004.
2. M.D.Ciletti , “Modeling, Synthesis and Rapid Prototyping with the Verilog HDL”, Prentice Hall, 1999.
3. M.G.Arnold, “Verilog Digital – Computer Design”, Prentice Hall (PTR), 1999.
4. Nripendra N Biswas,“Logic Design Theory”, Prentice Hall of India,2001.
5. Parag K. Lala, “Fault Tolerant and Fault Testable Hardware Design”, B S Publications,2002.
6. Parag K.Lala, “Digital system Design using PLD”, B S Publications, 2003.
7. S. Palnitkar, “Verilog HDL – A Guide to Digital Design and Synthesis”, Pearson, 2003.

	PO1	PO2	PO3	PO4	PO5	PO6
CO1			2			
CO2			2			
CO3	3			3	1	
CO4					2	
CO5				2		

VL5152 DIGITAL CMOS VLSI DESIGN L T P C
3 0 0 3

OBJECTIVES:

- To introduce the transistor level design of all digital building blocks common to all CMOS microprocessors, network processors, digital backend of all wireless systems etc
- To introduce the principles and design methodology in terms of the dominant circuit choices, constraints and performance measures
- To learn all important issues related to size, speed and power consumption.

UNIT I MOS TRANSISTOR PRINCIPLES AND CMOS INVERTER 12

MOS(FET) Transistor Characteristic under Static and Dynamic Conditions, MOS Transistor Secondary Effects, CMOS Inverter-Static Characteristic, Dynamic Characteristic, Power, Energy, and Energy Delay parameters, Stick diagram and Layout diagrams.

UNIT II COMBINATIONAL LOGIC CIRCUITS 9

Static CMOS design, Different styles of logic circuits, Logical effort of complex gates, Static and Dynamic properties of complex gates, Interconnect Delay, Dynamic Logic Gates.

UNIT III SEQUENTIAL LOGIC CIRCUITS 9

Static Latches and Registers, Dynamic Latches and Registers, Timing Issues, Pipelines, Nonbistable Sequential Circuits.

UNIT IV ARITHMETIC BUILDING BLOCKS 9

Data path circuits, Architectures for Adders, Accumulators, Multipliers, Barrel Shifters, Speed and Area Tradeoffs

UNIT V MEMORY ARCHITECTURES 6

Memory Architectures and Memory control circuits: Read-Only Memories, ROM cells, Read-write memories (RAM), dynamic memory design, 6 transistor SRAM cell, Sense amplifiers.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: To use mathematical methods and circuit analysis models in analysis of CMOS digital circuits

CO2: To be able to create models of moderately sized static CMOS combinational circuits that realize specified digital functions and to optimize combinational circuit delay using RC delay models and logical effort

CO3: To design sequential logic at the transistor level and Compare the tradeoffs of sequencing elements including flip-flops, transparent latches

CO4: To learn design methodology of arithmetic building blocks

CO5: To design functional units including ROM and SRAM

REFERENCES:

1. Jan Rabaey, Anantha Chandrakasan, B Nikolic, " Digital Integrated Circuits: A Design Perspective", Prentice Hall of India", 2nd Edition,Feb 2003.
2. N.Weste, K. Eshraghian, " Principles of CMOS VLSI Design", Addision Wesley, 2nd Edition, 1993.
3. M J Smith, "Application Specific Integrated Circuits", Addisson Wesley, 1997.
4. Sung-Mo Kang & Yusuf Leblebici, "CMOS Digital Integrated Circuits Analysis and Design", McGraw-Hill, 1998.

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3		2	1		
CO2	3		2	1		
CO3	3		2	1		
CO4	3		3	2	1	1
CO5	3		3	2	1	1

VL5161 ANALOG AND DIGITAL CMOS VLSI DESIGN LABORATORY L T P C
0 0 4 2

OBJECTIVES:

- Students will carry out a detailed analog circuit design starting with transistor characterization and finally realizing an IA design.
- At various stages of design, a typical state of art CAD VLSI tool will be used in various phases of experiments designed to bring out the key aspects of each important module in the CAD tool including the simulation, layout, LVS and parasitic extracted simulation.

List of Experiments:

1. Extraction of process parameters of CMOS process transistors
   a. Plot I_D vs. V_{GS} at different drain voltages for NMOS, PMOS.
   b. Plot I_D vs. V_{GS} at particular drain voltage (low) for NMOS, PMOS and determine Vt.
   c. Plot log I_D vs. VGS at particular gate voltage (high) for NMOS, PMOS and determine I_{OFF} and sub-threshold slope.
   d. Plot I_D vs. V_{DS} at different gate voltages for NMOS, PMOS and determine Channel length modulation factor.
   e. Extract V_{th} of NMOS/PMOS transistors (short channel and long channel). Use V_{DS} of appropriate voltage To extract V_{th} use the following procedure.
      i. Plot g_m vs V_{GS} using SPICE and obtain peak g_m point.

ii. Plot $y=I_D/(g_m)$ as a function of VGS using SPICE.
iii. Use SPICE to plot tangent line passing through peak gm point in y (V_{GS}) plane and determine V_{th}.

f. Plot I_D vs. V_{DS} at different drain voltages for NMOS, PMOS, plot DC load line and calculate gm, gds, gm/gds, and unity gain frequency. Tabulate result according to technologies and comment on it.

2. CMOS inverter design and performance analysis
   a. i. Plot VTC curve for CMOS inverter and thereon plot dV_{out} vs. dV_{in} and determine transition voltage and gain g. Calculate V_{IL}, V_{IH}, NM_H, NM_L for the inverter.
   ii. Plot VTC for CMOS inverter with varying V_{DD}.
   iii. Plot VTC for CMOS inverter with varying device ratio.
   b. Perform transient analysis of CMOS inverter with no load and with load and determine t_{pHL}, t_{pLH}, 20%-to-80% t_r and 80%-to-20% t_f.
   c. Perform AC analysis of CMOS inverter with fanout 0 and fanout 1.
3. Use spice to build a three stage and five stage ring oscillator circuit and compare its frequencies. Use FFT and verify the amplitude and frequency components in the spectrum.
4. Single stage amplifier design and performance analysis
   a. Draw small signal voltage gain of the minimum-size inverter in the technology chosen as a function of input DC voltage. Determine the small signal voltage gain at the switching point using spice and compare the values for two different process transistors.
   b. Consider a simple CS amplifier with active load, with NMOS transistor as driver and PMOS transistor as load.
      i. Establish a test bench to achieve $V_{DSQ}=V_{DD}/2$.
      ii. Calculate input bias voltage for a given bias current.
      iii. Use spice and obtain the bias current. Compare with the theoretical value
      iv. Determine small signal voltage gain, -3dB BW and GBW of the amplifier using small signal analysis in spice, considering load capacitance.
      v. Plot step response of the amplifier with a specific input pulse amplitude. Derive time constant of the output and compare it with the time constant resulted from -3dB BW.
      vi. Use spice to determine input voltage range of the amplifier
5. Three OPAMP Instrumentation Amplifier.
   Use proper values of resistors to get a three OPAMP INA with differential-mode voltage gain=10. Consider voltage gain=2 for the first stage and voltage gain=5 for the second stage.
   a. Draw the schematic of op-amp macro model.
   b. Draw the schematic of INA.
   c. Obtain parameters of the op-amp macro model such that it meets a given specification for:
      i. low-frequency voltage gain,
      ii. unity gain BW (fu),
      iii. input capacitance,
      iv. output resistance,
      v. CMRR
   d. Draw schematic diagram of CMRR simulation setup.
   e. Simulate CMRR of INA using AC analysis (it's expected to be around 6dB below CMRR of OPAMP).
   f. Plot CMRR of the INA versus resistor mismatches (for resistors of second stage only) changing from -5% to +5% (use AC analysis). Generate a separate plot for mismatch in each resistor pair. Explain how CMRR of OPAMP changes with resistor mismatches.
   g. Repeat (iii) to (vi) by considering CMRR of all OPAMPs with another low frequency gain setting.
6. Use Layout editor.
   a. Draw layout of a minimum size inverter using transistor from CMOS process library. Use Metal 1 as interconnect line between inverters.
   b. Run DRC, LVS and RC extraction. Make sure there is no DRC error.
   c. Extract the netlist. Use extracted netlist and obtain t_{PHL} t_{PLH} for the inverter using Spice.
   d. Use a specific interconnect length and connect and connect three inverters in a chain.

Extract the new netlist and obtain t_{PHL} and t_{PLH} of the middle inverter.

e. Compare new values of delay times with corresponding values obtained in part 'c'.

7. Design a differential amplifier with resistive load using transistors from CMOS process library that meets a given specification for the following parameter
   a. low-frequency voltage gain,
   b. unity gain BW (fu),
   c. Power dissipation
      i. Perform DC analysis and determine input common mode range and compare with the theoretical values.
      ii. Perform time domain simulation and verify low frequency gain.
      iii. Perform AC analysis and verify.

TOTAL:60 PERIODS

COURSE OUTCOMES:

CO1: Design digital and analog Circuit using CMOS given a design specification.

CO2: Design and carry out time domain and frequency domain simulations of simple analog building blocks, study the pole zero behaviors and compute the input/output impedances

CO3: Use EDA tools like Cadence, Mentor Graphics or other open source software tools like LTSpice

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	3	3	2	2
CO2	3	1	3	3	2	2
CO3	3	1	3	3	2	2

AP5261 PRINTED CIRCUIT BOARD DESIGN AND COMPONENT ASSEMBLING LABORATORY **L T P C 0 0 4 2**

OBJECTIVES

- To impart hands on experience in single, double and multi layer PCB design so that students would be able to design and to fabricate and develop electronic systems for various applications.

LIST OF EXPERIMENTS:

1. Introduction to PCB and EDA software tools.
2. To prepare design layout of PCBs using software tools.
3. To fabricate simple PCB by chemical and mechanical process and drilling of PCB.
4. To fabricate PCB using additive technology and testing of electronics circuit on PCB.
5. To perform Assembly Processes -Manual assembly processes,
6. To perform automated assembly processes (pick and place).
7. Identification of various types of Printed Circuit Boards (PCB) and soldering Techniques.
8. Convert the power supply circuit into PCB and simulate its 2D and 3D view.
9. Design and create single sided PCB Layout for Full wave rectifier circuit.
10. Design and create PCB Layout for DC Motor controller.
11. Design and create single sided PCB Layout for Flashing LEDs using 555 IC.
12. LED Scrolling Display Board using microcontroller
13. To perform continuity tester of PCB project.
14. To implement a Digital Counter To fabricate the PCB for the same.
15. To fabricate PCB dual power supply, analog design.
16. To fabricate PCB with Split power and ground planes.

TOTAL : 60 PERIODS

COURSE OUTCOMES:

CO1: Ability to use CAD software tools
CO2: Ability to design a schematic diagram
CO3: Ability to convert a schematic diagram to board/layout diagram
CO4: Implement routing in board/layout diagram
CO5: Ability to fabricate a PCB from board diagram
CO6: Ability to skillfully perform assembling and soldering of components

	PO1	PO2	PO3	PO4	PO5	PO6
CO1				3		
CO2		1	1	2		
CO3			3		1	
CO4				3	2	
CO5					1	
CO6			3			2

AP5001 DIGITAL IMAGE PROCESSING L T P C
3 0 0 3

OBJECTIVES:

- To introduce vision fundamentals and transforms for 2D signals
- To teach concepts for extracting images from their corresponding degraded version
- To introduce techniques for segregating and extracting objects in images
- To impart techniques for processing color images
- To teach efficient methods for storing and transmitting images

UNIT I DIGITAL IMAGE FUNDAMENTALS 9

Elements of digital image processing systems, Digital Camera working principles, Elements of visual perception, Image sampling, Quantization, Dither, 2D transforms - DFT, DCT, Discrete Sine, Walsh, Hadamard, Slant, Haar, KLT, SVD, Wavelet transform.

