ANNA UNIVERSITY, CHENNAI
NON - AUTONOMOUS COLLEGES AFFILIATED ANNA UNIVERSITY
M.E. ELECTRONICS AND COMMUNICATION ENGINEERING
REGULATIONS – 2021
CHOICE BASED CREDIT SYSTEM

1. PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

I To enable graduates to possess skills to develop new innovation in the field of Electronics and Communication Engineering using analytical reasoning and state-of-the-art approaches derived from the Engineering Sciences and Engineering practice.

II To enable graduates to create useful systems, components, or processes through agile, skillful, and innovative analysis and design, while respecting economic, environmental, cultural, and ethical standards or constraints.

III To enable graduates to engage in lifelong learning, adapt to evolving Technology, work in multidisciplinary research for designing innovative products & solutions and become Entrepreneurs.

IV To enable graduates to acquire technical and managerial leadership positions in their chosen fields.

2. PROGRAM OUTCOMES (POs)

PO	PROGRAMME OUTCOMES
1.	An ability to independently carry out research/investigation and development work to solve practical problems
2.	An ability to write and present a substantial technical report/document
3.	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program
4.	An ability to apply knowledge of Electronics and communication system concepts to solve engineering problems.
5.	An ability to identify and apply appropriate techniques, resources and EDA tools to model, analyze and test Electronic and communication systems
6.	An ability to engage in life- long learning for the design and development of Electronic and communication systems taking into consideration sustainability, societal, ethical and environmental aspects.

PROGRAM SPECIFIC OUTCOMES (PSOs):

1. To apply the core aspects of Electronics and Communication Engineering principles such as Signal Processing, Embedded Systems, Networking and Semiconductor Technology for designing Electronic products.

2. To identify and utilize the strengths of current technologies in the Microelectronics, Signal Processing and Communication System domains in implementing ICT enabled services for societal needs.

3. To identify user needs to provide suitable design solutions for implementing Analog & Digital Circuits or Systems for a given specification and function.

PROGRAMME EDUCATIONAL OBJECTIVES	PROGRAMME OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
I	✓		✓	✓	✓	✓
II		✓	✓		✓	✓
III	✓				✓	✓
IV		✓	✓	✓		

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CHOICE BASED CREDIT SYSTEM
I TO IV SEMESTERS CURRICULA AND SYLLABI
SEMESTER I

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	MA4156	Linear Algebra, Probability and Queueing Theory	FC	3	1	0	4	4
2.	RM4151	Research Methodology and IPR	RMC	2	0	0	2	2
3.	AP4151	Advanced Digital Signal Processing	PCC	3	0	0	3	3
4.	VE4152	Embedded System Design	PCC	3	0	0	3	3
5.	EL4101	RF Circuit Design	PCC	3	0	0	3	3
6.	EL4151	Modern Digital Communication Systems	PCC	3	0	0	3	3
7.		Audit Course – I*	AC	2	0	0	2	0
PRACTICALS								
8.	EL4161	Digital Communication Systems Laboratory	PCC	0	0	3	3	1.5
9.	EL4111	Embedded System Design Laboratory	PCC	0	0	3	3	1.5
			TOTAL	**19**	**1**	**6**	**26**	**21**

*Audit course is optional

SEMESTER II

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	EL4201	Advanced Wireless Communication Networks	PCC	3	0	2	5	4
2.	EL4202	FPGA Based System Design	PCC	3	0	0	3	3
3.	CU4152	Radiating Systems	PCC	3	0	0	3	3
4.	EL4251	Telecommunication System Modeling and Simulation	PEC	3	0	2	5	4
5.		Professional Elective I	PEC	3	0	0	3	3
6.		Professional Elective II	PEC	3	0	0	3	3
7.		Audit Course – II*	AC	2	0	0	2	0
PRACTICALS								
8.	EL4211	FPGA Based System Design Laboratory	PCC	0	0	4	4	2
9.	EL4212	Term Paper and Seminar	EEC	0	0	2	2	1
			TOTAL	**20**	**0**	**10**	**30**	**23**

*Audit course is optional

SEMESTER III

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIOD PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	EL4351	Optical Networks	PCC	3	0	0	3	3
2.		Professional Elective III	PEC	3	0	0	3	3
3.		Professional Elective IV	PEC	3	0	2	5	4
4.		Open Elective	OEC	3	0	0	3	3
PRACTICALS								
5.	EL4311	Project Work I	EEC	0	0	12	12	6
			TOTAL	**12**	**0**	**14**	**26**	**19**

SEMESTER IV

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
PRACTICALS								
1.	EL4411	Project Work II	EEC	0	0	24	24	12
			TOTAL	**0**	**0**	**24**	**24**	**12**

TOTAL NO. OF CREDITS: 75

PROFESSIONAL ELECTIVES

SEMESTER II, ELECTIVE I

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	EL4001	Solid State Device Modeling and Simulation	PEC	3	0	0	3	3
2.	EL4002	Smart Sensors for Healthcare	PEC	3	0	0	3	3
3.	EL4003	Nano Electronics	PEC	3	0	0	3	3
4.	AP4072	Computer Architecture and Parallel Processing	PEC	3	0	0	3	3
5.	EL4071	Electromagnetic Interference and Compatibility	PEC	3	0	0	3	3

SEMESTER II, ELECTIVE II

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	AP4078	Signal Integrity in High Speed Design	PEC	3	0	0	3	3
2.	CU4076	Speech Processing	PEC	3	0	0	3	3
3.	EL4004	Cryptography and Network Security	PEC	3	0	0	3	3
4.	EL4005	Cognitive Radio	PEC	3	0	0	3	3
5.	EL4006	Satellite Communication and Navigation Systems	PEC	3	0	0	3	3

SEMESTER III, ELECTIVE III

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	DS4251	Multimedia Compression Techniques	PEC	3	0	0	3	3
2.	VL4073	MEMS and NEMS	PEC	3	0	0	3	3
3.	AP4071	Automotive Electronics	PEC	3	0	0	3	3
4.	VL4072	CAD for VLSI Circuits	PEC	3	0	0	3	3
5.	VE4071	Hardware Software Co-design	PEC	3	0	0	3	3
6.	AP4073	Edge Analytics and Internet of Things	PEC	3	0	0	3	3

SEMESTER III, ELECTIVE IV

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	AP4074	PCB Design	PEC	3	0	2	5	4
2.	DS4151	Digital Image and Video Processing	PEC	3	0	2	5	4
3.	CP4252	Machine Learning	PEC	3	0	2	5	4
4.	EL4072	Signal Detection and Estimation	PEC	3	0	2	5	4

AUDIT COURSES (AC)

Registration for any of these courses is optional to students

SL. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS
			L	T	P	
1.	AX4091	English for Research Paper Writing	2	0	0	0
2.	AX4092	Disaster Management	2	0	0	0
3.	AX4093	Constitution of India	2	0	0	0
4.	AX4094	நற்றமிழ் இலக்கியம்	2	0	0	0

FOUNDATION COURSES (FC)

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	MA4156	Linear Algebra, Probability and Queueing Theory	3	1	0	4	I

PROFESSIONAL CORE COURSES (PCC)

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	AP4151	Advanced Digital Signal Processing	3	0	0	3	I
2.	VE4152	Embedded System Design	3	0	0	3	I
3.	EL4101	RF Circuit Design	3	0	0	3	I
4.	EL4151	Modern Digital Communication Systems	3	0	0	3	I
5.	EL4161	Digital Communication Systems Laboratory	0	0	3	1.5	I
6.	EL4111	Embedded System Design Laboratory	0	0	3	1.5	I
7.	EL4201	Advanced Wireless Communication Networks	3	0	2	4	I I
8.	EL4202	FPGA Based System Design	3	0	0	3	I I
9.	CU4152	Radiating Systems	3	0	0	3	I I
10.	EL4251	Telecommunication System Modeling and Simulation	3	0	2	4	I I
11.	EL4351	Optical Networks	3	0	0	3	I I I
12.	EL4211	FPGA Based System Design Laboratory	0	0	4	2	I I

RESEARCH METHODOLOGY AND IPR COURSES (RMC)

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	RM4151	Research Methodology and IPR	2	0	0	2	1

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	EL4212	Term Paper and Seminar	0	0	2	1	III
2.	EL4311	Project Work I	0	0	12	6	III
3.	EL4411	Project Work II	0	0	24	12	IV

SUMMARY

Sl. No.	Name of the Programme: M.E. ELECTRONICS AND COMMUNICATION ENGINEERING					
	SUBJECT AREA	CREDITS PER SEMESTER				CREDITS TOTAL
		I	II	III	IV	
1.	FC	04	00	00	00	04
2.	PCC	15	16	03	00	34
3.	PEC	00	06	07	00	13
4.	RMC	02	00	00	00	02
5.	OEC	00	00	03	00	03
6.	EEC	00	01	06	12	19
7.	Non Credit/Audit Course	✓	✓	00	00	
8.	**TOTAL CREDIT**	**21**	**23**	**19**	**12**	**75**

MA4156 LINEAR ALGEBRA, PROBABILITY AND QUEUEING THEORY L T P C
3 1 0 4

COURSE OBJECTIVES:

The objective of this course is to enable the student to

- Grasp the basic concepts of Probability, Random variables, correlation and regression.
- Characterize the phenomena which evolve with respect to time in a probabilistic manner.
- Encourage students to develop a working knowledge of the ventral ideas of linear algebra.
- Acquire skills in analyzing Queueing Models.
- Develop a fundamental understanding of linear programming models and apply the simplex method for solving linear programming problems.

UNIT – I LINEAR ALGEBRA 12

Vector spaces – Norms – Inner products – Eigenvalues using QR transformations – QR factorization – Generalized eigenvectors – Jordan Canonical forms – Singular value decomposition and applications – Pseudo inverse – Least square approximations.

UNIT – II PROBABILITY AND RANDOM VARIABLES 12

Probability Concepts – Axioms of probability – Conditional probability – Bayes theorem – Random variables – Probability functions – Two-dimensional random variables – Joint distributions – Marginal and conditional distributions – Correlation – Linear Regression.

UNIT – III RANDOM PROCESSES 12

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

UNIT – IV QUEUEING THEORY 12

Markovian queues – Single and multi-server models – Little's formula – Steady state analysis – Self-service queue.

UNIT – V LINEAR PROGRAMMING 12

Formulation – Graphical solution – Simplex method – Big M method – Variants of Simplex method – Transportation problems – Assignment models.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

After the completion of the course, the student will be able to

- apply various methods in Linear Algebra to solve the system of linear equations.
- use two-dimensional random variables, correlations and regression in solving application problem.
- apply the ideas of Random Processes.
- understand the basic characteristic features of a queueing system and acquire skills in analyzing queueing models.
- apply the Simplex method for solving linear programming problems.

REFERENCES:

1. Miller,S.L. and Childers D.G., "Probability and Random Processes with Applications to Signal Processing and Communications", Academic Press,2004.

2. Friedberg A.H, Insel A.J. and Spence L, “Linear Algebra”, Prentice Hall of India, New Delhi, 2004.
3. Gross, D., Shortie, J.F., Thompson, J.M and Harris, C.M., “Fundamentals of Queueing Theory”, 4th Edition, Wiley,2014.
4. T. Veerarajan, “Probability, Statistics and Random Process with Queueing Theory and Queueing Network, Tata McGraw Hill, 4th Edition,2017.
5. Taha H.A., “Operations Research: An Introduction”, 9th Edition, Pearson Education Asia, New Delhi,2016.
6. Richard Bronson, ”Matrix Operations” Schaum’s outline series, McGraw Hill, 2nd Edition, New York,2011.
7. Oliver C. Ibe, “ Fundamentals of Applied Probability and Random Processes”, Academic Press, (An Imprint of Elsevier), Boston,2014.

RM4151 RESEARCH METHODOLOGY AND IPR L T P C
2 0 0 2

UNIT I RESEARCH DESIGN 6

Overview of research process and design, Use of Secondary and exploratory data to answer the research question, Qualitative research, Observation studies, Experiments and Surveys.

UNIT II DATA COLLECTION AND SOURCES 6

Measurements, Measurement Scales, Questionnaires and Instruments, Sampling and methods. Data - Preparing, Exploring, examining and displaying.

UNIT III DATA ANALYSIS AND REPORTING 6

Overview of Multivariate analysis, Hypotheses testing and Measures of Association.
Presenting Insights and findings using written reports and oral presentation.

UNIT IV INTELLECTUAL PROPERTY RIGHTS 6

Intellectual Property – The concept of IPR, Evolution and development of concept of IPR, IPR development process, Trade secrets, utility Models, IPR & Bio diversity, Role of WIPO and WTO in IPR establishments, Right of Property, Common rules of IPR practices, Types and Features of IPR Agreement, Trademark, Functions of UNESCO in IPR maintenance.

UNIT V PATENTS 6

Patents – objectives and benefits of patent, Concept, features of patent, Inventive step, Specification, Types of patent application, process E-filling, Examination of patent, Grant of patent, Revocation, Equitable Assignments, Licences, Licensing of related patents, patent agents, Registration of patent agents.

TOTAL: 30 PERIODS

REFERENCES:

1. Cooper Donald R, Schindler Pamela S and Sharma JK, “Business Research Methods”, Tata McGraw Hill Education, 11e (2012).
2. Catherine J. Holland, “Intellectual property: Patents, Trademarks, Copyrights, Trade Secrets”, Entrepreneur Press, 2007.
3. David Hunt, Long Nguyen, Matthew Rodgers, “Patent searching: tools & techniques”, Wiley, 2007.

4. The Institute of Company Secretaries of India, Statutory body under an Act of parliament, "Professional Programme Intellectual Property Rights, Law and practice", September 2013.

AP4151 ADVANCED DIGITAL SIGNAL PROCESSING L T P C
3 0 0 3

COURSE OBJECTIVES:

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

UNIT I DIGITAL SIGNAL PROCESSING 9

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

UNIT II DIGITAL FILTER DESIGN 9

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

UNIT III ESTIMATION OF POWER SPECTRUM 9

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

UNIT IV MULTI RATE SIGNAL PROCESSING 9

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

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

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1: Describe the basics of Digital Signal Processing and Discrete Time Transforms.
CO2. Design and implement FIR/IIR digital filters using various structures
CO3. Estimate power spectrum using appropriate parametric/non-parametric method.

CO4: Analyze discrete time system at different sampling frequencies using the concept of Multirate signal processing

CO5: Design discrete time system for the given application using Multi rate signal processing

REFERENCES:

1. J.G.Proakis & D. G.Manolakis Digital Signal Processing: Principles, Algorithms & Applications -, 4th Ed., Pearson Education, 2013.
2. Alan V Oppenheim & Ronald W Schaffer Discrete Time signal processing, Pearson Education, 2014.
3. Keshab K. Parhi, 'VLSI Digital Signal Processing Systems Design and Implementation", John Wiley& Sons, 2007.
4. Steven. M .Kay, Modern Spectral Estimation: Theory & Application –PHI, 2009.
5. P.P.Vaidyanathan, Multi Rate Systems and Filter Banks , Pearson Education, 1993.
6. Emmanuel C. Ifeachor, Barrie W. Jervis, "Digital Signal Processing–A practical approach", Second Edition, Harlow, Prentice Hall, 2011.

