EXCEL ENGINEERING COLLEGE
(Autonomous)
Approved by AICTE, New Delhi & Affiliated to Anna University, ChennaiAccredited by NBA, NAAC with "A+" and Recognised by UGC (2f &12B)KOMARAPALAYAM – 637303

DEPARTMENT OF ELECTRONICS COMMUNICATION ENGINEERING
M.E – APPLIED ELECTRONICS
REGULATION – 2022
CHOICE BASED CREDIT SYSTEM
I TO IV SEMESTER CURRICULUM

I – SEMESTER									
Code No.	**Course**	**Category**	**Periods / Week**			**C**	**Maximum Marks**		
			L	**T**	**P**		**CA**	**FE**	**Total**
Theory Course(s)									
22PMA104	Applied Mathematics for Electronics Engineers	FC	3	2	0	4	40	60	100
22PAE101	Advanced Digital System Design	PC	3	0	0	3	40	60	100
22PAE102	Advanced Digital Signal Processing	PC	3	2	0	4	40	60	100
22PAE103	ASIC and FPGA Design	PC	3	0	0	3	40	60	100
22PEAXXX	Professional Elective I	PE	3	0	0	3	40	60	100
22PEAXXX	Professional Elective II	PE	3	0	0	3	40	60	100
Practical Course									
22PAE105	Electronic System Design Laboratory	PC	0	0	4	2	50	50	100
Total			**21**	**4**	**4**	**22**	**290**	**410**	**700**

II- SEMESTER									
Code No.	**Course**	**Category**	**Periods / Week**			**C**	**Maximum Marks**		
			L	**T**	**P**		**CA**	**FE**	**Total**
Theory Course(s)									
22PAE201	Advanced Image and VideoProcessing	PC	3	2	0	4	40	60	100
22PAE202	Soft Computing and Optimization Techniques	PC	3	0	0	3	40	60	100
22PAE203	Low Power VLSI	PC	3	0	0	3	40	60	100
22PAE204	Advanced Microprocessors and Microcontrollers Architectures	PC	3	0	0	3	40	60	100
22PEAXXX	Professional Elective-III	PE	3	0	0	3	40	60	100
22PEAXXX	Professional Elective-IV	PE	3	0	0	3	40	60	100
Employability Enhancement Courses									
22PAE205	Term Paper Writing and Seminar	EEC	0	0	4	2	50	50	100
		Total	**18**	**2**	**4**	**21**	**290**	**410**	**700**

III – SEMESTER									
Code No.	**Course**	**Category**	**Periods / Week**			**C**	**Maximum Marks**		
			L	**T**	**P**		**CA**	**FE**	**Total**
Theory Course(s)									
22PEE301	Research Methodology and Intellectual Property Rights	PC	3	0	0	3	40	60	100
22PEAXXX	Professional Elective V	PE	3	0	0	3	40	60	100
22PEAXXX	Professional Elective VI	PE	3	0	0	3	40	60	100
Employability Enhancement Courses									
22PAE301	Project Work Phase- I	EEC	0	0	12	6	50	50	100
TOTAL			**9**	**0**	**12**	**15**	**170**	**230**	**400**

IV- SEMESTER									
Code No.	**Course**	**Category**	**Periods / Week**			**C**	**Maximum Marks**		
			L	**T**	**P**		**CA**	**FE**	**Total**
Employability Enhancement Courses									
22PAE401	Project Work Phase -II	EEC	0	0	24	12	50	50	100
		Total	**0**	**0**	**24**	**12**	**50**	**50**	**100**

TOTAL CREDITS TO BE EARNED FOR THE AWARD OF THE DEGREE = 70

CREDITS SUMMARY

S. No	Category	CREDITS PER SEMESTER				Total Credit (AICTE)	Credits in %
		I	II	III	IV		
1	FC	4				4	6
2	PC	12	13	3		28	42
3	PE	6	6	6		18	26
4	EEC		2	6	12	20	26
Total		22	21	15	12	70	100

FC - Foundation Course
PC - Professional Core
PE - Professional Electives
EEC - Employability Enhancement Courses
MC - Mandatory Courses (Non-Credit Courses)
CA - Continuous Assessment
FE - Final Examination

LIST OF PROFESSIONALELECTIVES									
Code No.	**Course**	**Category**	**Periods / Week**			**C**	**Maximum Marks**		
			L	**T**	**P**		**CA**	**FE**	**Total**
Theory Course(s)									
Semester I- Elective I									
22PEA001	Digital Control Engineering	PE	3	0	0	3	40	60	100
22PEA002	Computer Architecture and Parallel Processing	PE	3	0	0	3	40	60	100
22PEA003	CAD for VLSI Circuits	PE	3	0	0	3	40	60	100
22PEA004	Electromagnetic Interference and Compatibility	PE	3	0	0	3	40	60	100
22PEA005	Embedded & Real Time Systems	PE	3	0	0	3	40	60	100
Semester I- Elective II									
22PEA006	VLSI Design Techniques	PE	3	0	0	3	40	60	100
22PEA007	Nano Electronics	PE	3	0	0	3	40	60	100
22PEA008	Wireless Adhoc and Sensor Networks	PE	3	0	0	3	40	60	100
22PEA009	High Performance Networks	PE	3	0	0	3	40	60	100
Semester II- Elective III									
22PEA010	DSP Processor Architecture and Programming	PE	3	0	0	3	40	60	100
22PEA011	RF System Design	PE	3	0	0	3	40	60	100
22PEA012	Speech and Audio Signal Processing	PE	3	0	0	3	40	60	100
22PEA013	Internet of Things	PE	3	0	0	3	40	60	100
Semester II- Elective IV									
22PEA014	Solid State Device Modeling and Simulation	PE	3	0	0	3	40	60	100
22PEA015	System on Chip Design	PE	3	0	0	3	40	60	100
22PEA016	Robotics	PE	3	0	0	3	40	60	100
22PEA017	Physical Design of VLSI Circuits	PE	3	0	0	3	40	60	100

Semester III- Elective V									
22PEA018	Signal Integrity for High Speed Design	PE	3	0	0	3	40	60	100
22PEA019	MEMS and NEMS	PE	3	0	0	3	40	60	100
22PEA020	Secure Computing Systems	PE	3	0	0	3	40	60	100
22PEA021	Pattern Recognition	PE	3	0	0	3	40	60	100
Semester III- Elective VI									
22PEA022	RF IC Design	PE	3	0	0	3	40	60	100
22PEA023	Nano Scale Devices	PE	3	0	0	3	40	60	100
22PEA024	Three Dimensional Network on Chip	PE	3	0	0	3	40	60	100
22PEA025	Wavelets and Signal Processing	PE	3	0	0	3	40	60	100

List of special Electives									
Code No.	**Course**	**Category**	**Periods / Week**			**C**	**Maximum Marks**		
			L	**T**	**P**		**CA**	**FE**	**Total**
Theory Course(s)									
Special Elective									
22SEA025	Human Computer Interaction	PE	3	0	0	3	40	60	100
22SEA026	Deep Learning Techniques	PE	3	0	0	3	40	60	100
22SEA027	Image Processing Applications	PE	3	0	0	3	40	60	100

I SEMESTER

22PMA104	APPLIED MATHEMATICS FOR ELECTRONICS ENGINEERS	L	T	P	C
		3	2	0	4
Nature of Course	Foundation Course				
Pre requisites	NIL				

Course Objectives

The course is intended to

1. Demonstrate various analytical skills in applied mathematics
2. Understand the basic concepts in , matrix theory
3. Study performance of probability and random variables.
4. Study the mathematical areas of dynamic programming
5. Study the mathematical areas queuing theory

Course Outcomes

On successful completion of the course, students will be able to

CO.No.	Course Outcome	Bloom's Level
CO1	Select the concept of fuzzy sets, knowledge representation using fuzzy rules.	Analyzing
CO2	Sketch the various methods in matrix theory to solve system of linear equations	Apply
CO3	Associate the Computation of probability and moments with standard distributions.	Understand
CO4	Infer the Mathematical areas in Dynamic Programming	Understand
CO5	Estimating the basic characteristic features of a queuing system and acquire skills in analyzing queuing models	Understand

Course Contents:

UNIT I FUZZY LOGIC **12**

Classical logic – Multivalued logics – Fuzzy propositions – Fuzzy quantifiers.

UNIT II MATRIX THEORY **12**

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

UNIT III PROBABILITY AND RANDOM VARIABLES **12**

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

UNIT IV DYNAMIC PROGRAMMING **12**

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

UNIT V QUEUEING MODELS **12**

Poisson Process – Markovian queues – Single and multi server models – Little‟s formula - Machineinterference model – Steady state analysis – Self service queue.

TOTAL: 60 PERIODS

REFERENCES:

1. Bronson, R., "Matrix Operations", Schaum's Outline Series, McGraw Hill, 2011.
2. George, J. Klir. and Yuan, B., "Fuzzy sets and Fuzzy logic, Theory and Applications", Prentice Hall of India Pvt. Ltd., 1997.
3. Gross, D., Shortle J. F., Thompson, J.M., and Harris, C. M., "Fundamentals of Queuing Theory", 4th Edition, John Wiley, 2014.
4. Johnson, R.A., Miller, I and Freund J., "Miller and Freund"s Probability and Statistics for Engineers", Pearson Education, Asia, 8th Edition, 2015.
5. Taha, H.A., "Operations Research: An Introduction", 9th Edition, Pearson Education, Asia, New Delhi, 2016.

Mapping of Course Outcomes (COs) with Program Outcomes (POs) Program Specific Outcomes (PSOs)															
COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	3	2										3	2	3
CO2	3	3	2										3	2	3
CO3	3	3	2										3	2	3
CO4	3	3	2										3	2	3
CO5	3	3	2										3	2	3
	3	High				2	Medium					1	Low		

Formative assessment			
Bloom's Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Classroom or Online Quiz	5	15
Understand	Class Presentation/Power point presentation	5	
	Attendance	5	

Summative Assessment				
Bloom's Category	**Continuous Assessment Tests**			**Terminal Examination (60)**
	1 (7.5)	**2 (7.5)**	**3 (10)**	
Remember	10	10	10	20
Understand	10	10	10	20
Apply	0	0	0	0
Analyse	30	30	30	60
Evaluate	0	0	0	0
Create	0	0	0	0

22PAE101	ADVANCED DIGITAL SYSTEM DESIGN	L	T	P	C
		3	0	0	3
Nature of Course	Professional Core				
Pre requisites	Fundamental of Digital System Circuits				

Course Objectives

The course is intended

1. To introduce methods to analyze and design synchronous
2. To introduce methods to analyze and design asynchronous sequential circuits.
3. To Find the fault diagnosis and testability algorithms.
4. To introduce the architectures of programmable devices.
5. To introduce design and implementation of digital circuits using programming tools.

Course Outcomes

On successful completion of the course, students will be able to

CO.No.	Course Outcome	Bloom's Level
CO1	Analyze and design sequential synchronous circuits.	Analyzing
CO2	Analyze and design sequential Asynchronous circuits.	Analyzing
CO3	Design and use fault diagnosis and testability algorithms	Understand
CO4	Identify the requirements and specifications of the system required for a given application	Understand
CO5	Classify the use programming tools for implementing digital circuits of industry standards	Understand

Course Contents:

UNIT I SEQUENTIAL CIRCUIT DESIGN **9**

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

UNIT II ASYNCHRONOUS SEQUENTIAL CIRCUIT DESIGN **9**

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

UNIT III FAULT DIAGNOSIS AND TESTABILITY ALGORITHMS **9**

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

UNIT IV SYNCHRONOUS DESIGN USING PROGRAMMABLE DEVICES **9**

Programming logic device families – Designing a synchronous sequential circuit using PLA/PAL –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 Modeling inVerilog HDL - Behavioral Descriptions in Verilog HDL – HDL Based Synthesis – Synthesis of FiniteState Machines– structural modeling – compilation and simulation of Verilog code –Test bench - Realization of combinational and sequential circuits using Verilog – Registers – counters – sequential machine – serial adder – Multiplier- Divider – Design of simple microprocessor. **TOTAL: 45 PERIODS**

REFERENCES:

1.Charles Hurth 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 “Dig.ital system Design using PLD” B S Publications,2003
6.Parag K.Lala “Fault Tolerant and Fault Testable Hardware Design” B S Publications,2002
7.S. Palnitkar , Verilog HDL – A Guide to Digital Design and Synthesis, Pearson , 2003.

Mapping of Course Outcomes (COs) with Program Outcomes (POs) Program Specific Outcomes (PSOs)															
COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	2										3	2	3
CO2	3	2	2										3	2	3
CO3	3	2	2										3	2	3
CO4	3	2	2										3	2	3
CO5	3	2	2										3	2	3
	3	High				2	Medium					1	Low		

Formative assessment			
Bloom’s Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Classroom or Online Quiz	5	15
Understand	Class Presentation/Power point presentation	5	
	Attendance	5	

Summative Assessment				
Bloom’s Category	**Continuous Assessment Tests**			**Terminal Examination (60)**
	1 (7.5)	**2 (7.5)**	**3 (10)**	
Remember	10	10	10	20
Understand	10	10	10	20
Apply	0	0	0	0
Analyse	30	30	30	60
Evaluate	0	0	0	0
Create	0	0	0	0

22PAE102	ADVANCED DIGITAL SIGNAL PROCESSING	L	T	P	C
		3	2	0	4
Nature of Course	Professional Core				
Pre requisites	Design for digital Signal Processing				

Course Objectives

The course is intended

1. To develop the mathematical description and modeling of discrete time random signals.
2. To apply the conversant with important theorems and random signal processing algorithms.
3. To apply Wiener filtering and Linear filtering.
4. To learns relevant figures of merit such as power, energy, bias and consistency.
5. To familiar with estimation, prediction, filtering, MultiMate concepts and techniques.

Course Outcomes

On successful completion of the course, students will be able to

CO.No.	Course Outcome	Bloom's Level
CO1	Apply the time domain and frequency domain description of Wide Sense Stationary process in terms of matrix algebra and relate to linear algebra concepts.	Apply
CO2	Sketch the W-K theorem, spectral factorization theorem, spectrum estimation, bias and consistency of estimators.	Apply
CO3	Explain the Linear Filtering and Wiener filtering.	Understand
CO4	Estimate LMS algorithms, Levinson recursion algorithm, applications of adaptive filters	Understand
CO5	Relate Decimation, interpolation, Sampling rate conversion, Applications of multirate signal processing	Understand

Course Contents:

UNITIDISCRETERANDOMSIGNALPROCESSING 12

Discrete random processes – Ensemble averages – Wide sense stationary process – Properties - Ergodic process — Sample mean & variance - Auto-correlation and Auto-correlation matricesProperties – White noise process – Weiner Khitchine relation - Power spectral density – Filtering random process – Spectral Factorization Theorem – Special types of Random Processes – ARMA, ARMA Processes – Yule-Walker equations.

UNIT II SPECTRUM ESTIMATION 12

Bias and Consistency of estimators - Non-Parametric methods – Periodogram – Modified Periodogram – Barlett‟s method – Welch‟s mehod – Blackman-Tukey method – Parametric methods – AR, MA and ARMA spectrum estimation - Performance analysis of estimators.

UNIT III SIGNAL MODELING AND OPTIMUM FILTERS 12

Introduction- Least square method – Pade approximation – Prony‟s method – Levinson Recursion – Lattice filter - FIR Wiener filter – Filtering – Linear Prediction – Non Causal and Causal IIR WeinerFilter -– Mean square error – Discrete Kalman filter.

UNIT IV ADAPTIVE FILTERS 12

FIR Adaptive filters - Newton's steepest descent method – Widrow Hoff LMS Adaptive algorithm – Convergence – Normalized LMS – Applications – Noise cancellation - channel equalization –

echo canceller – Adaptive Recursive Filters - RLS adaptive algorithm – Exponentially weighted RLSsliding window RLS.

UNIT V MULTIRATE SIGNAL PROCESSING **12**

Decimation - Interpolation – Sampling Rate conversion by a rational factor I/D – Multistage implementation of sampling rate conversion – Polyphase filter structures – Applications of multiratesignal processing.

TOTAL: 60 PERIODS

REFERENCES:

1. John G. Proakis, Dimitris G. Manolakis, “Digital Signal Processing”, Prentice Hall of a. India, New Delhi, 2005.
2. Monson H. Hayes, “Statistical Digital Signal Processing and Modeling”, John Wiley and Sons Inc., New York, 2006.
3. P. P. Vaidyanathan, “Multirate Systems and Filter Banks”, Prentice Hall, 1992.
4. S. Kay,” Modern spectrum Estimation theory and application”, Prentice Hall, Englehood a. Cliffs, NJ1988.
5. Simon Haykin, “Adaptive Filter Theory”, a. Prentice Hall, Englehood Cliffs, NJ1986.
6. Sophoncles J. Orfanidis, “Optimum Signal Processing “, McGraw a. -Hill, 2000.

Mapping of Course Outcomes (COs) with Program Outcomes (POs) Program Specific Outcomes (PSOs)

COs	POs												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	2										3	2	3
CO2	3	2	2										3	2	3
CO3	3	2	2										3	2	3
CO4	3	2	2										3	2	3
CO5	3	2	2										3	2	3
	3	High				2	Medium					1	Low		

Formative assessment			
Bloom’s Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Classroom or Online Quiz	5	15
Understand	Class Presentation/Power point presentation	5	
	Attendance	5	

Summative Assessment				
Bloom’s Category	**Continuous Assessment Tests**			**Terminal Examination**
	1 (7.5)	**2 (7.5)**	**3 (10)**	**(60)**
Remember	10	10	10	20
Understand	10	10	10	20
Apply	30	30	30	60
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

22PAE103	ASIC and FPGA DESIGN	L	T	P	C
		3	0	0	3
Nature of Course	Professional Core				
Pre requisites	Fundamental of VLSI				

Course objectives:

1. To study the design flow of different types of ASIC.
2. To familiarize the different types of programming technologies and logic devices.
3. To learn the architecture of different types of FPGA.
4. To gain knowledge about partitioning, floor planning, placement and routing including circuit extraction of ASIC.
5. To gain knowledge in issues of SOC.