UNIT II IMAGE ENHANCEMENT AND RESTORATION 9

Image Enhancement in the Spatial Domain - Basic Gray Level Transformations, Histogram Processing, Smoothing Spatial Filters, Sharpening Spatial Filters, Enhancement in the Frequency Domain- Smoothing Frequency-Domain Filters. Sharpening Frequency Domain Filters. Homomorphic Filtering, Image restoration - Model of the Image Degradation/Restoration Process. Noise Models. Restoration in the Presence of Noise Only-Spatial Filtering. Periodic Noise Reduction by Frequency Domain Filtering. Estimating the Degradation Function. Inverse Filtering. Minimum Mean Square Error (Wiener) Filtering. Constrained Least Squares Filtering. Geometric Transformations.

UNIT III IMAGE SEGMENTATION AND MORPHOLOGY 9

Image segmentation - Edge detection, Edge linking and boundary detection, Region growing, Region splitting and Merging, Image Recognition - Patterns and pattern classes, Matching by minimum distance classifier, Matching by correlation, Morphological Image Processing - Basics, SE, Erosion, Dilation, Opening, Closing, Hit-or-Miss Transform, Boundary Detection, Hole filling, Connected components, convex hull, thinning, thickening, skeletons, pruning, Geodesic Dilation, Erosion, Reconstruction by dilation and erosion.

UNIT IV COLOR IMAGE PROCESSING 9

Color Fundamentals. Color Models. Pseudocolor Image Processing. Basics of Full-Color Image Processing. Color Transformations. Smoothing and Sharpening. Color Segmentation. Noise in Color Images. Color Image Compression.

UNIT V IMAGE COMPRESSION 9

Need for data compression, Huffman, Run Length Encoding, Shift codes, Arithmetic coding, Vector Quantization, Block Truncation Coding, Transform coding, JPEG, MPEG, Digital Image Watermarking

TOTAL : 45 PERIODS

COURSE OUTCOMES:

CO1: Ability to apply transforms specific to applications
CO2: Ability to develop and implement algorithms to restore degraded images
CO3: Ability to develop and apply algorithms to extract objects of interest in images
CO4: Ability to process color images
CO5: Ability to develop and implement various nonlinear signal
CO6: Use image compression algorithms

REFERENCES:

1. Rafael C. Gonzalez, Richard E. Woods, "Digital Image Processing", Pearson Education, Inc., 4th Edition, 2018
2. Anil K. Jain, "Fundamentals of Digital Image Processing", Prentice Hall of India, 2002.
3. Rafael C. Gonzalez, Richard E. Woods, Steven Eddins, "Digital Image Processing using MATLAB", Pearson Education, Inc., 2nd Edition, 2010.
4. William K. Pratt, "Digital Image Processing", John Wiley, New York, 2002.
5. S. Sridhar, "Digital Image Processing", Oxford University Press.
6. Milan Sonka et al, "Image Processing, Analysis and Machine Vision", Brookes/Cole, Vikas Publishing House, 2nd Edition, 1999;
7. Sid Ahmed, M.A., "Image Processing Theory, Algorithms and Architectures", Mc Graw Hill, 1995.

	PO1	PO2	PO3	PO4	PO5	PO6
CO1			3	2		
CO2			3	3		
CO3			3	3		
CO4			3	2		
CO5	1		3	3		

AP5002 DSP INTEGRATED CIRCUITS L T P C
3 0 0 3

OBJECTIVES:

- To impart knowledge on fundamental signal processing algorithms and systems.
- To expose digital filter concepts, structures and hardware issues.
- To understand the various modules used in general purpose digital signal processors.
- To introduce various implementation strategies for signal processing algorithms.
- To gain knowledge for tuning signal processing algorithms for VLSI.

UNIT I INTRODUCTION TO DSP INTEGRATED CIRCUITS 9

Sampling of analog signals, Selection of sample frequency, Signal- processing systems, Frequency response, Transfer functions, FFT-The Fast Fourier Transform Algorithm, Discrete cosine transforms, Image coding, Adaptive DSP algorithms, Standard digital signal processors, Application specific IC"s for DSP, DSP system design, Integrated circuit design.

UNIT II DIGITAL FILTERS AND FINITE WORD LENGTH EFFECTS 12

FIR filters, FIR filter structures, IIR filters, Specifications of IIR filters, Mapping of analog transfer functions, Signal flow graphs, Filter structures, Mapping of analog filter structures, Finite word length effects - Parasitic oscillations, Scaling of signal levels, Round-off noise, Measuring round-off noise, Coefficient sensitivity, Sensitivity and noise. Multirate systems, Interpolation with an integer factor L, Sampling rate change with a ratio L/M, Multirate filters.

UNIT III DSP ARCHITECTURES 9

DSP system architectures, Standard DSP architecture-Harvard and Modified Harvard architecture. TMS320C54x and TMS320C6x architecture, Multiprocessors and multicomputers, Systolic and Wave front arrays, Shared memory architectures.

UNIT IV SYNTHESIS OF DSP ARCHITECTURES & ARITHMETIC UNIT 9

Synthesis: Mapping of DSP algorithms onto hardware, Implementation based on complex PEs, Shared memory architecture with Bit – serial PEs.

Arithmetic Unit : Conventional number system, Redundant Number system, Residue Number System, Bit-parallel and Bit-Serial arithmetic, Digit Serial arithmetic, CORDIC Algorithm, Basic shift accumulator, Reducing the memory size, Complex multipliers, Improved shift-accumulator.

UNIT V CASE STUDY-INTEGRATED CIRCUIT DESIGN 6

Layout of VLSI circuits, Layout Styles, Case Study : FFT processor, DCT processor and Interpolator.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: Ability to analyze and design fundamental signal processing algorithms and systems.
CO2: Adequacy to design and analyze digital filter concepts and structures.
CO3: Equipped to design general purpose digital signal processors.
CO4: Ability to use various implementation strategies for signal processing algorithms.
CO5: Equipped to design signal processing VLSI systems.

REFERENCES:

1. Lars Wanhammer, “DSP Integrated Circuits”, Academic press, New York, 1999.
2. John J. Proakis, Dimitris G. Manolakis, “Digital Signal Processing”, Pearson Education, 2002.
3. Avtar Singh, S.Srinivasan, “Digital Signal Processing Implementations: Using DSP Microprocessors (with examples from TMS320C54XX), Thomson Publications, 2004.
4. Rulph Chassaing , Donald Reay, “Digital Signal Processing and Applications with the TMS320C6713 and TMS320C6416 DSK”, John Wiley & Sons, 2008.
5. B.Venkatramani, M.Bhaskar, “Digital Signal Processors”, Tata McGraw-Hill, 2002.
6. Keshab K.Parhi, “VLSI Digital Signal Processing Systems design and Implementation”, John Wiley & Sons, 1999.
7. Emmanuel C. Ifeachor, Barrie W. Jervis, “Digital signal processing – A practical approach”, Tata McGraw-Hill, 2002.

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1		3			
CO2	2		3			
CO3	2		3			
CO4	2		3			
CO5	2		3			

AP5003 NONLINEAR SIGNAL PROCESSING L T P C
3 0 0 3

OBJECTIVES:

- To introduce statistical characteristics required for understanding nonlinear filters
- To introduce different types of nonlinear filters for image processing applications
- To teach adaptive filtering concepts and use of neural network nonlinear filtering
- To introduce varieties of sorting algorithms and architectures
- To understand the application of nonlinear filters in image processing

UNIT I INTRODUCTION TO NONLINEAR FILTERS AND STATISTICAL PRELIMINARIES 9

Nonlinear filters – measure of robustness – M estimators – L estimators – R estimators – order statistics – median filter and their characteristics – impulsive noise filtering by median filters – Recursive and weighted median filters – stock filters.

UNIT II NON LINEAR DIGITAL SIGNAL PROCESSING BASED ON ORDER STATISTICS 9

Time ordered nonlinear filters – rank ordered nonlinear filters – max/median filtering – median hybrid filters – characteristics of ranked order filters – L filters – M filters – R filters – comparison.

UNIT III ADAPTIVE NONLINEAR AND POLYNOMIAL FILTERS 9

Definition of polynomial filters – Wiener filters – robust estimation of scale – Adaptive filter based on local statistics – Decision directed filters – Adaptive L filters – Comparison of adaptive nonlinear filters – Neural networks for nonlinear filter

UNIT IV ALGORITHMS AND ARCHITECTURES 9

Sorting and selection algorithm – running median algorithm – fast structures for median and order statistics filtering – systolic array implementation – Wave front array implementation – quadratic digital filters implementation

UNIT V APPLICATIONS OF NONLINEAR FILTERS 9

Power spectrum analysis – Morphological image processing – nonlinear edge detection impulse noise rejection in image and bio signals – two component image filtering – speech processing

TOTAL : 45 PERIODS

COURSE OUTCOMES

CO1: Ability to evaluate the characteristics of non linear filters
CO2: Ability to design and implement rank order filters
CO3: Ability to develop polynomial filters
CO4: Ability to design architectures for nonlinear filters
CO5: Ability to implement nonlinear filters for different types of signals

REFERENCES:

1. Ioannis Pitas, Anastarios. N.Venetsanopoulos, “Nonlinear Digital filters – Principles and Applications”, Kluwer Academic Publishers, 1989.
2. Jaakko Astola, P Kuosmanen, “Fundamentals of Nonlinear Digital Filtering”, CRC Press LLC, 1997
3. Gonzalo R. Arce, “Nonlinear Signal Processing – A Statistical Approach”, Wiley Publishers, 2005
4. Wing Kuen Ling, “Nonlinear Digital Filters: Analysis and Applications”, Elsevier Science & Tech. 2007.

	PO1	PO2	PO3	PO4	PO5	PO6
CO1			2	2		
CO2			3	2		
CO3			3	3		
CO4	1		3	3	1	1
CO5	1		3	3	1	1

AP5004 DIGITAL CONTROL ENGINEERING L T P C
3 0 0 3

OBJECTIVES:

- To introduce continuous time systems, analysis and various controllers
- To introduce time and frequency response of digital control systems with modeling techniques.
- To introduce the design of digital controllers and analyze
- To represent state space modeling of digital systems
- To design state space based controllers for digital systems

UNIT I PRINCIPLES OF CONTROLLERS 9

Review of frequency and time response analysis and specifications of control systems, need for controllers, continues time compensations, continues time PI, PD, PID controllers, digital PID controllers.

UNIT II SIGNAL PROCESSING IN DIGITAL CONTROL 9

Sampling, time and frequency domain description, aliasing, hold operation, mathematical model of sample and hold, zero and first order hold, factors limiting the choice of sampling rate, reconstruction.

UNIT III MODELING AND ANALYSIS 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 variable concepts, first companion, second companion, Jordan canonical models, discrete state variable models, elementary principles.

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, software implementation, implementation using microprocessors and microcontrollers, finite word length effects, choice of data acquisition systems, microcontroller based temperature control systems, microcontroller based motor speed control systems.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: Understand the concepts of discrete system science related mathematics and principles of controllers.

CO2: Explain the discrete system, component or process to meet desired needs for signal processing in digital control systems.

CO3: Understand the Z-transform to process time sequences and solve difference equations to characterize the stability, frequency response, transient time response and steady-state error of a digital control system.

CO4: Design digital controllers in the z-domain and by approximation of S-domain design to solve discrete control engineering problems.

CO5: Understand the techniques, tools and skills related to discrete signals, computer science and modern discrete control engineering in modern engineering practice.