VE4152 EMBEDDED SYSTEM DESIGN L T P C

3 0 0 3

COURSE OBJECTIVES:

- To understand the design challenges in embedded systems.
- To program the Application Specific Instruction Set Processors.
- To understand the bus structures and protocols.
- To model processes using a state – machine model.
- To design a real time embedded system.

UNIT I EMBEDDED SYSTEM OVERVIEW 9

Embedded System Overview, Design Challenges – Optimizing Design Metrics, Design Methodology, RT-Level Combinational and Sequential Components, Optimizing Custom Components, Optimising 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, Wireless Protocols – IRDA, Bluetooth, IEEE 802.11.

UNIT IV STATE MACHINE AND CONCURRENT PROCESS MODELS 9

Basic State Machine Model, Finite-State Machine with Data path Model, Capturing State Machine in Sequential Programming Language, Program-State Machine Model, Concurrent Process Model, Communication among Processes, Synchronization among processes, RTOS – System design using RTOS.

UNIT V SYSTEM DESIGN 9

Burglar alarm system-Design goals -Development strategy-Software development-Relevance to more complex designs- Need for emulation -Digital echo unit-Creating echo and reverb-Design requirements-Designing the codecs -The overall system design

SUGGESTED ACTIVITIES:

1: Do microcontroller based design experiments.
2: Create program –state models for different embedded applications.
3: Design and develop embedded solutions for real world problems.

COURSE OUTCOMES:

CO1: Knowledge of different protocols
CO2: Apply state machine techniques and design process models.
CO3: Apply knowledge of embedded software development tools and RTOS
CO4: Apply networking principles in embedded devices.
CO5: Design suitable embedded systems for real world applications.

TOTAL:45 PERIODS

REFERENCES:

1. Frank Vahid and Tony Gwargie, “Embedded System Design”, John Wiley & Sons, 2009.
2. Steve Heath, “Embedded System Design”, Elsevier, Second Edition, 2004.
3. Bruce Powel Douglas, “Real Time UML, Second Edition: Developing Efficient Objects for Embedded Systems”, 3rd Edition 2004, Pearson Education
4. Daniel W.Lewis, “Fundamentals of Embedded Software where C and Assembly Meet”, Pearson Education, 2004
5. Bruce Powel Douglas, “Real Time UML; Second Edition: Developing Efficient Objects for Embedded Systems”, 3rd Edition 1999, Pearson Education.

EL4101 RF CIRCUIT DESIGN L T P C

3 0 0 3

COURSE OBJECTIVES:

- To understand and analyze the behaviour of high frequency components and transmission lines
- To recognize, analyze and design, the network parameters and RF filters
- To familiarize with the design of matching networks, couplers and power dividers
- To understand construction of high frequency RF active devices and design RF amplifiers
- To understand and analyze mixers and oscillators

UNIT I PASSIVE RF COMPONENTS AND TRANSMISSION LINE ANALYSIS 9

Resistors, Capacitor and Inductors at High frequency – Transmission Line Analysis: Line equation, Micro strip line, Voltage Reflection Coefficient, propagation constant phase velocity and special termination - Smith Chart-Impedance transformation - Analysis of parallel RL circuit and parallel RC circuit.

UNIT II NETWORK THEORY AND RF FILTER DESIGN 9

Definition - properties - interconnection of networks - ABCD parameters and S parameters - RF

Filter Resonator and filter configuration - Butterworth and Chebyshev filters. Design of micro strip filters

UNIT III IMPEDANCE MATCHING NETWORK AND PASSIVE DEVICES 9

Impedance Matching with lumped Elements - Design of T and π matching network- Matching by micro strip line -Stub matching. Single stub matching – Double stub matching. Basic properties of dividers and couplers – T Junction Power divider – Wilkinson Power divider – Quadrature Hybrid – Coupled line Directional Coupler.

UNIT IV RF ACTIVE DEVICES AND AMPLIFIER DESIGN 9

The Diode Model – Two Port Design Model: The output terminals of a two port RF Device, The bipolar Transistor, The heterojunction bipolar transistor , The GaAS MESFET, The High Electron Mobility Transistor. RF Amplifier Design - Two port power Gains- Stability circles- Tests for Unconditional stability - Low Noise amplifier Design – Low Noise MOSFET Amplifier –Broad Band Transistor Amplifier Design – Characteristics of Power Amplifiers and Amplifier classes-Design Examples – PA Linearization techniques.

UNIT V RF OSCILLATORS AND MIXERS 9

RF Oscillators –Oscillators using BJT and FET –Dielectric Resonator Oscillators – Oscillator Phase Noise. Mixers – Mixer Characteristics – Single –Ended Diode Mixer – Single-Ended FET Mixer- Balanced Mixer – Image Reject Mixer- Differential FET Mixer and Gilbert Cell Mixer.

SUGGESTED ACTIVITIES:

1. Design and Develop planar transmission line
2. Design and implement Filter for various RF inductor and capacitor frequencies
3. Design and implement impedance matching networks and couplers
4. Design RF amplifier with and without impedance matching networks in a Transceiver
5. Design mixer and oscillators for various RF frequencies

COURSE OUTCOMES:

Upon completion of the course, the students will be

CO1: Able to develop novel/compact transmission lines
CO2: Competent to design filters
CO3: Proficient in developing matching networks and couplers
CO4: Capable of designing Maximum gain, Low noise amplifiers
CO5: Able to develop mixers and oscillator for RF receivers

TOTAL :45 PERIODS

REFERENCES:

1. Reinhold Ludwig and Pavel Bretchko, "RF Circuit Design: Theory and Applications", Pearson Education
2. David M Pozar, "Microwave Engineering", John Wiley and Sons, 2005.
3. Les Besser and Rowan Gilmore, "Practical RF Circuit Design for Modern Wireless Systems", Vol I, Passive Circuit and Systems, Artech house, London, 2003
4. Rowan Gilmore and Les Besser, "Practical RF Circuit Design for Modern Wireless Systems", Vol II, Passive Circuit and Systems, Artech house, London, 2003

EL4151 MODERN DIGITAL COMMUNICATION SYSTEMS L T P C
3 0 0 3

COURSE OBJECTIVES:

- To understand the coherent and non coherent receivers and their performance under AWGN channel conditions
- To understand the effect of signalling through bandlimited channels and Equalization techniques used to overcome ISI
- To understand different channel models, channel capacity and different block coding techniques
- To understand the principle of convolutional coding and different decoding techniques
- To understand the basics of OFDM as a multicarrier communication and CDMA as a multiuser communication technique.

UNIT I COHERENT AND NON-COHERENT COMMUNICATION 9

Coherent receivers – Optimum receivers in WGN – IQ modulation & demodulation – QAM modulation and demodulation Noncoherent receivers in random phase channels; MFSK receivers – Rayleigh and Rician channels – Partially coherent receivers – DPSK; M-PSK; M-DPSK-BER Performance Analysis. Carrier SynchronizationBit synchronization.

UNIT II EQUALIZATION TECHNIQUES 9

Band Limited Channels- ISI – Nyquist Criterion- Controlled ISI-Partial Response signals- Equalization algorithms– Linear equalizer – Decision feedback equalization – Adaptive Equalization algorithms.

UNIT III BLOCK CODED DIGITAL COMMUNICATION 9

Architecture and performance – Binary block codes; – Shannon's channel coding theorem; Channel capacity; Matched filter; Concepts of Spread spectrum communication – Coded BPSK and DPSK demodulators– Linear block codes; Hamming; Golay; Cyclic; BCH ; Reed – Solomon codes. Space time block codes.

UNIT IV CONVOLUTIONAL CODED DIGITAL COMMUNICATION 9

Representation of codes using Polynomial, State diagram, Tree diagram, and Trellis diagram – Decoding techniques using Maximum likelihood, Viterbi algorithm, Sequential and Threshold methods – Error probability performance for BPSK and Viterbi algorithm, Turbo Coding.

UNIT V MULTICARRIER AND MULTIUSER COMMUNICATIONS 9

Single Vs multicarrier modulation, orthogonal frequency division multiplexing (OFDM), Modulation and demodulation in an OFDM system, An FFT algorithmic implementation of an OFDM system, Bit and power allocation in multicarrier modulation, Peak-to-average ratio in multicarrier modulation. Introduction to CDMA systems, multiuser detection in CDMA systems – optimum multiuser receiver, sub-optimum detectors, successive interference cancellation.

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1: Differentiate coherent and non coherent receivers and analyse their performance under AWGN channel conditions

CO2: Illustrate the effect of signalling through bandlimited channels and Equalization techniques used to overcome ISI

CO3: Determine the channel capacity and design various block coding techniques to combat

channel errors

CO4: Construct convolutional coders and analyze the performance of different decoding techniques.

CO5: Describe the basics of OFDM as a multicarrier communication and CDMA as a multiuser communication technique.

TOTAL:45 PERIODS

REFERENCES:

1. John G. Proakis and Masoud Salehi “Digital Communication”, Fifth Edition, Mc Graw Hill Publication, 2014.
2. Simon Haykin, “Digital communication Systems”, John Wiley and sons, 2014.
3. Bernard Sklar and Pabitra Kumar Ray, “Digital Communications Fundamentals & Applications ”, second edition, Pearson Education, 2009.
4. Lathi B P and Zhi Ding, “Modern Digital and Analog communication Systems", Oxford University Press, 2011.
5. Richard Van Nee & Ramjee Prasad, “OFDM for Multimedia Communications” Artech House Publication, 2001.
6. Theodore S.Rappaport, ‘Wireless Communications”, 2nd edition, Pearson Education, 2002.

EL4161 DIGITAL COMMUNICATION SYSTEMS LABORATORY L T P C
0 0 3 1.5

COURSE OBJECTIVES:

- To study & measure the performance of digital communication systems.
- To provide a comprehensive knowledge of Wireless Communication.
- To learn about the design of digital filter and its adaptive filtering algorithms.

LIST OF EXPERIMENTS (MATLAB/SCILAB/LABVIEW)
USE APPROPRIATE SIMULATION TOOLS FOR THE FOLLOWING EXPERIMENTS:

1. Generation & detection of binary digital modulation techniques using SDR
2. Spread Spectrum communication system-Pseudo random binary sequence generation-Baseband DSSS.
3. MIMO system transceiver design using MATLAB/SCILAB/LABVIEW
4. Performance evaluation of simulated CDMA system
5. Channel Coder/decoder design (block codes / convolutional codes/ turbo codes)
6. OFDM transceiver design using MATLAB /SCILAB/LABVIEW
7. Channel equalizer design using MATLAB (LMS, RLS algorithms)
8. Design and Analysis of Spectrum Estimators (Bartlett, Welch) using MATLAB
9. BER performance Analysis of M-ary digital Modulation Techniques (coherent & non coherent) in AWGN Environment using MATLAB/SCILAB/LABVIEW
10. Design and performance analysis of Lossless Coding Techniques - Huffman Coding and Lempel Ziv Algorithm using MATLAB/SCILAB/LABVIEW
11. Noise / Echo cancellation using MATLAB (LMS / RLS algorithms).
12. Study of synchronization (frame, bit, symbol.)
13. Wireless channel characterization.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

Upon the completion of course, students are able to

- Implement the adaptive filtering algorithms
- Generate and detect digital communication signals of various modulation techniques using MATLAB.
- Evaluate cellular mobile communication technology and propagation model.
- Apply mathematical formulation to analyze spectrum estimation of a signal and bit rate determination of a transmission link
- Analyze the performance of optimization algorithms for equalizing the channel or noise/echo cancellation
- Able to design synchronization algorithm for Digital Communication systems

EL4111	EMBEDDED SYSTEM DESIGN LABORATORY	L	T	P	C
		0	0	3	1.5

COURSE OBJECTIVES:

- To interface sensors and display devices with ARM processor.
- To program timers and UART in ARM processor.
- To understand I2C and CAN protocols.
- To understand concepts of scheduling, semaphores and deadlocks using RTOS.
- To design a real – time data acquisition system using ARM Cortex Processor.

LIST OF EXPERIMENTS:

1. Interfacing sensors and actuators with ARM core.
2. Configuration and programming timers and UART in ARM Processor.
3. Interfacing LCD and OLED display modules with ARM Processor.
4. Simulation of I2C and CAN protocols.
5. Simple task scheduling using freeware RTOS.
6. Exploration on semaphores, deadlocks using RTOS.
7. Exploration of any one SOC architecture using RTOS.
8. Study of Edge AI platform on any one of the embedded processors.
9. Design of a real – time data acquisition system and control using ARM Processor.
10. Design of an IoT based system.

COURSE OUTCOMES:

CO1: Interface an ARM processor with input – output devices.
CO2: Understand I2C and CAN protocols.
CO3: Explore concepts in RTOS.
CO4: Design a real – time embedded system.
CO5: Analyse design requirements of an IoT based system.

TOTAL:45 PERIODS

REFERENCES:

1. William Hohl, "ARM Assembly Language", CRC Press, Second Edition, 2015
2. Andrew Sloss, Dominic Symes, and Chris Wright, "ARM System Developer's Guide Designing and Optimizing System", The Morgan Kaufmann Series, 2004.
3. Steve Furber,"ARM System-on-Chip Architecture", Addison- Wesley Professional; ll Edition 2000.

EL4201 **ADVANCED WIRELESS COMMUNICATION NETWORKS** **L T P C**
3 0 2 4

COURSE OBJECTIVES:

- To understand the characteristics and advancements of UMTS and LTE Architecture.
- Understand the 5G Building blocks and Use Cases.
- Understand various wireless networking standards such as 4G and 5G.
- To understand 5G Networking principles.
- To have a good understanding of emerging wireless networks such as massive machine type communication

UNIT I 4G ARCHITECTURE 10

Overview of current advanced wireless technologies - High Level architecture of 4G – Evolved UMTS Terrestrial Radio Access Network – Evolved Packet Core – Communication Protocols – Bearer Management. Architecture of LTE Air Interface – Air Interface protocol stack , logical, physical and transport channels, The Resource grid, Resource element mapping.MAC Protocol – Radio Link Control Protocol – Packet Data Convergence Protocol.

UNIT II 5G ARCHITECTURE AND MILLIMETER WAVE COMMUNICATIONS 8

Key building blocks of 5G – 5G use cases and System Concepts – The 5G Architecture. Millimeter Wave Communications : Hardware technologies for mmW systems-Architecture and mobility – Massive MIMO – Resource Allocation and Transceiver algorithms for Massive MIMO

UNIT III 5G WAVEFORMS AND CHANNEL MODELS 9

5G Radio Access Technologies: Design principles - Multi-carrier with filtering - Non-orthogonal Multiple Access - Radio access for dense deployments – Radio Access for V2X Communication - Radio access for massive machine-type communication - 5G wireless propagation channel models: Modeling requirements and scenarios - The METIS channel models.