Course Outcomes

On successful completion of the course, students will be able to

CO.No.	Course Outcome	Bloom's Level
CO1	Analyze the synthesis, Simulation and testing of systems.	Analyze
CO2	Apply different high performance algorithms in ASICs	Apply
CO3	Design Logic Synthesis and testing.	Create
CO4	Analyze the FPGA tools and Routing	Analyze
CO5	Discuss the design issues of SOC.	Understand

Course Contents:

UNIT I OVERVIEW OF ASIC AND PLD **9**

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

UNIT II ASIC PHYSICAL DESIG **9**

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

UNIT III LOGIC SYNTHESIS, SIMULATION AND TESTING **9**

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

UNIT IV FIELD PROGRAMMABLE GATE ARRAYS **9**

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

UNIT V SOC DESIGN **9**

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

TOTAL: 45 PERIODS

REFERENCES:

1.David A.Hodges, Analysis and Design of Digital Integrated Circuits (3/e), MGH 2004
2H.Gerez, Algorithms for VLSI Design Automation, John Wiley, 1999
3.Jan. M. Rabaey et al, Digital Integrated Circuit Design Perspective (2/e), PHI 2003
4.M.J.S. Smith : Application Specific Integrated Circuits, Pearson, 2003
5.J. Old Field, R.Dorf, Field Programmable Gate Arrays, John Wiley& Sons, New york.
6.P.K.Chan& S. Mourad, Digital Design using Field Programmable Gate Array, Prentice Hall.
7.Sudeep Pasricha and NikilDutt, On-Chip Communication Architectures System on Chip Interconnect, Elsevier, 2008
8.S.Trimberger, Edr., Field Programmable Gate Array Technology, Kluwer Academic Pub.
9.S.Brown,R.Francis, J.Rose, Z.Vransic, Field Programmable Gate Array, Kluwer Pub. .Richard FJinder , "Engineering Digital Design,"Academic press.

Mapping of Course Outcomes (COs) with Program Outcomes (POs) Program Specific Outcomes (PSOs)															
COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2										2	3	2	3
CO2	3	2										2	3	2	3
CO3	3	2										2	3	2	3
CO4	3	2										2	3	2	3
CO5	3	2										2	3	2	3
	3	High				2	Medium					1	Low		

Formative assessment			
Bloom's Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Classroom or Online Quiz	5	15
Understand	Class Presentation/Power point presentation	5	
	Attendance	5	

Summative Assessment				
Bloom's Category	**Continuous Assessment Tests**			**Terminal Examination**
	1 (7.5)	**2 (7.5)**	**3 (10)**	**(60)**
Remember	10	10	10	20
Understand	10	10	10	20
Apply	30	30	30	60
Analyze	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

22PAE105	ELECTRONIC SYSTEM DESIGN LABORATORY	L	T	P	C
		0	0	4	2
Nature of Course	Devices and Circuits				
Pre requisites	Signal Processing and Microprocessor and Microcontroller				

Course Objectives

The course is intended

1. To study various controllers and different interfaces
2. Simulation of QMF using Simulation Packages
3. Sensor design using simulation tools
4. To learn asynchronous and clocked synchronous sequential circuits
5. To understand the concept of built in self test and fault diagnosis

Course Outcomes

1. Apply PIC, MSP430, „51 Microcontroller and 8086 for system design
2. Simulate QMF
3. Design sensor using simulation tools
4. Design and analyze of real time signal processing system
5. Design asynchronous and clocked synchronous sequential circuits

CYCLE-1

S.No.	Course Content	CO	Bloom's Level
1	System design using PIC, MSP430, „51 Microcontroller and 16- bit Microprocessor - 8086	CO1	Applying
2	Study of different interfaces (using embedded microcontroller)	CO1	Analysis
3	Implementation of Adaptive Filters and multistage multirate system in DSP Processor	CO4	Applying
4	Simulation of QMF using Simulation Packages	CO2	Analysis

CYCLE-2

S.No.	Course Content	CO	Bloom's Level
1	Analysis of Asynchronous and clocked synchronous sequential circuits	CO5	Analysis
2	Built in self test and fault diagnosis	CO4	Analysis
3	Sensor design using simulation tools	CO3	Applying
4	Design and analysis of real time signal processing system – Data acquisition and signal processing	CO4	Applying

Mapping of Course Outcomes (COs) with Program Outcomes (POs) Program Specific Outcomes (PSOs)															
COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2										2	3	2	3
CO2	3	2										2	3	2	3
CO3	3	2										2	3	2	3
CO4	3	2										2	3	2	3
CO5	3	2										2	3	2	3
	3	High				2	Medium					1	Low		

Summative assessment based on Continuous and End Semester Examination		
Bloom's Level	**Internal Assessment [50 marks]**	**End Semester Examination [50 marks]**
Remember	10	10
Understand	20	20
Apply	40	40
Analyze	30	30
Evaluate	-	-
Create	-	-

II SEMESTER

22PAE201	ADVANCED IMAGE and VIDEO PROCESSING	L	T	P	C
		3	2	0	4
Nature of Course	Professional Core				
Pre requisites	NIL				

Course Objective

The course is intended to

1. Understand the fundamentals of digital images.
2. Learn different image transforms.
3. Study concept of segmentation.
4. Study the enhancement and image compression.
5. Study the basic concepts of video processing

Course Outcomes

On successful completion of the course, students will be able to

CO.No.	Course Outcome	Bloom's Level
CO1	Analyze the fundamental concepts of digital image processing.	Analyzing
CO2	Apply the different types of image transforms.	Apply
CO3	Apply different algorithms for segmenting gray level images.	Apply
CO4	Interpret the concept of image enhancement in color imaging	Understand
CO5	Analyze the various concept of video processing	Analyze

Course Contents:

NIT-I DC IMAGE FUNDAMENTALS **12**

A simple image model, Sampling and Quantization, Imaging Geometry, Digital Geometry, Image Acquisition Systems, Different types of digital images. Basic concepts of digital distances, distance transform, medial axis transform, component labeling, thinning, morphological processing, extension to gray scale morphology

UNIT-II IMAGE TRANSFORMS **12**

1D DFT, 2D transforms - DFT, DCT, Discrete Sine, Walsh, Hadamard, Slant, Haar, KLT, SVD, Wavelet transform

UNITIII SEGMENTATION OF GRAY LEVEL IMAGES **12**

Histogram of gray level images, multilevel thresholding, optimal thresholding using Bayesian classification, Watershed and Dam Construction algorithms for segmenting graylevel image. Detection of edges and lines: First order and second order edge operators, multi-scale edge detection, Canny's edge detection algorithm, Hough transform for detecting lines and curves, edge linking.

UNITIVIMAGEENHANCEMENTANDCOLORIMAGEPROCESSING **12**

Point processing, Spatial Filtering, Frequency domain filtering, multi-spectral image enhancement, image restoration. Color Representation, Laws of color matching, chromaticity diagram, color enhancement, color image segmentation, color edge detection, color demos icing.

UNIT V BASIC STEPS OF VIDEO PROCESSIN **12**

Analog video, Digital Video, Time varying Image Formation models: 3D motion models, Geometric Image formation , Photometric Image formation, sampling of video signals, filtering operations.

TOTAL : 60 PERIODS

TEXT BOOKS

1. Gonzaleze and Woods ,"Digital Image Processing ", 3rd edition , Pearson.
2. Yao Wang, JoemOstarmann and Ya – quin Zhang, "Video processing and communication ",1st edition , PHI.

REFERENCE BOOKS

1.A.K. Jain, "Fundamentals of Digital Image Processing", Prentice-Hall, Addison- Wesley,1989.

2.B. Jähne, "Practical Handbook on Image Processing for Scientific Applications",CRC Press,1997.
3. Bernd Jähne, Digital Image Processing, Springer-Verlag Berlin Heidelberg2005.
4.Bovik (ed.), "Handbook of Image and Video Processing", Academic Press, 2000.
5. W. K. Pratt. Digital image processing, PIKS Inside. Wiley, New York, 3rd, edn.,2001

Mapping of Course Outcomes (COs) with Program Outcomes (POs) Program Specific Outcomes (PSOs)

COs	POs												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	3										2	3	2	3
CO2	3	3										2	3	2	3
CO3	3	2										2	3	2	3
CO4	3	2										2	3	2	3
CO5	3	2										2	3	2	3
	3	High				2	Medium					1	Low		

Formative assessment			
Bloom's Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Classroom or Online Quiz	5	15
Understand	Class Presentation/Power point presentation	5	
	Attendance	5	

Summative Assessment				
Bloom's Category	**Continuous Assessment Tests**			**Terminal Examination (60)**
	1 (7.5)	**2 (7.5)**	**3 (10)**	
Remember	10	10	10	20
Understand	10	10	10	20
Apply	30	30	30	60
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

22PAE202	SOFT COMPUTING and OPTIMIZATION TECHNIQUES	L	T	P	C
		3	0	0	3
Nature of Course	Professional Core				
Pre requisites	Fundamentals of Basic Mathematics and Data Analysis				

Course Objectives

The course is intended to

1. Familiarizes with the design of various neural networks.
2. Understand the concept of fuzzy logic.
3. Explore the knowledge Neuro Fuzzy modeling and control.
4. Gain knowledge in conventional optimization techniques.
5. Understand the various evolutionary optimization techniques.

Course Outcomes

On successful completion of the course, students will be able to

CO.No.	Course Outcome	Bloom's Level
CO1	Understand the different types of neural networks.	Understand
CO2	Identify the Fuzzy relations and Fuzzy expert systems	Understand
CO3	Determine the properties of field effect transistors	Understand
CO4	Analyze the concepts of Neuro-Fuzzy modeling	Analyze
CO5	Apply the evolutionary optimization techniques	Apply

Course Contents

Unit-I NEURAL NETWORKS **9**

Machine Learning using Neural Network, Learning algorithms, Supervised Learning Neural Networks — Feed Forward Networks, Radial Basis Function, Unsupervised Learning Neural Networks – Self Organizing map , Adaptive Resonance Architectures, Hopfield network.

Unit-II FUZZY LOGIC **9**

Fuzzy Sets – Operations on Fuzzy Sets – Fuzzy Relations – Membership Functions- Fuzzy Rules and Fuzzy Reasoning – Fuzzy Inference Systems – Fuzzy Expert Systems – Fuzzy Decision Making

Unit-III NEURO-FUZZY MODELING **9**

Adaptive Neuro-Fuzzy Inference Systems – Coactive Neuro-Fuzzy Modeling – Classification andRegression Trees – Data Clustering Algorithms – Rule base Structure Identification – Neuro-FuzzyControl — CaseStudies.

Unit-IV CONVENTIONAL OPTIMIZATIONTECHNIQUES **9**

Introduction to optimization techniques, Statement of an optimization problem, classification, Unconstrained optimization-gradient search method-Gradient of a function, steepest gradient-conjugate gradient, Newton‟s Method, Marquardt Method, Constrained optimization –sequential linear programming, Interior penalty function method, external penalty function method.

Unit-V EVOLUTIONARY OPTIMIZATION TECHNIQUES **9**

Genetic algorithm – Working principle, Basic operators and terminologies, Building block hypothesis, Traveling salesman problem, Particle swarm optimization, Ant colony optimization.

TOTAL : 45 PERIODS

TEXT BOOKS

1. David E. Goldberg, Genetic Algorithms in Search, Optimization and Machine Learning, Addison Wesley, 2009.Hill Inc.2012.
2. George J. Klir and Bo Yuan, Fuzzy Sets and Fuzzy Logic-Theory and Application, Prentice Hall, 1995.

REFERENCE BOOKS

1. James A. Freeman and David M. Skapura, Neural Networks Algorithms, Applications, andProgramming Techniques, Pearson Edn., 2003.
2. Timothy J.Ross, Fuzzy Logic with Engineering Applications, McGraw-Hill, 1997.

Mapping of Course Outcomes (COs) with Program Outcomes (POs) Program Specific Outcomes (PSOs)

COs	POs												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	2	3										1	3	2	2
CO2	3	3										1	3	2	2
CO3	2	3										1	3	2	2
CO4	3	2										1	3	2	2
CO5	3	3										1	3	2	2
	3	High				2	Medium					1	Low		

Formative assessment			
Bloom's Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Classroom / Online Quiz/Group discussion	5	15
Understand	Class Presentation/Power point presentation	5	
	Attendance	5	

Summative Assessment				
Bloom's Category	**Continuous Assessment Tests**			**Terminal Examination (60)**
	1 (7.5)	**2 (7.5)**	**3 (10)**	
Remember	10	10	10	20
Understand	10	10	10	20
Apply	30	30	30	60
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

22PAE203	LOW POWER VLSI	L	T	P	C
		3	0	0	3
Nature of Course	Professional Core				
Pre requisites	Fundamentals of Electronics				

Course Objectives

The course is intended to

1. Identify sources of power in an IC
2. Identify the power reduction techniques based on technology independent and Technology dependent
3. Power dissipation mechanism in various MOS logic style.
4. Identify suitable techniques to reduce the power dissipation
5. Design memory circuits with low power dissipation.

Course Outcomes

On successful completion of the course, students will be able to

CO.No.	Course Outcome	Bloom's Level
CO1	Analyze the power dissipation in CMOS circuits.	Analyze
CO2	Understand the various concepts of power optimization techniques	Understand
CO3	Design of Low power CMOS circuits	Apply
CO4	Analyze the power estimation techniques	Analyze
CO5	Software design for low power dissipation circuits	Apply

Course Contents

Unit-I POWER DISSIPATION IN CMOS **9**

Physics of power dissipation in CMOS FET devices — Hierarchy of limits of power — Sources of power consumption — Static Power Dissipation, Active Power Dissipation - Designing for Low Power, Circuit Techniques For Leakage Power Reduction - Basic principle of low power design.

Unit-II POWER OPTIMIZATION **9**

Logic level power optimization — Circuit level low power design — Standard Adder Cells, CMOS Adders Architectures-BiCMOS adders - Low Voltage Low Power Design Techniques, Current Mode Adders -Types Of Multiplier Architectures, Braun, Booth and Wallace Tree Multipliers and their performance comparison

Unit-III DESIGN OF LOW POWER CMOS CIRCUITS **9**

Computer arithmetic techniques for low power system — low voltage low power static Random access and dynamic Random access memories – low power clock, Inter connect and layout design
– Advanced techniques – Special techniques.

Unit-IV POWER ESTIMATION **9**

Power Estimation techniques – logic power estimation – Simulation power analysis – Probabilisticpower analysis.

Unit-V SYNTHESIS AND SOFTWARE DESIGN FOR LOW POWER **9**

Synthesis for low power – Behavioral level transform – software design for low power.

TOTAL : 45 PERIODS

TEXT BOOKS

1. AbdelatifBelaouar, Mohamed.I.Elmasry, “Low power digital VLSI design”, Kluwer, 1995.
2. A.P.Chandrasekaran and R.W.Broadersen, “Low power digital CMOS design”, Kluwer,1995

REFERENCE BOOKS

1. DimitriosSoudris, C.Pignet, Costas Goutis,“Designing CMOS Circuits for Low power”Kluwer, 2002.
2. Gary Yeap, “Practical low power digital VLSI design”, Kluwer, 1998.

Mapping of Course Outcomes (COs) with Program Outcomes (POs) Program Specific Outcomes (PSOs)															
COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	2	3	2										3	2	2
CO2	3	3	2										3	2	2
CO3	2	3	2										3	2	2
CO4	3	2	2										3	2	2
CO5	3	3	2										3	2	2
	3	High				2	Medium					1	Low		

Formative assessment			
Bloom’s Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Classroom / Online Quiz/Group discussion	5	15
Understand	Class Presentation/Power point presentation	5	
	Attendance	5	

Summative Assessment				
Bloom’s Category	**Continuous Assessment Tests**			**Terminal Examination (60)**
	1 (7.5)	**2 (7.5)**	**3 (10)**	
Remember	10	10	10	20
Understand	10	10	10	20
Apply	30	30	30	60
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

22PAE204	ADVANCED MICROPROCESSORS AND MICROCONTROLLERS ARCHITECTURES	L	T	P	C
		3	0	0	3
Nature of Course	Professional Core				
Pre requisites	Fundamentals of Microprocessor and Microcontroller				

Course Objectives

The course is intended to

1. Familiarize about the features, specification and features of modern microprocessors.
2. Gain knowledge about the architecture of Intel 32 and 64 bit microprocessors and salient features
   associated with them.
3. Understand the RISC and ARM architectures.
4. Extract the feature of modern microprocessors
5. Describe high performance microcontroller architectures.

Course Outcomes

On successful completion of the course, students will be able to

CO.No.	Course Outcome	Bloom's Level
CO1	Describe the features of modern microprocessors	Knowledge
CO2	Explain the concept of high performance CISC architecture	Understand
CO3	Describe the concept of high performance RISC and ARM architecture	Understand
CO4	Identify the different features of modern microcontrollers.	Understand
CO5	Outline the characteristics ARM – M3 architecture and its salient features.	Understand

Course Contents

Unit-I FEATURES OFMODERN MICROPROCESSORS 9

Evolution of microprocessors - Data and Address buses – clock speed – memory interface - multi- core architectures — cache memory hierarchy — operating modes — super scaler execution — dynamic execution – over clocking – integrated graphics processing - performance benchmarks.

Unit-II HIGH PERFORMANCECISCARCHITECTURES 9

Introduction to IA 32 bit architecture – Intel Pentium Processors family tree – Memory Management – Branch prediction logic - Superscalar architecture – Hyper threading technology – 64 bit extension technology – Intel 64 bit architecture - Intel Core processor family tree – Turbo boost technology –Smart cache - features of Nehalem micro architecture.

Unit-III HIGH PERFORMANCE RISC ARCHITECTURE-ARM 9

RISC architecture merits and demerits — The Program‟s model of ARM Architecture — 3-stage pipeline ARM organization - 3-stage pipeline ARM organization — ARM instruction execution — Salient features of ARM instruction set - ARM architecture profiles (A, R and M profiles).