REFERENCES:

1. M.Gopal, “Digital Control and Static Variable Methods”, Tata McGraw Hill, New Delhi, 1997.
2. John J. D'Azzo, “Constantive Houpios, “Linear Control System Analysis and Design”, Mc Graw Hill, 1995.
3. Kenneth J. Ayala, “The 8051 Microcontroller- Architecture, Programming and Applications”, Penram International, 2nd Edition, 1996.

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	2	---	---	1	--
CO2	---	3	--	---	---	---
CO3	--	3	--	----	----	----
CO4	2	1	2	--	---	--
CO5	1	---	1	1	---	2

AP5005 PROGRAMMING LANGUAGES FOR EMBEDDED SOFTWARE L T P C
2 1 0 3

OBJECTIVES:

- To make students familiar with the basic concepts embedded software.
- To foster ability to understand the design concept of object-oriented programming techniques
- To explain programming concepts and embedded programming in c and C++
- Ability to understand the role of scripting languages in embedded software

UNIT I EMBEDDED 'C' 9

Programming Bitwise operations, Dynamic memory allocation, OS services Linked list, stack and queue, Sparse matrices, Binary tree. Interrupt handling in C, Code optimization issues. Writing LCD drives, LED drivers, Drivers for serial port communication. Embedded Software Development Cycle & Methods(Waterfall, Agile)

UNIT II OBJECT ORIENTED PROGRAMMING 9

Introduction to procedural, modular, object-oriented and generic programming techniques, Limitations of procedural programming, objects, classes, data members, methods, data encapsulation, data abstraction and information hiding, inheritance, polymorphism

UNIT III CPP PROGRAMMING 9

'cin', 'cout', formatting and I/O manipulators, new and delete operators, Defining a class, data members and methods, 'this' pointer, constructors, destructors, friend function, dynamic memory allocation

UNIT IV OVERLOADING AND INHERITANCE 9

Need of operator overloading, overloading the assignment, overloading using friends, type conversions, single inheritance, base and derived classes, friend classes, types of inheritance, hybrid inheritance, multiple inheritance, virtual base class, polymorphism, virtual functions,

UNIT V TEMPLATES 9

Function template and class template, member function templates and template arguments, Exception Handling: syntax for exception handling code: try-catch- throw, Multiple Exceptions. **Scripting Languages :**Overview of Scripting Languages – PERL, CGI, VB Script, Java Script. PERL

TOTAL : 45 PERIODS

COURSE OUTCOMES:

CO1: Ability to write an embedded C application of moderate complexity.
CO2: Ability to develop and analyze algorithms in C++.
CO3: Differentiate interpreted languages from compiled languages.

REFERENCES:

1. Michael J. Pont , “Embedded C”, Pearson Education, 2nd Edition, 2008.
2. Randal L. Schwartz, “Learning Perl”, O’Reilly Publications, 6th Edition 2011.
3. A. Michael Berman, “Data structures via C++”, Oxford University Press, 2002.
4. Robert Sedgewick, “Algorithms in C++”, Addison Wesley Publishing Company, 1999.
5. Abraham Silberschatz, Peter B, Greg Gagne, “Operating System Concepts”, John Willey & Sons, 2005.

COs	PROGRAMME OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
1	1	1	2	2	1	
2		2	3	2		
3	1		1	1	1	

AP5006 ADVANCED COMPUTER ARCHITECTURE DESIGN L T P C
3 0 0 3

OBJECTIVES:

- To Illustrate, with suitable examples, the concepts and principles of parallel processing.
- To make the students familiarize with modern processor technology and the supporting memory hierarchy.
- To introduce and study the system architecture with parallel, vector and scalable architecture for building high-performance computers

UNIT I THEORY OF PARALLELISM 9

Parallel computer models - the state of computing, Multiprocessors and Multicomputers and Multivectors and SIMD computers, PRAM and VLSI models, Architectural development tracks. Program and network properties- Conditions of parallelism.

UNIT II PARTITIONING AND SCHEDULING 9

Program partitioning and scheduling, Program flow mechanisms, System interconnect architectures. Principles of scalable performance - performance matrices and measures, Parallel processing applications, speedup performance laws, scalability analysis and approaches.

UNIT III HARDWARE TECHNOLOGIES 9

Processor and memory hierarchy advanced processor technology, superscalar and vector processors, memory hierarchy technology, virtual memory technology, bus cache and shared memory – Bus Arbitration, cache memory organisations, shared memory organisations, sequential and weak consistency models.

UNIT IV PIPELINING, SUPERSCALAR , PARALLEL AND SCALABLE ARCHITECTURE 9

Linear and Non-Linear Pipeline processor – Instruction and Arithmetic Pipeline Design – Superscalar and Superpipeline Design – Multiprocessor Interconnects – Cache Coherence and Synchronization mechanism – Message Passing Mechanism – Flow Control Strategies – Multicast Routing Strategies

UNIT V MULTIVECTOR AND SIMD COMPUTERS 9

Vector processing Principles – Compound Vector Processing – SIMD Computer Organisation –Synchronized MIMD machine – Latency Hiding Technique – Multithreading –Scalable and and Multithreaded Architectures – Data Flow and Hybrid Architectures - Parallel models, Languages and compilers, Parallel program development and environments.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: Able to build up on advanced concepts of parallel architecture
CO2: Able to design parallel architectures for improved performance
CO3: Ability to apply memory hierarchy for multiprocessor system
CO4: Able to analyze the design structures of pipelined systems
CO5: Able to analyze and design multiprocessor systems

REFERENCES

1. Kai Hwang, "Advanced Computer Architecture", Mc Graw Hill International, 2001.
2. Dezso Sima, Terence Fountain, Peter Kacsuk, “Advanced Computer Architecture – A Design Space Approach”, Pearson Education, 2003.
3. John P.Shen, “Modern Processor Design Fundamentals of Super Scalar Processors”, Tata McGraw Hill, 2003.
4. Kai Hwang, “Scalable parallel computing”, Tata McGraw Hill 1998.
5. William Stallings, “Computer Organization and Architecture”, Macmillan Publishing Company, 1990.
6. M.J. Quinn, “Designing Efficient Algorithms for Parallel Computers”, McGraw Hill International, 1994.
7. Barry, Wilkinson, Michael, Allen “Parallel Programming”, Pearson Education Asia , 2002
8. Harry F. Jordan Gita Alaghband, “ Fundamentals of parallel Processing”, Pearson Education , 2003
9. Richard Y.Kain, “Advanced Computer Architecture – A Systems Design Approach”, PHI, 2003.

AP5007 DESIGN AND ANALYSIS OF COMPUTER ALGORITHMS L T P C
3 0 0 3

OBJECTIVES:

- To introduce the Algorithms and Models of Computation.
- To introduce Data Structures and its Applications.
- To study Algorithms Analysis and Design Techniques.
- To study various Searching and Sorting Algorithms.
- To study NP-Complete Problems.

UNIT I INTRODUCTION 9

Introduction to Design and Analysis of Algorithms – Good Programming Practice – Problems to Programs – Algorithms and their Complexity – Models of Computation – Turing Machine.

UNIT II DATA STRUCTURES 9

Introduction to Data Structures – Linear and Non-linear Data Structures – Lists – Stack – Queue – Graph – Tree – Data Structure Operations - Shortest Path Algorithms – Minimal Spanning Tree Construction.

UNIT III ALGORITHMS ANALYSIS AND DESIGN TECHNIQUES 9

Efficiency of Algorithms – Large Class of Recurrences – Divide and Conquer Algorithms – Dynamic Programming – Greedy Algorithms – Backtracking and Local Search Algorithms.

UNIT IV SEARCHING AND SORTING 9

Linear Search – Binary Search – Selection Sort – Insertion Sort – Quick Sort – Radix Sort – Merge Sort – Heap Sort – Analysis of Searching and Sorting Algorithms.

UNIT V NP-COMPLETE PROBLEMS 9

Nondeterministic Turing Machines – The Classes P and NP – Languages and Problems – NP Completeness of the Satisfiability Problems – Provably Intractable Problems.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: Understand the Principles of Algorithms and Models of Computation.
CO2: Understand the Principles of Data Structures and its Applications.
CO3: Analyze and Design of Various Algorithms.
CO4: Create and Analyze Various Searching and Sorting Algorithms.
CO5: Understand the Principles of NP-Complete Problems.

REFERENCES:

1. Alfred V. Aho, John E. Hopcroft and Jeffrey D. Ullman, "The Design and Analysis of Computer Algorithms", Pearson Education, 2017.
2. Alfred V. Aho, John E. Hopcroft and Jeffrey D. Ullman, "Data Structures and Algorithms", Pearson Education, 2017.
3. Udi Manber, "Introduction to Algorithms: A Creative Approach", Addison-Wesley Publishing Company, 2017.

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2		3			
CO2	2		3			
CO3	2		3			
CO4	2		3			
CO5	2		3			

AP5078 WIRELESS SENSOR NETWORKS L T P C
3 0 0 3

OBJECTIVES:

- To enable the student to understand the role of sensors and the networking of sensed data for different applications.
- To expose the students to the sensor node essentials and the architectural details, the medium access and routing issues and the energy constrained operational scenario.
- To enable the student to understand the challenges in synchronization and localization of sensor nodes, topology management for effective and sustained communication, data management and security aspects

UNIT I OVERVIEW OF WIRELESS SENSOR NETWORKS 9

Challenges for Wireless Sensor Networks-Characteristics requirements-required mechanisms, Difference between mobile ad-hoc and sensor networks, Applications of sensor networks- case study, Enabling Technologies for Wireless Sensor Networks.

UNIT II ARCHITECTURES 9

Single-Node Architecture - Hardware Components, Energy Consumption of Sensor Nodes , Operating Systems and Execution Environments, Network Architecture - Sensor Network Scenarios, Optimization Goals and Figures of Merit, Gateway Concepts. Physical Layer and Transceiver Design Considerations

UNIT III MAC AND ROUTING 9

MAC Protocols for Wireless Sensor Networks, IEEE 802.15.4, Zigbee, Low Duty Cycle Protocols And Wakeup Concepts - S-MAC , The Mediation Device Protocol, Wakeup Radio Concepts, Address and Name Management, Assignment of MAC Addresses, Routing Protocols- Energy- Efficient Routing, Geographic Routing.

UNIT IV INFRASTRUCTURE ESTABLISHMENT 9

Topology Control, Clustering, Time Synchronization, Localization and Positioning, Sensor Tasking and Control.

UNIT V DATA MANAGEMENT AND SECURITY 9

Data management in WSN, Storage and indexing in sensor networks, Query processing in sensor, Data aggregation, Directed diffusion, Tiny aggregation, greedy aggregation, security in WSN.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: Ability to design implement simple wireless network concepts
CO2: Ability to design, analyze implement different network architectures
CO3: Ability to implement MAC layer and routing protocols
CO4: Ability to deal with timing and control issues in wireless sensor networks
CO5: Ability to analyze and design secured wireless sensor networks

REFERENCES

1. Ian F. Akyildiz, Mehmet Can Vuran, “Wireless Sensor Networks”, John Wiley, 2010
2. Yingshu Li, My T. Thai,Weili Wu, “Wireless Sensor Networks and Applications”, Springer, 2008
3. Holger Karl & Andreas Willig, "Protocols And Architectures for Wireless Sensor Networks", John Wiley, 2005.
4. Feng Zhao & Leonidas J. Guibas, “Wireless Sensor Networks- An Information Processing Approach", Elsevier, 2007.
5. Kazem Sohraby, Daniel Minoli, & Taieb Znati, “Wireless Sensor Networks-s Technology, Protocols, And Applications”, John Wiley, 2007.
6. Anna Hac, “Wireless Sensor Network Designs”, John Wiley, 2003.
7. Bhaskar Krishnamachari, “Networking Wireless Sensors”, Cambridge Press,2005.
8. Mohammad Ilyas And Imad Mahgaob, “Handbook Of Sensor Networks: Compact Wireless And Wired Sensing Systems”, CRC Press,2005.
9. Wayne Tomasi, “Introduction To Data Communication And Networking”, Pearson Education, 2007.