UNIT IV NETWORKING IN 5G 9

Coordinated multi-point transmission in 5G: Joint Transmission CoMP enablers - Distributed cooperative transmission - JT CoMP with advanced receivers - Relaying and network coding in 5G: Multi-flow wireless backhauling - Buffer-aided relaying.

UNIT V EVALUATION OF 5G AND 5G APPLICATIONS 9

Machine-type communications: Fundamental techniques for MTC - Massive MTC - Ultra-reliable low-latency MTC - Device-to-device (D2D) communications - Multi-hop D2D communications - Multi-operator D2D communication - Simulation methodology: Evaluation methodology – Calibration - New challenges in the 5G modeling

45 PERIODS

SUGGESTED ACTIVITIES:

1:Modeling of 4G LTE – A System
2: Design of Radio Network Access for 4G Networks
3: Modeling of 5G Networks
4: Design of Radio Network Access for 5G Systems
5: Design of Smart Antenna System

PRACTICALS:

1. Modeling a 4G LTE System
2. Test and Measurement of 4G LTE Baseband signals
3. Design of MIMO System
4. Analysis and study of millimetre wave applications
5. Simulation of NOMA Principles
6. METIS Modeling
7. Simulation of Joint Transmission CoMP
8. Analysis of buffer-aided relaying
9. Design of Massive MTC.
10 Implementation and testing of Device to Device Communication

30 Periods

COURSE OUTCOMES:

CO1: Able to understand and develop 4G LTE Networks
CO2: Able to understand and develop 5G Building blocks
CO3: Able to understand and develop 5G Radio Access Technologies
CO4: Able to understand and develop Networking in 5G
CO5: Able to understand and develop Device to Device Communication

TOTAL PERIODS:75

REFERENCES

1. Christopher Cox, " An Introduction to LTE, LTE-Advanced, SAE and 4G Mobile Communications", Wiley publications, 2012.
2. AfifOsseiran, Jose F. Monserrat and Patrick Marsch, - 5G Mobile and Wireless Communications Technology, Cambridge University Press, 2016.
3. Wei Xiang, Kan Zheng, Xuemin (Sherman) Shen, - 5G Mobile Communications, Springer, 2017.
4. Jonathan Rodriguez, - Fundamentals of 5G mobile networks, John Wiley & Sons, Ltd, 2015.
5. Sassan Ahmadi, "LTE-Advanced – A practical systems approach to understanding the 3GPP LTE Releases 10 and 11 radio access technologies", Elsevier, 2014.

	PO					
	1	**2**	**3**	**4**	**5**	**6**
CO1	3	3	3	3	3	3
CO2	3	3	2	3	3	3
CO3	3	3	2	3	3	3
CO4	3	3	3	3	3	3
CO5	3	3	3	3	3	3
Avg	(15/5)=3	(15/5)=3	(13/5)=2.6	(15/5)=3	(15/5)=3	(15/5)=3

EL4202 **FPGA BASED SYSTEM DESIGN** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To learn the different types of programming elements, programmable logic blocks, programmable input-output blocks and programmable interconnects of various types of FPGAs
- To understand the steps involved in synthesis, simulation, and testing of systems
- To design and implement circuits, subsystem and system using FPGA and I/O boards

UNIT I FPGA ARCHITECTURES 9

FPGA-Based Systems: Basic Concepts - Digital Design and FPGAs - The Role of FPGAs - FPGA Types - FPGAs vs. Custom VLSI - FPGA-Based System Design - Goals and Techniques - Hierarchical Design - Design Abstraction- Methodologies. **FPGA Basics**: Components of an FPGA - Programming Technology - Antifuse Technology - Logic Circuit Representation of FPGA. **FPGA Structure**: Logic Block - Logic Cluster – Adaptive LUT - Routing Part - Switch Block - Connection Block - I/O Block - DSP Block - Hard Macros - Embedded Memory - Configuration Chain - PLL and DLL

UNIT II FPGA DESIGN FLOW 9

Design Flow and Design Tools: Design Flow - Design Flow by HDL - HLS Design - IP-Based Design - Design with Processor. Design Methodology: **FPGA Design Flow** - Technology Mapping - Clustering - Place and Route - Low Power Design Tools. Simulation and Synthesis Concepts - Place and Route – Technology Mapping.

UNIT III FPGA BASED SUBSYSTEM DESIGN 9

Combinational Circuits: Basic Gates - Majority Logic and Concatenation - Shift Operations - Multiplexers - Demultiplexer - Full Adder - Magnitude Comparator. **Sequential Circuits**: D Flip-flop - Registers - Shift Registers - Counters - Finite State Machines - Pattern Sequence Detector. **Arithmetic Circuit Designs**: Digital Pipelining - Partitioning of a Design - Signed Adder Design - Multiplier Design.

UNIT IV FPGA BASED SYSTEM DESIGN 9

Design of Memories: On-chip Dual Address ROM Design - Single Address ROM Design - On-Chip Dual RAM Design - External Memory Controller Design. **System Designs**: Discrete Cosine Transform and Quantization Processor - FOSS Motion Estimation Processor - DCTQ Processor

UNIT V FPGA BASED PROJECT DESIGN 9

Project Designs: Traffic Light Controller - Real Time Clock - Digital Signal Processor - PCI Bus Arbiter - DCTQ Processor - Electrostatic Precipitator Controller - JPEG/H.263/MPEG 1/ MPEG 2 Codec.

TOTAL PERIODS:45

COURSE OUTCOMES:

CO1: Able to understand the basic concepts of FPGA and its structures
CO2: Able to understand the steps involved in synthesis, simulation, and testing of systems
CO3: Able to design combinational and arithmetic circuits using FPGA board
CO4: Able to design memories and DCTQ processor.
CO5: Able to design real time applications using FPGA board

REFERENCES

1. Wayne Wolf, “FPGA-Based System Design”, PTR Prentice Hall, 2004
2. Hideharu Amano, “Principles and Structures of FPGAs”, Springer, 2018
3. S. Ramachandran, “Digital VLSI Systems Design: A Design Manual for Implementation of Projects on FPGAs and ASICs Using Verilog”, Springer, 2007
4. Peter R. Wilson, “Design Recipes for FPGAs”, Springer, 2008
5. Sanjay Churiwala, “Designing with Xilinx FPGAs Using Vivado”, Springer, 2017

	PO					
	1	**2**	**3**	**4**	**5**	**6**
CO1	2	1	1			
CO2	2	1	1	1		
CO3	3	2	2	2	1	
CO4	3	2	2	2	1	1
CO5	3	2	2	2	1	1
Avg	(13/5) = 2.6	(8/5) = 1.6	(8/5) = 1.6	(7/4) = 1.75	(3/3) = 1	(2/2) = 1

CU4152 RADIATING SYSTEMS L T P C
3 0 0 3

COURSE OBJECTIVES:

- To understand Antenna basics
- To learn about Antenna arrays and their characteristics
- To study about operating Antennas
- To familiarize with modern Antennas and Measurement Techniques
- To learn about recent trends in Antenna Design

UNIT I ANTENNA FUNDAMENTALS & WIRE ANTENNAS 9

Introduction –Types of Antennas – Radiation Mechanism – Current distribution on wire antennas – Maxwell‘s equations – Antenna fundamental parameters – Radiation integrals – Radiation from surface and line current distributions – dipole, monopole, loop antenna

UNIT II ANTENNA ARRAYS 9

Linear array –uniform array, end fire and broad side array, gain, beam width, side lobe level; Linear array synthesis techniques – Binomial and Chebyshev distributions; Two dimensional uniform arrays; phased array antennas, smart antennas, switched beam and adaptive arrays, Mutual Coupling in Finite Arrays

UNIT III APERTURE ANTENNAS 9

Field equivalence principle, Radiation from Rectangular and Circular apertures, Babinets principle, Slot antenna; Horn antenna; Reflector antenna, aperture blockage, and design consideration. Radiation Mechanism and Excitation techniques, Microstrip dipole; Patch, Rectangular patch, Circular patch – Microstrip array and feed network; Lens Antennas

UNIT IV MODERN ANTENNAS & MEASUREMENT TECHNIQUES 9

Base station antennas, PIFA – Antennas for WBAN – RFID Antennas – Automotive antennas, MIMO Antennas, Diversity techniques – Antenna impedance and radiation pattern measurements

UNIT V RECENT TRENDS IN ANTENNA DESIGN 9

UWB antenna arrays – Vivaldi antenna arrays – Artificial magnetic conductors/High impedance surfaces – Antennas in medicine – Plasma antennas – Antennas for millimeter wave communication - optimization techniques – Numerical methods

SUGGESTED ACTIVITIES:

1. Design and develop an antenna to receive AM and FM radio
2. Design Yagi-Uda Antenna at very high frequency band
3. Design Microstrip patch antenna for mobile applications
4. Design and develop Microstrip dipole antenna
5. Design reflector antenna for satellite - TV reception

TOTAL:45 PERIODS

COURSE OUTCOMES:

At the end of the course, the student will be able to:

CO1: Understand the fundamentals behind the different techniques in antenna technology.

CO2: Understand the challenges associated in designing antennas based on different technologies

CO3: Understand the capability and assess the performance of various antennas.

CO4: Identify the antennas specific to the applications, design and characterize.

CO5: Understand the need for optimizing in antenna design and the methodologies for the same.

REFERENCES:

1. Balanis.A, “Antenna Theory Analysis and Design”, John Wiley and Sons, New York, 3rd Edition,1982.
2. Frank B. Gross, “Frontiers in Antennas”, Mc Graw Hill, 2011.
3. S. Drabowitch, A. Papiernik, H.D.Griffiths, J.Encinas, B.L.Smith, “Modern Antennas”, Springer Publications, 2nd Edition, 2007.
4. Krauss.J.D, “Antennas”, John Wiley and sons, New York, 2nd Edition, 1997.
5. I.J. Bahl and P. Bhartia, “Microstrip Antennas”, Artech House,Inc.,1980
6. W.L.Stutzman and G.A.Thiele, “Antenna Theory and Design”, John Wiley& Sons Inc., 2nd Edition, 1998.
7. Jim R. James,P.S.Hall ,”Handbook of Microstrip Antennas” IEE Electromagnetic wave series 28, Volume 2,1989.

EL4251 TELECOMMUNICATION SYSTEM MODELING AND SIMULATION L T P C
3 0 2 4

COURSE OBJECTIVES:

- To enable the student to understand the various aspects of simulation methodology and performance
- To appreciate the significance of selecting sampling frequency and modeling different types of signals and processing them
- To expose the student to the different simulation techniques, their pros and cons and enable him to understand and interpret results using case studies

UNIT I SIMULATION METHODOLOGY 9

Introduction, Aspects of methodology, Performance Estimation, Simulation sampling frequency, Low

pass equivalent simulation models for bandpass signals, Multicarrier signals, Non-linear and time-varying systems, Post processing – Basic graphical techniques and estimations

UNIT II RANDOM SIGNAL GENERATION & PROCESSING 9

Uniform random number generation, Mapping uniform random variables to an arbitrary pdf, Correlated and Uncorrelated Gaussian random number generation, PN sequence generation, Random signal processing, Testing of random number generators.

UNIT III MONTE CARLO SIMULATION 9

Fundamental concepts, Application to communication systems, Monte Carlo integration, Semi - analytic techniques, Case study: Performance estimation of a wireless system

UNIT IV ADVANCED MODELS & SIMULATION TECHNIQUES 9

Modeling and simulation of non-linearities : Types, Memoryless non-linearities, Non-linearities with memory, Modeling and simulation of Time varying systems : Random process models, Tapped delay line model, Modeling and simulation of waveform channels, Discrete memoryless channel models, Markov model for discrete channels with memory.

UNIT V EFFICIENT SIMULATION TECHNIQUES 9

Tail extrapolation, pdf estimators, Importance Sampling methods, Case study: Simulation of a Cellular Radio System.

PRACTICALS:

1. Study the spectrum of response of linear and non-linear systems for single tone input
2. Generation of OFDM (multicarrier) signal and plot the spectrum (RF and Low pass equivalent)
3. Generation of uniform / Gaussian random numbers and verification of their probability distribution, autocorrelation and spectrum
4. Generation of uncorrelated and correlated random processes and verification of cross-correlations
5. Generation of PN sequence and verification of properties and spectrum.
6. Application of Monte Carlo simulation for estimation of BER of a wireless communication link
7. Study the impact of non-linearity of amplifier on transmitter symbol constellation with the help of Saleh model
8. Studying the effect of time invariant (slow fading) frequency selecting channel with the help of symbol constellation
9. Studying the effect of time variant flat fading (memoryless) channel with the help of symbol constellation

COURSE OUTCOMES:

Upon completion of the course the student will

CO1: Understand the different signal generation and processing methods

CO2: Mathematically model a physical phenomena.

CO3: Simulate a phenomena so as to depict the characteristics that may be observed in a real experiment.

CO4: Apply knowledge of the different simulation techniques for designing a communication system or channel

CO5: Ability to validate a simulated system performance so as to match a realistic scenario

TOTAL PERIODS:45

REFERENCES

1. William.H.Tranter, K. Sam Shanmugam, Theodore. S. Rappaport, Kurt L. Kosbar, Principles of Communication Systems Simulation, Pearson Education (Singapore) Pvt. Ltd, 2004.
2. M.C. Jeruchim, P.Balaban and K. Sam Shanmugam, Simulation of Communication Systems: Modeling, Methodology and Techniques, Plenum Press, New York, 2001.
3. Averill.M.Law and W. David Kelton, Simulation Modeling and Analysis, McGraw Hill Inc., 2000.
4. Geoffrey Gorden, System Simulation, Prentice Hall of India, 2nd Edition, 1992.
5. Jerry Banks and John S. Carson, Discrete Event System Simulation, Prentice Hall of India, 1984.

EL4211 **FPGA BASED SYSTEM DESIGN LAB** **L T P C**
0 0 4 2

COURSE OBJECTIVES

- To understand Verilog and VHDL in modelling of digital circuits and systems.
- To understand the principles of modelling, simulation, synthesis and implementation of digital circuits and systems using FPGA and I/O boards.