Unit-IV FEATURES OFMODERN MICROPROCESSORS 9

Introduction to microcontrollers – microcontroller vs microprocessors – microcontroller architecture - Processor Core – Memory interfaces– Communication interfaces (SPI,I^2C, USB and CAN) – ADC -PWM – Watchdog timers – Interrupts – Debugging interfaces.

Unit-V HIGH PERFORMANCEMICROCONTROLLERARCHITECTURES 9

Introduction to the Cortex-M Processor Family - ARM 'Cortex-M3' architecture for microcontrollers – Thumb 2 instruction technology – Internal Registers - Nested Vectored Interrupt controller - Memory map - Interrupts and exception handling – Applications of Cotex-M3 architecture.

TOTAL: 45 PEROIODS

TEXT BOOKS

1. Barry. B. Breg," The Intel Microprocessors" , PHI,2008
2. Gene .H.Miller." Micro Computer Engineering," Pearson Education, 2003.

REFERENCE BOOKS

1. Intel Inc, "Intel 64 and IA-32 Architectures Developer‟s Manual", Volume-I, 2016
2. Steve Furber, „" ARM System –On –Chip architecture "Addision Wesley , 2000

Mapping of Course Outcomes (COs) with Program Outcomes (POs) Program Specific Outcomes (PSOs)

COs	POs												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	2	3		3								1	3	2	2
CO2	3	3		3								1	3	2	2
CO3	2	3		2								1	3	2	2
CO4	3	2		3								1	3	2	2
CO5	3	3		3								2	3	2	2
	3	High				2	Medium					1	Low		

Formative assessment

Bloom's Level	Assessment Component	Marks	Total marks
Remember	Classroom / Online Quiz/Group discussion	5	15
Understand	Class Presentation/Power point presentation	5	
	Attendance	5	

Summative Assessment

Bloom's Category	Continuous Assessment Tests			Terminal Examination (60)
	1 (7.5)	2 (7.5)	3 (10)	
Remember	10	10	10	20
Understand	10	10	10	20
Apply	30	30	30	60
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

22PAE205	TERM PAPER WRITING AND SEMINAR	L	T	P	C
		0	0	4	2
Nature of Course	Professional Core				
Pre requisites	Document writing				

Course Objectives

In this course, students will develop their scientific and technical reading and writing skills that they need to understand and construct research articles.

A term paper requires a student to obtain information from a variety of sources (i.e., Journals, dictionaries, reference books) and then place it in logically developed ideas.

The work involves the following steps:

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

Please keep a file where the work carried out by you is maintained.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)															
Cos	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	3	3	3	3				3	3	2	1	3	2	2
CO2	3	3	3	3	3				3	3	2	1	3	2	2
CO3	3	3	3	3	3				3	3	2	1	3	2	2
CO4	3	3	3	3	3				3	3	2	1	3	2	2
CO5	3	3	3	3	3				3	3	2	1	3	2	2
	3	High				2	Medium					1	Low		

Summative assessment based on Continuous and End Semester Examination		
Bloom's Level	**Rubric based Continuous Assessment [50 marks]**	**End Semester Examination [50 marks]**
Remember	30	30
Understand		
Apply	70	70
Analyze		
Evaluate		
Create		

20PEE301	Research Methodology and Intellectual Properties Rights	L	T	P	C
		3	0	0	3
Nature of Course	Professional core				
Pre requisites	Nil				

Course Objectives

The course is intended to

1. Impart knowledge and skills required for research problem formulation
2. Identify the relevant literatures for research
3. Develop skills on technical paper writing / presentation without violating professionalethics
4. Acquire knowledge on IPR and patents.
5. Gain knowledge on patent rights and Patent information database

Course Outcomes

On successful completion of the course, students will be able to

CO. No.	Course Outcome	Bloom's Level
CO1	Identify and formulate researchproblem	Apply
CO2	Concentrate on literatures related to research problem.	Understand
CO3	Possess the ability to write a standard technical paper and presentation.	Apply
CO4	Find the correct procedure for applying patents	Apply
CO5	Become well versed on patent rights, licensing and transfer of technology.	Understand

Course Contents:

Unit- I Research Problem Formulation9

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 Revie 9

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

Unit - III TechnicalWriting /Presentation9

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

Unit- IV Introduction to Intellectual PropertyRights(IPR) 9

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, Research Hypothesis, Innovation, patenting development, Citation, International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

Unit-V Intellectual PropertyRights(IPR) 9

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: 45 Periods

Text Books:

1. Asimov, “Introduction to Design”, Prentice Hall,1962.
2. Halbert, “Resisting Intellectual Property”, Taylor & Francis Ltd,2007.

Reference Books:

1.Mayall, “Industrial Design”, McGraw Hill, 1992.
2. Niebel, “Product Design”, McGraw Hill, 1974.
3. Ranjith Kumar, 2nd Edition, Research Methodology: A Step-by-Step Guide for beginners” 2010

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)														
COs	**Pos**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	3	3												2
CO2	3													2
CO3	3							3						2
CO4	3				3									2
CO5	3					3						3		2
	3	High				2	Medium					1	Low	

Formative assessment			
Bloom’s Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Online Quiz	5	15
Understand	Class Presentation/Power point presentation	5	
	Attendance	5	

Summative Assessment				
Bloom’s Category	**Internal Assessment Examination**			**Final Examination (60)**
	IAE 1 (7.5)	**IAE 2 (7.5)**	**IAE3 (10)**	
Remember	10	10	10	20
Understand	10	10	10	20
Apply	30	30	30	60
Analyse				
Evaluate				
Create				

PROFESSIONAL ELECTIVE

22PEA001	DIGITAL CONTROL ENGINEERING	L	T	P	C
		3	0	0	3
Nature of Course	Elective Core				
Pre requisites	Embedded System				

Course Objectives:

1. To learn the principles of PI, PD, PID controllers.
2 To analyses time and frequency response discrete time control system.
3. To familiar with digital control algorithms.
4. To have the knowledge to implement PID control algorithms.
5. To design the Digital controllers

Course Outcomes

On successful completion of the course, students will be able to

CO. No.	Course Outcome	Bloom's Level
CO1	Describe continuous time and discrete time controllers analytically	Knowledge
CO2	Define and state basic analog to digital and digital to analog conversion principles	Understand
CO3	Analyze sampled data control system in time and frequency domains	Analyze
CO4	Illustrate schemes for practical implementation of temperature and motor control systems	Apply
CO5	Design simple PI, PD, PID continuous and digital controllers	Create

Course Contents

UNIT I CONTROLLERS IN FEEDBACK SYSTEMS 9

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

UNIT II BASIC DIGITAL SIGNAL PROCESSING IN CONTROL SYSTEMS 9

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

UNIT III MODELING OF SAMPLED DATA CONTROL SYSTEM 9

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

UNIT IV DESIGN OF DIGITAL CONTROL ALGORITHMS 9

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

UNIT V PRACTICAL ASPECTS OF DIGITAL CONTROL ALGORITHMS 9

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

TOTAL: 45 PERIODS

REFERENCES:

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

Mapping of Course Outcomes (COs) with Program Outcomes (POs) Program Specific Outcomes (PSOs)															
COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	2	3		3								1	3	2	2
CO2	3	3		3								1	3	2	2
CO3	2	3		2								1	3	2	2
CO4	3	2		3								1	3	2	2
CO5	3	3		3								2	3	2	2
	3	High				2	Medium					1	Low		

Formative assessment			
Bloom's Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Classroom / Online Quiz/Group discussion	5	15
Understand	Class Presentation/Power point presentation	5	
	Attendance	5	

Summative Assessment				
Bloom's Category	**Continuous Assessment Tests**			**Terminal Examination (60)**
	1 (7.5)	**2 (7.5)**	**3 (10)**	
Remember	10	10	10	20
Understand	10	10	10	20
Apply	30	30	30	60
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

22PEA002	COMPUTER ARCHITECTURE AND PARALLEL PROCESSING	L	T	P	C
		3	0	0	3
Nature of Course	Elective core				
Pre requisites	Computer Architecture and Organization				

Course Objectives:

1. To Understand the difference between pipeline and parallel processing concepts
2. To Study various types of processor architectures and the importance of scalable architectures
3. To Study Memory Architectures, Memory Technology and Optimization.
4. To discuss about multiprocessor and its applications
5. To discuss about multicore Architectures

Course Outcomes

On successful completion of the course, students will be able to

CO. No.	Course Outcome	Bloom's Level
CO1	Explain design of memory hierarchies	Understand
CO2	Understand the various process architectures	Understand
CO3	Infer the memory architecture and Optimization techniques	Analyze
CO4	Assess Performance Issues and Synchronization issues	Evaluate
CO5	Compare multicore architectures	Analyze

Course Contents

UNIT I COMPUTER DESIGN AND PERFORMANCE MEASURES 9

Fundamentals of Computer Design – Parallel and Scalable Architectures – Multiprocessors – Multivector and SIMD architectures – Multithreaded architectures – Stanford Dash multiprocessor –KSR1 - Data-flow architectures - Performance Measures

UNIT II PARALLEL PROCESSING, PIPELINING AND ILP 9

Instruction Level Parallelism and Its Exploitation - Concepts and Challenges - Pipelining processors - Overcoming Data Hazards with Dynamic Scheduling – Dynamic Branch Prediction - Speculation - Multiple Issue Processors - Performance and Efficiency in Advanced Multiple Issue Processors

UNIT III MEMORY HIERARCHY DESIGN 9

Memory Hierarchy - Memory Technology and Optimizations – Cache memory – Optimizations of Cache Performance – Memory Protection and Virtual Memory - Design of Memory Hierarchies.

UNIT IV MULTIPROCESSORS 9

Symmetric and distributed shared memory architectures – Cache coherence issues – Performance Issues – Synchronization issues – Models of Memory Consistency - Interconnection networks – Buses, crossbar and multi-stage switches.

UNIT V MULTI-CORE ARCHITECTURES 9

Software and hardware multithreading – SMT and CMP architectures – Design issues – Case-studies — Intel Multi-core architecture — SUN CMP architecture — IBM cell architecture — hp architecture.

TOTAL : 45 PERIODS

REFERENCES:

1. David E. Culler, Jaswinder Pal Singh, “Parallel Computing Architecture: A hardware/ softwareapproach”, Morgan Kaufmann / Elsevier, 1997
2. Dimitrios Soudris, Axel Jantsch, "Scalable Multi-core Architectures: Design Methodologies and Tools", Springer, 2012
3. Hwang Briggs, “Computer Architecture and parallel processing”, McGraw Hill, 1984.
4. John L. Hennessey and David A. Patterson, “Computer Architecture – A quantitative approach”,Morgan Kaufmann / Elsevier, 4th. edition, 2007
5. John P. Hayes, “Computer Architecture and Organization”, McGraw Hill
6. John P. Shen, “Modern processor design. Fundamentals of super scalar processors”, Tata McGraw Hill 2003
7. Kai Hwang, "Advanced Computer Architecture", McGraw Hill International, 2001
8. William Stallings, “Computer Organization and Architecture – Designing for Performance”,Pearson Education, Seventh Edition, 2006

Mapping of Course Outcomes (COs) with Program Outcomes (POs) Program Specific Outcomes (PSOs)															
COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	2	3		3								1	3	2	2
CO2	3	3		3								1	3	2	2
CO3	2	3		2								1	3	2	2
CO4	3	2		3								1	3	2	2
CO5	3	3		3								2	3	2	2
	3	High				2	Medium					1	Low		

Formative assessment			
Bloom’s Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Classroom / Online Quiz/Group discussion	5	15
Understand	Class Presentation/Power point presentation	5	
	Attendance	5	

Summative Assessment				
Bloom’s Category	**Continuous Assessment Tests**			**Terminal Examination (60)**
	1 (7.5)	**2 (7.5)**	**3 (10)**	
Remember	10	10	10	20
Understand	10	10	10	20
Apply	30	30	30	60
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

22PEA003	CAD FOR VLSI CIRCUITS	L	T	P	C
		3	0	0	3
Nature of Course	Elective core				
Pre requisites	VLSI Design				

Course objectives:

1. To study various physical design methods in VLSI.
2. To understand the concepts behind the VLSI design rules and routing techniques.
3. To understand the concepts of various algorithms used for floor planning and routing techniques.
4. To Simulate the logic synthesis
5. To Evaluate in High Level Synthesis.

Course Outcomes

On successful completion of the course, students will be able to

CO. No.	Course Outcome	Bloom's Level
CO1	Simulate techniques at various levels in VLSI design flow	Apply
CO2	Discuss the concepts of floor planning and routing	Understand
CO3	Outline high level synthesis	Analyze
CO4	Understand the logic syntheis	Understand
CO5	Evaluate the high Level Synthesis	Evaluate

Course Contents

UNIT I INTRODUCTION TO VLSI DESIGN FLOW 9

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

UNIT II LAYOUT, PLACEMENT AND PARTITIONING 9

Layout Compaction, Design rules, Problem formulation, Algorithms for constraint graph compaction, Placement and partitioning, Circuit representation, Placement algorithms, Partitioning

UNIT III FLOOR PLANNING AND ROUTING 9

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

UNIT IV SIMULATION AND LOGIC SYNTHESIS 9

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

UNIT V HIGH LEVEL SYNTHESIS 9

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

TOTAL: 45 PERIODS

REFERENCES:

1. N.A. Sherwani, "Algorithms for VLSI Physical Design Automation", Kluwer Academic Publishers, 2002.
2. S.H. Gerez, "Algorithms for VLSI Design Automation", John Wiley & Sons, 2002. . Sadiq M. Sait, Habib Youssef, “VLSI Physical Design automation: Theory and Practice”, World scientific 1999. Steven M.Rubin, “Computer Aids for VLSI Design”, Addison Wesley Publishing 1987.

Mapping of Course Outcomes (COs) with Program Outcomes (POs) Program Specific Outcomes (PSOs)

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	3		3								1	3	2	2
CO2	3	3		3								1	3	2	2
CO3	2	3		2								1	3	2	2
CO4	3	2		3								1	3	2	2
CO5	3	3		3								2	3	2	2
	3	High				2	Medium					1	Low		

Formative assessment			
Bloom’s Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Classroom / Online Quiz/Group discussion	5	15
Understand	Class Presentation/Power point presentation	5	
	Attendance	5	

Summative Assessment				
Bloom’s Category	**Continuous Assessment Tests**			**Terminal Examination (60)**
	1 (7.5)	**2 (7.5)**	**3 (10)**	
Remember	10	10	10	20
Understand	10	10	10	20
Apply	30	30	30	60
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

22PEA004	ELECTROMAGNETIC INTERFERENCE AND COMPATIBILITY	L	T	P	C
		3	0	0	3
Nature of Course	Elective core				
Pre requisites	RFand Microwave Engineering				

Course Objectives:

The students should be made to be familiar with:

1. The basics of EMI , EMI sources EMI problems .
2. To give the basic Solutions methods in PCB.
3. To understand the Measurements techniques for emission.
4. To identify the Measurement techniques for immunity.
5. To identify the Test methods and Instrumentation.

Course Outcomes

On successful completion of the course, students will be able to

CO. No.	Course Outcome	Bloom's Level
CO1	Identify Standards of EMI	Apply
CO2	Compare EMI test methods	Understand
CO3	Discuss EMI mitigation techniques	Understand
CO4	Discuss Standard and Regulation	Understand
CO5	Evaluate the Test Methods	Evaluate

Course Contents

UNIT I BASIC THEORY **9**

Introduction to EMI and EMC, Intra and inter system EMI, Elements of Interference, Sources and Victims of EMI, Conducted and Radiated EMI emission and susceptibility, Case Histories, Radiation hazards to humans, Various issues of EMC, EMC Testing categories EMC Engineering Application.

UNIT II COUPLING MECHANISM **9**

Electromagnetic field sources and Coupling paths, Coupling via the supply network, Common mode coupling, Differential mode coupling, Impedance coupling, Inductive and Capacitive coupling, Radioactive coupling, Ground loop coupling, Cable related emissions and coupling, Transient sources, Automotive transients.

UNIT III EMI MITIGATION TECHNIQUES **9**

Working principle of Shielding and Murphy"s Law, LF Magnetic shielding, Apertures and shielding effectiveness, Choice of Materials for H, E, and free space fields, Gasketting and sealing, PCB Level shielding, Principle of Grounding, Isolated grounds, Grounding strategies for Large systems, Grounding for mixed signal systems, Filter types and operation, Surge protection devices, Transient Protection.

UNIT IV STANDARD AND REGULATION **9**

Need for Standards, Generic/General Standards for Residential and Industrial environment, Basic Standards, Product Standards, National and International EMI Standardizing Organizations; IEC, ANSI, FCC, AS/NZS, CISPR, BSI, CENELEC, ACEC. Electro Magnetic Emission and susceptibility standards and specifications, MIL461E Standards

UNIT V EMI TEST METHODS AND INSTRUMENTATION **9**

Fundamental considerations, EMI Shielding effectiveness tests, Open field test, TEM cell for immunity test, Shielded chamber , Shielded anechoic chamber, EMI test receivers, Spectrum analyzer, EMI test wave simulators, EMI coupling networks, Line impedance stabilization networks, Feed through capacitors, Antennas, Current probes, MIL -STD test methods, Civilian STD test methods.

TOTAL: 45 PERIODS

REFERENCES:

1. Bemhard Keiser, “Principles of Electromagnetic Compatibility”, 3rd Ed, Artech house, Norwood, 1986.
2. Clayton Paul, “Introduction to Electromagnetic Compatibility”, Wiley Interscience, 2006.
3. Daryl Gerke and William Kimmel, “EDN‟s Designer‟s Guide to Electromagnetic Compatibility”, Elsevier Science & Technology Books, 2002
4. Dr Kenneth L Kaiser, “The Electromagnetic Compatibility Handbook”, CRC Press 2005.
5. Electromagnetic Compatibility by Norman Violette ,Published by Springer, 2013
6. Electromagnetic Interference and Compatibility: Electrical noise and EMI specifications Volume 1 of A Handbook Series on Electromagneti Interference and Compatibility, Donald R. J. White Publisher-Don white consultants Original from the University of Michigan Digitized 6 Dec 2007
7. Henry W. Ott, “Electromagnetic Compatibility Engineering”, John Wiley & Sons Inc, Newyork,2009
8. V Prasad Kodali, “Engineering Electromagnetic Compatibility”, IEEE Press, Newyork, 2001.
9. W Scott Bennett, “Control and Measurement of Unintentional Electromagnetic Radiation”, John Wiley & Sons Inc., (Wiley Interscience Series) 1997.