COs	PROGRAMME OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
1			1	2		
2			2	2		
3	1		3	3	1	1
4	1		2	2		
5	1		2	3	1	1

AP5074 PCB DESIGN AND FABRICATION L T P C
3 0 0 3

OBJECTIVES:

- To expose the students to the basics of PCB design
- To lead the new users of the software through a very simple design
- To address the mechanical aspect of PCB design and to aid in understanding the design issues, manufacturing processes.
- To address the electrical aspect of PCB design
- To expose the students to the state of art technology in PCB design and manufacturing

UNIT I BASICS OF PCB DESIGN, TOOLS & INDUSTRY STANDARDS 9

Printed Circuit Board Fabrication- PCB cores and layer stack-up. PCB fabrication process- Photolithography and chemical etching, Mechanical Layer registration. Function of the Layout in the PCB Design Process. Design Files Created by Layout - Layout format files, Postprocess (Gerber) files, PCB assembly layers and files. Introduction to the Standards Organizations, Classes and Types of PCBs, Introduction to Standard Fabrication Allowances, PCB Dimensions and Tolerances, Copper Trace and Etching Tolerances, Standard Hole Dimensions, Soldermask Tolerance.

UNIT II PCB DESIGN FLOW USING CAD TOOL 9

Overview of Computer-Aided Design. Project structures and the layout toolset- Project Setup and Schematic Entry Details, the Layout Environment and Tool Set. Creating a Circuit Design with Capture-Starting a new project placing parts, Wiring (connecting) the parts, creating the Layout netlist in Capture. Designing the PCB with Layout- Starting Layout and importing the netlist, Performing a design rule check, Making a board outline, Placing the parts, Auto routing the board Manual routing, Cleanup Locking traces, Post processing the board design for manufacturing. Setting up a user account, Submitting Gerber files and requesting a quote, Annotating the layer types and stack-up, Receipt inspection and testing, Nonstandard Gerber files.

UNIT III DESIGN FOR MANUFACTURING 9

PCB Assembly and Soldering Processes- Component Placement and Orientation Guide, Component Spacing for Through-hole Devices. Component Spacing for Surface Mounted Devices SMDs, Mixed THD and SMD Spacing Requirements. Footprint and Padstack Design for PCB Manufacturability- Land Patterns for Surface-Mounted Devices- Land Patterns for Through-hole Devices, Padstack design, Hole-to-lead ratio, PTH land dimension (annular ring width), Clearance between plane layers and PTHs Soldermask and solder paste dimensions.

UNIT IV PCB DESIGN FOR SIGNAL INTEGRITY 9

Circuit Design Issues Not Related to PCB Layout, Issues Related to PCB Layout, Ground Planes and Ground Bounce, PCB Electrical Characteristics, PCB Routing Topics, Making and editing capture parts, The Capture Part Libraries, Types of Packaging, Pins, Part Editing Tools, Constructing Capture Parts, making and editing layout footprints.

UNIT V EMERGING ADDITIVE PROCESSES FOR PCB MANUFACTURING 9

Fundamentals of additive manufacturing, classification, advantages and standards on Additive manufacturing. Stereo lithography (SL), Stereo lithography (SL), Fused Deposition Modelling (FDM), Three Dimensional Printing (3DP), Materials, Applications. Voltera-V-one PCB double side Printer, Bot Factory- SV2-multi layer PCB printer, LPKF circuit board plotter and LDS Prototyping.

TOTAL: 45 PERIODS

COURSE OUTCOMES

CO1: To understand the basics, industry standards organizations related to the design and fabrication of PCBs.

CO2: Leads new users of the software through a very simple design

CO3: To know and guide in designing plated through-holes, surface-mount lands, and Layout footprints in general.

CO4: To know to construct Capture parts using the Capture Library Manager and Part Editor and the PSpice Model Editor.

CO5: To understand and to fabricate PCBs

REFERENCES:

1. Kraig Mitzner, “Complete PCB Design Using OrCad Capture and Layout”, Newness, 1st Edition, 2009.
2. Simon Monk, “Make Your Own PCBs with EAGLE: From Schematic Designs to Finished Boards”, McGraw-Hill Education TAB; 2nd Edition, 2017.
3. Douglas Brooks, “Signal Integrity Issues and Printed Circuit Board Design”, Prentice Hall PTR, 2003.
4. Lee W. Ritchey , John Zasio, Kella J. Knack, “Right the First Time: a Practical Handbook on High Speed PCB and System Design”, Speeding Edge , 2003.

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1				
CO2		1	3			
CO3		1	2			
CO4		1	2	3		
CO5			1	3	2	3

AP5008 IOT SYSTEM DESIGN AND SECURITY L T P C
3 0 0 3

OBJECTIVES:

- To understand the basics of IoT.
- To get an idea about the various services provided by IoT**.**
- To familiarize themselves with various communication techniques.
- To get an idea of some application area where IoT can be applied.
- To understand the various issues in IoT.

UNIT I INTRODUCTION TO INTERNET OF THINGS 9

Rise of the machines – Evolution of IoT – Web 3.0 view of IoT – Definition and characteristics of IoT – Physical design of IoT – Logical design of IoT – IoT enabling technologies – IoT levels and deployment templates – A panaromic view of IoT applications.

UNIT II ARCHITECTURE OF IoT 9

Identifaction and Access to objects and services in the IoT environment(Current technologies for IoT naming-Solutions proposed by research projects-Research and Future development trends and forecast) – Middleware technologies for IoT system (IoT Ecosystem Overview – Horizontal Architecture Approach for IoT Systems-SOA-based IoT Middleware)Middleware architecture of RFID,WSN,SCADA,M2M–Challenges Introduced by 5G in IoT Middleware(Technological Requirements of 5G Systems-5G-based IoT Services and Applications Requirements-5G-based Challenges for IoT Middleware) - Perspectives and a Middleware Approach Toward 5G (COMPaaS Middleware) – Resource management in IoT.

UNIT III SECURITY CONSIDERATIONS IN IOT SMART AMBIENT SYSTEMS 9

Security in Smart Grids and Smart Spaces for Smooth IoT Deployment in 5G (5G and the Internet of Things-Smart Spaces-Smart Grids Security and Privacy - Services that Need to Be Secure - Security Requirements -Security Attacks-Security Measures and Ongoing Research) - Security Challenges in 5G-Based IoT Middleware Systems(Security in 5G-Based IoT Middleware-Security Challenges Toward 5G).

UNIT IV IOT ENABLERS AND THEIR SECURITY AND PRIVACY ISSUES 9

Internet of Things layer wise Protocols and Standards**-** EPCglobal(architecture, specifications, industry adaptation, security and vulnerabilities , advantages and disadvantages)-WirelessHART-Zigbee-Near Field Communication-6LoWPAN-Dash7-Comparative Analysis.

UNIT V APPLICATIONS AND CASE STUDIES 9

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

TOTAL:45 PERIODS

COURSE OUTCOMES:

CO1: Articulate the main concepts, key technologies, strength and limitations of IoT.
CO2: Identify the architecture, infrastructure models of IoT.
CO3: Analyze the core issues of IoT such as security, privacy and interoperability.
CO4: Analyze and design different models for network dynamics.
CO5: Identify and design the new models for market strategic interaction.

REFERENCES:

1. Honbo Zhou, “Internet of Things in the cloud:A middleware perspective”, CRC press 2012.
2. Vijay Madisetti and Arshdeep Bahga, “Internet of Things (A Hands-onApproach)”, VPT, 1st Edition, 2014.
3. Constandinos X. Mavromoustakis, George Mastorakis, Jordi Mongay Batalla, “Internet of Things (IoT) in 5G Mobile Technologies” Springer International Publishing, Switzerland, 2016.
4. Dieter Uckelmann, Mark Harrison, Florian Michahelles, “Architecting the Internet of Things”, Springer-Verlag Berlin Heidelberg, 2011.
5. http://www.cse.wustl.edu/~jain/cse570-15/ftp/iot_prot/index.html.

	PO1	PO2	PO3	PO4	PO5	PO6
CO1		1				
CO2						
CO3		1	1			
CO4			2		2	1
CO5	2			3	3	1

AP5071 ADVANCED MICROPROCESSORS & MICROCONTROLLERS L T P C
3 0 0 3

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

COURSE OUTCOMES:

CO1: To understand the fundamentals of microprocessor architecture.
CO2: To know and appreciate the high performance features in CISC architecture.
CO3: To know and appreciate the high performance features in RISC architecture.
CO4: To perceive the basic features in Motorola microcontrollers.
CO5: To interpret and understand PIC Microcontroller.

REFERENCES:

1. Daniel Tabak , „" Advanced Microprocessors" McGraw Hill.Inc., 1995
2. James L. Antonakos , " The Pentium Microprocessor „" Pearson Education , 1997.
3. Steve Furber , „" ARM System –On –Chip architecture "Addision Wesley , 2000.
4. Gene .H.Miller ." Micro Computer Engineering ," Pearson Education , 2003.
5. John .B.Peatman , " Design with PIC Microcontroller , Prentice hall, 1997.
6. John H.Davis , "MSP 430 Micro controller basics", Eelsevier, 2008.
7. James L.Antonako, "An Introduction to the Intel family of Microprocessors", Pearson Education 1999.
8. Barry.B.Breg, "The Intel Microprocessors Architecture , Programming and Interfacing" , PHI,2002.
9. Valvano, "Embedded Microcomputer Systems", Thomson Asia PVT LTD, 1st reprint 2001.

Readings: Web links -- www.ocw.mit.edu, www.arm.com

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1		1			
CO2	1			3	1	1
CO3	1			3	1	1
CO4	1		1	3	2	1
CO5	1		1	3	2	1

AP5072 ELECTRONICS FOR SOLAR POWER L T P C
3 0 0 3

OBJECTIVES

- Study the behavior of photovoltaic solar energy systems, focusing on the behavior of "stand-alone" systems.
- Do a first order, conceptual design of a stand-alone system for a location anywhere in India
- Introduce the hardware elements and their behavior.
- Select battery for a PV system and battery sizing
- Simulate standalone and grid tied PV system

UNIT I INTRODUCTION TO SOLAR POWER 9

Semiconductor – properties - energy levels - basic equations of semiconductor devices physics - Basic characteristics of sunlight - Solar angles - day length - angle of incidence on tilted surface – Sun path diagrams – Equivalent circuit of PV cell, PV cell characteristics (VI curve, PV curve) - Maximum power point, Vmp, I_{MP}, Voc, I_{SC} – types of PV cell - Block diagram of solar photo voltaic system, PV array sizing.

UNIT II DC-DC CONVERTER 9

Principles of step-down and step-up converters – Analysis and design issues of buck, boost, buckboost and Cuk converters – time ratio and current limit control – Full bridge converter – Resonant and quasi – resonant converters.

UNIT III MAXIMUM POWER POINT TRACKING 9

Direct Energy transmission, Impedance Matching, Maximum Power Point Tracking (MPPT) - Function of MPPT, P&O method, INC Method, Fractional Open circuit voltage method, Fractional short circuit current method, parasitic capacitance and other MPPT techniques, Development of hardware, algorithms using processors for Standalone and Grid tied systems.

UNIT IV BATTERY 9

Types of Battery, Battery Capacity – Units of Battery Capacity-impact of charging and discharging rate on battery capacity-Columbic efficiency-Voltage Efficiency, Charging – Charge Efficiency, Charging methods, State of Charge, Charging Rates, Discharging - Depth of discharge-Discharge Methods, Circuits for Battery Management System (BMS), selection of Battery and sizing.