LIST OF EXPERIMENTS

1. **Combinational Circuits:** Basic Gates - Majority Logic and Concatenation - Shift Operations - Multiplexers - Demultiplexer - Full Adder - Magnitude Comparator.
2. **Sequential Circuits:** D Flip-flop - Registers - Shift Registers - Counters - Finite State Machines - Pattern Sequence Detector.
3. **Arithmetic Circuit Designs**: Signed Adder - Multiplier - 8/16 Bit MAC – 16 Bit ALU - 8x64 FIFO Buffer
4. **System Designs**: Traffic Light Controller - Real Time Clock – 4 Bit Slice Processor

COURSE OUTCOMES

On successful completion of this course, the student will be able to

CO1: Able to design and implement various combinational circuits using FPGA boards

CO2: Able to design and implement various sequential circuits using FPGA boards

CO3: Able to design and implement various arithmetic circuits using FPGA boards

CO4: Create and import logic modules into FPGA, synthesize and analyze the module with FPGA and I/O boards

	PO					
	1	**2**	**3**	**4**	**5**	**6**
CO1	3	3	2	1	3	1
CO2	3	3	2	1	3	1
Avg	(6/2) = 3	(6/2) = 3	(4/2) = 2	(2/2) = 1	(6/2) = 3	(2/2) = 1

EL4212 **TERM PAPER WRITING AND SEMINAR** **L T P C**
0 0 2 1

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.
Activities to be carried out

Activity	Instructions	Submission week	Evaluation
Selection of area of interest and Topic Stating an Objective	You are requested to select an area of interest, topic and state an objective	2nd week	**3 %** Based on clarity of thought, current relevance and clarity in writing
Collecting Information about your area & topic	1. List 1 Special Interest Groups or professional society 2. List 2 journals 3. List 2 conferences, symposia or workshops 4. List 1 thesis title 5. List 3 web presences (mailing lists, forums, news sites) 6. List 3 authors who publish regularly in your area 7. Attach a call for papers (CFP) from your area.	3rd week	**3%** (the selected information must be area specific and of international and national standard)

Collection of Journal papers in the topic in the context of the objective – collect 20 & then filter	• You have to provide a complete list of references you will be using- Based on your objective -Search various digital libraries and Google Scholar
	• When picking papers to read - try to:
	  • Pick papers that are related to each other in some ways and/or that are in the same field so that you can write a meaningful survey out of them,
	  • Favour papers from well-known journals and conferences,
	  • Favour "first" or "foundational" papers in the field (as indicated in other people's survey paper),
	  • Favour more recent papers,
	  • Pick a recent survey of the field so you can quickly gain an overview,
	  • Find relationships with respect to each other and to your topic area (classification scheme/categorization)
	  • Mark in the hard copy of papers whether complete work or section/sections of the paper are being considered
		4th week	**6%**
			(the list of standard papers and reason for selection)

Reading and notes for first 5 papers	Reading Paper Process • For each paper form a Table answering the following questions: • What is the main topic of the article? • What was/were the main issue(s) the author said they want to discuss? • Why did the author claim it was important? • How does the work build on other's work, in the author's opinion? • What simplifying assumptions does the author claim to be making? • What did the author do? • How did the author claim they were going to evaluate their work and compare it to others? • What did the author say were the limitations of their research? • What did the author say were the important directions for future research?	5th week	**8%** (the table given should indicate your understanding of the paper and the evaluation is based on your conclusions about each paper)

	Conclude with limitations/issues not addressed by the paper (from the perspective of your survey)		
Reading and notes for next5 papers	Repeat Reading Paper Process	6th week	**8%** (the table given should indicate your understanding of the paper and the evaluation is based on your conclusions about each paper)
Reading and notes for final 5 papers	Repeat Reading Paper Process	7th week	**8%** (the table given should indicate your understanding of the paper and the evaluation is based on your conclusions about each paper)
Draft outline 1 and Linking papers	Prepare a draft Outline, your survey goals, along with a classification / categorization diagram	8th week	**8%** (this component will be evaluated based on the linking and classification among the papers)
Abstract	Prepare a draft abstract and give a presentation	9th week	**6%** (Clarity, purpose and conclusion) **6%** Presentation & Viva Voce
Introduction Background	Write an introduction and background sections	10th week	**5%** (clarity)
Sections of the paper	Write the sections of your paper based on the classification / categorization diagram in keeping with the goals of your survey	11thweek	**10%** (this component will be evaluated based on the linking and classification among the papers)
Your conclusions	Write your conclusions and future work	12th week	**5%** (conclusions – clarity and your ideas)
Final Draft	Complete the final draft of your paper	13th week	**10%** (formatting, English, Clarity and linking) **4%** Plagiarism Check Report
Seminar	A brief 15 slides on your paper	14th & 15th week	**10%** (based on presentation and

			Viva-voce)

TOTAL: 30 PERIODS

EL4351 **OPTICAL NETWORKS** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- Understand the concepts of optical components and networks.
- To gain an understanding of various issues in designing a high speed, and huge bandwidth optical network.
- To acquire knowledge of architecture and standards of optical networks.
- Thorough knowledge about the routing and access mechanism in optical networks.
- Thorough understanding of the scientific and engineering principles underlying the photonics technology.

UNIT I OPTICAL SYSTEM COMPONENTS 9

Light propagation in optical fibers-Loss & Bandwidth, System limitations, Non-Linear effect, Solitons, Optical Network Components- Couplers, Isolators & Circulators, Multiplexers & Filters Optical Amplifiers, Switches, Wavelength Converters.

UNIT II OPTICAL NETWORK ARCHITECTURES 9

Introduction to Optical Networks**;** WDM networks , SONET / SDH, Metropolitan-Area Networks, Layered Architecture; Broadcast and Select Networks- Topologies for Broadcast Networks, Media-Access Control Protocols, Wavelength Routing Architecture. WOBAN and OTDM networks. Introduction to ASON.

UNIT III WAVELENGTH ROUTING NETWORKS 9

The Optical layer, Node Designs, Optical layer cost tradeoff, Routing and Wavelength Assignment algorithms, Virtual Topology design, Architectural variations

UNIT IV PACKET SWITCHING AND ACCESS NETWORKS 9

Photonic Packet Switching – OTDM , Multiplexing and Demultiplexing, Synchronization, Broadcast OTDM networks, Switch based networks; Access Networks- Network Architecture overview , Future Access Networks, Optical Access Network Architectures.

UNIT V NETWORK DESIGN AND MANAGEMENT 9

Transmission system Engineering-system model, Power penalty-transmitter, receiver, Optical amplifiers, crosstalk, dispersion, wavelength stabilization; overall design consideration; Control and Management-Network management functions, Configuration management, Performance management, Fault management. Optical safety, Service interface.

COURSE OUTCOMES:

On completion of the course the student will be

CO1:able to design state-of-the-art optical networks.

CO2: able to implement optical network protocols.

CO3: able to design high speed networks using optical fibers

CO4: able to simulate access network

CO5: able to design the optical network infrastructure and network management methods.

TOTAL: 45 PERIODS

REFERENCES

1. Rajiv Ramaswami and Kumar N.Sivarajan, "Optical Networks: A Practical Perspective ", Harcourt Asia Pvt Ltd., Second Edition 2004.
2. C.Siva Ram Moorthy and Mohan Gurusamy, "WDM Optical Networks: Concept, Design and Algorithms", PHI, 1st Edition, 2002.
3. P.E.Green, jr., "Fiber Optical Networks", Prentice Hall, New Jersey, 1993.
4. Optical Networks: Third Generation Transport Systems, Prentice Hall, 2002.
5. Martin Maier, "Optical Switching Networks", Cambridge India, 2014.

EL4001 SOLID STATE DEVICE MODELING AND SIMULATION L T P C

3 0 0 3

COURSE OBJECTIVES:

- Apply the knowledge of device physics in modeling of integrated diode.
- Analyze and model MOS capacitor.
- Analyze and model MOSFET, FINFET and UTB.
- Analyze and model MESFET, HBT, HEMT MODFET,
- Analyze and model Optoelectronic Devices

UNIT I INTRODUCTION TO SEMICONDUCTOR PHYSICS AND DIODE MODELLING 10

Review of Quantum Mechanics - Boltzman transport equation - Continuity equation - Poisson equation. Junction and Schottky diodes in monolithic technologies - static and dynamic behavior - small and large signal models . SPICE modeling and simulation of PN junction and Schottky diode.

UNIT II INTEGRATED MOS CAPACITANCE : : **8**

Band diagram- flat band condition and flat band voltage-surface accumulation, surface depletion-threshold condition and threshold voltage, charge versus gate voltage, MOS C-V Characteristics, Poly Si gate depletion-effective Increase In Tox.

UNIT III INTEGRATED MOS TRANSISTOR 11

NMOS and PMOS Transistor - Threshold voltage - Threshold voltage equations - MOS device equations - Basic DC equations Second order effects - Small signal AC Characteristics- MOS models SPICE model, EKV Model, BSIM Model. Technology scaling for cost, speed and power consumption, Subthreshold Current –Subthreshold Swing, Threshold voltage Roll Off-Short Channel Leakage, reducing gate insulator electrical thickness And Tunneling Leakage, Short Channel Effects. Ultra Thin body, SOI and Multigate MOSFET - FINFET. Compact Model for Circuit Simulation using Verilog A.

UNIT IV ADVANCED SEMICONDUCTOR DEVICES 8

MESFETs, HBTs, HEMTs, MOSFETs.

UNIT V OPTOELECTRONICS DEVICES 8

Light Emitting Diodes, Lasers, Photoconductors, Junction Photodiodes, Avalanche Photodiodes, Solar Cells

45 PERIODS

SUGGESTED ACTIVITIES:

1: Expert Lectures from the Faculty guiding in the area of Device Modelling
2: Using facilities in https://nanohub.org/ for online simulation of devices
3. Usage of Synopsis/ Silvaco TCAD is required

COURSE OUTCOMES:

Upon completion of the course the student will

CO1: Acquire the knowledge of modelling of integrated diode
CO2: Able to model and simulate MOS capacitor for different values of process and operating parameters
CO3 : Able to model and simulate SPICE, EKV and BSIM model of MOSFETs
CO4: Acquire the knowledge of modelling SoI, multigate MOSFET, UTB and FINFET devices
CO5: Acquire the knowledge of modelling of Optoelectronic devices

TOTAL PERIODS:45

REFERENCES

1. Tyagi M S, "Introduction to Semi-conductor Materials and Devices", John Wiley, 2008.
2. Chenming C.Hu, "Modern Semiconductors for Integrated Circuits", Prentice Hall, 2010
3. S. A. Neamen and D. Biswas, *Semiconductor Physics and Devices*, 4th Edition, TMH, 2012.
4. YannisTsividis,"Operation and modeling of the mos transistor" Oxford University Press
5. P. Bhattacharya, *Semiconductor Optoelectronics Devices*, 2nd Edition, PHI, 2009.

EL4002 SMART SENSORS FOR HEALTHCARE L T P C

3 0 0 3

COURSE OBJECTIVES:

- To introduce different types of electrodes used in bio potential recording
- To provide an overview of smart sensors and the associated signal processing
- Gain knowledge for implementing different types of physiological parameter measurement using appropriate sensors
- To introduce smart chemical sensors
- To present an overview of the direction of future health care system

UNIT I BIOPOTENTIAL ELECTRODES 9

Origin of bio potential and its propagation. Electrode-electrolyte interface, electrode–skin interface, half-cell potential, impedance, polarization effects of electrode – nonpolarizable electrodes. Types of electrodes - surface, needle and micro electrodes and their equivalent circuits. Recording problems - measurement with two electrodes.

UNIT II SMART SENSORS 9

Smart Physical sensors-Fiber based sensors-Primary Sensors – Excitation – Amplification – Filters – Converters – Compensation– Information Coding/Processing - Data Communication – Standards for Smart Sensor Interface– The Automation.

UNIT III PHYSICAL SENSORS IN BIOMEDICINE 9

Temperature measurement: core temperature,-surface temperature- invasive. Blood flow measurement: skin blood- hot film anemometer- Doppler sonography- electromagnetic sensor - blood pressure measurement: noninvasive- hemodynamic invasive. Spirometry- sensors for pressure pulses and movement- ocular pressure sensor-acoustic sensors in hearing aid, in blood flow measurement, sensors for bio-magnetism, tactile sensors for artificial limbs, sensors in ophthalmoscopy, artificial retina.

UNIT IV CHEMICAL BIOSENSORS 9

Field Effect Transistor Technologies for Biological and Chemical Sensors -Electrochemical sensor, Chemical fibrosensors, Noninvasive blood gas monitoring-Blood glucose sensors-Electronic noses-gamma radiation dosimeter.

UNIT V NEXT GENERATION HEALTHCARE 9

Internet of Things in Healthcare -Robotics in Healthcare-Implantable Neural Sensors for Brain Machine Interface-Cell Based Sensor -Sensors for food contaminant detection-Liposome Based Sensors-limitations and challenges in state-of-the-art smart biochemical sensors-Future scope of wearable sensors

TOTAL HOURS: 45

COURSE OUTCOMES:

On completion of the course the student will be

CO1: Understand about the different types of bio-potential electrodes

CO2: Able to design systems with smart sensors

CO3:Ability to use appropriate sensors as well as to measure and analyze the physiological parameters obtained

CO4:design chemical sensors for typical issues

CO5: Ability to understand the role of upcoming technology in future healthcare

TOTAL PERIODS:45

REFERENCES

1. J. G. Webster, J. G. Webster ,“Medical Instrumentation; Application and Design”, John Wiley & Sons, Inc., New York, 4th Edition, 2015
2. Chong-Min Kyung,Smart Sensors for Health and Environment Monitoring,Springer Publications,2015.
3. Editors:DomenicoFormicaEmilianoSchena,Smart Sensors for Healthcare andMedicalApplications,Published in *Sensors*,ISBN 978-3-0365-0651-7 (pdf),August 2021.
4. Editors: Kyung, C., Yasuura, H., Liu, Y., Lin, Y.-L. ,Smart Sensors and Systems-Innovations for Medical, Environmental, and IoTApplications,Springer Publications,2017.
5. Editors: HamidaHallilland HadiHeidari,Smart Sensors for Environmental and Medical Applications,Wiley-IEEE Press,2020,ISBN: 978-1-119-58734-7.
6. Edward Sazonov, Michael R. Newman, “Wearable Sensors: Fundamentals, Implementation and Applications”, 2014, 1st Edition, Academic Press, Cambridge.

EL4003 **NANOELECTRONICS** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To understand design of transistor as Nano device
- To understand various forms of Nano Devices
- To understand properties of different types of Nano Sensors

UNIT I SEMICONDUCTOR AND NANODEVICES 9

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

UNIT II ELECTRONICS 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 biosensor applications - fabrication of biosensors - future potential.

COURSE OUTCOMES:

CO1: To be able to design and simulate nanodevices
CO2: To be able to design and simulate nano sensors

TOTAL PERIODS:45

REFERENCES - Recent Reference books may be included

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

AP4072 COMPUTER ARCHITECTURE AND PARALLEL PROCESSING L T P C
3 0 0 3

COURSE OBJECTIVES:

- Discuss the basic concepts and structure of computers.
- Explain the concepts of number representation and arithmetic operations.
- Explain different types of Memory architectures.
- Describe various parallel processing schemes and vector architecture.
- Summarize the Instruction execution stages and Memory hierarchy.

UNIT I INTRODUCTION TO COMPUTER ORGANIZATION 9

Architecture and function of general computer system - Basic Operational Concepts, Bus Structures, Software Performance – Memory locations & addresses – Memory operations – Instruction and instruction sequencing – addressing modes – assembly language - System buses, Multi-bus organization

UNIT II DATA REPRESENTATION 9

Signed number representation, fixed and floating point representations, character representation. Computer arithmetic - integer addition and subtraction, ripple carry adder, carry look-ahead adder - multiplication - shift-and-add, Booth multiplier, carry save multiplier - Division - non-restoring and restoring techniques, floating point arithmetic.