Mapping of Course Outcomes (COs) with Program Outcomes (POs) Program Specific Outcomes (PSOs)

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	3		3								1	3	2	2
CO2	3	3		3								1	3	2	2
CO3	2	3		2								1	3	2	2
CO4	3	2		3								1	3	2	2
CO5	3	3		3								2	3	2	2
	3	High				2	Medium					1	Low		

Formative assessment			
Bloom’s Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Classroom / Online Quiz/Group discussion	5	15
Understand	Class Presentation/Power point presentation	5	
	Attendance	5	

Summative Assessment				
Bloom’s Category	**Continuous Assessment Tests**			**Terminal Examination (60)**
	1 (7.5)	**2 (7.5)**	**3 (10)**	
Remember	10	10	10	20
Understand	10	10	10	20
Apply	30	30	30	60
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

22PEA005	Embedded & Real Time Systems	L	T	P	C
		3	0	0	3
Nature of Course	Professional Core				
Pre requisites	Fundamental of Embedded Systems				

Course Objectives

The course is intended

1. To Learn design challenges and design methodologies
2. To Study general and single purpose processor
3. To Understand bus structures
4. To gain knowledge about State Machine and Concurrent process models
5. To gain knowledge in embedded tools.

Course Outcomes

On successful completion of the course, students will be able to

CO.No.	Course Outcome	Bloom's Level
CO1	Analyze the design methodologies	Analyzing
CO2	Apply various types of single processor	Apply
CO3	Discuss about the bus structure	Understand
CO4	Design the State machine and process models	Understand
CO5	Discuss the design embedded tools	Understand

Course Contents:

UNIT I EMBEDDED SYSTEM OVERVIEW 9

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

UNIT II GENERAL AND SINGLE PURPOSE PROCESSOR 9

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

UNIT III BUS STRUCTURES 9

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

UNIT IV STATE MACHINE AND CONCURRENT PROCESS MODELS 9

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

UNIT V EMBEDDED SOFTWARE DEVELOPMENT TOOLS AND RTOS 9

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

TOTAL: 45 PERIODS

REFERENCES:

1. Bruce Powel Douglas, “Real time UML, second edition: Developing efficient objects for embedded systems”, 3rd Edition 1999, Pearson Education.
2. Daniel W. Lewis, “Fundamentals of embedded software where C and assembly meet”, Pearson Education, 2002.
3. Frank Vahid and Tony Gwargie, “Embedded System Design”, John Wiley & sons, 2002.
4. Steve Heath, “Embedded System Design”, Elsevier, Second Edition, 2004.

Mapping of Course Outcomes (COs) with Program Outcomes (POs) Program Specific Outcomes (PSOs)

COs	POs												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2										2	3	2	3
CO2	3	2										2	3	2	3
CO3	3	2										2	3	2	3
CO4	3	2										2	3	2	3
CO5	3	2										2	3	2	3
	3	High				2	Medium					1	Low		

Formative assessment			
Bloom’s Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Classroom or Online Quiz	5	15
Understand	Class Presentation/Power point presentation	5	
	Attendance	5	

Summative Assessment				
Bloom’s Category	**Continuous Assessment Tests**			**Terminal Examination (60)**
	1 (7.5)	**2 (7.5)**	**3 (10)**	
Remember	10	10	10	20
Understand	10	10	10	20
Apply	30	30	30	60
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

22PEA006		L	T	P	C
	VLSI DESIGN TECHNIQUES	**3**	**0**	**0**	**3**
Nature of Course	Elective core				
Pre requisites	VLSI Design				

Course Objectives:

1. To Find the Transistor level design of all the digital building blocks common to all CMOS
2. To find the microprocessors, DPSs, network processors, digital backend of all wireless systems
3. To focus on the transistor level design and will address all important issues
4. To classify the important building and will introduce the principles and design methodology
5. To terms of the dominant circuit choices, constraints and performance measures

Course Outcomes

On successful completion of the course, students will be able to

CO. No.	Course Outcome	Bloom's Level
CO1	Demonstration the transistor level design of the most important building blocks used in digital CMOS VLSI circuits	Apply
CO2	Discuss the design methodology of arithmetic building block	Understand
CO3	Analyze the tradeoffs of the various circuit choices for each of the building block	Analyze
CO4	Understand the principles of design methodology	Understand
CO5	Understand the dominant circuit choices, constraints and performance measures	Understand

Course Contents:

UNIT I MOS TRANSISTOR PRINCIPLES AND CMOS INVERTER 12

MOS(FET) Transistor Characteristic under Static and Dynamic Conditions, MOS Transistor Secondary Effects, Process Variations, Technology Scaling, Internet Parameter and electrical wise models CMOS Inverter - Static Characteristic, Dynamic Characteristic, Power, Energy, and Energy Delay parameters.

UNIT II COMBINATIONAL LOGIC CIRCUITS 9

Propagation Delays, Stick diagram, Layout diagrams, Examples of combinational logic design, Elmore"s constant, Dynamic Logic Gates, Pass Transistor Logic, Power Dissipation, Low Power Design principles.

UNIT III SEQUENTIAL LOGIC CIRCUITS 9

Static Latches and Registers, Dynamic Latches and Registers, Timing Issues, Pipelines, Pulse and sense amplifier based Registers, Nonbistable Sequential Circuits.

UNIT IV ARITHMETIC BUILDING BLOCKS AND MEMORY ARCHITECTURES 9

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

UNIT V INTERCONNECT AND CLOCKING STRATEGIES 6

Interconnect Parameters — Capacitance, Resistance, and Inductance, Electrical Wire Models, Timing classification of Digital Systems, Synchronous Design, Self-Timed Circuit Design.

TOTAL : 45 PERIODS

REFERENCES:

1. Jacob Baker “CMOS: Circuit Design, Layout, and Simulation, Third Edition”, Wiley IEEE Press 2010.
2. Jan Rabaey, Anantha Chandrakasan, B Nikolic, “Digital Integrated Circuits: A Design Perspective”. Prentice Hall of India 2nd Edition, Feb 2003,
3. M J Smith, “Application Specific Integrated Circuits”, Addisson Wesley, 1997 4. N.Weste, K. Eshraghian, “Principles of CMOS VLSI Design”. Addision Wesley, 2nd Edition, 1993

Mapping of Course Outcomes (COs) with Program Outcomes (POs) Program Specific Outcomes (PSOs)															
COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	2	3		3								1	3	2	2
CO2	3	3		3								1	3	2	2
CO3	2	3		2								1	3	2	2
CO4	3	2		3								1	3	2	2
CO5	3	3		3								2	3	2	2
	3	High				2	Medium					1	Low		

Formative assessment			
Bloom’s Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Classroom / Online Quiz/Group discussion	5	15
Understand	Class Presentation/Power point presentation	5	
	Attendance	5	

Summative Assessment				
Bloom’s Category	**Continuous Assessment Tests**			**Terminal Examination (60)**
	1 (7.5)	**2 (7.5)**	**3 (10)**	
Remember	10	10	10	20
Understand	10	10	10	20
Apply	30	30	30	60
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

22PEA007	NANOELECTRONICS	L	T	P	C
		3	0	0	3
Nature of Course	Elective core				
Pre requisites	Electronic circuits				

Course objectives

1. To understand how transistor as Nano device
2. To understand various forms of Nano Devices
3. To understand the Nano Sensors
4. To understand the concept of Gas sensor
5. To understand the future potential of biosensor

Course Outcomes

On successful completion of the course, students will be able to

CO. No.	Course Outcome	Bloom's Level
CO1	Sketch and design the nano device	Apply
CO2	Summarize the design of nano sensors	Understand
CO3	Analyze the thermal sensors	Analyze
CO4	Discuss the Gas Sensor Material	Understand
CO5	Determine the potential biosensors	Understand

Course Contents:

UNIT I SEMICONDUCTOR NANO DEVICES **9**

Single-Electron Devices; Nano scale MOSFET – Resonant Tunneling Transistor - Single-Electron Transistors; Nanorobotics and Nanomanipulation; Mechanical Molecular Nanodevices; Nanocomputers: Optical Fibers for Nanodevices; Photochemical Molecular Devices; DNA-Based Nanodevices; Gas-Based Nanodevices.

UNIT II ELECTRONIC AND PHOTONIC MOLECULAR MATERIALS **9**

Preparation — Electroluminescent Organic materials - Laser Diodes - Quantum well lasers:- Quantum cascade lasers- Cascade surface-emitting photonic crystal laser- Quantum dot lasers - Quantum wire lasers:- White LEDs - LEDs based on nanowires - LEDs based on nanotubes - LEDs based on nanorods - High Efficiency Materials for OLEDs- High Efficiency Materials for OLEDs - Quantum well infrared photo detectors.

UNIT III THERMAL SENSORS **9**

Thermal energy sensors -temperature sensors, heat sensors - Electromagnetic sensors - electrical resistance sensors, electrical current sensors, electrical voltage sensors, electrical power sensors, magnetism sensors - Mechanical sensors - pressure sensors, gas and liquid flow sensors, position sensors - Chemical sensors - Optical and radiation sensors.

UNIT IV GAS SENSOR MATERIALS **9**

Criteria for the choice of materials - Experimental aspects – materials, properties, measurement of gas sensing property, sensitivity; Discussion of sensors for various gases, Gas sensors based on semiconductor devices.

UNIT V BIOSENSORS **9**

Principles - DNA based biosensors — Protein based biosensors — materials for biosensorapplications - fabrication of biosensors - future potential.

TOTAL: 45 PERIODS

REFERENCES:

1. K.E. Drexler, “Nano systems”, Wiley,1992.
2. M.C. Petty, “Introduction to Molecular Electronics”, 1995.
3. W. Ranier, “Nano Electronics and Information Technology”, Wiley, 2003.

Mapping of Course Outcomes (COs) with Program Outcomes (POs) Program Specific Outcomes (PSOs)															
COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	2	3		3								1	3	2	2
CO2	3	3		3								1	3	2	2
CO3	2	3		2								1	3	2	2
CO4	3	2		3								1	3	2	2
CO5	3	3		3								2	3	2	2
	3	High				2	Medium					1	Low		

Formative assessment			
Bloom’s Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Classroom / Online Quiz/Group discussion	5	15
Understand	Class Presentation/Power point presentation	5	
	Attendance	5	

Summative Assessment				
Bloom’s Category	**Continuous Assessment Tests**			**Terminal Examination (60)**
	1 (7.5)	**2 (7.5)**	**3 (10)**	
Remember	10	10	10	20
Understand	10	10	10	20
Apply	30	30	30	60
Analyze	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

22PEA008	WIRELESS ADHOC AND SENSOR NETWORKS	L	T	P	C
		3	0	0	3
Nature of Course	Elective core				
Pre requisites	Wireless Networks				

Course Objectives:

1. To understand the basics of Ad-hoc & Sensor Networks.
2. To learn various fundamental and emerging protocols of all layers.
3. To study about the issues pertaining to major obstacles in establishment and efficient management of Ad-hoc and sensor networks.
4. To understand the nature and applications of Ad-hoc and sensor networks.
5. To understand various security practices and protocols of Ad-hoc and Sensor Networks.

Course Outcomes

On successful completion of the course, students will be able to

CO. No.	Course Outcome	Bloom's Level
CO1	Identify different issues in wireless ad hoc and sensor networks	Analyze
CO2	Analyze protocols developed for ad hoc and sensor networks.	Analyze
CO3	Modify the address in the security threats in ad hoc and sensor networks.	Apply
CO4	Manipulate a Sensor network environment for different type of applications	Apply
CO5	Understand various security practices and protocols of Ad-hoc and Sensor Networks.	Understand

Course Contents:

UNIT I MAC & TCP IN AD HOC NETWORKS 9

Fundamentals of WLANs — IEEE 802.11 Architecture - Self configuration and Auto configuration- Issues in Ad-Hoc Wireless Networks – MAC Protocols for Ad-Hoc Wireless Networks – Contention Based Protocols - TCP over Ad-Hoc networks-TCP protocol overview - TCP and MANETs — Solutions for TCP over Ad-Hoc Networks.

UNIT II ROUTING IN AD HOC NETWORKS 9

Routing in Ad-Hoc Networks- Introduction-Topology based versus Position based Approaches-Proactive, Reactive, Hybrid Routing Approach-Principles and issues – Location services - DREAM – Quorums based location service – Grid – Forwarding strategies – Greedy packet forwarding – Restricted directional flooding- Hierarchical Routing- Issues and Challenges in providing QoS.

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

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

UNIT IV SENSOR MANAGEMENT 9

Sensor Management - Topology Control Protocols and Sensing Mode Selection Protocols - Timesynchronization - Localization and positioning — Operating systems and Sensor Network programming – Sensor Network Simulators.

UNIT V SECURITY IN AD HOC AND SENSOR NETWORKS 9

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

TOTAL : 45 PERIODS

REFERENCES:

1. Adrian Perrig, J. D. Tygar, "Secure Broadcast Communication: In Wired and Wireless Networks", Springer, 2006.
2. Carlos De Morais Cordeiro, Dharma Prakash Agrawal “Ad Hoc and Sensor Networks: Theory and Applications (2nd Edition), World Scientific Publishing, 2011
3. C.Siva Ram Murthy and B.S.Manoj, “Ad Hoc Wireless Networks – Architectures and Protocols”, Pearson Education, 2004.
4. C.K.Toh, “Ad Hoc Mobile Wireless Networks”, Pearson Education, 2002.
5. Erdal Çayırcı , Chunming Rong, “Security in Wireless Ad Hoc and Sensor Networks”, John Wiley and Sons, 2009.
6. Holger Karl, Andreas willig, Protocols and Architectures for Wireless Sensor Networks, John Wiley & Sons, Inc .2005.
7. Subir Kumar Sarkar, T G Basavaraju, C Puttamadappa, “Ad Hoc Mobile Wireless Networks”, Auerbach Publications, 2008.
8. Waltenegus Dargie, Christian Poellabauer, “Fundamentals of Wireless Sensor Networks Theory and Practice”, John Wiley and Sons, 2010.

Mapping of Course Outcomes (COs) with Program Outcomes (POs) Program Specific Outcomes (PSOs)															
COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
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CO2	3	3		3								1	3	2	2
CO3	2	3		2								1	3	2	2
CO4	3	2		3								1	3	2	2
CO5	3	3		3								2	3	2	2
	3	High				2	Medium					1	Low		

Formative assessment			
Bloom’s Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Classroom / Online Quiz/Group discussion	5	15
Understand	Class Presentation/Power point presentation	5	
	Attendance	5	

Summative Assessment				
Bloom’s Category	**Continuous Assessment Tests**			**Terminal Examination (60)**
	1 (7.5)	**2 (7.5)**	**3 (10)**	
Remember	10	10	10	20
Understand	10	10	10	20
Apply	30	30	30	60
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

22PEA009	HIGH PERFORMANCE NETWORKS	L	T	P	C
		3	0	0	3
Nature of Course	Elective core				
Pre requisites	Microwave				

Course Objectives:

1.To develop a comprehensive understanding of multimedia networking.
2.To study the types of VPN and tunneling protocols for security.
3.To learn about network security in many layers and network management.
4.To understand the traffic modeling concept
5. To Evaluate the network security.

Course Outcomes

On successful completion of the course, students will be able to

CO. No.	Course Outcome	Bloom's Level
CO1	Discuss advanced networks concepts	Understand
CO2	Understand the networking Applications	Understand
CO3	Examine the advanced topics	Analyze
CO4	Outline traffic modeling	Remember
CO5	Evaluate network security	Evaluate

Course Contents:

UNIT I INTRODUCTION **9**

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

UNIT II MULTIMEDIA NETWORKING APPLICATIONS **9**

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

UNIT III ADVANCED NETWORKS CONCEPTS **9**

VPN-Remote-Access VPN, site-to-site VPN, Tunneling to PPP, Security in VPN.MPLS- operation, Routing, Tunneling and use of FEC, Traffic Engineering, MPLS based VPN, overlay networksP2P connections.

UNIT IV TRAFFIC MODELLING **9**

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

UNIT V NETWORK SECURITY AND MANAGEMENT **9**

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

TOTAL: 45 PERIODS

REFERENCES:

1. Aunurag Kumar, D. M Anjunath, Joy Kuri, “Communication Networking”, Morgan Kaufmann Publishers, 1 st edition 2004.
2. Fred Halsall and Lingana Gouda Kulkarni, "Computer Networking and the Internet”, fifth edition, Pearson education 2006
3. Hersent Gurle & Petit, “IP Telephony, packet Pored Multimedia communication Systems”, Pearson education 2003
4. J.F. Kurose & K.W. Ross,"Computer Networking- A top down approach featuring the internet”, Pearson, 2 nd edition, 2003
5. Larry l.Peterson & Bruce S.David, “Computer Networks: A System Approach”- 1996
6. LEOM-GarCIA, WIDJAJA, “Communication networks”, TMH seventh reprint 2002.
7. Nader F.Mir ,Computer and Communication Networks, first edition 2010
8. Walrand .J. Varatya, High performance communication network, Morgan Kauffman – HarcourtAsia Pvt. Ltd. 2 nd Edition, 2000

Mapping of Course Outcomes (COs) with Program Outcomes (POs) Program Specific Outcomes (PSOs)															
COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	2	3		3								1	3	2	2
CO2	3	3		3								1	3	2	2
CO3	2	3		2								1	3	2	2
CO4	3	2		3								1	3	2	2
CO5	3	3		3								2	3	2	2
	3	High				2	Medium					1	Low		

Formative assessment			
Bloom’s Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Classroom / Online Quiz/Group discussion	5	15
Understand	Class Presentation/Power point presentation	5	
	Attendance	5	

Summative Assessment				
Bloom’s Category	**Continuous Assessment Tests**			**Terminal Examination (60)**
	1 (7.5)	**2 (7.5)**	**3 (10)**	
Remember	10	10	10	20
Understand	10	10	10	20
Apply	30	30	30	60
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

22PEA010	DSP Processor Architecture and Programming	L	T	P	C
		3	0	0	3
Nature of Course	Elective core				
Pre requisites	Digital Signal Processing				

Course objectives:
1. To study the basics of Digital Signal Processor
2. To learn the programming skills
3.To Learn the DSP Architecture
4.To find the Advanced DSP architectures
5.To identify the architectures and some applications

Course Outcomes

On successful completion of the course, students will be able to

CO. No.	Course Outcome	Bloom's Level
CO1	Become Digital Signal Processor specialized engineer	Understand
CO2	Understand by learning the programming skills	Understand
CO3	Analyze the DSP based System Developer	Analyze
CO4	Analyze the Advanced DSP architectures	Analyze
CO5	Identify the architectures and some applications	Evaluate

Course Contents:

UNIT I FUNDAMENTALS OF PROGRAMMABLE DSPs 9

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

UNIT II TMS320C5X PROCESSOR 9

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

UNIT III TMS320C6X PROCESSOR 9

Architecture of the C6x Processor - Instruction Set - DSP Development System: Introduction – DSP Starter Kit Support Tools- Code Composer Studio - Support Files - Programming Examples to Test the DSK Tools – Application Programs for processing real time signals.