UNIT V SIMULATION OF PV MODULE & CONVERTERS 9

Simulation of PV module - VI Plot, PV Plot, finding V_{MP}, I_{MP}, Voc, Isc of PV module, Simulation of DC to DC converter -buck, boost, buck-boost and Cuk converters, standalone and grid tied photo voltaic system.

TOTAL:45 PERIODS

COURSE OUTCOMES:

CO1: Ability to collect solar power characteristics at a given location
CO2: Ability to design and realize dc-dc converters for solar power utilization
CO3: Ability to design algorithms for improving solar power utilization
CO4: Ability to deal with battery issues and selection
CO5: Ability to design and simulate PV systems to validate its performance.

REFERENCES:

1. Chetan Singh Solanki, “Solar Photovoltaic: Fundamentals, Technologies and Applications”, PHI Ltd., 2013.
2. Tommarkvart, Luis castaner, “Solar cells; materials, manufacture and operation”, Elsevier, 2005.
3. G.D .Rai, “Solar energy utilization “, Khanna publishes, 1993.
4. Ned Mohan, Undeland and Robbin, “Power Electronics: converters, Application and Design”, John Wiley and sons.Inc, Newyork, 1995.

AP5076 ROBOTICS AND INTELLIGENT SYSTEMS L T P C
3 0 0 3

OBJECTIVES:

- To Teach the basic concepts in robotics.
- To expose the various design aspects in robot grippers.
- To make learn various drives and control systems.
- To impart knowledge on machine vision systems.
- To apply robot based concepts for automation

UNIT I INTRODUCTION 9

Basic Concepts such as Definition, three laws, DOF, Misunderstood devices etc., Elements of Robotic Systems i.e. Robot anatomy, Classification, Associated parameters i.e. resolution, accuracy, repeatability, dexterity, compliance, RCC device, etc. Automation-Concept, Need, Automation in Production System, Principles and Strategies of Automation, Basic Elements of an Automated System, Advanced Automation Functions, Levels of Automations, introduction to automation productivity.

UNIT II ROBOT GRIPPERS 9

Types of Grippers , Design aspect for gripper, Force analysis for various basic gripper system. Sensors for Robots:- Characteristics of sensing devices, Selections of sensors, Classification and applications of sensors. Types of Sensors, Need for sensors and vision system in the working and control of a robot.

UNIT III DRIVES AND CONTROL SYSTEMS 9

Types of Drives, Actuators and its selection while designing a robot system. Types of transmission systems, Control Systems -Types of Controllers, Introduction to closed loop control .Control Technologies in Automation:- Industrial Control Systems, Process Industries Verses Discrete-Manufacturing Industries, Continuous Verses Discrete Control, Computer Process and its Forms. Control System Components such as Sensors, Actuators and others.

UNIT IV MACHINE VISION SYSTEM 9

Vision System Devices, Robot Programming :- Methods of robot programming, lead through programming, motion interpolation, branching capabilities, WAIT, SIGNAL and DELAY commands, subroutines, Programming Languages: Introduction to various types such as RAIL and VAL II etc, Features of type and development of languages for recent robot systems.

UNIT V MODELING AND SIMULATION FOR MANUFACTURING PLANT AUTOMATION 9

Introduction, need for system Modeling, Building Mathematical Model of a manufacturing Plant,Modern Tools- Artificial neural networks in manufacturing automation, AI in manufacturing,Fuzzy decision and control, robots and application of robots for automation.Artificial Intelligence:- Introduction to Artificial Intelligence, AI techniques, Need and application of AI. Other Topics in Robotics:- Socio-Economic aspect of robotisation. Economical aspects for robot design, Safety for robot and associated mass, New Trends & recent updates in robotics.

TOTAL:45 PERIODS

COURSE OUTCOMES:

CO1: Ability to implement simple concepts associated with Robotics and Automation
CO2: Ability to use various Robotic sub-systems
CO3: Ability to use kinematics and dynamics to design exact working pattern of robots
CO4: Ability to implement computer vison algorithms for robots
CO5: Be aware of the associated recent updates in Robotics

REFERENCES:

1. John J. Craig," Introduction to Robotics (Mechanics and Control)", Addison-Wesley, 2nd Edition, 2004.
2. Mikell P. Groover et. Al., "Industrial Robotics: Technology, Programming and Applications", McGraw – Hill International, 1986.

3. Shimon Y. Nof , “Handbook of Industrial Robotics” , John Wiley Co,2001.
4. Automation, “Production Systems and Computer Integrated Manufacturing”, M.P. Groover, Pearson Education.
5. W.P. David, “Industrial Automation”, John Wiley and Sons.
6. Richard D. Klafter , Thomas A. Chemielewski, Michael Negin, “Robotic Engineering : An Integrated Approach” , Prentice Hall India, 2002.
7. R.C. Dorf, “Handbook of design, manufacturing & Automation” John Wiley and Sons.

AP5075 RF SYSTEM DESIGN L T P C
3 0 0 3

OBJECTIVES:

- The students will learn various design steps starting from system specifications to hardware/software implementation and will experience process optimization while considering various design decisions.
- Students will gain design experience with project/case studies using contemporary high-level methods and tools.

UNIT I CMOS PHYSICS, TRANSCEIVER SPECIFICATIONS AND ARCHITECTURES 9

Introduction to MOSFET Physics, Noise: Thermal, shot, flicker, popcorn noise, Two port Noise theory, Noise Figure, THD, IP2, IP3, Sensitivity, SFDR, Phase noise - Specification distribution over a communication link, Homodyne Receiver, Heterodyne Receiver, Image reject, Low IF Receiver Architectures Direct upconversion Transmitter, Two step upconversion Transmitter.

UNIT II IMPEDANCE MATCHING AND AMPLIFIERS 9

S-parameters with Smith chart, Passive IC components, Impedance matching networks, Common Gate, Common Source Amplifiers, OC Time constants in bandwidth estimation and enhancement, High frequency amplifier design, Power match and Noise match, Single ended and Differential LNAs, Terminated with Resistors and Source Degeneration LNAs.

UNIT III FEEDBACK SYSTEMS AND POWER AMPLIFIERS 9

Stability of feedback systems: Gain and phase margin, Root-locus techniques, Time and Frequency domain considerations, Compensation, General model – Class A, AB, B, C, D, E and F amplifiers, Power amplifier Linearisation Techniques, Efficiency boosting techniques, ACPR metric, Design considerations

UNIT IV MIXERS AND OSCILLATORS 9

Mixer characteristics, Non-linear based mixers, Quadratic mixers, Multiplier based mixers, Single balanced and double balanced mixers, subsampling mixers, Oscillators describing Functions, Colpitts oscillators Resonators, Tuned Oscillators, Negative resistance oscillators, Phase noise.

UNIT V PLL AND FREQUENCY SYNTHESIZERS 9

Linearised Model, Noise properties, Phase detectors, Loop filters and Charge pumps, Integer-N frequency synthesizers, Direct Digital Frequency synthesizers.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

CO1: Ability to collect user specifications for RF systems
CO2: Ability to analyze and design RF amplifiers
CO3: Ability to analyze and design RF power amplifiers
CO4: Ability to analyze and design RF mixers and oscillators
CO5: Ability to design PLL for RF applications

REFERENCE BOOKS:

1. T.Lee, “Design of CMOS RF Integrated Circuits”, Cambridge, 2004.
2. B.Razavi, “RF Microelectronics”, Pearson Education, 1997.
3. Jan Crols, Michiel Steyaert, “CMOS Wireless Transceiver Design”, Kluwer Academic Publishers, 1997.
4. B.Razavi, “Design of Analog CMOS Integrated Circuits”, McGraw Hill, 2001
5. Recorded lectures and notes available at . http://www.ee.iitm.ac.in/~ani/ee6240/

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3		3	1	2	2
CO2	3		3	1	2	2
CO3	3		3	1	2	2
CO4	3		3	1	2	2
CO5	3		3	1	2	2

AP5077 SIGNAL INTEGRITY FOR HIGH SPEED DESIGN L T P C
3 0 0 3

OBJECTIVES:

- To identify sources affecting the speed of digital circuits.
- To introduce methods 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 stackups and layer/Cu thicknesses, cross-sectional analysis tools, Zo and Td equations for microstrip and stripline 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 (stripline and microstrip) Differential signalling, termination, balanced circuits ,S-parameters, Lossy and Lossless models.

UNIT III NON-IDEAL EFFECTS 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, IBIS models ,Bit streams, PRBS and filtering functions of link-path components , Eye diagrams , jitter , inter-symbol interference Bit-error rate ,Timing analysis.

UNIT V CLOCK DISTRIBUTION AND CLOCK OSCILLATORS 9

Timing margin, Clock slew, low impedance drivers, terminations, Delay Adjustments, canceling parasitic capacitance, Clock jitter.

TOTAL : 45 PERIODS

S

COURSE OUTCOMES:
CO1: Ability to identify sources affecting the speed of digital circuits.
CO2: Ablility to identify methods to improve the signal transmission characteristics

REFERENCES

1. H. W. Johnson and M. Graham, High-Speed Digital Design: A Handbook of Black Magic, Prentice Hall, 1993.
2. Douglas Brooks, Signal Integrity Issues and Printed Circuit Board Design, Prentice Hall PTR , 2003.
3. S. Hall, G. Hall, and J. McCall, High-Speed Digital System Design: A Handbook of Interconnect Theory and Design Practices, Wiley-Interscience, 2000.
4. Eric Bogatin , Signal Integrity – Simplified , Prentice Hall PTR, 2003.

TOOLS REQUIRED
1. SPICE, source - http://www-cad.eecs.berkeley.edu/Software/software.html
2. HSPICE from synopsis, www.synopsys.com/products/ mixedsignal/hspice/hspice.html
3. SPECCTRAQUEST from Cadence, http://www.specctraquest.com

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2		3			1
CO2	2		3		1	
CO3	2		3		1	
CO4	2		3		1	
CO5	2		3		1	

AP5073 EMI AND EMC IN SYSTEM DESIGN L T P C
3 0 0 3

OBJECTIVES:
- To understand the concepts related to Electromagnetic interference in PCBs.
- To provide solutions for minimizing EMI in PCBs .
- To learn various EMI coupling principles.
- To indulge knowledge on EMI control techniques and design procedures to make EMI compatible PCBs
- To learn electromagnetic compatibility issues with regard to the design of PCBS
- To learn, EMI standards and measurements in the design of PCBs

UNIT I EMI/EMC CONCEPTS 9
EMI-EMC definitions and Units of parameters; Sources and victim of EMI; Conducted and Radiated EMI Emission and Susceptibility; Transient EMI, ESD; Radiation Hazards.

UNIT II EMI COUPLING PRINCIPLES 9
Conducted, radiated and transient coupling; Common ground impedance coupling ; Common mode and ground loop coupling ; Differential mode coupling ; Near field cable to cable coupling, cross talk ; Field to cable coupling ; Power mains and Power supply coupling.

UNIT III EMI CONTROL TECHNIQUES 9
Shielding, Filtering, Grounding, Bonding, Isolation transformer, Transient suppressors, Cable routing, Signal control.

UNIT IV EMC DESIGN OF PCBS 9

Component selection and mounting; PCB trace impedance; Routing; Cross talk control; Power distribution decoupling; Zoning; Grounding; VIAs connection; Terminations

UNIT V EMI MEASUREMENTS AND STANDARDS 9

Open area test site; TEM cell; EMI test shielded chamber and shielded ferrite lined anechoic chamber; Tx /Rx Antennas, Sensors, Injectors / Couplers, and coupling factors; EMI Rx and spectrum analyzer; Civilian standards-CISPR, FCC, IEC, EN; Military standards-MIL461E/462.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

CO1: Gain enough knowledge to understand the concept of EMI / EMC related to product design & development.