UNIT III PROCESSOR ARCHITECTURE AND CONTROL UNIT 9

A Basic MIPS implementation – Building a Datapath – Control Implementation Scheme – Hardwired control – micro programmed control - Pipelining – Pipelined datapath and control – Handling Data Hazards & Control Hazards – Exceptions. Processor Architecture: Very Long Instruction Word (VLIW) Architecture, Digital Signal Processor Architecture, System on Chip (SoC) architecture, MIPS Processor and programming

UNIT IV PARALLEL PROCESSING 9

Parallel processing challenges – Flyn's classification – Single Instruction Single Data (SISD), Multiple Instruction Multiple Data (MIMD), Single Instruction Multiple Data (SIMD), Single Program Multiple Data (SPMD), and Vector Architectures - Hardware multithreading – Multi-core processors and other Shared Memory Multiprocessors - Introduction to Graphics Processing Units, Clusters, Warehouse Scale Computers and other Message-Passing Multiprocessors.

UNIT V MEMORY & I/O SYSTEMS 9

Memory Hierarchy – memory technologies – cache memory – measuring and improving cache performance – virtual memory, Translation Lookaside Buffers – Accessing I/O Devices – Interrupts – Direct Memory Access – Bus structure – Bus operation – Arbitration – Interface circuits – Universal Serial Bus.

L: 45; TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: Understand the basic organization of computer and different instruction formats and addressing modes. (K2)

CO2: Interpret the representation and manipulation of data on the computer. (K3)

CO3: Illustrate about implementation schemes of control unit and pipeline performance. (K2)

CO4: Summarize the various types of parallelism architectures. (K2)

CO5: Compare the various memory hierarchy and I/O systems. (K2)

REFERENCE BOOKS

1. David A. Patterson and John L. Hennessy, “Computer Organization and Design: The Hardware/Software Interface”, Morgan Kaufmann / Elsevier, 5th Edition, 2014.
2. Carl Hamacher, ZvonkoVranesic, SafwatZaky and NaraigManjikian, “Computer Organization and Embedded Systems”, Tata McGraw Hill, 6th Edition, 2012.
3. William Stallings, “Computer Organization and Architecture – Designing for Performance”, Pearson Education, 8th Edition, 2010.
4. John P. Hayes, “Computer Architecture and Organization”, Tata McGraw Hill, 3rd Edition, 2012.
5. John L. Hennessey and David A. Patterson, “Computer Architecture – A Quantitative Approach”, Morgan Kaufmann / Elsevier Publishers, 5th Edition, 2012.

EL4071 ELECTROMAGNETIC INTERFERENCE AND COMPATIBILITY L T P C
3 0 0 3

COURSE OBJECTIVES:

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

UNIT I INTRODUCTION & SOURCES OF EM INTERFERENCE 9

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

UNIT II EM SHIELDING 9

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

UNIT III INTERFERENCE CONTROL TECHNIQUES 9

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

UNIT IV EMC STANDARDS, MEASUREMENTS AND TESTING 9

Need for standards - The international framework - Human exposure limits to EM fields -EMC measurement techniques - Measurement tools - Test environments. Need for standards - The international framework - Human exposure limits to EM fields –EMC measurement techniques - Measurement tools - Test environments

UNIT V EMC CONSIDERATIONS IN WIRELESS AND BROADBAND TECHNOLOGIES **9**

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

45 PERIODS

SUGGESTED ACTIVITIES:

1. Investigate various case studies related to EMIC.Example: Chernobyl Disaster in 1986.
2. Develop some understanding about the design of EM shields in electronic system design and packaging.

COURSE OUTCOMES:

1. Demonstrate knowledge of the various sources of electromagnetic interference
2. Display an understanding of the effect of how electromagnetic fields couple through apertures, and solve simple problems based on that understanding
3. Explain the EMI mitigation techniques of shielding and grounding
4. Explain the need for standards and EMC measurement methods
5. Discuss the impact of EMC on wireless and broadband technologies

TOTAL PERIODS:45

REFERENCES

1. Christopoulos C, Principles and Techniques of Electromagnetic Compatibility, CRC Press, Second Edition, Indian Edition, 2013.
2. Paul C R, Introduction to Electromagnetic Compatibility, Wiley India, Second Edition,2008.
3. Kodali V P, Engineering Electromagnetic Compatibility, Wiley India, Second Edition,2010.
4. Henry W Ott, Electromagnetic Compatibility Engineering, John Wiley & Sons Inc, Newyork,2009.
5. Scott Bennett W, Control and Measurement of Unintentional Electromagnetic Radiation, John Wiley& Sons Inc., Wiley Interscience Series, 1997.

AP4078 SIGNAL INTEGRITY FOR HIGH SPEED DESIGN L T P C
3 0 0 3

COURSE OBJECTIVES:

- To identify sources affecting the speed of digital circuits.
- To introduce methods to improve the signal transmission characteristics

UNIT I SIGNAL PROPAGATION ON TRANSMISSION LINES **9**

Transmission line equations, wave solution, wave *vs*. circuits, initial wave, delay time, Characteristic impedance , wave propagation, reflection, and bounce diagrams Reactive terminations – L, C , static field maps of micro strip and strip line cross-sections, per unit length parameters, PCB layer stackups and layer/Cu thicknesses, cross-sectional analysis tools, Zo and Td equations for microstrip and stripline Reflection and terminations for logic gates, fan-out, logic

switching , input impedance into a transmission-line section, reflection coefficient, skin-effect, dispersion.

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

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

UNIT III NON-IDEAL EFFECTS 9

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

UNIT IV POWER CONSIDERATIONS AND SYSTEM DESIGN 9

SSN/SSO , DC power bus design , layer stack up, SMT decoupling ,, Logic families, power consumption, and system power delivery , Logic families and speed Package types and parasitic ,SPICE, IBIS models ,Bit streams, PRBS and filtering functions of link-path components , Eye diagrams , jitter , inter-symbol interference Bit-error rate ,Timing analysis.

UNIT V CLOCK DISTRIBUTION AND CLOCK OSCILLATORS 9

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

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to
CO1: identify sources affecting the speed of digital circuits.
CO2:identify methods to improve the signal transmission characteristics

REFERENCES

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

TOOLS REQUIRED

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

CU4076 **SPEECH PROCESSING** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To introduce speech production and related parameters of speech.
- To illustrate the concepts of speech signal representations and coding.
- To understand different speech modeling procedures such Markov and their implementation issues.
- To gain knowledge about text analysis and speech synthesis.

UNIT I FUNDAMENTALS OF SPEECH PROCESSING 9

Introduction – Spoken Language Structure – Phonetics and Phonology – Syllables and Words – Syntax and Semantics – Probability, Statistics and Information Theory – Probability Theory – Estimation Theory – Significance Testing – Information Theory.

UNIT II SPEECH SIGNAL REPRESENTATIONS AND CODING 9

Overview of Digital Signal Processing – Speech Signal Representations – Short time Fourier Analysis – Acoustic Model of Speech Production – Linear Predictive Coding – Cepstral Processing – Formant Frequencies – The Role of Pitch – Speech Coding – LPC Coder, CELP, Vocoders.

UNIT III SPEECH RECOGNITION 9

Hidden Markov Models – Definition – Continuous and Discontinuous HMMs – Practical Issues – Limitations. Acoustic Modeling – Variability in the Speech Signal – Extracting Features – Phonetic Modeling – Adaptive Techniques – Confidence Measures – Other Techniques.

UNIT IV TEXT ANALYSIS 9

Lexicon – Document Structure Detection – Text Normalization – Linguistic Analysis – Homograph Disambiguation – Morphological Analysis – Letter-to-sound Conversion – Prosody – Generation schematic – Speaking Style – Symbolic Prosody – Duration Assignment – Pitch Generation

UNIT V SPEECH SYNTHESIS 9

Attributes – Formant Speech Synthesis – Concatenative Speech Synthesis – Prosodic Modification of Speech – Source-filter Models for Prosody Modification – Evaluation of TTS Systems.

COURSE OUTCOMES:

Upon completion of this course, the students will be able to:

CO1: Model speech production system and describe the fundamentals of speech.
CO2: Extract and compare different speech parameters.
CO3: Choose an appropriate statistical speech model for a given application.
CO4: Design a speech recognition system.
CO5: Use different text analysis and speech synthesis techniques.

TOTAL PERIODS:45

REFERENCES

1. Ben Gold and Nelson Morgan, “Speech and Audio Signal Processing, Processing and Perception of Speech and Music”, Wiley- India Edition, 2006
2. Claudio Becchetti and Lucio Prina Ricotti, “Speech Recognition”, John Wiley and Sons, 1999.
3. Daniel Jurafsky and James H Martin, “Speech and Language Processing – An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition”, Pearson Education, 2002.

4. Frederick Jelinek, “Statistical Methods of Speech Recognition”, MIT Press, 1997. 5. Lawrence Rabiner and Biing-Hwang Juang, “Fundamentals of Speech Recognition”, Pearson Education, 2003.
5. Steven W. Smith, “The Scientist and Engineer"s Guide to Digital Signal Processing”, California Technical Publishing, 1997.

6. Thomas F Quatieri, “Discrete-Time Speech Signal Processing – Principles and Practice”, Pearson Education, 2004.

EL4004 CRYPTOGRAPHY AND NETWORK SECURITY L T P C
3 0 0 3

COURSE OBJECTIVES:

- To understand· the importance and goals of communication network and information security and introduce them to the different types of attacks.
- To expose· different approaches to handling security and the algorithms in use for maintaining data integrity and authenticity.
- To· appreciate the practical aspects of security features design and their implementation in wired and wireless internetworking domains.

UNIT I INTRODUCTION ON SECURITY 9

Security Goals, Cryptographic attacks, Security services and mechanisms Techniques: Cryptography and Steganography, Traditional Symmetric-Key Ciphers: Substitution Ciphers and Transposition Ciphers, Mathematics for Cryptography.

UNIT II SYMMETRIC & ASYMMETRIC KEY ALGORITHMS 9

Introduction to Block Ciphers and Stream Ciphers, Data Encryption Standards (DES), Advanced Encryption Standard (AES), RC4, Principle of asymmetric key algorithms, RSA Cryptosystem.

UNIT III INTEGRITY, AUTHENTICATION AND KEY MANAGEMENT 9

Message Integrity, Hash functions: **SHA 512, Whirlpool**, Digital signatures: Digital signature standards. Authentication: Entity Authentication: Biometrics, Key management Techniques.

UNIT IV NETWORK SECURITY, FIREWALLS AND WEB SECURITY 9

Introduction on Firewalls, Types of Firewalls, IP Security, E-mail security: PGP- S/MIME, Web security: SSL-TLS, SET.

UNIT V WIRELESS NETWORK SECURITY 9

Security Attack issues specific to Wireless systems: Worm hole, Tunneling, DoS. Security for WLAN, Security for Broadband networks: Security challenges in 4G and 5G deployments, Introduction to side channel attacks and their counter measures.

COURSE OUTCOMES:

CO1: Able to demonstrate an understanding of the ways in which communication network security may get compromised and the basic principles of security algorithm design.

CO2: Familiar with the different types of security attacks, approaches to handling security and the algorithms in use for maintaining data integrity and authenticity

CO3: Able to implement and analyse the different algorithms and compare their performances.

CO4: Able to appreciate the practical aspects of security features design and their implementation in wired and wireless internetworking domains

CO5: In a position to apply his knowledge for designing or modifying existing algorithms and implementing using simulation.

TOTAL PERIODS:45

REFERENCES

1. Behrouz A. Forouzan ,"Cryptography and Network security", McGraw- Hill, 2011
2. William Stallings, "Cryptography and Network security: principles and practice", Prentice Hall of India, New Delhi, 2nd Edition,2002
3. AtulKahate ,"Cryptography and Network security", Tata McGraw-Hill,2nd Edition, 2008.
4. R.K.Nichols and P.C. Lekkas ,"Wireless Security: Models , threats and Solutions", McGraw- Hill, 2001.
5. H. Yang et al., "Security in Mobile Ad Hoc Networks: Challenges and Solution", IEEE Wireless Communications, Feb. 2004.
6. "Securing Ad Hoc Networks", IEEE Network Magazine, vol. 13, no. 6, pp. 24-30, December 1999.
7. "Security of Wireless Ad Hoc Networks," http://www.cs.umd.edu/~aram/wireless/ survey.pdf
8. David Boelet.al,"Securing Wireless Sensor Networks – Security Architecture", Journal of networks , Vol.3. No. 1. pp. 65 -76, Jan 2008.
9. Perrig, A., Stankovic, J., Wagner, D., "Security in Wireless Sensor Networks", Communications of the ACM, 47(6), 53-57, 2004.
10. Introduction to side channel attacks – http://gauss.ececs.uc.edu/Courses/c653/lectures/SideC/intro.pdf.

EL4005 COGNITIVE RADIO L T P C

3 0 0 3

COURSE OBJECTIVES:

- To understand the evolving paradigm of cognitive radio communication and the enabling technologies for its implementation.
- To understand the essential functionalities and requirements in designing software defined radios and their usage for cognitive communication.
- To expose evolving next generation wireless networks and their associated challenges.

UNIT I SOFTWARE DEFINED RADIO AND ITS ARCHITECTURE 9

Definitions and potential benefits, software radio architecture evolution, technology tradeoffs and architecture implications. Essential functions of the software radio, basic SDR, hardware architecture, Computational processing resources, software architecture, top level component interfaces, interface topologies among plug and play modules.

UNIT II COGNITIVE RADIOS AND ITS ARCHITECTURE 9

Marking radio self-aware, cognitive techniques – position awareness, environment awareness in cognitive radios, optimization of radio resources, Artificial Intelligence Techniques, Cognitive Radio – functions, components and design rules, Cognition cycle – orient, plan, decide and act phases, Inference Hierarchy, Architecture maps, Building the Cognitive Radio Architecture on Software defined Radio Architecture.

UNIT III SPECTRUM SENSING AND IDENTIFICATION 9

Primary Signal Detection: Energy Detector, Cyclostationary Feature Detector, Matched Filter ,Cooperative Sensing , Definition and Implications of Spectrum Opportunity, Spectrum Opportunity Detection , Fundamental Trade-offs: Performance versus Constraint , MAC Layer Performance Measures, Global Interference Model, Local Interference Model, Fundamental Trade-offs: Sensing Accuracy versus Sensing Overhead.

UNIT IV USER COOPERATIVE COMMUNICATIONS 9

User Cooperation and Cognitive Systems , Relay Channels: General Three-Node Relay Channel, Wireless Relay Channel , User Cooperation in Wireless Networks: Two-User Cooperative Network, Cooperative Wireless Network , Multihop Relay Channel

UNIT V INFORMATION THEORETICAL LIMITS ON CR NETWORKS 9

Types of Cognitive Behavior, Interference-Avoiding Behavior: Spectrum Interweave, Interference-Controlled Behavior: Spectrum Underlay, Underlay in Small Networks: Achievable Rates, Underlay in Large Networks: Scaling Laws, Interference-Mitigating Behavior: Spectrum Overlay, Opportunistic Interference Cancellation, Asymmetrically Cooperating Cognitive Radio Channels.

COURSE OUTCOMES:

On completion of the course the student will

CO1: Able to appreciate the motivation and the necessity for cognitive radio communication strategies.