UNIT IV ADSP PROCESSORS 9

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

UNIT V ADVANCED PROCESSORS 9

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

TOTAL : 45 PERIODS

REFERENCES:

1. Avtar Singh and S. Srinivasan, Digital Signal Processing – Implementations using DSP Microprocessors with Examples from TMS320C54xx, cengage Learning India Private Limited, Delhi 2012

2. B.Venkataramani and M.Bhaskar, "Digital Signal Processors – Architecture, Programming andApplications" – Tata McGraw – Hill Publishing Company Limited. New Delhi, 2003.

3. RulphChassaing, Digital Signal Processing and Applications with the C6713 and C6416 DSK, A JOHN WILEY & SONS, INC., PUBLICATION, 2005

4. User guides Texas Instrumentation, Analog Devices, Motorola.

Mapping of Course Outcomes (COs) with Program Outcomes (POs) Program Specific Outcomes (PSOs)															
COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	2	3		3								1	3	2	2
CO2	3	3		3								1	3	2	2
CO3	2	3		2								1	3	2	2
CO4	3	2		3								1	3	2	2
CO5	3	3		3								2	3	2	2
	3	High				2	Medium					1	Low		

Formative assessment			
Bloom's Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Classroom / Online Quiz/Group discussion	5	15
Understand	Class Presentation/Power point presentation	5	
	Attendance	5	

Summative Assessment				
Bloom's Category	**Continuous Assessment Tests**			**Terminal Examination (60)**
	1 (7.5)	**2 (7.5)**	**3 (10)**	
Remember	10	10	10	20
Understand	10	10	10	20
Apply	30	30	30	60
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

22PEA011	RF SYSTEM DESIGN	L	T	P	C
		3	0	0	3
Nature of Course	Elective core				
Pre requisites	RF and Antenna design				

Course Objectives:

1. To understand the CMOS RF Front End (RFE) is a very crucial building block and in all of wireless and many high frequency wire-line systems.
2. To study the RFE has few important building blocks within ii including the Low Noise Amplifiers, Phase Locked Loop Synthesizers, Mixers, Power Amplifiers, and impedance matching circuits.
3. To introduce the principles of operation and design principles associated with these important blocks.
4. To provide and highlight the appropriate digital communication related design objectives and constraints associated with the RFEs
5. To understand the concept of frequency synthesizers.

Course Outcomes

On successful completion of the course, students will be able to

CO. No.	Course Outcome	Bloom's Level
CO1	Understand the CMOS RF Front End (RFE)	Understand
CO2	Analyze the transistor level design of the entire RFE.	Analyze
CO3	Able to translate the top level wireless communications system	Analyze
CO4	Design objectives and constraints associated with the RFEs	Create
CO5	Understand the concept of frequency synthesizers	Understand

Course Contents:

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 up conversion Transmitter, Two step up conversion 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

REFERENCES:

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

Mapping of Course Outcomes (COs) with Program Outcomes (POs) Program Specific Outcomes (PSOs)															
COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	2	3		3								1	3	2	2
CO2	3	3		3								1	3	2	2
CO3	2	3		2								1	3	2	2
CO4	3	2		3								1	3	2	2
CO5	3	3		3								2	3	2	2
	3	High				2	Medium					1	Low		

Formative assessment			
Bloom’s Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Classroom / Online Quiz/Group discussion	5	15
Understand	Class Presentation/Power point presentation	5	
	Attendance	5	

Summative Assessment				
Bloom’s Category	**Continuous Assessment Tests**			**Terminal Examination (60)**
	1 (7.5)	**2 (7.5)**	**3 (10)**	
Remember	10	10	10	20
Understand	10	10	10	20
Apply	30	30	30	60
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

22PEA012	SPEECH AND AUDIO SIGNAL PROCESSING	L	T	P	C
		3	0	0	3
Nature of Course	Elective core				
Pre requisites	Audio Engineering				

Course Objectives:

1.To study basic concepts of processing speech and audio signals
2.To study and analyse various M-band filter-banks for audio coding
3.To understand audio coding based on transform coders.
4. To study time and frequency domain speech processing method.
5. To understand the speech processing concept

Course Outcomes

On successful completion of the course, students will be able to

CO. No.	Course Outcome	Bloom's Level
CO1	Compute the basic concepts of processing speech and audio signals	Apply
CO2	Analyze various M-band filter-banks for audio coding	Analyze
CO3	Understand audio coding based on transform coders.	Understand
CO4	Compare the time and frequency domain speech processing method	Analyze
CO5	Understand the speech processing concept	Understand

Course Contents:

UNIT I MECHANICS OF SPEECH AND AUDIO 9

Introduction - Review of Signal Processing Theory-Speech production mechanism — Nature of Speech signal – Discrete time modelling of Speech production – Classification of Speech sounds –Phones — Phonemes — Phonetic and Phonemic alphabets — Articulatory features. Absolute Threshold of Hearing - Critical Bands- Simultaneous Masking, Masking-Asymmetry, and the Spread of Masking- Nonsimultaneous Masking - Perceptual Entropy - Basic measuring philosophy - Subjective versus objective perceptual testing - The perceptual audio quality measure (PAQM) -Cognitive effects in judging audio quality.

UNIT II TIME-FREQUENCY ANALYSIS: FILTER BANKS AND TRANSFORMS 9

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

UNIT III AUDIO CODING AND TRANSFORM CODERS 9

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

UNIT IV TIME AND FREQUENCY DOMAIN METHODS FOR SPEECH PROCESSING 9

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

methods Homomorphic Speech Analysis: Cepstral analysis of Speech – Formant and Pitch Estimation — Homomorphic Vocoders

UNIT V PREDICTIVE ANALYSIS OF SPEECH **9**

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

TOTAL : 45 PERIODS

REFERENCES:

1. B.Gold and N.Morgan, “Speech and Audio Signal Processing”, Wiley and Sons, 2000.
2. L.R.Rabiner and R.W.Schaffer, "Digital Processing of Speech Signals", Prentice Hall, 1978.
3. Mark Kahrs, Karlheinz Brandenburg, Kluwer Applications of Digital Signal Processing to Audio And Acoustics, Academic Publishers,
4. Udo Zölzer, "Digital Audio Signal Processing", Second Edition A John Wiley& sons Ltd

Mapping of Course Outcomes (COs) with Program Outcomes (POs) Program Specific Outcomes (PSOs)															
COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	2	3		3								1	3	2	2
CO2	3	3		3								1	3	2	2
CO3	2	3		2								1	3	2	2
CO4	3	2		3								1	3	2	2
CO5	3	3		3								2	3	2	2
	3	High				2	Medium					1	Low		

Formative assessment			
Bloom’s Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Classroom / Online Quiz/Group discussion	5	15
Understand	Class Presentation/Power point presentation	5	
	Attendance	5	

Summative Assessment				
Bloom’s Category	**Continuous Assessment Tests**			**Terminal Examination (60)**
	1 (7.5)	**2 (7.5)**	**3 (10)**	
Remember	10	10	10	20
Understand	10	10	10	20
Apply	30	30	30	60
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

22PEA013	INTERNET of THINGS	L	T	P	C
		3	0	0	3
Nature of Course	Elective core				
Pre requisites	Electronic circuits				

Course Objectives:

1. To understand the fundamentals of Internet of Things
2. To learn about the basics of IOT protocols
3. To build a small low cost embedded system using Raspberry Pi.
4. To apply the concept of Internet of Things in real world
5. To understand the IoT in real world scenario

Course Outcomes

On successful completion of the course, students will be able to

CO. No.	Course Outcome	Bloom's Level
CO1	Analyze various protocols for IoT	Analyze
CO2	Develop web services to access/control IoT devices	Create
CO3	Design a portable IoT using Rasperry Pi	Create
CO4	Deploy an IoT application and connect to the cloud.	Apply
CO5	Analyze applications of IoT in real time scenario	Analyze

Course Contents:

UNIT I INTRODUCTION TO IoT **9**

Internet of Things - Physical Design- Logical Design- IoT Enabling Technologies - IoT Levels & Deployment Templates - Domain Specific IoTs - IoT and M2M - IoT System Management with NETCONF-YANG- IoT Platforms Design Methodology

UNIT II IoT ARCHITECTURE **9**

M2M high-level ETSI architecture - IETF architecture for IoT - OGC architecture - IoT reference model - Domain model - information model - functional model - communication model - IoT reference architecture

UNIT III IoT PROTOCOLS **9**

Protocol Standardization for IoT – Efforts – M2M and WSN Protocols – SCADA and RFID Protocols — Unified Data Standards — Protocols — IEEE 802.15.4 — BACNet Protocol — Modbus– ZigbeeArchitecture – Network layer – 6LowPAN - CoAP – Security

UNIT IV BUILDING IoT WITH RASPBERRY PI & ARDUINO **9**

Building IOT with RASPERRY PI- IoT Systems - Logical Design using Python — IoT Physical Devices & Endpoints - IoT Device -Building blocks -Raspberry Pi -Board - Linux on Raspberry Pi - Raspberry Pi Interfaces -Programming Raspberry Pi with Python - Other IoT Platforms - Arduino.

UNIT V CASE STUDIES AND REAL-WORLD APPLICATIONS **9**

Real world design constraints - Applications - Asset management, Industrial automation, smart grid, Commercial building automation, Smart cities - participatory sensing - Data Analytics for IoT — Software & Management Tools for IoT Cloud Storage Models & Communication APIs - Cloud for IoT - Amazon Web Services for IoT.

TOTAL :45 PERIODS

REFERENCES:

1. Arshdeep Bahga, Vijay Madisetti, “Internet of Things – A hands-on approach”, Universities Press,2015
2. Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), “Architecting the Internet of Things”, Springer, 2011.
3. Honbo Zhou, “The Internet of Things in the Cloud: A Middleware Perspective”, CRC Press, 2012.
4. Jan Ho¨ ller, Vlasios Tsiatsis , Catherine Mulligan, Stamatis , Karnouskos, Stefan Avesand. David Boyle, "From Machine-to-Machine to the Internet of Things - Introduction to a New Age of Intelligence", Elsevier, 2014.
5. Olivier Hersent, David Boswarthick, Omar Elloumi , “The Internet of Things – Key applicationsand Protocols”, Wiley, 2012

Mapping of Course Outcomes (COs) with Program Outcomes (POs) Program Specific Outcomes (PSOs)															
COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	2	3		3								1	3	2	2
CO2	3	3		3								1	3	2	2
CO3	2	3		2								1	3	2	2
CO4	3	2		3								1	3	2	2
CO5	3	3		3								2	3	2	2
	3	High				2	Medium					1	Low		

Formative assessment			
Bloom’s Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Classroom / Online Quiz/Group discussion	5	15
Understand	Class Presentation/Power point presentation	5	
	Attendance	5	

Summative Assessment				
Bloom’s Category	**Continuous Assessment Tests**			**Terminal Examination (60)**
	1 (7.5)	**2 (7.5)**	**3 (10)**	
Remember	10	10	10	20
Understand	10	10	10	20
Apply	30	30	30	60
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

22PEA014	SOLID STATE DEVICE MODELLING AND SIMULATION	L	T	P	C
		3	0	0	3
Nature of Course	Elective core				
Pre requisites	VLSI deisgn				

Course Objectives:

1. To understand the concept of device modeling
2. To learn multistep method
3. To study device simulations
4. To study the concept
5. To understand

Course Outcomes

On successful completion of the course, students will be able to

CO. No.	Course Outcome	Bloom's Level
CO1	Explain the importance of MOS Capacitor and Small signal modeling	Remember
CO2	Apply and determine the drift diffusion equation and stiff system equation	Apply
CO3	Analyze circuits using parasitic BJT parameters and newton Raphson method	Analyze
CO4	Model the MOS transistor using schrodinger equation	Apply
CO5	Evaluate the Multistep methods.	Evaluate

Course Contents:

UNIT I MOSFET DEVICE PHYSICS MOSFET **9**

capacitor, Basic operation, Basic modeling, Advanced MOSFET modeling, RF modeling of MOS transistors, Equivalent circuit representation of MOS transistor, High frequency behavior of MOS transistor and A.C small signal modeling, model parameter extraction, modeling parasitic BJT, Resistors, Capacitors, Inductors.

UNIT II DEVICE MODELLING **9**

Prime importance of circuit and device simulations in VLSI; Nodal, mesh, modified nodal and hybrid analysis equations. Solution of network equations: Sparse matrix techniques, solution of nonlinear networks through Newton-Raphson technique, convergence and stability.

UNIT III MULTISTEP METHODS **9**

Solution of stiff systems of equations, adaptation of multistep methods to the solution of electrical networks, general purpose circuit simulators.

UNIT IV MATHEMATICAL TECHNIQUES DEVICE SIMULATIONS **9**

Poisson equation, continuity equation, drift-diffusion equation, Schrodinger equation, hydrodynamic equations, trap rate, finite difference solutions to these equations in 1D and 2D space, grid generation.

UNIT V SIMULATION OF DEVICES **9**

Computation of characteristics of simple devices like p-n junction, MOS capacitor and MOSFET; Small-signal analysis.

TOTAL :45 PERIODS

REFERENCES:

1. Arora, N., “MOSFET Modeling for VLSI Simulation”, Cadence Design Systems, 2007
2. Chua, L.O. and Lin, P.M., “Computer-Aided Analysis of Electronic Circuits: Algorithms and Computational Techniques”, Prentice-Hall., 1975
3. Fjeldly, T., Yetterdal, T. and Shur, M., “Introduction to Device Modeling and Circuit Simulation”, Wiley-Interscience., 1997
4. Grasser, T., “Advanced Device Modeling and Simulation”, World Scientific Publishing Company., 2003
5. Selberherr, S., “Analysis and Simulation of Semiconductor Devices”, Springer- Verlag.,1984
6. Trond Ytterdal, Yuhua Cheng and Tor A. FjeldlyWayne Wolf, “Device Modeling for Analog and RF CMOS Circuit Design”, John Wiley & Sons Ltd.

Mapping of Course Outcomes (COs) with Program Outcomes (POs) Program Specific Outcomes (PSOs)															
COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	2	3		3								1	3	2	2
CO2	3	3		3								1	3	2	2
CO3	2	3		2								1	3	2	2
CO4	3	2		3								1	3	2	2
CO5	3	3		3								2	3	2	2
	3	High				2	Medium					1	Low		

Formative assessment			
Bloom’s Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Classroom / Online Quiz/Group discussion	5	15
Understand	Class Presentation/Power point presentation	5	
	Attendance	5	

Summative Assessment				
Bloom’s Category	**Continuous Assessment Tests**			**Terminal Examination (60)**
	1 (7.5)	**2 (7.5)**	**3 (10)**	
Remember	10	10	10	20
Understand	10	10	10	20
Apply	30	30	30	60
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

22PEA015	SYSTEM ON CHIP DESIGN	L	T	P	C
		3	0	0	3
Nature of Course	Elective core				
Pre requisites	Embedded systems				

Course Objectives:

1. To Analyse algorithms and architecture of hardware software
2. To Model and specify systems at high level of abstraction
3. To appreciate the co-design approach and virtual platform models
4. To Understand hardware, software and interface synthesis
5. To evaluate the system based on requirements and implementation constraints

Course Outcomes

On successful completion of the course, students will be able to

CO. No.	Course Outcome	Bloom's Level
CO1	Analyse algorithms and architecture of hardware software	Analyze
CO2	Model and specify systems at high level of abstraction	Apply
CO3	Appreciate the co-design approach and virtual platform models	Analyze
CO4	Understand hardware, software and interface synthesis	Understand
CO5	Evaluate the system based on requirements and implementation constraints	Evaluate

Course Contents:

UNIT I INTRODUCTION **9**

Introduction to SoC Design, system level design, methodologies and tools, system hardware: IO, communication, processing units, memories; operating systems: prediction of execution, real time scheduling, embedded OS, middle ware; Platform based SoC design, multiprocessor SoC and Network on Chip, Low power SoC Design

UNIT II SYSTEM LEVEL MODELLING **9**

SystemC: overview, Data types, modules, notion of time, dynamic process, basic channels, structure communication, ports and interfaces, Design with examples

UNIT III HARDWARE SOFTWARE CO-DESIGN **9**

Analysis, partitioning, high level optimisations, real-time scheduling, hardware acceleration, voltage scaling and power management; Virtual platform models, co-simulation and FPGAs for prototyping of HW/SW systems.