CO2: To analyze the different EM coupling principles and its impact on performance of electronic system.

CO3: Analyze electromagnetic interference, highlighting the concepts of both susceptibility and immunity

CO4: Interpret various EM compatibility issues with regard to the design of PCBs and ways to improve the overall system performance

CO5: To obtain broad knowledge of various EM radiation measurement techniques and the present leading edge industry standards in different countries

REFERENCES:

1. V.P.Kodali, “Engineering EMC Principles, Measurements and Technologies”, IEEE Press, Newyork, 1996.
2. Henry W.Ott.,”Noise Reduction Techniques in Electronic Systems”, A Wiley Inter Science Publications, John Wiley and Sons, Newyork, 1988.
3. Bemhard Keiser, “Principles of Electromagnetic Compatibility”, Artech house, Norwood, 3rd Edition, 1986.
4. C.R.Paul,”Introduction to Electromagnetic Compatibility” , John Wiley and Sons, Inc, 1992.
5. Don R.J.White Consultant Incorporate, “Handbook of EMI/EMC” , Vol I-V, 1988.

	PO1	PO2	PO3	PO4	PO5	PO6
CO1			2			
CO2	1				3	3
CO3			2			
CO4			2	3	2	3
CO5					3	2
CO6				3	1	

AP5009 MEMS BASED DEVICES L T P C
3 0 0 3

OBJECTIVES:

- To provide knowledge of semiconductors and solid mechanics to fabricate MEMS devices by understanding the essential material properties
- To study various sensing and transduction technique and educate on the rudiments of Micro fabrication techniques.
- To know about RF MEMS.
- To study about optical MEMS.
- To construct models using MEMS systems.

UNIT I INTRODUCTION TO MEMS 9

Principles of Microsystems, Nano and Microscale systems, devices, and structures, Microstructures, Axial stress and strain, Shear stress and strain, Static bending of beams and thin plates, Mechanical vibration, Stiction issue, Scaling laws in miniaturization & Materials ; MEMS Materials: Substrates and Wafers, Active substrate materials, Silicon, Silicon compounds, Silicon Piezoresistors, Gallium Arsenide, Quartz, Polymers, Packaging materials.

UNIT II ACTUATION MECHANISMS IN MEMS AND FABRICATION 9

Electrostatic Actuators : charge control, voltage control, spring suspended C, pull-in voltage, linearization methods, comb drive actuators, levitation, equivalent circuits, Piezoelectric, Thermal, Magnetic actuators, gap closers, rotary finger pull up, Electronics Interface, Feedback systems, Noise,circuit and system issues.

MEMS Fabrication: Bulk micromachining, Surface micromachining, Thin-film depositions (LPCVD, Sputtering, Evaporation), LIGA, Electroplating, Wet and dry etching, Packaging: Microsystems packaging, Interfaces in microsystem packaging, Essential packaging technologies, 3D packaging, Assembly of Microsystems, Selection of packaging materials, Current and future trends for NEMS

UNIT III RF MEMS 9

Introduction to RF MEMS, general concepts in high frequency effects, RF MEMS Switches-Intro, banalog intesign guidelines, RF switch design case studies, RF filters with MEMS-Tunable Capacitors and Inductors, RF MEMS resonators and their applications, Comparison of electrostatic and piezoelectric resonators, Case Study: Micromachined Antennas, Microstrip antenna ,Micromachining for antennas fabrication, Reconfigurable antennas, Example of RF MEMS switches and applications, design approaches.

UNIT IV MOEMS 9

Digital Micro mirror Device, Grating Light Valve, Optical switches, optical filters, arrayed waveguide grating,, Electrostatic reflective light modulator, Torsion mirror (TI DMD) Micromachined optical structures ,Fiber-optic couplers, Refractive lenses, Diffractive lenses, Waveguide optical systems, MEMS deformable mirrors Case study: Grating Light Valve

UNIT V MODELLING OF MEMS SYSTEMS 9

Circuit Modeling of MEMS: resonator equivalent circuits, thermal circuits, fluidic circuits, general filter topologies, insertion loss , shape factor, resonator and couplers, circuit modeling of coupled resonators, systematic micromechanical filter design procedure, Electrostatically actuated micro-mirror, design of optical filters, case studies.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: Analyze the mechanical performance of microsystems.
CO2: Understand the operational theory of common MEMS actuators and analyze different MEMS technologies.
CO3: Develop ideas in the micro machnied designs for the design of reconfigurable antennas.
CO4: Analyze the engineering science and physics of MEMS devices at the micro scale in optics.
CO5: Develop new ideas and applications for MEMS devices.

REFERENCES:

1. Gregory T.A. Kovacs, Micromachined Transducers Sourecbook, The McGraw-Hill, Inc.1998.
2. Stephen D. Senturia, Microsystem Design, Kluar Publishers, 2001.
3. Nadim Maluf, An Introduction to Microelectromechanical Systems Engineering, Artech House, 2000.
4. Vijay Varadan, K. J. Vinoy, K. A. Jose, .RF MEMS and Their applications,Wiley, 2002.
5. N.P.Mahalik,MEMS,Tata McGraw Hill,2007.
6. Tai Ran Hsu ,MEMS and Microsystems Design and Manufacture, TataMcGraw Hill,2002.

	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3	1				1	
CO4			2		2	
CO5				3		1

AP5010 ARTIFICIAL INTELLIGENCE AND OPTIMIZATION TECHNIQUES L T P C
3 0 0 3

OBJECTIVES:

- To introduce the techniques of computational methods inspired by nature, such as neural networks, genetic algorithms and other evolutionary computation systems, ant swarm optimization and artificial immune systems.
- To present main rules underlying in these techniques.
- To present selected case-studies.
- To adopt these techniques in solving problems in the real world.

UNIT I NEURAL NETWORKS 9

Neural Networks: Back Propagation Network, generalized delta rule, Radial Basis Function Network, interpolation and approximation RBFNS, comparison between RBFN and BPN, Support Vector Machines: Optimal hyperplane for linearly separable patterns, optimal hyperplane for nonlinearly separable patterns, Inverse Modeling.

UNIT II FUZZY LOGIC SYSTEMS 9

Fuzzy Logic System: Basic of fuzzy logic theory , crisp and fuzzy sets, Basic set operation like union , interaction , complement , T-norm , T-conorm , composition of fuzzy relations, fuzzy if-then rules , fuzzy reasoning, Neuro-Fuzzy Modeling: Adaptive Neuro-Fuzzy Inference System (ANFIS) , ANFIS architecture , Hybrid Learning Algorithm.

UNIT III EVOLUTIONARY COMPUTATION & GENETIC ALGORITHMS 9

Evolutionary Computation (EC) – Features of EC – Classification of EC – Advantages – Applications. Genetic Algorithms: Introduction – Biological Background – Operators in GA-GA Algorithm – Classification of GA – Applications

UNIT IV ANT COLONY OPTIMIZATION 9

Ant Colony Optimization: Introduction – From real to artificial ants- Theoretical considerations – Convergence proofs – ACO Algorithm – ACO and model based search – Application principles of ACO.

UNIT V PARTICLE SWARM OPTIMIZATION 9

Particle Swarm Optimization: Introduction – Principles of bird flocking and fish schooling – Evolution of PSO – Operating principles – PSO Algorithm – Neighborhood Topologies – Convergence criteria – Applications of PSO, Honey Bee Social Foraging Algorithms, Bacterial Foraging Optimization Algorithm.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: Ability to design and train neural networks with different rules
CO2: Ability to devise fuzzy logic rules
CO3: Ability to implement genetic algorithms
CO4: Ability to implement ANT colony optimization technique for various problems
CO5: Ability to use PSO technique

REFERENCES:

1. Wolfgang Ertel, "Introduction to Artificial Intelligence", Springer, 2nd Edition, 2017
2. Nello Cristianini, John Shawe-Taylor, "An Introduction to Support Vector Machines and Other Kernel-based Learning Methods",Cambridge University Press. 2013
3. Christopher M. Bishop, "Neural Networks for Pattern Recognition", Oxford University Press, 1995
4. H.-J. Zimmermann, "Fuzzy Set Theory and its Applications", Springer Science+Business Media New York, 4th edition, 2001
5. David E. Goldberg, "Genetic Algorithms in search, Optimization & Machine Learning", Pearson Education, 2006
6. Kenneth A DeJong,"Evolutionary Computation A Unified Approach", Prentice Hall of India, New Delhi, 2006.
7. Marco Dorigo and Thomas Stutzle, "Ant Colony optimization", Prentice Hall of India, New Delhi, 2004.
8. N P Padhy, "Artificial Intelligence and Intelligent Systems", Oxford University Press, 2005.
9. Engelbrecht, A.P., "Fundamentals of Computational Swarm Intelligence", Wiley, 2005.

	PO1	PO2	PO3	PO4	PO5	PO6
CO1			2	2		
CO2			3	2		
CO3	1		3	3		
CO4	1		3	2	1	1
CO5			3	3		

OE5091 BUSINESS DATA ANALYTICS L T P C
3 0 0 3

OBJECTIVES:

- To understand the basics of business analytics and its life cycle.
- To gain knowledge about fundamental business analytics.
- To learn modeling for uncertainty and statistical inference.
- To understand analytics using Hadoop and Map Reduce frameworks.
- To acquire insight on other analytical frameworks.

UNIT I OVERVIEW OF BUSINESS ANALYTICS 9

Introduction – Drivers for Business Analytics – Applications of Business Analytics: Marketing and Sales, Human Resource, Healthcare, Product Design, Service Design, Customer Service and Support – Skills Required for a Business Analyst – Framework for Business Analytics Life Cycle for Business Analytics Process.

Suggested Activities:

- Case studies on applications involving business analytics.
- Converting real time decision making problems into hypothesis.
- Group discussion on entrepreneurial opportunities in Business Analytics.

Suggested Evaluation Methods:

- Assignment on business scenario and business analytical life cycle process.
- Group presentation on big data applications with societal need.
- Quiz on case studies.

UNIT II ESSENTIALS OF BUSINESS ANALYTICS 9

Descriptive Statistics – Using Data – Types of Data – Data Distribution Metrics: Frequency, Mean, Median, Mode, Range, Variance, Standard Deviation, Percentile, Quartile, z-Score, Covariance, Correlation – Data Visualization: Tables, Charts, Line Charts, Bar and Column Chart, Bubble Chart, Heat Map – Data Dashboards.

Suggested Activities:

- Solve numerical problems on basic statistics.
- Explore chart wizard in MS Excel Case using sample real time data for data visualization.
- Use R tool for data visualization.

Suggested Evaluation Methods:

- Assignment on descriptive analytics using benchmark data.
- Quiz on data visualization for univariate, bivariate data.

UNIT III MODELING UNCERTAINTY AND STATISTICAL INFERENCE 9

Modeling Uncertainty: Events and Probabilities – Conditional Probability – Random Variables – Discrete Probability Distributions – Continuous Probability Distribution – Statistical Inference: Data Sampling – Selecting a Sample – Point Estimation – Sampling Distributions – Interval Estimation – Hypothesis Testing.

Suggested Activities:

- Solving numerical problems in sampling, probability, probability distributions and hypothesis testing.
- Converting real time decision making problems into hypothesis.

Suggested Evaluation Methods:

- Assignments on hypothesis testing.
- Group presentation on real time applications involving data sampling and hypothesis testing.
- Quizzes on topics like sampling and probability.

UNIT IV ANALYTICS USING HADOOP AND MAPREDUCE FRAMEWORK 9

Introducing Hadoop – RDBMS versus Hadoop – Hadoop Overview – HDFS (Hadoop Distributed File System) – Processing Data with Hadoop – Introduction to MapReduce – Features of MapReduce – Algorithms Using Map-Reduce: Matrix-Vector Multiplication, Relational Algebra Operations, Grouping and Aggregation – Extensions to MapReduce.