CO2: Demonstrate understanding of the enabling technologies for its implementation

CO3: Demonstrate understanding of the essential functionalities and requirements in designing software defined radios and their usage for cognitive communication.

CO4: Able to evolve new techniques and demonstrate their feasibility using mathematical validations and simulation tools.

CO5: Able to demonstrate the impact of the evolved solutions in future wireless network design.

TOTAL PERIODS:45

REFERENCES

1. Alexander M. Wyglinski, MaziarNekovee, And Y. Thomas Hou, “Cognitive Radio Communications and Networks - Principles And Practice”, Elsevier Inc. , 2010.
2. Kwang-Cheng Chen and Ramjee Prasad, “Cognitive Radio Networks”, John Wiley & Sons, Ltd, 2009.
3. Khattab, Ahmed, Perkins, Dmitri, Bayoumi, Magdy, “Cognitive Radio Networks - From Theory to Practice”, Springer Series, Analog Circuits and Signal Processing, 2009.
4. J. Mitola, “Cognitive Radio: An Integrated Agent Architecture for software defined radio”, Doctor of Technology thesis, Royal Inst. Technology, Sweden 2000.
5. Simon Haykin, “Cognitive Radio: Brain –empowered wireless communications”, IEEE Journal on selected areas in communications, Feb 2005.

6. Ian F. Akyildiz, Won – Yeol Lee, Mehmet C. Vuran, ShantidevMohanty, “Next generation / dynamic spectrum access / cognitive radio wireless networks: A Survey Elsevier Computer Networks”, May 2006.

EL4006 SATELLITE COMMUNICATIONS AND NAVIGATION SYSTEMS L T P C
3 0 0 3

COURSE OBJECTIVES:

- To enable the student to understand the necessity for satellite based communication, the essential elements involved and the transmission methodologies.
- To enable the student to understand the different interferences and attenuation mechanisms affecting the satellite link design.
- To expose the student to the advances in satellite based navigation, GPS and the different application scenarios.

UNIT I ELEMENTS OF SATELLITE COMMUNICATION 9

Satellite Systems, Orbital description and Orbital mechanics of LEO, MEO and GSO, Placement of a Satellite in a GSO, Antennas and earth coverage, Altitude and eclipses, Satellite drift and station keeping, Satellite – description of different Communication subsystems, Bandwidth allocation

UNIT II SATELLITE SPACE SEGMENT AND ACCESS 9

Introduction; attitude and orbit control system; telemetry, tracking and command; power systems, communication subsystems, antenna subsystem, equipment reliability and space qualification, Multiple Access: Demand assigned FDMA - SPADE system - TDMA - satellite switched TDMA – CDMA.

UNIT III SATELLITE LINK DESIGN 9

Basic link analysis, Interference analysis, Rain induced attenuation and interference, Ionospheric characteristics, Link Design: System noise temperature and G/T ratio, Downlink and uplink design, C/N, Link Design with and without frequency reuse, link margins, Error control for digital satellite link.

UNIT IV SATELLITE BASED BROADBAND COMMUNICATION 9

VSAT Network for Voice and Data – TDM/TDMA, SCPC/DAMA, Elements of VSAT Network, Mobile and Personal Communication Services, Satellite based Internet Systems, Multimedia Broadband Satellite Systems, UAVs.

UNIT V SATELLITE NAVIGATION AND GLOBAL POSITIONING SYSTEM 9

Radio and Satellite Navigation, GPS Position Location Principles of GPS Receivers and Codes, Satellite Signal Acquisition, GPS Receiver Operation and Differential GPS, INS, Indian Remote Sensing and ISRO GPS Systems.

COURSE OUTCOMES:

At the end of the course the student would be

CO1: Able to demonstrate an understanding of the basic principles of satellite based communication the essential elements involved and the transmission methodologies.

CO2: Familiar with satellite orbits, placement and control, satellite link design and the communication system components.

CO3: Able to demonstrate an understanding of the different interferences and attenuation mechanisms affecting the satellite link design.

CO4: The student would be able to demonstrate an understanding of the different communication, sensing and navigational applications of satellite.

CO5: Familiar with the implementation aspects of existing satellite based systems

TOTAL PERIODS:45

REFERENCES

1. Wilbur L. Pritchard, Hendri G. Suyderhoud and Robert A. Nelson, "Satellite Communication Systems Engineering", Prentice Hall/ Pearson, 2007.
2. Timothy Pratt and Charles W.Bostain, "Satellite Communications", John Wiley and Sons, 2nd Edition, 2012.
3. D.Roddy, "Satellite Communication", McGraw Hill, 4th Edition (Reprint), 2009.
4. Tri T Ha, "Digital Satellite Communication", McGraw Hill, 2nd Edition,1990.
5. B.N.Agarwal, "Design of Geosynchronous Spacecraft", Prentice Hall, 1993.
6. Brian Ackroyd, "World Satellite Communication and Earth Station Design", BSP Professional Books, 1990.

DS4251 MULTIMEDIA COMPRESSION TECHNIQUES L T P C

3 0 0 3

COURSE OBJECTIVES:

- To understand the basics about compression algorithms related to multimedia components such as text, speech, audio, image and video.
- To understand the principles, standards, and their applications with an emphasis on underlying technologies, algorithms, and performance.
- To understand the importance of compression in multimedia processing applications.
- To understand and implement compression standards

UNIT I ESSENTIALS OF COMPRESSION 9

Introduction to multimedia system- Elements, Categories, Features, Applications, and Stages of multimedia Application Development- Graphics, Image and Video representations – Fundamental concepts of video, digital audio–Storage Requirements Of Multimedia Applications–Need For Compression-Taxonomy of compression Algorithms

UNIT II TEXT COMPRESSION TECHNIQUES 9

Elements of Information Theory-Entropy coding: Run length coding -Huffman coding – Adaptive Huffman coding – Arithmetic coding – Shannon-Fano coding – Analysis/Synthesis Schemes - Dictionary techniques – LZW family algorithms.

UNIT III IMAGE COMPRESSION TECHNIQUES 9

Image Compression: Fundamentals —- Compression Standards – Still image coding JPEG Standard – Sub-band coding – Wavelet transform for image coding– Implementation using Filters – EZW, SPIHT coders – JPEG 2000 standards – JBIG and JBIG2 standards- Non-standardized still image coding.

UNIT IV AUDIO COMPRESSION TECHNIQUES 9

Audio compression Techniques –μ law, A-Law companding – Frequency domain and filtering – Basic sub-band coding – Application to speech coding – G.722 – MPEG audio – progressive encoding – Silence compression, Speech compression – Formant and CELP vocoders.

UNIT V VIDEO COMPRESSION TECHNIQUES 9

Video compression: Fundamentals, techniques and Standards – MPEG video coding: MPEG-1 and MPEG-2 video coding: MPEG-3 and MPEG-4 – Content-Based Video Coding. ITU-T Video Coding Standards H.261 and H.263. Video Coding Standard--H.264/AVC. A New Video Coding Standard--HEVC/H.265. Internet Video Coding Standard--IVC. MPEG Media Transport-DVI technology – DVI real time compression – Current Trends in Compression standards.

45 PERIODS

COURSE OUTCOMES:

CO1: Implement basic compression algorithms familiar with the use of MATLAB and its equivalent open source environments

CO2: Design and analyse text compression techniques

CO3: Design and implement image and audio compression techniques

CO4: Develop basic audio compression standards

CO5: Critically analyze different approaches of compression algorithms in multimedia related mini projects.

REFERENCES

1. Khalid Sayood: Introduction to Data Compression", Morgan Kauffman Harcourt India, Fifth Edition,2017.
2. David Solomon, "Data Compression – The Complete Reference", Fourth Edition, Springer Verlag, New York, 2011.
3. Thomas m. Cover Joy a. Thomas, "Elements Of Information Theory", Wiley Second edition 2013.
4. Yun Q.Shi, Huifang Sun, "Image and Video Compression for Multimedia Engineering: Fundamentals, Algorithms, and Standards, Third Edition", CRC Press,2019.
5. Mark S. Drew, Ze-Nian Li, "Fundamentals of Multimedia", PHI, Springer Nature; 2nd ed. 2014.
6. Mohammed Ghanbari, Standard Codecs: Image compression to Advanced Video Coding, Telecommunication Series, IET, 3rd edition, 2011.
7. Peter Symes, Digital Video Compression, McGraw Hill, 2004
8. Iain E.G. Richardson, H.264 and MPEG-4, Video Compression: Video Coding for Next generation Multimedia, John Wiley, 2003.

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	✔	✔	✔			✔
CO2	✔	✔	✔	✔	✔	✔
CO3	✔	✔	✔	✔	✔	✔
CO4	✔	✔	✔	✔	✔	✔
CO5	✔	✔	✔	✔	✔	✔

VL4073 MEMS AND NEMS **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- to introduce the concepts of Micro Electro Mechanical devices.
- to know the fabrication process of microsystems.
- to know the design concepts of micro sensors and micro actuators.
- to familiarize concepts of Quantum Mechanics and Nano systems.

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 NANOSYSTEMS 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

COURSE OUTCOMES:

At the end of this course, the student should be able to:

CO1:Discuss micro sensors

CO2:Explain micro actuators

CO3:Outline nanosystems and Quantum mechanics

CO4:Design micro actuators for different applications

CO5:Analyze atomic sturctures

REFERENCES

1. Chang Liu, “Foundations of MEMS”, Pearson Education India Limited, 2006.
2. Marc Madou, “Fundamentals of Microfabrication”, CRC Press 1997.
3. Stephen D. Senturia,” Micro System Design”, Kluwer Academic Publishers,2001
4. Sergey Edward Lyshevski, “MEMS and NEMS: Systems, Devices, and Structures” CRC Press, 2002.
5. Tai Ran Hsu ,”MEMS and Microsystems Design and Manufacture” ,Tata Mcraw Hill, 2002.

	PO					
	1	**2**	**3**	**4**	**5**	**6**
CO1	3	0	2	3	0	0
CO2	3	0	2	3	0	0
CO3	3	0	2	3	0	0
AVG	(9/3)=3	0	(6/3)=2	(9/3)=3	0	0

AP4071 **AUTOMOTIVE ELECTRONICS** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To explain the principle of electronic management system and different sensors used in the systems.
- To know the concepts and develop basic skills necessary to diagnose automotive electronic problems.
- To know Starting, and charging, lighting systems, advanced automotive electrical systems.
- To include electronic accessories and basic computer control.
- To explore practically about the components present in an Automotive electrical and electronics system.

UNIT I FUNDAMENTALS 9

Components for electronic engine management system, open and closed loop control strategies, PID control, Look up tables, introduction to modern control strategies like Fuzzy logic and adaptive control. Switches, active resistors, Transistors, Current mirrors/amplifiers, Voltage and current references, Comparator, Multiplier. Amplifier, filters, A/D and D/A converters.

UNIT II MODERN SENSORS 9

Film sensors, micro-scale sensors, Particle measuring systems, Vibration Sensors, SMART sensors, Machine Vision, Multi-sensor systems Applications of Sensors: Applications and case studies of Sensors in Automobile Engineering, Aeronautics, Machine tools and Manufacturing processes.

UNIT III CHARGING SYSTEM 9

Generation of Direct Current- Shunt Generator Characteristics- Armature Reaction- Third Brush Regulation- Cutout. Voltage and Current Regulators- Compensated Voltage Regulator Alternators Principle and Constructional Aspects and Bridge Rectifiers- New Developments.

UNIT IV AUTOMOTIVE TRANSMISSION CONTROL SYSTEMS 9

Transmission control - Cruise control – Braking control – Traction control –Suspension control – Steering control – Stability control – Integrated engine control.

UNIT V ELECTRONICS SYSTEMS 9

Current Trends in Automotive Electronic Engine Management System- Types of EMS Electromagnetic interference Suppression- Electromagnetic Compatibility- Electronic Dashboard Instruments- Onboard Diagnostic System- Security - Warning System infotainment and Telematics.

SUGGESTED ACTIVITIES:

1: Testing of battery, starting systems, charging systems, ignition systems and body controller systems
2: Study of various sensors and actuators used in two wheelers and four wheelers for electronic control.
3: Study of Development of Embedded Systems projects.

COURSE OUTCOMES:
At the end of this course the students will be able to:
CO1: Explain the fundamentals, operation, function of various sensors and actuators in engine management systems.
CO2: Explain the Automotive Transmission Control Systems.
CO3: Enumerate the principles, application, construction and specification of different sensors and actuators usable in typical automobile by suitable testing.
CO4: List out the principles and characteristics of charging system components and demonstrate their working with suitable tools.
CO5: Describe the principles and architecture of electronics systems and its components present in an automobile related to instrumentation, control, security and warning systems.

TOTAL PERIODS: 45

REFERENCES

1. Allan Bonnick, “Automotive Computer Controlled Systems”, Butterworth-Heinemann, Elsevier, Indian Edition, 2011.
2. Eric Chowanietz, “Automobile Electronics” by SAE Publications, 1995
3. Tom Weather Jr and Cland C. Hunter, “Automotive Computers and Control System” Prentice Hall Inc.,1984 New Jersey.
4. R.K. Jurgen, “Automotive Electronics Handbook”, McGraw Hill 2 nd Edition,1995.
5. William B Ribbens, “understanding automotive electronics”, 5th edition - Butter worth Heinemann Woburn, 1998.

VL4072 CAD FOR VLSI DESIGN L T P C
3 0 0 3

COURSE OBJECTIVES:

- to introduce the VLSI design methodologies and design methods.
- to introduce data structures and algorithms required for VLSI design.
- to study algorithms for partitioning and placement.
- to study algorithms for floor planning and routing.
- to study algorithms for modelling, simulation and synthesis.

UNIT I INTRODUCTION 9

Introduction to VLSI Design Methodologies – VLSI Design Cycle – New Trends in VLSI Design Cycle – Physical Design Cycle – New Trends in Physical Design Cycle – Design Styles – Review of VLSI Design Automation Tools

UNIT II DATA STRUCTURES AND BASIC ALGORITHMS 9

Introduction to Data Structures and Algorithms – Algorithmic Graph Theory and Computational Complexity – Tractable and Intractable Problems – General Purpose Methods for Combinatorial Optimization.

UNIT III ALGORITHMS FOR PARTITIONING AND PLACEMENT 9

Layout Compaction – Problem Formulation – Algorithms for Constraint Graph Compaction – Partitioning – Placement – Placement Algorithms.

UNIT IV ALGORITHMS FOR FLOORPLANNING AND ROUTING 9

Floorplanning – Problem Formulation – Floorplanning Algorithms – Routing – Area Routing – Global Routing – Detailed Routing.

UNIT V MODELLING, SIMULATION AND SYNTHESIS 9

Simulation – Gate Level Modeling and Simulation – Logic Synthesis and Verification – Binary Decision Diagrams – High Level Synthesis.

TOTAL:45 PERIODS

COURSE OUTCOMES:

At the end of this course, the students should be able to:

CO1: use various VLSI design methodologies

CO2: understand different data structures and algorithms required for VLSI design.