UNIT IV SYNTHESIS **9**

System synthesis: Transaction Level Modelling (TLM) based design, automaticTLM generation and mapping, platform synthesis; software synthesis: code generation, multi task synthesis, internal and external communication; Hardware synthesis: RTL architecture, Input models, estimation and optimisation, resource sharing and pipelining and scheduling

UNIT V SOC VERIFICATION AND TESTING **9**

SoC and IP integration, Verification : Verification technology options, verification methodology, overview: system level verification, physical verification, hardware/software co-verification; Test requirements and methodologies, SoC design for testability - System modeling, test power dissipation, test access mechanism

TOTAL : 45 PERIODS

REFERENCES:

1. Arshdeep Bahga, Vijay Madisetti, “Internet of Things – A hands-on approach”, Universities Press, 2015
2. Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), “Architecting the Internet of Things”, Springer, 2011.
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Mapping of Course Outcomes (COs) with Program Outcomes (POs) Program Specific Outcomes (PSOs)

COs	POs												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
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CO3	2	3		2								1	3	2	2
CO4	3	2		3								1	3	2	2
CO5	3	3		3								2	3	2	2
	3	High				2	Medium					1	Low		

Formative assessment			
Bloom’s Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Classroom / Online Quiz/Group discussion	5	15
Understand	Class Presentation/Power point presentation	5	
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Summative Assessment				
Bloom’s Category	**Continuous Assessment Tests**			**Terminal Examination (60)**
	1 (7.5)	**2 (7.5)**	**3 (10)**	
Remember	10	10	10	20
Understand	10	10	10	20
Apply	30	30	30	60
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

22PEA016	ROBOTICS	L	T	P	C
		3	0	0	3
Nature of Course	Elective core				
Pre requisites	Embedded systems				

Course Objectives:

1. To understand robot locomotion and mobile robot kinematics
2. To understand perception in robotics
3. To understand mobile robot localization
4. To understand mobile robot mapping
5. To understand simultaneous localization and mapping (SLAM)

Course Outcomes

On successful completion of the course, students will be able to

CO. No.	Course Outcome	Bloom's Level
CO1	Explain robot locomotion	Remember
CO2	Apply kinematics models and constraints	Apply
CO3	Implement vision algorithms for robotics	Apply
CO4	Implement SLAM algorithms	Apply
CO5	Understand the planning and navigation	Understand

Course Contents:

UNIT I LOCOMOTION AND KINEMATICS **9**

Introduction to Robotics – key issues in robot locomotion – legged robots – wheeled mobile robots –aerial mobile robots – introduction to kinematics – kinematics models and constraints – robot maneuverability

UNIT II ROBOT PERCEPTION **9**

Sensors for mobile robots – vision for robotics – cameras – image formation – structure from stereo – structure from motion – optical flow – color tracking – place recognition – range data

UNIT III MOBILE ROBOT LOCALIZATION **9**

Introduction to localization – challenges in localization – localization and navigation – belief representation – map representation – probabilistic map-based localization – Markov localization –EKF localization – UKF localization – Grid localization – Monte Carlo localization – localization in dynamic environments

UNIT IV MOBILE ROBOT MAPPING **9**

Autonomous map building — occupancy grip mapping — MAP occupancy mapping — SLAM — extended Kalman Filter SLAM – graph-based SLAM – particle filter SLAM – sparse extended information filter — fastSLAM algorithm.

UNIT V PLANNING AND NAVIGATION **9**

Introduction to planning and navigation — planning and reacting — path planning — obstacle avoidance techniques – navigation architectures – basic exploration algorithms

TOTAL 45 PERIODS

REFERENCES:

1. Gregory DudekandMichael Jenkin, “Computational Principles of Mobile Robotics”, Second Edition, Cambridge University Press, 2010.
2. Howie Choset et al., “Principles of Robot Motion: Theory, Algorithms, and Implementations”, A Bradford Book, 2005.
3. Maja J. Mataric, “The Robotics Primer”, MIT Press, 2007.
4. Roland Seigwart, Illah Reza Nourbakhsh, and Davide Scaramuzza, “Introduction to autonomous mobile robots”, Second Edition, MIT Press, 2011.
5. Sebastian Thrun, Wolfram Burgard, and Dieter Fox, “Probabilistic Robotics”, MIT Press, 2005.

Mapping of Course Outcomes (COs) with Program Outcomes (POs) Program Specific Outcomes (PSOs)															
COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	2	3		3								1	3	2	2
CO2	3	3		3								1	3	2	2
CO3	2	3		2								1	3	2	2
CO4	3	2		3								1	3	2	2
CO5	3	3		3								2	3	2	2
	3	High				2	Medium					1	Low		

Formative assessment			
Bloom’s Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Classroom / Online Quiz/Group discussion	5	15
Understand	Class Presentation/Power point presentation	5	
	Attendance	5	

Summative Assessment				
Bloom’s Category	**Continuous Assessment Tests**			**Terminal Examination (60)**
	1 (7.5)	**2 (7.5)**	**3 (10)**	
Remember	10	10	10	20
Understand	10	10	10	20
Apply	30	30	30	60
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

22PEA017	PHYSICAL DESIGN OF VLSI CIRCUITS	L	T	P	C
		3	0	0	3
Nature of Course	Elective core				
Pre requisites	Embedded systems				

Course Objectives:

1. To introduce the physical design concepts such as routing, placement, partitioning and packaging
2. To study the performance of circuits layout designs, compaction techniques.
3. To study the outline 1D compaction- 2D compaction.
4. To Understand the performance issues in circuit Layout.
5. To Understand the concept of routing

Course Outcomes

On successful completion of the course, students will be able to

CO. No.	Course Outcome	Bloom's Level
CO1	Explain different types of routing	Remember
CO2	Discuss performance issues in circuit layout	Apply
CO3	Outline 1D compaction- 2D compaction.	Apply
CO4	Understand the performance issues in circuit Layout	Understand
CO5	Understand the concept of routing	Understand

Course Contents:

UNIT I INTRODUCTION TO VLSI TECHNOLOGY 9

Layout Rules-Circuit abstraction Cell generation using programmable logic array transistor chaining, Wein Berger arrays and gate matrices-layout of standard cells gate arrays and sea of gates, field programmable gate array(FPGA)-layout methodologies Packaging-Computational Complexity - Algorithmic Paradigms.

UNIT II PLACEMENT USING TOP-DOWN APPROACH 9

Partitioning: Approximation of Hyper Graphs with Graphs, Kernighan-Lin Heuristic Ratio cut partition with capacity and i/o constrants. Floor planning: Rectangular dual floor planning hierarchical approach- simulated annealing- Floor plan sizing Placement: Cost function- force directed methodplacement by simulated annealing partitioning placement- module placement on a resistive network — regular placement linear placement.

UNIT III ROUTING USING TOP DOWN APPROACH 9

Fundamentals: Maze Running- line searching- Steiner trees Global Routing: Sequential Approaches - hierarchial approaches - multi commodity flow based techniques - Randomised Routing- One Step approach - Integer Linear Programming Detailed Routing: Channel Routing - Switch box routing. Routing in FPGA: Array based FPGA- Row based FPGAs

UNIT IV PERFORMANCE ISSUES IN CIRCUIT LAYOUT 9

Delay Models: Gate Delay Models- Models for interconnected Delay- Delay in RC trees. Timing — Driven Placement: Zero Stack Algorithm- Weight based placement- Linear Programming Approach Timing riving Routing: Delay Minimization- Click Skew Problem- Buffered Clock Trees. Minimization: constrained via Minimization unconstrained via Minimization- Other issues in minimization

UNIT V SINGLE LAYER ROUTING, CELL GENERATION AND COMPACTION 9

Planar subset problem(PSP)- Single Layer Global Routing- Single Layer detailed Routing- Wire length and bend minimization technique — Over The Cell (OTC) Routing Multiple chip modules(MCM)- programmable Logic Arrays- Transistor chaining- Wein Burger Arrays- Gate matrix layout- 1D compaction- 2D compaction.

TOTAL: 45 PERIODS

REFERENCES:

1. Preas M. Lorenzatti, “Physical Design and Automation of VLSI systems”, The Benjamin Cummins Publishers, 1998.
2. Sarafzadeh, C.K. Wong, “An Introduction to VLSI Physical Design”, McGraw Hill Int. Edition 1995

Mapping of Course Outcomes (COs) with Program Outcomes (POs) Program Specific Outcomes (PSOs)															
COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	2	3		3								1	3	2	2
CO2	3	3		3								1	3	2	2
CO3	2	3		2								1	3	2	2
CO4	3	2		3								1	3	2	2
CO5	3	3		3								2	3	2	2
	3	High				2	Medium					1	Low		

Formative assessment			
Bloom’s Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Classroom / Online Quiz/Group discussion	5	15
Understand	Class Presentation/Power point presentation	5	
	Attendance	5	

Summative Assessment				
Bloom’s Category	**Continuous Assessment Tests**			**Terminal Examination (60)**
	1 (7.5)	**2 (7.5)**	**3 (10)**	
Remember	10	10	10	20
Understand	10	10	10	20
Apply	30	30	30	60
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

22PEE301	RESEARCH METHODOLOGY AND INTELLECTUAL PROPERTIES RIGHTS	L	T	P	C
		3	0	0	3
Nature of course	Professional core				
Pre requisites	Nil				

Course Objectives

The course is intended to

1. Impart knowledge and skills required for research problem formulation
2. Identify the relevant literatures for research
3. Develop skills on technical paper writing / presentation without violating professional ethics
4. Acquire knowledge on IPR and patents.
5. Gain knowledge on patent rights and Patent information database.

Course Outcomes

On successful completion of the course, students will be able to

CO. No	Course Outcome	Bloom's Level
CO 1	Identify and formulate research problem	Apply
CO 2	Concentrate on literatures related to research problem.	Understand
CO 3	Possess the ability to write a standard technical paper and presentation.	Apply
CO 4	Find the correct procedure for applying patents	Apply
CO 5	Become well versed on patent rights, licensing and transfer of technology.	Understand

Course Contents

Unit – I	**Research Problem Formulation**	**9**

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**	**9**

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

Unit – III	**Technical Writing /Presentation**	**9**

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

Unit – IV	**Introduction to Intellectual Property Rights (IPR)**	**9**

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, Research Hypothesis, Innovation, patenting development, Citation, International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

Unit – V	**Intellectual Property Rights (IPR)**	**9**

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 : 45 Periods

Reference Books

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.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	3	3			3	3		2				3		2	
CO 2	3	3			3	3		2				3		2	
CO 3	3	3			3	3		2				3		2	
CO 4	3	3			3	3		2				3		2	
CO 5	3	3			3	3		2				3		2	
	3	High				2	Medium					1	Low		

Formative assessment			
Bloom’s Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Online Quiz	5	15
Understand	Tutorial Class / Assignment	5	
	Attendance	5	

Summative Assessment				
Bloom’s Category	**Internal Assessment Examinations**			**Final Examination (60)**
	IAE – I (7.5)	**IAE – II (7.5)**	**IAE – III (10)**	
Remember	10	10	10	20
Understand	10	10	10	20
Apply	30	30	30	60
Analyze				
Evaluate				
Create				

22PAE301	PROJECT WORK PHASE - I	L	T	P	C
		0	0	12	6
Nature of course	Employability Enhancement Course				
Pre requisites	Concepts of Research Methodology				

Course Objectives

The course is intended to

1. Identify a specific problem for the current structural needs of the society.
2. Collect information related to the same through detailed review of literature.
3. Develop the methodology to solve the identified problem
4. Review the methodology and comparing its merits and demerits.
5. Experimental work related to the methodology which includes basic concepts , basic tests etc.,

Course Outcomes

On successful completion of the course, students will be able to

CO. No	Course Outcome	Bloom's Level
CO 1	Identify and formulate research problem	Apply
CO 2	Concentrate on literatures related to research problem.	Understand
CO 3	Possess the ability to write a standard technical paper and presentation.	Apply
CO 4	Find the correct procedure for applying patents	Apply
CO 5	Become well versed on patent rights, licensing and transfer of technology.	Understand

Course Contents

The student individually works on a specific topic approved by faculty member who is familiar in this area of interest. The student can select any topic which is relevant to his/her specialization of the programme. The topic may be experimental or analytical or case studies. At the end of the semester, a detailed report on the work done should be submitted which contains clear definition of the identified problem, detailed literature review related to the area of work and methodology for carrying out the work. The students will be evaluated through a viva-voce examination by a panel of examiners including one external examiner.

Total : 180 Periods

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)															
COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO 1	3	3	3	3	3	3	3	3	3	3	3	3	2	3	
CO 2	3	3	3	3	3	3	3	3	3	3	3	3	2	3	
CO 3	3	3	3	3	3	3	3	3	3	3	3	3	2	3	
CO 4	3	3	3	3	3	3	3	3	3	3	3	3	2	3	
CO 5	3	3	3	3	3	3	3	3	3	3	3	3	2	3	
	3	High				2	Medium					1	Low		

	Continuous Assessment [50 marks]						**Final Viva Voce Examination [50 marks]**
	Review I [10]	**Review II [10]**	**Review III [10]**	**Publication [10]**	**Report [10 Marks]**	**Total [50]**	
Marks	100	100	100	10	10	50	50

22PEA018	Signal Integrity for High Speed Design	L	T	P	C
		3	0	0	3
Nature of course	Professional Elective				
Pre requisites	Transmission Lines and RF Systems				

Course Objectives

The course is intended to

1. Acquire the Knowledge of Signal Propagation on Transmission Lines.
2. Understand the Multi Conductor Transmission Lines.
3. Analyze the Non Ideal characteristics of Transmission lines.
4. Design the systems for power consideration.
5. Explain the Clock Distributors and Oscillators.

Course Outcomes

On successful completion of the course, students will be able to

CO. No	Course Outcome	Bloom's Level
CO 1	Acquire the Knowledge of Signal Propagation on Transmission Lines.	Remember
CO 2	Observe the Multi Conductor Transmission Lines.	Understand
CO 3	Analyze the Non-Ideal characteristics of Transmission Lines.	Analyze
CO 4	Design the systems for power consideration.	Understand
CO 5	Explain the Clock Distributors and Oscillators.	Understand

Course Contents

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 micro strip) Differential signaling, 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**

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 component, Eye diagram, jitter, inter-symbol interference Bit-error rate.

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

Text Books

1. Douglas Brooks, Signal Integrity Issues and Printed Circuit Board Design, Prentice Hall PTR, 2003
2. Eric Bogatin," Signal and power Integrity "Pearson Publisher, Third Edition ,2018.

Reference Books

1. Stephen H.Hall,Howard L.Heck,"Advanced Signal Integrity for High Speed Digital Design" Wiley Publisher, First Edition, 2011.
2. H. W. Johnson and M. Graham, High-Speed Digital Design: A Handbook of Black Magic, Prentice Hall, 2002
3. S. Hall, G. Hall, and J. McCall, High-Speed Digital System Design: A Handbook of Interconnect Theory and Design Practices, Wiley-Interscience, 2008.

Additional / Web References

1. https://www.the technologyacademy.com/online-course/
2. https://www.doulos.com/training/signal-intergrity

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)															
COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO 1	3	2	2	2										2	
CO 2	3	2	2	2										2	
CO 3	3	3	2	2										3	
CO 4	3	3	2	2										3	
CO 5	3	3	2	2										3	
	3	High				2	Medium					1	Low		

Formative assessment			
Bloom's Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Online Quiz	5	15
Understand	Tutorial Class / Assignment	5	
	Attendance	5	

Summative Assessment				
Bloom's Category	**Internal Assessment Examinations**			**Final Examination (60)**
	IAE – I (7.5)	**IAE – II (7.5)**	**IAE – III (10)**	
Remember	10	10	10	20
Understand	30	30	30	60
Apply	0	0	0	0
Analyze	10	10	10	20
Evaluate	0	0	0	0
Create	0	0	10	0

22PEA019	MEMS AND NEMS	L	T	P	C
		3	0	0	3
Nature of course	Professional Elective				
Pre requisites	VLSI				

Course Objectives

The course is intended to

1. To introduce the concepts of micro electro mechanical devices.
2. To know the fabrication process of Microsystems.
3. To know the design concepts of micro sensors
4. To know the design concepts of micro actuators
5. To familiarize concepts of quantum mechanics and nano systems

Course Outcomes

On successful completion of the course, students will be able to

CO. No	Course Outcome	Bloom's Level
CO 1	Examine the concepts of micro electro mechanical devices	Remember
CO 2	Interpret the fabrication process of Microsystems.	Understand
CO 3	Illustrate the concepts of micro sensors.	Understand
CO 4	Determine the concepts of Micro Actuators.	Understand
CO 5	Develop the familiarize concepts of quantum mechanics and nano systems	Apply

Course Contents

Unit – I Overview **9**

New trends in Engineering and Science: Micro and Nanoscale systems, Introduction to Design of MEMS and NEMS, MEMS and NEMS – Applications, Devices and structures. Materials for MEMS: Silicon, silicon compounds, polymers, metals.

Unit – II Mems Fabrication Technologies **9**

Microsystem fabrication processes: Photolithography, Ion Implantation, Diffusion, Oxidation. Thin film depositions: LPCVD, Sputtering, Evaporation, Electroplating; Etching techniques: Dry and wet etching, electrochemical etching; Micromachining: Bulk Micromachining, Surface Micromachining, High Aspect- Ratio (LIGA and LIGA-like) Technology; Packaging: Microsystems packaging, Essential packaging technologies, Selection of packaging materials..

Unit – III Micro Sensors **9**

MEMS Sensors: Design of Acoustic wave sensors, resonant sensor, Vibratory gyroscope, Capacitive and Piezo Resistive Pressure sensors- engineering mechanics behind these Microsensors. Case study: Piezo-resistive pressure sensor.

Unit – IV Micro Actuators **9**

Design of Actuators: Actuation using thermal forces, Actuation using shape memory Alloys, Actuation using piezoelectric crystals, Actuation using Electrostatic forces (Parallel plate, Torsion bar, Comb drive actuators), Micromechanical Motors and pumps. Case study: Comb drive actuators

Unit – V Nano systems And Quantum Mechanics **9**

Atomic Structures and Quantum Mechanics, Molecular and Nanostructure Dynamics: Schrodinger Equation and Wave function Theory, Density Functional Theory, Nanostructures and Molecular Dynamics, Electromagnetic Fields and their quantization, Molecular Wires and Molecular Circuits.

