VELALAR COLLEGE OF ENGINEERING AND TECHNOLOGY

(Autonomous)

Thindal, Erode - 638 012

(Approved by AICTE, New Delhi, Affiliated to Anna University, Chennai)
(Accredited by NAAC with 'A+' grade)

REGULATIONS 2022

CURRICULUM AND SYLLABUS

M.E. - APPLIED ELECTRONICS

Choice Based Credit System (CBCS)

	VELALAR COLLEGE OF ENGINEERING AND TECHNOLOGY **(Autonomous)**
Department	Electronics and Communication Engineering
Programme	M.E. - Applied Electronics
Regulations	2022

SUMMARY OF CREDIT

S.No	Course Category	Credits per Semester				Total Credits
		1	2	3	4	
1	FC	4	-	-	-	04
2	PC	14	13	-	-	27
3	PE	-	6	9	-	15
4	RM	3	-	-	-	3
5	OE	-	-	3	-	3
6	EC	-	1	6	12	19
7	VC, OC, AC, SC	✓				-
Total Credits / Sem		21	20	18	12	71

FC - Foundation Courses
PC - Professional Core
PE - Professional Elective
RM - Research Methodology and IPR
OE - Open Elective
EC - Employability Enhancement Course (Project, Seminar, Industrial Training, Internship etc.)
VC - Value Added Courses
OC - Online Course
AC - Audit Course
SC - Self Study course

	VELALAR COLLEGE OF ENGINEERING AND TECHNOLOGY (Autonomous)	CURRICULUM
		PG
		R - 2022
Department	Electronics and Communication Engineering	
Programme	M.E. - Applied Electronics	

SEMESTER 1										
S. No	Course Code	Course Title	Category	Periods / Week			Credits	Max. Marks		
				L	T	P		CA	SE	Tot.
Theory										
1	22MAT15	Advanced Applied Mathematics	FC	3	1	0	4	40	60	100
2	22RMT01	Research Methodology and IPR	RM	3	0	0	3	40	60	100
3	22AET11	Advanced Digital Signal Processing	PC	3	0	0	3	40	60	100
4	22AET12	Advanced Digital System Design	PC	3	0	0	3	40	60	100
5	22AET13	Advanced Microprocessor and Microcontroller	PC	3	0	0	3	40	60	100
6	22AET14	Digital CMOS VLSI Design	PC	3	0	0	3	40	60	100
7		Audit Course I	AC	2	0	0	0	100	0	100
Practical										
8	22AEL11	Electronics System Design Laboratory	PC	0	0	2	1	60	40	100
9	22AEL12	Signal Processing Laboratory	PC	0	0	2	1	60	40	100
						Total Credits	21			

SEMESTER 2										
S. No	Course Code	Course Title	Category	Periods / Week			Credits	Max. Marks		
				L	T	P		CA	SE	Tot.
Theory										
1	22AET21	Analog Integrated Circuit Design	PC	3	0	0	3	40	60	100
2	22AET22	Industrial Internet of Things	PC	3	0	0	3	40	60	100
3	22AET23	Embedded and Real Time Systems	PC	3	0	0	3	40	60	100
4	22AET24	Wireless Adhoc and Sensor Networks	PC	3	0	0	3	40	60	100
5		Professional Elective - 1	PE	3	0	0	3	40	60	100
6		Professional Elective - 2	PE	3	0	0	3	40	60	100
7		Audit Course II	AC	2	0	0	0	100	0	100
Practical										
8	22AEL21	VLSI Design Laboratory	PC	0	0	2	1	60	40	100
9	22AEL22	Mini Project with seminar	EC	0	0	2	1	60	40	100
						Total Credits	20			

SEMESTER 3										
S. No	Course Code	Course Title	Category	Periods / Week			Credits	Max. Marks		
				L	T	P		CA	SE	Tot.
Theory										
1		Professional Elective - 3	PE	3	0	0	3	40	60	100
2		Professional Elective - 4	PE	3	0	0	3	40	60	100
3		Professional Elective - 5	PE	3	0	0	3	40	60	100
4		Open Elective	OE	3	0	0	3	40	60	100
Practical										
5	22AEL31	Project Work I	EC	0	0	12	6	40	60	100
						Total Credits	18			

SEMESTER 4										
S. No	Course Code	Course Title	Category	Periods / Week			Credits	Max. Marks		
				L	T	P		CA	SE	Tot.
Practical										
1	22AEL41	Project Work II	EC	0	0	24	12	40	60	100
						Total Credits	12			