CO3: develop algorithms for partitioning and placement.

CO4: develop algorithms for floorplanning and routing.

CO5: design algorithms for modelling, simulation and synthesis.

REFERENCES

1. Sabih H. Gerez, “Algorithms for VLSI Design Automation”, Second Edition, Wiley-India, 2017.
2. Naveed a. Sherwani, “Algorithms for VLSI Physical Design Automation”, 3rd Edition, Springer, 2017.
3. Charles J. Alpert, Dinesh P. Mehta and Sachin S Sapatnekar, “Handbook of Algorithms for Physical Design Automation, CRC Press, 1st Edition, 2.
4. N.a. Sherwani, "Algorithms for VLSI Physical Design Automation", Kluwer Academic Publishers, 2002.

	PO					
	1	**2**	**3**	**4**	**5**	**6**
CO1	3	0	3	2	3	0
CO2	3	0	3	2	3	0
CO3	3	0	3	2	3	0
CO4	3	0	3	2	3	0
CO5	3	0	3	2	3	0
AVG	(15/5)=3	(0/0)=0	(15/5)=3	(10/5)=2	(15/5)=3	(0/0)=0

VE4071 **HARDWARE SOFTWARE CO-DESIGN** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

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

UNIT I SYSTEM SPECIFICATION AND MODELLING 9

Embedded Systems, Hardware/Software Co-Design, Co-Design for System Specification And Modeling, Co-Design for Heterogeneous Implementation - Processor Synthesis, Single-Processor Architectures With One ASIC, Single-Processor Architectures With Many ASICs, Multi-Processor Architectures, Comparison of Co-Design Approaches, Models of Computation, Requirements for Embedded System Specification.

UNIT II HARDWARE/SOFTWARE PARTITIONING 9

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

UNIT III HARDWARE/SOFTWARE CO-SYNTHESIS 9

The Co-Synthesis Problem, State-Transition Graph, Refinement and Controller Generation, Distributed System Co-Synthesis

UNIT IV PROTOTYPING AND EMULATION 9

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

UNIT V DESIGN SPECIFICATION AND VERIFICATION 9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course, the students should will be able to:

CO1: describe the broad range of system architectures and design methodologies that currently exist and define their fundamental attributes.

Co2: discuss the dataflow models as a state-of-the-art methodology to solve co-design problems and to optimize the balance between software and hardware.

Co3: understand in translating between software and hardware descriptions through co-design methodologies.

Co4: understand the state-of-the-art practices in developing co-design solutions to problems using modern hardware/software tools for building prototypes.

Co5: understand the concurrent specification from an algorithm, analyze its behavior and partition the specification into software (C code) and hardware (HDL) components

TOTAL PERIODS:45

REFERENCES

1. Patrick Schaumont, “a Practical Introduction To Hardware/Software Codesign”, Springer,2010.
2. Ralf Niemann, “Hardware/Software Co-Design for Data Flow Dominated Embedded Systems”, Kluwer Academic Publisher, 1998.

3. Jorgen Staunstrup, Wayne Wolf, “Hardware/Software Co-Design: Principles And Practice”, Kluwer Academic Publisher,1997.
4. Giovanni De Micheli, Rolf Ernst Morgon, “Reading In Hardware/Software Co-Design”, Kaufmann Publisher,2001.

	1	2	3	4	5	6
CO1	3	0	3	3	0	0
CO2	3	0	3	3	0	0
CO3	3	0	3	3	0	0
CO4	3	0	3	3	0	0
CO5	3	0	3	3	0	0
AVG	(15/5)=3	(0/0)=0	(15/5)=3	(15/5)=3	(0/0)=0	(0/0)=0

AP4073 EDGE ANALYTICS AND INTERNET OF THINGS L T P C
3 0 0 3

UNIT I INTRODUCTION TO IOT 9

Importance and Need for IoT - Application and Use cases of IoT - Overview of Industrial IoT - Intersection of IoT and Edge Analytics.

UNIT II IOT PROTOCOLS AND SYSTEMS 9

IoT protocols and standards - Cloud IoT Infrastructure - Setup and program IoT device- Data Collection from IoT device.

UNIT III MACHINE LEARNING AND ARTIFICIAL INTELLIGENCE 9

Introduction to Machine Learning and Artificial Intelligence - Overview of Deep Learning and Neural Networks- Introduction to Convolution Neural Networks.

UNIT IV AUTO ENCODERS AND ITS PROGRAMMING 9

Introduction to Recurrent Neural Networks- Introduction to Auto Encoders- Programming Practice: Build Image Classifier, Build Anomaly Detector

UNIT V EDGE ANALYTICS 9

Challenges with Edge Devices and Deployment - Need for Model Quantization Quantization Aware Training- Post Model Quantization- Programming Practice: Model quantization, Deploying model on Edge Devices

L: 45; TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of this course, student will be able to

CO 1: Understand foundational concepts in Edge Analytics.

CO 2: Analysis of IOT protocols in cloud environment.

CO 3: Understand the principles of Machine Learning and Artificial Intelligence

CO 4: Analysis of various unsupervised learning algorithm.

CO 5: Deployment of Edge devices and its challenges.

REFERENCES:

1. Honbo Zhou, "The Internet of Things in the Cloud: A Middleware Perspective", CRC Press, 2012.
2. P. Flach, —Machine learning: The art and science of algorithms that make sense of datall, Cambridge University Press, 2012.
3. 3.Anirudh Koul, Siddha Ganju, Meher Kasam, "Practical Deep Learning for Cloud, Mobile, and Edge" O'Reilly Media, 2019.
4. Dieter Uckelmann, Mark Harrison, Florian Michahelles, "Architecting the Internet of Things", Springer, 2011.

AP4074 PCB DESIGN L T P C
3 2 0 4

COURSE OBJECTIVES:

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

UNIT I INTRODUCTION TO PRINTED CIRCUIT BOARD 12

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

UNIT II DESIGN RULES FOR PCB 12

Design rules for PCB: Design rules for Digital circuit PCBs, Analog circuit PCBs, high frequency and fast pulse applications, Power electronic applications, Microwave applications,

PCB Technology Trends: Multilayer PCBs. Multiwire PCB, Flexible PCBs, Surface mount PCBs, Reflow soldering, Introduction to High-Density Interconnection (HDI) Technology.

UNIT III INTRODUCTION TO ELECTRONIC DESIGN AUTOMATION(EDA) TOOLS FOR PCB DESIGNING **12**

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

UNIT IV INTRODUCTION PRINTED CIRCUIT BOARD PRODUCTION TECHNIQUES **12**

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

UNIT V PCB DESIGN FOR EMI/EMC **12**

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

SUGGESTED ACTIVITIES:

1. Using any Electronic design automation (EDA) software, Practice following PCB Design steps (Open source EDA Tool KiCad Preferable or equivalent) Example circuit: Basic RC Circuit Schematic Design: Familiarization of the Schematic Editor, Schematic creation, Annotation, Netlist generation Layout Design: Familiarization of Footprint Editor, Mapping of components, Creation of PCB layout Schematic Create new schematic components Create new component footprints.

2. Fabricate single-sided PCB, mount the components and assemble in a cabinet for any one of the circuits mentioned below.

3. Regulator circuit using 7805.
4. Astable or Monostable multivibrator using IC555
5. RC Phase-shift or Wein-bridge Oscillator using transistor.
6. 4 bit binary /MOD N counter using D-Flip flops.
7. Design a 8051 Development board having Power section consisting of IC7805, capacitor, resistor, headers, LED,Serial communication section consisting of MAX 232, Capacitors,DB9 connector, Jumper, LEDs, Reset & Input/ output sections consisting of89C51 Microcontroller, Electrolytic Capacitor, Resistor, Jumper, Crystal Oscillator, Capacitors.
8. Touch plate switches – transistorized or 555 based
9. Doorbell/cordless bell
10. Clapping switch and IR switch
11. Blinkers

12.Cell charger, battery charger, mobile charger
13.Fire/smoke/intruder alarm
14.Liquid level controller
15. Audio amplifiers

COURSE OUTCOMES:

Upon the completion of this course, students will demonstrate the ability to:
CO1:Appreciate the necessity and evolution of PCB, types and classes of PCB.
CO2:Understand the steps involved in schematic, layout, fabrication and assembly process of PCB design.
CO3:Apply advanced techniques, skills and modern tools for designing and fabrication of PCBs.
CO4:Apply the knowledge and techniques to fabricate Multilayer, SMT and HDI PCB.
CO5:Design (schematic and layout) and fabricate PCB for simple circuits.

TOTAL PERIODS:60

REFERENCES

1. Printed circuit board design ,fabrication assembly and testing By R. S. Khandpur, Tata McGraw Hill 2006
2. Printed Circuits Handbook, Sixth Edition,by Clyde F. Coombs, Jr, Happy T. Holden,Publisher: McGraw-Hill Education Year: 2016
3. Complete PCB Design Using OrCAD Capture and PCB Editor,Kraig Mitzner Bob Doe Alexander Akulin Anton Suponin Dirk Müller, 2nd Edition 2009.
4. Introduction to System-on-Package, Rao R ,Tummala,&MadhavanSwaminathan, McGraw Hill, 2008
5. EMC and Printed circuit board ,Design theory and layout, Mark I Montrose IEEE compatibility society
6. Electronic Product Design Volume-I by S D Mehta, S Chand Publications
7. Open source EDA Tool KiCad Tutorial: http://kicad-pcb.org/help/tutorials/
8. PCB Fabrication user guide page: http://www.wikihow.com/Create-Printed-Circuit-Boards , http://www.siongboon.com/projects/2005-09-07_home_pcb_fabrication/ ,
9. http://reprap.org/wiki/MakePCBInstructions#Making_PCBs_yourself
10. PCB Fabrication at home(video): https://www.youtube.com/watch?v=mv7Y0A9YeUc,
11. https://www.youtube.com/watch?v=imQTCW1yWkg

DS4151 DIGITAL IMAGE AND VIDEO PROCESSING L T P C
3 0 2 4

COURSE OBJECTIVES:

- To provide the student with basic understanding of image fundamentals and transforms
- To provide exposure to the students about image enhancement and restoration
- To impart a thorough understanding about segmentation and Recognition.
- To know the Video Processing and motion estimation

- Learning the concepts will enable students to design and develop an image processing application .

UNIT I FUNDAMENTALS OF IMAGE PROCESSING AND TRANSFORMS 9

Introduction, Image sampling, Quantization, Resolution, Image file formats, Elements of image processing system, Need for transform, image transforms, Fourier transform, 2 D Discrete Fourier transform ,Walsh transform, Hadamard transform, Haar transform, KL transform, singular value decomposition, Radon transform, comparison of different image transforms. Digital Camera working principle.

UNIT II ENHANCEMENT AND RESTORATION 9

Spatial domain methods: Histogram processing, Fundamentals of Spatial filtering, Smoothing spatial filters, Sharpening spatial filters. Frequency domain methods: Basics of filtering in frequency domain, image smoothing, image sharpening, Introduction to Image restoration, Image degradation, Image restoration model, Linear and Nonlinear image restoration techniques, Blind deconvolution. Color image enhancement.

UNIT III SEGMENTATION AND RECOGNITION 9

Edge detection, Edge linking via Hough transform – Thresholding – Region based segmentation – Region growing – Region splitting and merging – Morphological processing- erosion and dilation, Boundary representation, Boundary description, Fourier Descriptor, Regional Descriptors – Topological feature, Texture – Patterns and Pattern classes – Recognition based on matching.

UNIT IV BASIC STEPS OF VIDEO PROCESSING 9

Analog Video, Digital Video. Time-Varying Image Formation models:Three-Dimensional Motion Models, Geometric Image Formation, Photometric Image Formation,Sampling of Videosignals, Filtering operations

UNIT V 2-D MOTION ESTIMATION 9

Optical flow, optical flow constraints, General Methodologies, Pixel Based Motion Estimation, Block-Matching Algorithm, Mesh based Motion Estimation, Global Motion Estimation, Region based MotionEstimation, Multi resolution motion estimation, Waveform based coding, Block based transform coding,Predictive coding, Application of motion estimation in Video coding.

45 PERIODS

PRACTICAL EXERCISES: 30 PERIODS

- Histogram Equalization
- Image Filtering (spatial-domain)
- Image Filtering (frequency-domain)
- Image Segmentation
- Familiarization with Video Processing tools
- Denoising video
- Video resizing
- Background subtraction
- Interpolation methods for re-sampling
- Adaptive unsharp masking based interpolation for video up-sampling
- Gaussian mixture model (GMM) based background subtraction

- Video encoding

COURSE OUTCOMES:

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

CO1: Analyze the digital image, representation of digital image and digital images in transform Domain.
CO2: Analyze the detection of point, line and edges in images and understand the redundancy in images, various image compression techniques.
CO3: Analyze the video technology from analog color TV systems to digital video systems, how video signal is sampled and filtering operations in video processing.
CO4: Obtain knowledge in general methodologies for 2D motion estimation, various coding used in video processing.
CO5: Design image and video processing systems.

TOTAL:75 PERIODS

REFERENCES:

1. Digital Image Processing – Gonzalez and Woods, 3rd Ed., Pearson, 2016
2. Handbook of Image and Video processing, Academic press, 2010
3. K.R.Castelman, Digital Image processing, Prentice Hall, 1996
4. Anil Kumar Jain, Fundamentals of Digital Image Processing, Prentice Hall of India.2nd edition, 2002
5. R C Gonzalez, R E Woods and S L Eddins, Digital Image Processing Using Matlab, Pearson Education , 2006

CP4252 **MACHINE LEARNING** **L T P C**
3 0 2 4

COURSE OBJECTIVES:

- To understand the concepts and mathematical foundations of machine learning and types of problems tackled by machine learning
- To explore the different supervised learning techniques including ensemble methods
- To learn different aspects of unsupervised learning and reinforcement learning
- To learn the role of probabilistic methods for machine learning
- To understand the basic concepts of neural networks and deep learning

UNIT I INTRODUCTION AND MATHEMATICAL FOUNDATIONS 9

What is Machine Learning? Need –History – Definitions – Applications - Advantages, Disadvantages & Challenges -Types of Machine Learning Problems – Mathematical Foundations - Linear Algebra & Analytical Geometry -Probability and Statistics- Bayesian Conditional Probability -Vector Calculus & Optimization - Decision Theory - Information theory

UNIT II SUPERVISED LEARNING 9

Introduction-Discriminative and Generative Models -Linear Regression - Least Squares -Under-fitting / Overfitting -Cross-Validation – Lasso Regression- Classification - Logistic Regression- Gradient Linear Models -Support Vector Machines –Kernel Methods -Instance based Methods - K-Nearest Neighbours - Tree based Methods –Decision Trees –ID3 – CART - Ensemble Methods –Random Forest - Evaluation of Classification Algorithms

UNIT III UNSUPERVISED LEARNING AND REINFORCEMENT LEARNING 9

Introduction - Clustering Algorithms -K – Means – Hierarchical Clustering - Cluster Validity - Dimensionality Reduction –Principal Component Analysis – Recommendation Systems - EM algorithm. Reinforcement Learning – Elements -Model based Learning – Temporal Difference Learning

UNIT IV PROBABILISTIC METHODS FOR LEARNING- 9

Introduction -Naïve Bayes Algorithm -Maximum Likelihood -Maximum Apriori -Bayesian Belief Networks -Probabilistic Modelling of Problems -Inference in Bayesian Belief Networks – Probability Density Estimation - Sequence Models – Markov Models – Hidden Markov Models

UNIT V NEURAL NETWORKS AND DEEP LEARNING 9

Neural Networks – Biological Motivation- Perceptron – Multi-layer Perceptron – Feed Forward Network – Back Propagation-Activation and Loss Functions- Limitations of Machine Learning – Deep Learning– Convolution Neural Networks – Recurrent Neural Networks – Use cases

45 PERIODS

SUGGESTED ACTIVITIES:

1. Give an example from our daily life for each type of machine learning problem
2. Study at least 3 Tools available for Machine Learning and discuss pros & cons of each
3. Take an example of a classification problem. Draw different decision trees for the example and explain the pros and cons of each decision variable at each level of the tree
4. Outline 10 machine learning applications in healthcare
5. Give 5 examples where sequential models are suitable.
6. Give at least 5 recent applications of CNN

PRACTICAL EXERCISES: 30 PERIODS

1. Implement a Linear Regression with a Real Dataset (https://www.kaggle.com/harrywang/housing). Experiment with different features in building a model. Tune the model's hyperparameters.