Total : 45 Periods

Text Books

1. Tai Ran Hsu ,"MEMS and Microsystems Design and Manufacture" ,Tata McGraw Hill, 2012
2. Chang Liu, "Foundations of MEMS", Pearson education India limited, 2012.

Reference Books

1. Marc Madou, "Fundamentals of Microfabrication", CRC press 2017
2. Stephen D. Senturia," Micro system Design", Kluwer Academic Publishers,2005
3. Sergey Edward Lyshevski, "MEMS and NEMS: Systems, Devices, and Structures" CRC, 2018

Additional / Web References

1. https://www.coursera.org/lecture/sensor-manufacturing-process-control
2. https://nptel.ac.in/courses/117/105/117105082/

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)															
COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO 1	2	3	2	3									3	2	2
CO 2	3	3	2	3									3	2	2
CO 3	2	3	2	2									3	2	2
CO 4	3	2	2	3									3	2	2
CO 5	3	3	2	3									3	2	2
	3	High				2	Medium					1	Low		

Formative assessment			
Bloom's Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Online Quiz	5	15
Understand	Tutorial Class / Assignment	5	
	Attendance	5	

Summative Assessment				
Bloom's Category	**Internal Assessment Examinations**			**Final Examination (60)**
	IAE – I (7.5)	**IAE – II (7.5)**	**IAE – III (10)**	
Remember	10	10	10	20
Understand	30	30	30	60
Apply	10	10	10	20
Analyze				
Evaluate				
Create				

22PEA020	SECURE COMPRISING SYSTEMS	L	T	P	C
		3	0	0	3
Nature of course	Professional Elective				
Pre requisites	Computer Architecture And Organization				

Course Objectives

The course is intended to

1. Learn Computer Security and Management.
2. Acquire the Knowledge of Computer Hardware Architecture.
3. Expose Assembly and Operating systems Security.
4. Study the Advanced Computer Architecture.
5. Know the Network and web security

Course Outcomes

On successful completion of the course, students will be able to

CO. No	Course Outcome	Bloom's Level
CO 1	Show the computer security and management.	Remember
CO 2	Outline the Computer Hardware Architecture.	Understand
CO 3	Infer Assembly and Operating systems security.	Understand
CO 4	Identify the Advanced computer Architecture.	Apply
CO 5	Examine Network and Web security.	Apply

Course Contents

Unit – I	**Computer Security And Management**	**9**

Overview of Computer Security, Threats, Malware, Vulnerabilities, Authentication, Access Control, Security Management Models, Security Management Practices, Protection Mechanisms, Legal aspects of security, Ethical Hacking.

Unit – II	**Hardware Security**	**9**

Need for Hardware Security, Computer Memory and storage, Bus and Interconnection, I/O and Network Interface, CPU; Side channel Analysis: Power Analysis Attack, Timing Attack, Fault attack. Countermeasures of Side Channel Attack, Secure Hardware Intellectual Properties, Physically Unclonable Functions (PUFs), Secure PUF.

Unit – III	**Assembly And Operating Systems Security**	**9**

Opcode, Operands, Addressing Modes, Stack and Buffer Overflow, FIFO and M/M/1 Problem, Kernel, Drivers and OS Security; Secure Design Principles, Trusted Operating Systems, Trusted System Function.

Unit – IV	**Advanced Computer Architecture**	**9**

Security aspects : Multiprocessors, parallel processing, Ubiquitous computing, Grid, Distributed and cloud computing, Internet computing, Virtualization

Unit – V	**Network and Web security**	**9**

ATCP/IP Protocol, Network switches, Routers, Gateways, Wireless Networks and Network Address Translation (NAT); Network Security Issues in TCP/IP, Threat Models, Denial of Service Attacks, Firewalls, Intrusion Detection, Browser Attacks, Web Attacks Targeting Users, Email Attacks, Secure Shell (SSH), HTTPS

Total : 45 Periods

Text Books

1. Charles B. Pfleeger, Shari Lawrence Pfleeger, “Security in Computing”, Fourth Edition, Pearson Education, 2007
2. Debdeep Mukhopadhyay, Rajat Subhra Chakraborty, “Hardware Security - Design Threats and Safeguards”, CRC Press, 2015

Reference Books

1. Michael Whitman, Herbert J. Mattord, “Management of Information Security”, Third Edition, Course Technology, 2018
2. Shuangbao Wang, Robert S.Ledley, Computer Architecture and Security, Wiley, 2013
3. William Stallings, “Network Security Essentials, Applications and Standards”, Dorling Kindersley I P Ltd, Delhi, 2008.

Additional / Web References

1. https://www.coursera.org/specializations/computer-security-systems-management/
2. https://www.coursera.org/specializations/embedded-systems-security

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)															
COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO 1	3	3	1										3	1	
CO 2	3	2	2										3	1	1
CO 3	3	3	2										3	1	1
CO 4	3	2											3	1	
CO 5	3	2	2										3	1	1
	3	High				2	Medium					1	Low		

Formative assessment			
Bloom’s Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Online Quiz	5	15
Understand	Tutorial Class / Assignment	5	
	Attendance	5	

Summative Assessment				
Bloom’s Category	**Internal Assessment Examinations**			**Final Examination (60)**
	IAE – I (7.5)	**IAE – II (7.5)**	**IAE – III (10)**	
Remember	10	10	10	20
Understand	30	30	30	60
Apply	10	10	10	20
Analyze				
Evaluate				
Create				

22PEA021	PATTERN RECOGNITION	L	T	P	C
		3	0	0	3
Nature of course	Professional Elective				
Pre requisites	Digital Image Processing				

Course Objectives

The course is intended to

1. Learn about supervised and unsupervised pattern classifiers.
2. Learn about Clustering.
3. Familiarize about different feature extraction techniques.
4. Explore the role of Hidden Marko model and SVM in pattern recognition
5. Understand the application of Fuzzy logic and genetic algorithms for pattern classifier

Course Outcomes

On successful completion of the course, students will be able to

CO. No	Course Outcome	Bloom's Level
CO 1	Observe the supervised and unsupervised pattern classifiers.	Remember
CO 2	Interpret the Clustering.	Understand
CO 3	Express about different feature extraction techniques.	Apply
CO4	Identify the role of Hidden Marko model and SVM in pattern recognition	Apply
CO5	Understand the application of Fuzzy logic and genetic algorithms for pattern classifier.	Understand

Course Contents

Unit – I **Pattern Classifier** **9**

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

Unit – II **Clustering** **9**

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

Unit – III **Feature Extraction And Structural Pattern Recognition** **9**

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

Unit – IV **Hidden Markov Models And Support Vector Machine** **9**

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

Unit – V **Recent Advances** **9**

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

Total : 45 Periods

Text Books

1. Andrew Webb, “Stastical Pattern Recognition”, Arnold publishers, London,1999
2. C.M.Bishop, “Pattern Recognition and Machine Learning”, Springer, 2006

Reference Books

1. M. Narasimha Murthy and V. Susheela Devi, “Pattern Recognition”, Springer 2011.
2. Menahem Friedman , Abraham Kandel, “Introduction to Pattern Recognition Statistical, Structural, Neural and Fuzzy Logic Approaches”, World Scientific publishing Co. Ltd, 2000.
3. Robert J.Schalkoff, “Pattern Recognition Statistical, Structural and Neural Approaches”, John Wiley & Sons Inc., New York, 2005.

Additional / Web References

1. https://www.coursera.org/courses?query=pattern%20recognition
2. https://nptel.ac.in/courses/106/106/106106046/

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)															
COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO 1	3	3	2										3	3	2
CO 2	3	3	2										1	3	3
CO 3	3	3	2										2	3	2
CO 4	3	3	2										1	3	1
CO 5	3	3	2										2	3	1
	3	High				2	Medium					1	Low		

Formative assessment			
Bloom’s Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Online Quiz	5	15
Understand	Tutorial Class / Assignment	5	
	Attendance	5	

Summative Assessment				
Bloom’s Category	**Internal Assessment Examinations**			**Final Examination (60)**
	IAE – I (7.5)	**IAE – II (7.5)**	**IAE – III (10)**	
Remember	10	10	10	20
Understand	10	10	10	20
Apply	30	30	30	60
Analyze				
Evaluate				
Create				

22PAE401	PROJECT WORK PHASE - II	L	T	P	C
		0	0	24	12
Nature of course	Employability Enhancement Course				
Pre requisites	Knowledge in Electronics Engineering				

Course Objectives

The course is intended to

1. Solve the identified problem based on the formulated methodology
2. Develop skills to analyze the problem related to area.
3. Continue the trials until the expected positive results are obtained
4. Preparation of preliminary report and discussion on test results
5. Arrive at conclusion and suggestion for future works.

Course Outcomes

On successful completion of the course, students will be able to

CO. No	Course Outcome	Bloom's Level
CO 1	Select different software/ computational/analytical tools.	Select
CO 2	Design and develop an experimental set up/ equipment/test rig.	Creating
CO 3	Conduct tests on existing setup with equipments and draw logical results.	Analyzing
CO 4	Conclude the results with suitable remarks and suggestion for further extension of work.	Evaluating
CO 5	Present their topic of study to the engineering community.	Apply

Course Contents

The student should continue the phase I work on the selected topic as per the formulated methodology. At the end of the semester, after completing the work to the satisfaction of the supervisor and review committee, a detailed report should be prepared and submitted to the head of the department. The students will be evaluated based on the report and the viva-voce examination by a panel of examiners including one external examiner.

Total : 360 Periods

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	3	3	3	3	3	3	3	3	3	3	3	3	2	3	
CO 2	3	3	3	3	3	3	3	3	3	3	3	3	2	3	
CO 3	3	3	3	3	3	3	3	3	3	3	3	3	2	3	
CO 4	3	3	3	3	3	3	3	3	3	3	3	3	2	3	
CO 5	3	3	3	3	3	3	3	3	3	3	3	3	2	3	
	3	High				2	Medium					1	Low		

	Continuous Assessment [50 marks]						**Final Viva Voce Examination [50 marks]**
	Review I [10]	**Review II [10]**	**Review III [10]**	**Publication [10]**	**Report [10 Marks]**	**Total [50]**	
Marks	100	100	100	10	10	50	50

22PEA022	RF IC DESIGN	L	T	P	C
		3	0	0	3
Nature of course	Professional Elective				
Pre requisites	Electronic circuits				

Course Objectives

The course is intended to

1. To study the various impedance matching techniques used in RF circuit design.
2. To understand the functional design aspects of amplifier and LNAs
3. To know the various concepts of active and passive Mixers
4. To study the principles of operation of RF Oscillators
5. To analyze the design and apply constraints for PLL and Frequency synthesizers.

Course Outcomes

On successful completion of the course, students will be able to

CO. No	Course Outcome	Bloom's Level
CO 1	Find the various impedance matching techniques used in RF circuit design.	Remember
CO 2	Interpret the functional design aspects of amplifier and LNAs	Understand
CO 3	Explain the various concepts of active and passive Mixers	Understand
CO 4	Illustrate the principles of operation of RF Oscillators	Apply
CO 5	Analyze the design and apply constraints for PLL and Frequency Synthesizers.	Analyze

Course Contents

Unit – I **Impedance Matching In Amplifiers** **9**

Definition of „Q', series parallel transformations of lossy circuits, impedance matching using „L', „PI' and T networks, Integrated inductors, resistors, Capacitors, tunable inductors, transformers.

Unit – II **Amplifier Design** **9**

Noise characteristics of MOS devices, Design of CG LNA and inductor degenerated LNAs,Principles of RF Power Amplifiers design.

Unit – III **Active and Passive Mixers** **9**

Qualitative Description of the Gilbert Mixer - Conversion Gain, and distortion and noise , analysis of Gilbert Mixer – Switch in Mixer - Distortion in Unbalanced Switching Mixer - Conversion Gain in Unbalanced Switching Mixer - Noise in Unbalanced Switching Mixer - A Practical Unbalanced Switching Mixer. Sampling Mixer - Conversion Gain in Single Ended Sampling Mixer - Distortion in Single Ended Sampling Mixer - Intrinsic Noise in Single Ended Sampling Mixer - Extrinsic Noise in Single Ended Sampling Mixer.

Unit – IV **Oscillators** **9**

LC Oscillators, Voltage Controlled Oscillators, Ring oscillators, Delay Cells, tuning range in ring oscillators, Tuning in LC oscillators, Tuning sensitivity, Phase Noise in oscillators, sources of phase noise.

Unit – V **PLL and Frequency Synthesizers** **9**

Phase Detector/Charge Pump, Analog Phase Detectors, Digital Phase Detectors, Frequency Dividers, Loop Filter Design, Phase Locked Loops, Phase noise in PLL, Loop Bandwidth, Basic Integer-N frequency synthesizer, Basic Fractional-N frequency synthesizer.

Total : 45 Periods

Text Books

1. B.Razavi ,"RF Microelectronics" , Prentice-Hall ,2011
2. Bosco H Leung "VLSI for Wireless Communication", Second edition, Springer, 2011

Reference Books

1. Behzad Razavi, "Design of Analog CMOS Integrated Circuits" McGraw-Hill, 2017
2. Jia-sheng Hong, "Microstrip filters for RF/Microwave applications", Wiley, 2011
3. Thomas H.Lee, "The Design of CMOS Radio –Frequency Integrated Circuits", Cambridge University Press ,2003

Additional / Web References

1. https://www.coursera.org/learn/rf-mmwave-circuit-design
2. https://www.udemy.com/course/introduction-to-radio-frequency-integrated-circuit-design/

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)															
COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO 1	3	3	2	3									3	2	2
CO 2	3	3	2	3									3	2	2
CO 3	3	3	2	2									3	2	2
CO 4	3	2	2	2									3	2	2
CO 5	3	3	2	2									3	2	2
	3	High				2	Medium					1	Low		

Formative assessment			
Bloom's Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Online Quiz	5	15
Understand	Tutorial Class / Assignment	5	
	Attendance	5	

Summative Assessment				
Bloom's Category	**Internal Assessment Examinations**			**Final Examination (60)**
	IAE – I (7.5)	**IAE – II (7.5)**	**IAE – III (10)**	
Remember	10	10	10	20
Understand	10	10	10	20
Apply	30	30	30	60
Analyze				
Evaluate				
Create				

22PEA023	NANO SCALE DEVICES	L	T	P	C
		3	0	0	3
Nature of course	Elective Core				
Pre requisites	VLSI Design				

Course Objectives

The course is intended to

1. Introduce the basic concepts of nano scale MOS transistors.
2. Understand the physical insights of MOS systems.
3. Introduce the nano wire FETS and transistors using molecular scale
4. Study various radiation effects in MOSFETS.
5. Explain the sampling, impulse response and convolution in CT and DT signals.

Course Outcomes

On successful completion of the course, students will be able to

CO. No	Course Outcome	Bloom's Level
CO 1	Examine the basic concepts of nano scale MOS transistors.	Remember
CO 2	Illustrate the physical insights of MOS systems	Understand
CO 3	Explain the basic concepts and characteristics of nano wire FETS and transistors	Apply
CO 4	Analyze the radiation effects of MOSFETS.	Analyze
CO 5	Analyze the analog and digital circuits using multi gate devices	Analyze

Course Contents

Unit – I	**Impedance Matching in Amplifiers**	**9**

MOSFET scaling, short channel effects - channel engineering - source/drain engineering - high k dielectric - copper interconnects - strain engineering, SOI MOSFET, multigate transistors – single gate - double gate – triple gate – surround gate, quantum effects – volume inversion – mobility – threshold voltage – inter subband scattering, multigate technology – mobility – gate stack.

Unit – II	**Amplifier Design**	**9**

MOS Electrostatics – 1D – 2D MOS Electrostatics, MOSFET Current-Voltage Characteristics – CMOS Technology – Ultimate limits, double gate MOS system – gate voltage effect - semiconductor thickness effect – asymmetry effect – oxide thickness effect – electron tunnel current – two dimensional confinement, scattering – mobility.

Unit – III	**Active And Passive Mixers**	**9**

Silicon nanowire MOSFETs – Evaluvation of I-V characteristics – The I-V characteristics for non-degenerate carrier statistics – The I-V characteristics for degenerate carrier statistics – Carbon nanotube – Band structure of carbon nanotube – Band structure of graphene – Physical structure of nanotube – Band structure of nanotube – Carbon nanotube FETs – Carbon nanotube MOSFETs – Schottky barrier carbon nanotube FETs – Electronic conduction in molecules .

Unit – IV	**Oscillators**	**9**

Radiation effects in SOI MOSFETs, total ionizing dose effects – single gate SOI – multigate devices, single event effect, scaling effects.

Unit – V	**PLL and Frequency Synthesizers**	**9**

Digital circuits – impact of device performance on digital circuits – leakage performance trade off – multi VT devices and circuits – SRAM design, analog circuit design – transconductance - intrinsic gain – flicker noise – self heating –band gap voltage reference – operational amplifier – comparator designs, mixed signal – successive approximation DAC, RF circuits.

Total : 45 Periods

Text Books

1. Brajesh kumar Kaushik,"NanoScale Devices:Physics,Modeling and their applications,CRC Publisher,First Edition ,2020.
2. Risal Singh Mital Gupta,"Introduction to Nanotechnology",Oxford University, First Edition 2018.