Suggested Activities:

- Practical – Install and configure Hadoop.
- Practical – Use web based tools to monitor Hadoop setup.
- Practical – Design and develop MapReduce tasks for word count, searching involving text corpus etc.

Suggested Evaluation Methods:

- Evaluation of the practical implementations.
- Quizzes on topics like HDFS and extensions to MapReduce.

UNIT V OTHER DATA ANALYTICAL FRAMEWORKS 9

Overview of Application development Languages for Hadoop – PigLatin – Hive – Hive Query Language (HQL) – Introduction to Pentaho, JAQL – Introduction to Apache: Sqoop, Drill and Spark, Cloudera Impala – Introduction to NoSQL Databases – Hbase and MongoDB.

Suggested Activities:

- Practical – Installation of NoSQL database like MongoDB.
- Practical – Demonstration on Sharding in MongoDB.
- Practical – Install and run Pig
- Practical – Write PigLatin scripts to sort, group, join, project, and filter data.
- Design and develop algorithms to be executed in MapReduce involving numerical methods for analytics.

Suggested Evaluation Methods:

- Mini Project (Group) – Real time data collection, saving in NoSQL, implement analytical techniques using Map-Reduce Tasks and Result Projection.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of the course, the student will be able to:

CO1: Identify the real world business problems and model with analytical solutions.

CO2: Solve analytical problem with relevant mathematics background knowledge.

CO3:Convert any real world decision making problem to hypothesis and apply suitable Statistical testing.

CO4:Write and Demonstrate simple applications involving analytics using Hadoop and MapReduce

CO5: Use open source frameworks for modeling and storing data.

CO6: Apply suitable visualization technique using R for visualizing voluminous data.

REFERENCES:

1. Vignesh Prajapati, “Big Data Analytics with R and Hadoop”, Packt Publishing, 2013.
2. Umesh R Hodeghatta, Umesha Nayak, “Business Analytics Using R – A Practical Approach”, Apress, 2017.
3. Anand Rajaraman, Jeffrey David Ullman, “Mining of Massive Datasets”, Cambridge University Press, 2012.
4. Jeffrey D. Camm, James J. Cochran, Michael J. Fry, Jeffrey W. Ohlmann, David R. Anderson, “Essentials of Business Analytics”, Cengage Learning, second Edition, 2016.
5. U. Dinesh Kumar, “Business Analytics: The Science of Data-Driven Decision Making”, Wiley, 2017.
6. A. Ohri, “R for Business Analytics”, Springer, 2012
7. Rui Miguel Forte, “Mastering Predictive Analytics with R”, Packt Publication, 2015.

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	1	2	3	1
CO2	2	1	1	2	1	1
CO3	1	1	2	3	3	1
CO4	2	2	1	2	1	1
CO5	1	1	2	2	1	1
CO6	1	1	1	3	2	1

OE5092 **INDUSTRIAL SAFETY** **LT P C**
3 0 0 3

OBJECTIVES:

- Summarize basics of industrial safety
- Describe fundamentals of maintenance engineering
- Explain wear and corrosion
- Illustrate fault tracing
- Identify preventive and periodic maintenance

UNIT I INTRODUCTION **9**

Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and firefighting, equipment and methods.

UNIT II FUNDAMENTALS OF MAINTENANCE ENGINEERING **9**

Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

UNIT III WEAR AND CORROSION AND THEIR PREVENTION **9**

Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.

UNIT IV FAULT TRACING **9**

Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, I. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.

UNIT V PERIODIC AND PREVENTIVE MAINTENANCE **9**

Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Students will be able to:

CO1: Ability to summarize basics of industrial safety

CO2: Ability to describe fundamentals of maintenance engineering

CO3: Ability to explain wear and corrosion

CO4: Ability to illustrate fault tracing

CO5: Ability to identify preventive and periodic maintenance

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

REFERENCES:

1. Audels, Pump-hydraulic Compressors, Mcgrew Hill Publication, 1978.
2. Garg H P,Maintenance Engineering, S. Chand and Company,1987.
3. Hans F. Winterkorn, Foundation Engineering Handbook, Chapman & Hall London, 2013.
4. Higgins & Morrow, Maintenance Engineering Handbook, Eighth Edition,2008

OE5093 OPERATIONS RESEARCH L T P C

3 0 0 3

OBJECTIVES:

- Solve linear programming problem and solve using graphical method.
- Solve LPP using simplex method
- Solve transportation, assignment problems
- Solve project management problems
- Solve scheduling problems

UNIT I LINEAR PROGRAMMING 9

Introduction to Operations Research – assumptions of linear programming problems - Formulations of linear programming problem – Graphical method

UNIT II ADVANCES IN LINEAR PROGRAMMING 9

Solutions to LPP using simplex algorithm- Revised simplex method - primal dual relationships – Dual simplex algorithm - Sensitivity analysis

UNIT III NETWORK ANALYSIS – I 9

Transportation problems -Northwest corner rule, least cost method, Voges's approximation method - Assignment problem -Hungarian algorithm

UNIT IV NETWORK ANALYSIS – II 9

Shortest path problem: Dijkstra's algorithms, Floyds algorithm, systematic method -CPM/PERT

UNIT V NETWORK ANALYSIS – III 9

Scheduling and sequencing - single server and multiple server models - deterministic inventory models - Probabilistic inventory control models

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Students will be able to:

CO1: To formulate linear programming problem and solve using graphical method.

CO2: To solve LPP using simplex method

CO3: To formulate and solve transportation, assignment problems

CO4: To solve project management problems

CO5: To solve scheduling problems

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

REFERENCES:

1. Harvey M Wagner, Principles of Operations Research: Prentice Hall of India 2010
2. Hitler Libermann, Operations Research: McGraw Hill Pub. 2009
3. Pant J C, Introduction to Optimisation: Operations Research, Jain Brothers, Delhi, 2008
4. Pannerselvam, Operations Research: Prentice Hall of India 2010
5. Taha H A, Operations Research, An Introduction, PHI, 2008

OE5094 COST MANAGEMENT OF ENGINEERING PROJECTS L T P C
3 0 0 3

OBJECTIVES:

- Summarize the costing concepts and their role in decision making
- Infer the project management concepts and their various aspects in selection
- Interpret costing concepts with project execution
- Develop knowledge of costing techniques in service sector and various budgetary control techniques
- Illustrate with quantitative techniques in cost management

UNIT I INTRODUCTION TO COSTING CONCEPTS 9

Objectives of a Costing System; Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost; Creation of a Database for operational control.

UNIT II INTRODUCTION TO PROJECT MANAGEMENT 9

Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and nontechnical activities, Detailed Engineering activities, Pre project execution main clearances and documents, Project team: Role of each member,Importance Project site: Data required with significance, Project contracts.

UNIT III PROJECT EXECUTION AND COSTING CONCEPTS 9

Project execution Project cost control, Bar charts and Network diagram, Project commissioning: mechanical and process, Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis, Various decision-making problems, Pricing strategies: Pareto Analysis, Target costing, Life Cycle Costing.

UNIT IV COSTING OF SERVICE SECTOR AND BUDGETERY CONTROL 9

Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis, Budgetary Control: Flexible Budgets; Performance budgets; Zero-based budgets.

UNIT V QUANTITATIVE TECHNIQUES FOR COST MANAGEMENT 9

Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Learning Curve Theory.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Students will be able to:

CO1 – Understand the costing concepts and their role in decision making

CO2–Understand the project management concepts and their various aspects in selection

CO3–Interpret costing concepts with project execution

CO4–Gain knowledge of costing techniques in service sector and various budgetary control techniques

CO5 - Become familiar with quantitative techniques in cost management

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

REFERENCES:

1.Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher, 1991

2. Charles T. Horngren and George Foster, Advanced Management Accounting, 1988

3. Charles T. Horngren et al Cost Accounting A Managerial Emphasis, Prentice Hall of India, New Delhi, 2011

4. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting, 2003

5. Vohra N.D., Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd, 2007

OE5095 COMPOSITE MATERIALS L T P C

3 0 0 3

OBJECTIVES:

- Summarize the characteristics of composite materials and effect of reinforcement in composite materials.
- Identify the various reinforcements used in composite materials.
- Compare the manufacturing process of metal matrix composites.
- Understand the manufacturing processes of polymer matrix composites.
- Analyze the strength of composite materials.

UNIT I INTRODUCTION 9

Definition – Classification and characteristics of Composite materials - Advantages and application of composites - Functional requirements of reinforcement and matrix - Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance.

UNIT II REINFORCEMENTS 9

Preparation-layup, curing, properties and applications of glass fibers, carbon fibers, Kevlar fibers and Boron fibers - Properties and applications of whiskers, particle reinforcements - Mechanical Behavior of composites: Rule of mixtures, Inverse rule of mixtures - Isostrain and Isostress conditions.

UNIT III MANUFACTURING OF METAL MATRIX COMPOSITES 9

Casting – Solid State diffusion technique - Cladding – Hot isostatic pressing - Properties and applications. Manufacturing of Ceramic Matrix Composites: Liquid Metal Infiltration – Liquid phase sintering. Manufacturing of Carbon – Carbon composites: Knitting, Braiding, Weaving - Properties and applications.

UNIT IV MANUFACTURING OF POLYMER MATRIX COMPOSITES 9

Preparation of Moulding compounds and prepregs – hand layup method – Autoclave method – Filament winding method – Compression moulding – Reaction injection moulding - Properties and applications.

UNIT V STRENGTH 9

Laminar Failure Criteria-strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hygrothermal failure. Laminate first play failure-insight strength; Laminate strength-ply discount truncated maximum strain criterion; strength design using caplet plots; stress concentrations.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Students will be able to:

- CO1 - Know the characteristics of composite materials and effect of reinforcement in composite materials.
- CO2 – Know the various reinforcements used in composite materials.
- CO3 – Understand the manufacturing processes of metal matrix composites.
- CO4 – Understand the manufacturing processes of polymer matrix composites.
- CO5 – Analyze the strength of composite materials.

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

REFERENCES:

1. Cahn R.W. - Material Science and Technology – Vol 13 – Composites, VCH, West Germany.
2. Callister, W.D Jr., Adapted by Balasubramaniam R, Materials Science and Engineering, An introduction, John Wiley & Sons, NY, Indian edition, 2007.
3. Chawla K.K., Composite Materials, 2013.
4. Lubin.G, Hand Book of Composite Materials, 2013.

OE5096 **WASTE TO ENERGY** **L T P C**
3 0 0 3

OBJECTIVES:

- Interpret the various types of wastes from which energy can be generated
- Develop knowledge on biomass pyrolysis process and its applications
- Develop knowledge on various types of biomass gasifiers and their operations
- Invent knowledge on biomass combustors and its applications on generating energy
- Summarize the principles of bio-energy systems and their features

UNIT I INTRODUCTION TO EXTRACTION OF ENERGY FROM WASTE 9

Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors

UNIT II BIOMASS PYROLYSIS 9

Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods - Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.

UNIT III BIOMASS GASIFICATION 9

Gasifiers – Fixed bed system – Downdraft and updraft gasifiers – Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.

UNIT IV BIOMASS COMBUSTION 9

Biomass stoves – Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.

UNIT V BIO ENERGY 9

Properties of biogas (Calorific value and composition), Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion - Types of biogas Plants – Applications - Alcohol production from biomass - Bio diesel production - Urban waste to energy conversion - Biomass energy programme in India.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Students will be able to:

CO1 – Understand the various types of wastes from which energy can be generated
CO2 – Gain knowledge on biomass pyrolysis process and its applications
CO3 – Develop knowledge on various types of biomass gasifiers and their operations
CO4 – Gain knowledge on biomass combustors and its applications on generating energy
CO5 – Understand the principles of bio-energy systems and their features

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

REFERENCES:

1. Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.
2. Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996.
3. Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991.
4. Non Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.