2. Implement a binary classification model. That is, answers a binary question such as "Are houses in this neighborhood above a certain price?"(use data from exercise 1). Modify the classification threshold and determine how that modification influences the model. Experiment with different classification metrics to determine your model's effectiveness.

3. Classification with Nearest Neighbours. In this question, you will use the scikit-learn's KNN classifer to classify real vs. fake news headlines. The aim of this question is for you to read the scikit-learn API and get comfortable with training/validation splits. Use California Housing Dataset

4. In this exercise, you'll experiment with validation sets and test sets using the dataset. Split a training set into a smaller training set and a validation set. Analyze deltas between training set and validation set results. Test the trained model with a test set to determine whether your trained model is overfitting. Detect and fix a common training problem.

5. Implement the k-means algorithm using https://archive.ics.uci.edu/ml/datasets/Codon+usage dataset

6. Implement the Naïve Bayes Classifier using https://archive.ics.uci.edu/ml/datasets/Gait+Classification dataset

7. Project - (in Pairs) Your project must implement one or more machine learning algorithms and apply them to some data.

   a. Your project may be a comparison of several existing algorithms, or it may propose a new algorithm in which case you still must compare it to at least one other approach.

b. You can either pick a project of your own design, or you can choose from the set of pre-defined projects.

c. You are free to use any third-party ideas or code that you wish as long as it is publicly available.

d. You must properly provide references to any work that is not your own in the write-up.

e. Project proposal You must turn in a brief project proposal. Your project proposal should describe the idea behind your project. You should also briefly describe software you will need to write, and papers (2-3) you plan to read.

List of Projects (datasets available)

1. Sentiment Analysis of Product Reviews
2. Stock Prediction
3. Sales Forecasting
4. Music Recommendation
5. Handwriting Digit Classification
6. Fake News Detection
7. Sports Prediction
8. Object Detection
9. Disease Prediction

COURSE OUTCOMES:

CO1: Understand and outline problems for each type of machine learning

CO2: Design a Decision tree and Random forest for an application

CO3: Implement Probabilistic Discriminative and Generative algorithms for an application and analyze the results.

CO4: Use a tool to implement typical Clustering algorithms for different types of applications.

CO5: Design and implement an HMM for a Sequence Model type of application.

C06: Identify applications suitable for different types of Machine Learning with suitable justification.

TOTAL PERIODS:75

REFERENCES

1. Stephen Marsland, “Machine Learning: An Algorithmic Perspective”, Chapman & Hall/CRC, 2nd Edition, 2014.
2. Kevin Murphy, “Machine Learning: A Probabilistic Perspective”, MIT Press, 2012
3. Ethem Alpaydin, “Introduction to Machine Learning”, Third Edition, Adaptive Computation and Machine Learning Series, MIT Press, 2014
4. Tom M Mitchell, “Machine Learning”, McGraw Hill Education, 2013.
5. Peter Flach, “Machine Learning: The Art and Science of Algorithms that Make Sense of Data”, First Edition, Cambridge University Press, 2012.
6. Shai Shalev-Shwartz and Shai Ben-David, “Understanding Machine Learning: From Theory to Algorithms”, Cambridge University Press, 2015
7. Christopher Bishop, “Pattern Recognition and Machine Learning”, Springer, 2007.
8. Hal Daumé III, “A Course in Machine Learning”, 2017 (freely available online)
9. Trevor Hastie, Robert Tibshirani, Jerome Friedman, “The Elements of Statistical Learning”, Springer, 2009 (freely available online)
10. Aurélien Géron , Hands-On Machine Learning with Scikit-Learn and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems 2nd Edition, o'reilly, (2017)

	PO					
	1	2	3	4	5	6

C01	1	2	1	3	1	1
C02	2	3	1	2	1	2
C03	1	1	2	1		2
C04	2	2				3
C05	3	3	1	1	1	3
AVG	1.80	2.20	1.25	1.75	1.00	2.20

EL4072 **SIGNAL DETECTION AND ESTIMATION** **L T P C**
3 0 2 4

COURSE OBJECTIVES:

- To understand the concepts of detection and estimation.
- To learn the basics of multi-user detection theory
- To understand the theory behind various estimation techniques.
- To understand Wiener filter and Kalman filter in detail.

UNIT I REVEIW OF PROBABILITY AND STOCHASTIC PROCESS 9

Conditional Probability, Bayes' Theorem , Random Variables, Conditional Distributions and Densities, moments and distribution of random variables., Stationary Processes Cyclostationary Processes Averages and Ergodicity Autocorrelation Function Power Spectral Density Discrete Time Stochastic Processes, Spatial Stochastic Processes, Random Signals, Relationship of Power Spectral Density and Autocorrelation Function.

UNIT II SINGLE AND MULTIPLE SAMPLE DETECTION 9

Hypothesis Testing and the MAP Criterion, Bayes Criterion, Minimax Criterion, Neyman-Pearson Criterion, Sequential Detection, The Optimum Digital Detector in Additive Gaussian Noise , Performance of Binary Receivers in AWGN.

UNIT III FUNDAMENTALS OF ESTIMATION THEORY 9

Formulation of the General Parameter Estimation Problem, Relationship between Detection and Estimation Theory, Types of Estimation Problems, Properties of Estimators, Bayes estimation, Minimax Estimation, Maximum-Likelihood Estimation, Comparison of Estimators of Parameters.

UNIT IV WIENER AND KALMAN FILTERS 9

Orthogonality Principle, Autoregressive Techniques, Discrete Wiener Filter, Continuous Wiener Filter, Generalization of Discrete and Continuous Filter Representations , Linear Least-Squares Methods, Minimum-Variance Weighted Least-Squares Methods, Minimum-Variance, Least Squares, Kalman Algorithm - Computational Considerations, Signal Estimation, Continuous Kalman Filter, Extended Kalman Filter.

UNIT V APPLICATIONS 9

Detector Structures in Non-Gaussian Noise , Examples of Noise Models, Receiver Structures, and Error-Rate Performance, Estimation of Non-Gaussian Noise Parameters Fading Multipath Channel Models, Receiver Structures with Known Channel Parameters, Receiver Structures without Knowledge of Phase, Receiver Structures without Knowledge of Amplitude or Phase, Receiver Structures and Performance with No Channel Knowledge.

PRACTICALS: **Period – 30 hrs**

Suggested List of Experiments

Software Requirement: Matlab / Python / Equivalent

1. Power Spectrum Estimation of a Random Signal
2. Maximum Likelihood Estimation
3. Design of optimum receiver in AWGN channel
4. Wiener Filter Design
5. Adaptive Filter Design using LMS algorithm
6. Minimum Variance Estimation

COURSE OUTCOMES:

CO1: Able to understand the importance of probability and stochastic process concepts in detection and estimation.
CO2: Able to design optimum detector and estimator for AWGN channel
CO3: Able to design and analyze the various estimators.
CO4: Able to design Wiener and Kalman filters to solve linear estimation problems.
CO5: Able to design and develop novel receiver structures suitable for modern technology.

TOTAL PERIODS:75

REFERENCES

1. Harry L. Van Trees, "Detection, Estimation and Modulation Theory", Part I John Wiley and Sons, New York, 2004.
2. Ludeman, Lonnie C. Random processes: filtering, estimation, and detection. John Wiley & Sons, Inc., 2003
3. . Sergio Verdu " Multi User Detection" Cambridge University Press, 1998
4. Steven M. Kay, "Fundamentals of Statistical Processing, Volume I: Estimation Theory", Prentice Hall Signal Processing Series, Prentice Hall, PTR, NewJersy, 1993.
5. Thomas Schonhoff, "Detection and Estimation Theory", Prentice Hall, NewJersy, 2007.

AUDIT COURSES

AX4091 ENGLISH FOR RESEARCH PAPER WRITING **L T P C**
2 0 0 0

COURSE OBJECTIVES:

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

UNIT I INTRODUCTION TO RESEARCH PAPER WRITING **6**

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

UNIT II PRESENTATION SKILLS **6**

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

UNIT III TITLE WRITING SKILLS 6

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

UNIT IV RESULT WRITING SKILLS 6

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

UNIT V VERIFICATION SKILLS 6

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

TOTAL: 30 PERIODS

COURSE OUTCOMES:

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

REFERENCES:

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

AX4092 DISASTER MANAGEMENT L T P C
2 0 0 0

COURSE OBJECTIVES :

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

UNIT I INTRODUCTION 6

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

UNIT II REPERCUSSIONS OF DISASTERS AND HAZARDS 6

Economic Damage, Loss of Human and Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And

Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.

UNIT III DISASTER PRONE AREAS IN INDIA 6

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

UNIT IV DISASTER PREPAREDNESS AND MANAGEMENT 6

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

UNIT V RISK ASSESSMENT 6

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

TOTAL : 30 PERIODS

COURSE OUTCOMES:

CO1: Ability to summarize basics of disaster

CO2: Ability to explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.

CO3: Ability to illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.

CO4: Ability to describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.

CO5: Ability to develop the strengths and weaknesses of disaster management approaches

REFERENCES:

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

AX4093 CONSTITUTION OF INDIA L T P C
2 0 0 0

COURSE OBJECTIVES:

Students will be able to:

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

Revolutionin1917and its impact on the initial drafting of the Indian Constitution.

UNIT I HISTORY OF MAKING OF THE INDIAN CONSTITUTION

History, Drafting Committee, (Composition & Working)

UNIT II PHILOSOPHY OF THE INDIAN CONSTITUTION

Preamble, Salient Features

UNIT III CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES

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

UNIT IV ORGANS OF GOVERNANCE

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

UNIT V LOCAL ADMINISTRATION

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

UNIT VI ELECTION COMMISSION

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

TOTAL: 30 PERIODS

COURSE OUTCOMES:

Students will be able to:

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

SUGGESTED READING

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

AX4094 **நற்றமிழ் இலக்கியம்** **L T P C**
2 0 0 0

UNIT I **சங்க இலக்கியம்** **6**

1. தமிழின் துவக்க நூல் தொல்காப்பியம்
   – எழுத்து, சொல், பொருள்
2. அகநானூறு (82)
   - இயற்கை இன்னிசை அரங்கம்
3. குறிஞ்சிப் பாட்டின் மலர்க்காட்சி
4. புறநானூறு (95,195)
   - போரை நிறுத்திய ஔவையார்

UNIT II **அறநெறித் தமிழ்** **6**

1. அறநெறி வகுத்த திருவள்ளுவர்
   - அறம் வலியுறுத்தல், அன்புடைமை, ஒப்புறவு அறிதல், ஈகை, புகழ்
2. பிற அறநூல்கள் - இலக்கிய மருந்து
   – ஏலாதி, சிறுபஞ்சமூலம், திரிகடுகம், ஆசாரக்கோவை

(தூய்மையை வலியுறுத்தும் நூல்)

UNIT III **இரட்டைக் காப்பியங்கள்** **6**

1. கண்ணகியின் புரட்சி
   - சிலப்பதிகார வழக்குரை காதை
2. சமூகசேவை இலக்கியம் மணிமேகலை
   - சிறைக்கோட்டம் அறக்கோட்டமாகிய காதை

UNIT IV **அருள்நெறித் தமிழ்** **6**

1. சிறுபாணாற்றுப்படை
   - பாரி முல்லைக்குத் தேர் கொடுத்தது, பேகன் மயிலுக்குத் கொடுத்தது, அதியமான் ஔவைக்கு நெல்லிக்கனி கொடுத்தது, அரசர் பண்புகள்
2. நற்றிணை
   - அன்னைக்குரிய புன்னை சிறப்பு
3. திருமந்திரம் (617, 618)
   - இயமம் நியமம் விதிகள்
4. தர்மச்சாலையை நிறுவிய வள்ளலார்
5. புறநானூறு
   - சிறுவனே வள்ளலானான்
6. அகநானூறு (4) - வண்டு

நற்றிணை (11) - நண்டு
கலித்தொகை (11) - யானை, புறா
ஐந்திணை 50 (27) - மான்
ஆகியவை பற்றிய செய்திகள்

UNIT V **நவீன தமிழ் இலக்கியம்** **6**

1. உரைநடைத் தமிழ்,
   - தமிழின் முதல் புதினம்,
   - தமிழின் முதல் சிறுகதை,
   - கட்டுரை இலக்கியம்,
   - பயண இலக்கியம்,
   - நாடகம்,
2. நாட்டு விடுதலை போராட்டமும் தமிழ் இலக்கியமும்,
3. சமுதாய விடுதலையும் தமிழ் இலக்கியமும்,
4. பெண் விடுதலையும் விளிம்பு நிலையினரின் மேம்பாட்டில் தமிழ் இலக்கியமும்,
5. அறிவியல் தமிழ்,
6. இணையத்தில் தமிழ்,
7. சுற்றுச்சூழல் மேம்பாட்டில் தமிழ் இலக்கியம்.

TOTAL: 30 PERIODS

<u>தமிழ் இலக்கிய வெளியீடுகள் / புத்தகங்கள்</u>

1. தமிழ் இணைய கல்விக்கழகம் (Tamil Virtual University)
   - www.tamilvu.org
2. தமிழ் விக்கிப்பீடியா (Tamil Wikipedia)
   -https://ta.wikipedia.org
3. தர்மபுர ஆதீன வெளியீடு
4. வாழ்வியல் களஞ்சியம்
   - தமிழ்ப் பல்கலைக்கழகம், தஞ்சாவூர்
5. தமிழ்கலைக் களஞ்சியம்
   - தமிழ் வளர்ச்சித் துறை (thamilvalarchithurai.com)
6. அறிவியல் களஞ்சியம்
   - தமிழ்ப் பல்கலைக்கழகம், தஞ்சாவூர்