Reference Books

1. J P Colinge, "FINFETs and other multi-gate transistors", Springer – Seriesson integrated circuits and systems, 2008
2. Mark Lundstrom, Jing Guo, "Nanoscale Transistors: Device Physics, Modeling and Simulation", Springer, 2006
3. M S Lundstorm, "Fundamentals of Carrier Transport", 2nd Ed., Cambridge University Press, Cambridge UK, 2009

Additional / Web References

1. https://www.coursera.org/learn/nanotechnology
2. https://nanohub.org/resources/courses?view=tags

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)															
COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO 1	3	2	2	2									2	2	
CO 2	3	2	2	2									3	2	
CO 3	3	3	2	2									3	3	
CO 4	3	3	2	2									2	3	
CO 5	3	3	2	2									2	3	
	3	High				2	Medium					1	Low		

Formative assessment			
Bloom's Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Online Quiz	5	15
Understand	Tutorial Class / Assignment	5	
	Attendance	5	

Summative Assessment				
Bloom's Category	**Internal Assessment Examinations**			**Final Examination (60)**
	IAE – I (7.5)	**IAE – II (7.5)**	**IAE – III (10)**	
Remember	10	10	10	20
Understand	10	10	10	20
Apply				
Analyze	30	30	30	60
Evaluate				
Create				

22PEA024	THREE DIMENSIONAL NETWORKS ON CHIP	L	T	P	C
		3	0	0	3
Nature of course	Professional Elective				
Pre requisites	Communication Networks				

Course Objectives

The course is intended to

1. Introduce the concept of 3D NOC.
2. study the architectures and protocols of 3D NOC
3. Identify the types of fault and study the testing methods for fault rectification.
4. learn DimDE router for 3D NOC
5. Understand challenges and future trends in IoT

Course Outcomes

On successful completion of the course, students will be able to

CO. No	Course Outcome	Bloom's Level
CO 1	Understanding of the concepts, issues, and process of designing highly integrated SoCs	Understand
CO 2	Analyse algorithms of software in order to optimise the system based on requirements and implementation constraints	Analyze
CO 3	Evaluate the co-design approach and virtual platform models	Analyze
CO 4	Assess system and hardware level synthesis for integrated SoCs	Evaluate
CO 5	Testing the verification principles of SoCs	Evaluate

Course Contents

Unit – I	**INTRODUCTION TO THREE DIMENSIONAL NOC**	**12**

Three-Dimensional Networks-on-Chips Architectures. – Resource Allocation for QoSOn-Chip Communication – Networks-on-Chip Protocols-On-Chip Processor Traffic Modeling for Networks-on-Chip

Unit – II	**TEST AND FAULT TOLERANCE OF NOC**	**12**

Design-Security in Networks-on-Chips-Formal Verification of Communications in Networks-on-Chips-Test and Fault Tolerance for Networks-on-Chip Infrastructures-Monitoring Services for Networks-on-Chips.

Unit – III	**ENERGY AND POWER ISSUES OF NOC**	**12**

Energy and Power Issues in Networks-on-Chips-The CHAIN works Tool Suite: AComplete Industrial Design Flow for Networks-on-Chip.

Unit – IV	**MICRO-ARCHITECTURE OF NOC ROUTER**	**12**

Baseline NoC Architecture – MICRO-Architecture Exploration ViChaR: A Dynamic Virtual Channel Regulator for NoC Routers- RoCo: The Row-Column Decoupled Router – A Gracefully Degrading and Energy-Efficient Modular Router Architecture for On-Chip Networks. Exploring Fault Tolerant Networks-on-Chip Architectures.

Unit – V	**DIMDE ROUTER FOR 3D NOC**	**12**

A Novel Dimensionally-Decomposed Router for On-Chip Communication in 3D Architectures-Digest of Additional NoC MACRO-Architectural Research

Total : 60 Periods

Text Books

1. Fayezgebali, Haythamelmiligi, Hqhahed Watheq E1-Kharashi “Networks-on-Chips theory and practice CRC press,Second Edition ,2015.

Reference Books

1. Chrysostomos Nicopoulos, Vijaykrishnan Narayanan, Chita R.Das” Networks-on –Chip Architectures A Holistic Design Exploration”, Springer.D,Second Edition ,2017.

Additional / Web References

1. https://www.upf.edu/pra/en/3376/22580.
2. https://www.coursera.org/learn/iot.
1. https://bcourses.berkeley.edu.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)															
COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO 1	3	2	2	2										2	
CO 2	3	2	2	2										2	
CO 3	3	3	2	2										3	
CO 4	3	3	2	2										3	
CO 5	3	3	2	2										3	
	3	High				2	Medium					1	Low		

Formative assessment			
Bloom’s Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Online Quiz	5	15
Understand	Tutorial Class / Assignment	5	
	Attendance	5	

Summative Assessment				
Bloom’s Category	**Internal Assessment Examinations**			**Final Examination (60)**
	IAE – I (7.5)	**IAE – II (7.5)**	**IAE – III (10)**	
Remember				
Understand	10	10	10	20
Apply				
Analyze	30	30	30	60
Evaluate	10	10	10	20
Create				

22APE025	WAVELETS AND SIGNAL PROCESSING	L	T	P	C
		3	1	0	4
Nature of course					
Pre requisites					

Course Objectives

The course is intended to

1. Understand the multi resolution analysis for discrete signals
2. Study the families of wavelets
3. Solve discrete wavelet transforms.
4. Analyze the filter banks
5. Explain the wavelet transforms, types and applications of multi resolution analysis

Course Outcomes

On successful completion of the course, students will be able to

CO. No	Course Outcome	Bloom's Level
CO 1	Discuss about multi resolution analysis for discrete signals	Understand
CO 2	Explain the families of wavelets	Understand
CO 3	Solve Discrete wavelet transform	Apply
CO 4	Analyze the filter banks	Analyze
CO 5	Illustrate an outline about wavelet transforms, types and applications of multi resolution analysis	Analyze

Course Contents

Unit – I **Multi Resolution Analysis (MRA)** **12**

Introduction to multi resolution/ multi scale analysis-Time-frequency analysis and wavelets-Piecewise constant approximation-Haar wavelet-Building up the concept of dyadic Multi resolution Analysis (MRA)-Relating dyadic MRA to filter banks-Review of discrete signal processing - Elements of multi rate systems - Two band filter bank design for dyadic wavelets

Unit – II **Families of Wavelets** **12**

Orthogonal and Biorthogonal wavelets-Daubechies' family of wavelets-Conjugate Quadrature Filter Banks (CQF) and their design-Data compression- Fingerprint compression standards- JPEG 2000 standards-problems

Unit – III **Discrete Wavelet Transform** **12**

Discretization in steps-Discretization of scale-Generalized filter bank-Discretization of translation-Generalized output sampling-Discretization of time/ space (independent variable) - from piecewise linear to piecewise polynomial - The class of spline wavelets - A case for infinite impulse response (IIR) filter banks

Unit – IV **Filter Banks** **12**

Introduction to Variants of the wavelet transform-Implementational structures-The wave packet transform-Computational efficiency in realizing filter banks-Polyphase components-The lattice structure - The lifting scheme - Problems.

Unit – V **Applications** **12**

Transient analysis-Singularity detection-Biomedical signal processing applications-Efficient signal design and realization-Wavelet based modulation and demodulation-Applications in mathematical approximation - Applications to the solution of some differential equations – Problems.

Total : 60 Periods

Text Books

1. C. S.Burrus, Ramesh A. Gopinath, and Haitao Guo, Introduction to Wavelets and Wavelet Transforms: A Primer, Prentice Hall, 1997
2. Gilbert Strang, Truong Nguyen, Wavelets and Filter Banks, 2nd ed., Wellesley-Cambridge Press,1998.

Reference Books

1. M. Vetterli, J. Kovacevic, Wavelets and Subband Coding, Prentice Hall, 1995
2. S. Mallat, A Wavelet Tour of Signal Processing, 2nd ed., Academic Press, 1999
3. P.P. Vaidyanathan, Multirate Systems and Filter Banks, Pearson Education, 1993

Additional / Web References

1. https://classcentral.com/course/swayam-foundations-of-wavelets-and -multirate-digital-signal-processing-5805.
2. https://nptel.ac.in/courses/117/101/117101001/

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)															
COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO 1	3	3	2										2	2	
CO 2	3	3	2										2	2	
CO 3	3	2	2										3	3	
CO 4	3	2	2										2	1	
CO 5	3	2	1										2	2	
	3	High				2	Medium					1	Low		

Formative assessment			
Bloom's Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Online Quiz	5	15
Understand	Tutorial Class / Assignment	5	
	Attendance	5	

Summative Assessment				
Bloom's Category	**Internal Assessment Examinations**			**Final Examination (60)**
	IAE – I (7.5)	**IAE – II (7.5)**	**IAE – III (10)**	
Remember				
Understand	10	10	10	20
Apply	10	10	10	20
Analyze	30	30	30	60
Evaluate				
Create				

22SEA025	HUMAN COMPUTER INTERACTION	L	T	P	C
		3	0	0	3
Nature of Course	Professional Core				
Pre requisites	Fundamentals of Computer Architecture				

Course objectives:

- To encourage empirical research (using valid and reliable methodology, with studies of the methods themselves where necessary)
- To promote the use of knowledge and methods from the human sciences in both design and evaluation of computer systems
- To promote better understanding of the relation between formal design methods and system usability and acceptability
- To develop guidelines, models and methods by which designers may be able to provide better human-oriented computer systems

Course outcomes

On successful completion of the course, students will be able to

CO.No.	Course Outcome	Bloom's Level
CO1	Describe the Empirical Research	Knowledge
CO2	Explain the the human sciences in both design and evaluation of computer systems	Understand
CO3	Describe the relation between formal design methods and system usability and acceptability	Understand
CO4	Explain the models and methods by which designers	Understand
CO5	Case Study	Understand

Course Contents:

UNIT I INTRODUCTION TO HCI 9

Human Computer Interaction Models – Ergonomics – Industrial Interface Design – Basics of Interaction Devices – Interaction Styles – Utility of Hypertext – Multimedia Signal Aspects – World Wide Web.

UNIT II USABILITY ENGINEERING PROCESS 8

Paradigms – Principles Supporting Usability – User Interface Generation – Usability Engineering Life Cycle — Different Stages — Requirements Modeling — Task Analysis and Uses — Dialog Notations – System Models – Implementation.

UNIT III USABILITY HEURISTICS, TESTING AND EVALUATION 8

Heuristics in Usability Engineering – Testing – Types of Evaluating and Assessing the Design – Implementation Aspects .

UNIT IV APPLICATION AREAS 10

Applications Involving Speech, Handwriting and Gesture Recognition – Computer Vision – VirtualReality – Unconventional Human Computer Interfaces.

UNIT V CASE STUDY 10

Case Study of Dasher, Interface for Entering Text — Case Study of P300 Based Brain Computer Interface.

TOTAL: 45 PERIODS

Text Books

1. Ian Goodfellow, Yoshua Bengio and Aaron Courville, Deep Learning, MIT Press, 2016.
2. Yusuke Sugomori, "Java Deep Learning Essentials", PACKT, 2016
3. Timothy Masters, Deep Belief Nets in C++ and CUDA C: Volume 1: Restricted Boltzmann Machines and Supervised Feed forward Networks, 2015

References Books

1. Jeff Heaton, Artificial Intelligence for Humans, Volume 3: Deep Learning and Neural Networks, Heaton Research, 2015
2. Kevin P. Murphy, “Machine Learning: A Probabilistic Perspective”, MIT Press, 2012

Mapping of Course Outcomes (COs) with Program Outcomes (POs) Program Specific Outcomes (PSOs)

COs	POs												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	2	3	2										3	2	2
CO2	3	3	2										3	2	2
CO3	2	3	2										3	2	2
CO4	3	2	2										3	2	2
CO5	3	3	2										3	2	2
	3	High				2	Medium					1	Low		

Formative assessment			
Bloom’s Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Classroom / Online Quiz/Group discussion	5	15
Understand	Class Presentation/Power point presentation	5	
	Attendance	5	

Summative Assessment				
Bloom’s Category	**Continuous Assessment Tests**			**Terminal Examination (60)**
	1 (7.5)	**2 (7.5)**	**3 (10)**	
Remember	10	10	10	20
Understand	10	10	10	20
Apply	30	30	30	60
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

22SEA026	DEEP LEARNING TECHNIQUES	L	T	P	C
		3	0	0	3
Nature of Course	Professional Core				
Pre requisites	Fundamentals of Basic Mathematics and Computer vision				

Course objectives:

- To understand the concept of deep learning and fundamental mathematics required for deep learning
- To know the core parametric function approximation techniques behind deep learning
- To appreciate the modern practical deep networks and their applications
- To study about the various deep learning models
- To know about applications and visualization of deep learning networks

Course outcomes

On successful completion of the course, students will be able to

CO.No.	Course Outcome	Bloom's Level
CO1	Describe the concept of deep Learning and Fundamental mathematics	Knowledge
CO2	Explain the Concept of core parametric function approximation techniques	Understand
CO3	Describe the concept of modern practical deep networks and their applications	Understand
CO4	Identify the various deep learning models	Understand
CO5	Outline the applications and visualization of deep learning networks	Understand

Course Contents:

UNIT I- INTRODUCTION AND PREREQUISITE MATHEMATICS **9**

Introduction – Historical Trends in Deep Learning - Probability and Information Theory –The Chain rule of conditional probability - Bayes Rule — Machine Learning Basics — Supervised and Unsupervised learning algorithms.

UNIT II- MODERN PRACTICAL DEEP NETWORKS **9**

Deep Feed forward Networks – Gradient-Based Learning – Back-Propagation and Other Differentiation Algorithms – Regularization for Deep Learning: Parameter Norm Penalties – Norm Penalties as Constrained Optimization – Challenges in training deep models

UNIT III- DEEP LEARNING NETWORKS **9**

Convolution Networks Operation – Pooling – Recurrent Neural Networks – Bidirectional RNNs –Deep Recurrent Networks — Recursive Neural Networks

UNIT IV- DEEP GENERATIVE MODELS **9**

Boltzmann Machines - Restricted Boltzmann Machines - Deep Belief Networks - Deep Boltzmann Machines - Boltzmann Machines for Real-Valued Data - Convolution Boltzmann Machines - Boltzmann Machines for Structured or Sequential Outputs

UNIT V- APPLICATION AND VISUALIZATION **9**

Large-Scale Deep Learning – Computer Vision – Speech Recognition – Natural Language Processing – Other Applications - Visualizations - Visual Data Analysis Techniques - InteractionTechniques

TOTAL: 45 PERIODS

Text Books

1. Ian Goodfellow, Yoshua Bengio and Aaron Courville, Deep Learning, MIT Press, 2016.
2. Yusuke Sugomori, "Java Deep Learning Essentials", PACKT, 2016
3. Timothy Masters, Deep Belief Nets in C++ and CUDA C: Volume 1: Restricted Boltzmann Machines and Supervised Feed forward Networks, 2015

References Books

1. Jeff Heaton, Artificial Intelligence for Humans, Volume 3: Deep Learning and Neural Networks, Heaton Research, 2015
2. Kevin P. Murphy, “Machine Learning: A Probabilistic Perspective”, MIT Press, 2012

Mapping of Course Outcomes (COs) with Program Outcomes (POs) Program Specific Outcomes (PSOs)

COs	POs												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	2	3	2										3	2	2
CO2	3	3	2										3	2	2
CO3	2	3	2										3	2	2
CO4	3	2	2										3	2	2
CO5	3	3	2										3	2	2
	3	High				2	Medium					1	Low		

Formative assessment			
Bloom’s Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Classroom / Online Quiz/Group discussion	5	15
Understand	Class Presentation/Power point presentation	5	
	Attendance	5	

Summative Assessment				
Bloom’s Category	**Continuous Assessment Tests**			**Terminal Examination (60)**
	1 (7.5)	**2 (7.5)**	**3 (10)**	
Remember	10	10	10	20
Understand	10	10	10	20
Apply	30	30	30	60
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

22SEA027	IMAGE PROCESSING APPLICATIONS	L	T	P	C
		3	0	0	3
Nature of Course	Professional Core				
Pre requisites	Fundamentals of Digital Image Processing				

Course objectives:

- To study the recognition and processing techniques.
- To study the disease analysis and image analysis.
- To study the spectral reflectance and classification strategies.
- To study the classification of industries.
- To study the video based models and object tracking methods.

Course outcomes

On successful completion of the course, students will be able to

CO.No.	Course Outcome	Bloom's Level
CO1	Explain the recognition and processing techniques.	Knowledge
CO2	Identify the disease analysis and image analysis.	Understand
CO3	Identify the spectral reflectance and classification strategies.	Understand
CO4	Outline the classification of industries.	Understand
CO5	Describe the video based models and object tracking methods.	Understand

Course Contents:

UNIT I – REMOTE SENSING & MONITORING APPLICATIONS 9

Introduction- Biometric Pattern Recognition- Face Recognition –Feature Extraction Selection-Face Identification -Signature Verification-Preprocessing of Signature Patterns

UNIT II – MEDICAL IMAGE APPLICATIONS 9

Lung Disease Identification-Heart Disease Identification- Bone Disease Identification-Dental X-Ray Image Analysis- Classification of Dental Caries- Mammogram Image Analysis-Pelvic Image Analysis

UNIT III– SATELLITE AND REMOTE SENSING APPLICATIONS 9

Introduction-Satellite sensors and imageries- Features of Multispectral Images- Spectral reflectance of various earth objects-Water Regions-Vegetation Regions-Soil- Manmade/Artificial Objects-Scene Classification Strategies-Neural Network-Based Classifier Using Error Back propagation- Counter propagation network

UNIT IV – INDUSTRIAL APPLICATIONS 9

Food Industry-Automotive Industry-Textile Industry-Agriculture Industry-Robotics

UNIT V – VIDEO PROCESSING APPLICATIONS 9

Pixel-based model- Shadow Detection-Surveillance system- Region-based model- Principles of object tracking-Case Study. Geometrical model- Video restoration –Case Study

TOTAL: 45 PERIODS

Text Books

1. Tinku Acharya and Ajoy K. Ray-Image Processing Principles and Applications, A John Wiley & Sons, Mc., Publication 2005.
2. Gonzalez & Woods —Digital Image Processing, 3rd ed., Pearson educaon, 2008 3. Ardeshir Goshtasby, " 2D and 3D Image registration for Medical, Remote Sensing and Industrial Applications",John Wiley and Sons,2005.

Reference Books

1. S. Sridhar - Digital Image Processing, 2nd ed., Oxford University Press, 2016.
2. Chanda Dutta Magundar – Digital Image Processing and Analysis, Prentice Hall of India, 2000.

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