AUDIT COURSES (AC)

AX5091 ENGLISH FOR RESEARCH PAPER WRITING L T P C
2 0 0 0

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 VERIFICATION SKILLS 6

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

TOTAL: 30 PERIODS

COURSE OUTCOMES

CO1 –Understand that how to improve your writing skills and level of readability
CO2 – Learn about what to write in each section
CO3 – Understand the skills needed when writing a Title
CO4 – Understand the skills needed when writing the Conclusion
CO5 – Ensure the good quality of paper at very first-time submission

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

REFERENCES

1. Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011
2. Day R How to Write and Publish a Scientific Paper, Cambridge University Press 2006
3. Goldbort R Writing for Science, Yale University Press (available on Google Books) 2006
4. Highman N, Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book 1998.

AX5092 DISASTER MANAGEMENT L T P C
2 0 0 0

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, People's Participation in Risk Assessment. Strategies for Survival

TOTAL : 30 PERIODS

COURSE OUTCOMES

CO1: Ability to summarize basics of disaster
CO2: Ability to explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
CO3: Ability to illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
CO4: Ability to describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
CO5: Ability to develop the strengths and weaknesses of disaster management approaches

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

REFERENCES

1. Goel S. L., Disaster Administration And Management Text And Case Studies",Deep & Deep Publication Pvt. Ltd., New Delhi,2009.
2. NishithaRai, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'NewRoyal book Company,2007.
3. Sahni, PardeepEt.Al. ," Disaster Mitigation Experiences And Reflections", Prentice Hall OfIndia, New Delhi,2001.

AX5093 SANSKRIT FOR TECHNICAL KNOWLEDGE L T P C
2 0 0 0

OBJECTIVES

- Illustrate the basic sanskrit language.
- Recognize sanskrit, the scientific language in the world.
- Appraise learning of sanskrit to improve brain functioning.
- Relate sanskrit to develop the logic in mathematics, science & other subjects enhancing the memory power.
- Extract huge knowledge from ancient literature.

UNIT I ALPHABETS **6**

Alphabets in Sanskrit

UNIT II TENSES AND SENTENCES **6**

Past/Present/Future Tense - Simple Sentences

UNIT III ORDER AND ROOTS **6**

Order - Introduction of roots

UNIT IV SANSKRIT LITERATURE **6**

Technical information about Sanskrit Literature

UNIT V TECHNICAL CONCEPTS OF ENGINEERING **6**

Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics

TOTAL: 30 PERIODS

COURSE OUTCOMES

- CO1 - Understanding basic Sanskrit language.
- CO2 - Write sentences.
- CO3 - Know the order and roots of Sanskrit.
- CO4 - Know about technical information about Sanskrit literature.
- CO5 - Understand the technical concepts of Engineering.

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

REFERENCES

1. "Abhyaspustakam" – Dr. Vishwas, Samskrita-Bharti Publication, New Delhi
2. "Teach Yourself Sanskrit" Prathama Deeksha-Vempati Kutumbshastri, Rashtriya Sanskrit Sansthanam, New Delhi Publication
3. "India's Glorious Scientific Tradition" Suresh Soni, Ocean books (P) Ltd., New Delhi, 2017.

AX5094 **VALUE EDUCATION** **L T P C**
2 0 0 0

OBJECTIVES

Students will be able to

- Understand value of education and self-development
- Imbibe good values in students
- Let the should know about the importance of character

UNIT I

Values and self-development–Social values and individual attitudes. Work ethics, Indian vision of humanism. Moral and non-moral valuation. Standards and principles. Value judgements

UNIT II

Importance of cultivation of values. Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truthfulness, Cleanliness. Honesty, Humanity. Power of faith, National Unity. Patriotism. Love for nature, Discipline

UNIT III

Personality and Behavior Development-Soul and Scientific attitude. Positive Thinking. Integrity and discipline. Punctuality, Love and Kindness. Avoid fault Thinking. Free from anger, Dignity of labour.

Universal brother hood and religious tolerance. True friendship. Happiness Vs suffering, love for truth. Aware of self-destructive habits. Association and Cooperation. Doing best for saving nature

UNIT IV

Character and Competence–Holy books vs Blind faith. Self-management and Good health. Science of reincarnation. Equality, Nonviolence, Humility, Role of Women. All religions and same message. Mind your Mind, Self-control. Honesty, Studying effectively.

TOTAL: 30 PERIODS

COURSE OUTCOMES

Students will be able to

- Knowledge of self-development.
- Learn the importance of Human values.
- Developing the overall personality.

SUGGESTED READING

1. Chakroborty, S.K."Values and Ethics for organizations Theory and practice", Oxford University Press, New Delhi

AX5095 CONSTITUTION OF INDIA L T P C
2 0 0 0

OBJECTIVES

Students will be able to:

- Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
- To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional
- Role and entitlement to civil and economic rights as well as the emergence nation hood in the early years of Indian nationalism.
- To address the role of socialism in India after the commencement of the Bolshevik Revolutionin1917and its impact on the initial drafting of the Indian Constitution.

UNIT I HISTORY OF MAKING OF THE INDIAN CONSTITUTION

History, Drafting Committee, (Composition & Working)

UNIT II PHILOSOPHY OF THE INDIAN CONSTITUTION

Preamble, Salient Features

UNIT III CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES

Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

UNIT IV ORGANS OF GOVERNANCE

Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions.

UNIT V LOCAL ADMINISTRATION

District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO, Municipal Corporation. Pachayati raj: Introduction, PRI: Zila Pachayat. Elected officials and their roles, CEO Zila Pachayat: Position and role. Block level: Organizational Hierarchy(Different departments), Village level:Role of Elected and Appointed officials, Importance of grass root democracy.

UNIT VI ELECTION COMMISSION

Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners - Institute and Bodies for the welfare of SC/ST/OBC and women.

TOTAL: 30 PERIODS

COURSE OUTCOMES

Students will be able to:

- Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
- Discuss the intellectual origins of the framework of argument that informed the conceptualization
- of social reforms leading to revolution in India.
- Discuss the circumstances surrounding the foundation of the Congress Socialist Party[CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
- Discuss the passage of the Hindu Code Bill of 1956.

SUGGESTED READING

1. The Constitution of India,1950(Bare Act),Government Publication.
2. Dr.S.N.Busi, Dr.B. R.Ambedkar framing of Indian Constitution,1st Edition, 2015.
3. M.P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis,2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

AX5096 PEDAGOGY STUDIES L T P C
2 0 0 0

OBJECTIVES

Students will be able to:

- Review existing evidence on there view topic to inform programme design and policy
- Making under taken by the DfID, other agencies and researchers.
- Identify critical evidence gaps to guide the development.

UNIT I INTRODUCTION AND METHODOLOGY:

Aims and rationale, Policy background, Conceptual framework and terminology - Theories of learning, Curriculum, Teacher education - Conceptual framework, Research questions **-** Overview of methodology and Searching.

UNIT II INTRODUCTION AND METHODOLOGY:

Aims and rationale, Policy background, Conceptual framework and terminology - Theories of learning, Curriculum, Teacher education - Conceptual framework, Research questions **-** Overview of methodology and Searching.

UNIT III THEMATIC OVERVIEW

Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries - Curriculum, Teacher education.

UNIT IV EVIDENCE ON THE EFFECTIVENESS OF PEDAGOGICAL PRACTICES

Methodology for the in depth stage: quality assessment of included studies - How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy? - Theory of change - Strength and nature of the body of evidence for effective pedagogical practices - Pedagogic theory and pedagogical approaches - Teachers' attitudes and beliefs and Pedagogic strategies.

UNIT V PROFESSIONAL DEVELOPMENT

Professional development: alignment with classroom practices and follow up support - Peer support - Support from the head teacher and the community - Curriculum and assessment - Barriers to learning: limited resources and large class sizes

UNIT VI RESEARCH GAPS AND FUTURE DIRECTIONS

Research design – Contexts – Pedagogy - Teacher education - Curriculum and assessment - Dissemination and research impact.

TOTAL: 30 PERIODS

COURSE OUTCOMES

Students will be able to understand:

- What pedagogical practices are being used by teachers informal and informal classrooms in developing countries?
- What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?
- How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?

SUGGESTED READING

1. Ackers J, HardmanF (2001) Classroom interaction in Kenyan primary schools, Compare, 31(2): 245-261.
2. Agrawal M (2004)Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36(3):361-379.
3. Akyeampong K (2003) Teacher training in Ghana-does it count? Multi-site teacher education research project (MUSTER) country report 1.London:DFID.
4. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33(3): 272–282.
5. Alexander RJ(2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.
6. Chavan M(2003) Read India: Amass scale, rapid, 'learning to read' campaign.
7. www.pratham.org/images/resource%20working%20paper%202.pdf

AX5097 STRESS MANAGEMENT BY YOGA L T P C
2 0 0 0

OBJECTIVES

- To achieve overall health of body and mind
- To overcome stress

UNIT I

Definitions of Eight parts of yoga.(Ashtanga)

UNIT II

Yam and Niyam - Do`s and Don't's in life - i) Ahinsa, satya, astheya, bramhacharya and aparigraha, ii) Ahinsa, satya, astheya, bramhacharya and aparigraha.

UNIT III

Asan and Pranayam - Various yog poses and their benefits for mind & body - Regularization of breathing techniques and its effects-Types of pranayam

TOTAL: 30 PERIODS

COURSE OUTCOMES

Students will be able to:

- Develop healthy mind in a healthy body thus improving social health also
- Improve efficiency

SUGGESTED READING

1. 'Yogic Asanas for Group Tarining-Part-I":Janardan Swami Yoga bhyasi Mandal, Nagpur
2. "Rajayoga or conquering the Internal Nature" by Swami Vivekananda, Advaita Ashrama (Publication Department), Kolkata

AX5098	PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS	L T P C 2 0 0 0

OBJECTIVES

- To learn to achieve the highest goal happily
- To become a person with stable mind, pleasing personality and determination
- To awaken wisdom in students

UNIT I

Neetisatakam-holistic development of personality - Verses- 19,20,21,22 (wisdom) - Verses-29,31,32 (pride & heroism) – Verses- 26,28,63,65 (virtue) - Verses- 52,53,59 (dont's) - Verses-71,73,75,78 (do's)

UNIT II

Approach to day to day work and duties - Shrimad Bhagwad Geeta: Chapter 2-Verses 41, 47,48 - Chapter 3-Verses 13, 21, 27, 35 Chapter 6-Verses 5,13,17,23, 35 - Chapter 18-Verses 45, 46, 48.

UNIT III

Statements of basic knowledge - Shrimad Bhagwad Geeta: Chapter2-Verses 56, 62, 68 Chapter 12 -Verses 13, 14, 15, 16,17, 18 - Personality of role model - shrimad bhagwad geeta - Chapter2-Verses 17, Chapter 3-Verses 36,37,42 - Chapter 4-Verses 18, 38,39 Chapter18 – Verses 37,38,63

TOTAL: 30 PERIODS

OUTCOMES

Students will be able to

- Study of Shrimad-Bhagwad-Geeta will help the student in developing his personality and achieve the highest goal in life
- The person who has studied Geeta will lead the nation and mankind to peace and prosperity
- Study of Neet is hatakam will help in developing versatile personality of students.

SUGGESTED READING

1. Gopinath, Rashtriya Sanskrit Sansthanam P, Bhartrihari's Three Satakam, Niti-sringar-vairagya, New Delhi,2010
2. Swami Swarupananda , Srimad Bhagavad Gita, Advaita Ashram, Publication Department, Kolkata, 2016.