PROFESSIONAL ELECTIVES										
S. No	Course Code	Course Title	Category	Periods / Week			Credits	Max. Marks		
				L	T	P		CA	SE	Tot.
Semester - 2		**Professional Elective - 1**								
1	22AEE01	High Performance Communication Networks	PE	3	0	0	3	40	60	100
2	22AEE02	Applications Specific Integrated Circuits	PE	3	0	0	3	40	60	100
3	22AEE03	Computer Architecture and Parallel Processing	PE	3	0	0	3	40	60	100
4	22AEE04	Advanced Wireless Communication	PE	3	0	0	3	40	60	100
5	22AEE05	Soft Computing and Optimization Techniques	PE	3	0	0	3	40	60	100
Semester - 2		**Professional Elective - 2**								
1	22AEE06	Advanced Digital Image Processing	PE	3	0	0	3	40	60	100
2	22AEE07	Electromagnetic Interference and Compatibility	PE	3	0	0	3	40	60	100
3	22AEE08	Nano Electronic Devices	PE	3	0	0	3	40	60	100
4	22AEE09	Multimedia Compression Techniques	PE	3	0	0	3	40	60	100
5	22AEE10	RF System Design	PE	3	0	0	3	40	60	100
Semester - 3		**Professional Elective - 3**								
1	22AEE11	Cloud Computing	PE	3	0	0	3	40	60	100
2	22AEE12	CAD for VLSI Circuits	PE	3	0	0	3	40	60	100

3	22AEE13	MEMS	PE	3	0	0	3	40	60	100
4	22AEE14	Machine Learning	PE	3	0	0	3	40	60	100
5	22AEE15	Wavelet Transforms and their Applications	PE	3	0	0	3	40	60	100
Semester - 3		**Professional Elective - 4**								
1	22AEE16	Cryptography and Information Security	PE	3	0	0	3	40	60	100
2	22AEE17	DSP Integrated Circuits	PE	3	0	0	3	40	60	100
3	22AEE18	Optical Sensors	PE	3	0	0	3	40	60	100
4	22AEE19	DSP Processor Architecture and Programming	PE	3	0	0	3	40	60	100
5	22AEE20	Deep Learning	PE	3	0	0	3	40	60	100
Semester - 3		**Professional Elective - 5**								
1	22AEE21	System on Chip Design	PE	3	0	0	3	40	60	100
2	22AEE22	Automotive Electronics	PE	3	0	0	3	40	60	100
3	22AEE23	Signal Integrity for High Speed Design	PE	3	0	0	3	40	60	100
4	22AEE24	PCB Design	PE	3	0	0	3	40	60	100
5	22AEE25	Biomedical Signal Processing	PE	3	0	0	3	40	60	100

OPEN ELECTIVES										
S. No	**Course Code**	**Course Title**	**Category**	**Periods / Week**			**Credits**	**Max. Marks**		
				L	**T**	**P**		**CA**	**SE**	**Tot.**
OFFERED BY DEPARTMENT OF BIO MEDICAL ENGINEERING										
1	22BPO01	Biomedical Waste Management in Hospitals	OE	3	0	0	3	40	60	100
2	22BPO02	Introduction to Clinical Trials	OE	3	0	0	3	40	60	100
3	22BPO03	Quality Assurance and Safety in Hospitals	OE	3	0	0	3	40	60	100
4	22BPO04	Telemedicine Technology	OE	3	0	0	3	40	60	100
OFFERED BY DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING										
1	22CSO01	Principles of Information Security	OE	3	0	0	3	40	60	100
2	22CSO02	Fundamentals of Block ch ain	OE	3	0	0	3	40	60	100
3	22CSO03	Big Data Management	OE	3	0	0	3	40	60	100
4	22CSO04	Social Network Analysis	OE	3	0	0	3	40	60	100
OFFERED BY DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING										
1	22AEO01	Hardware Software Co-Design	OE	3	0	0	3	40	60	100
2	22AEO02	Embedded C	OE	3	0	0	3	40	60	100
OFFERED BY DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING										
1	22ESO01	Waste to Energy	OE	3	0	0	3	40	60	100
2	22ESO02	Industrial Drives for Automation	OE	3	0	0	3	40	60	100
3	22ESO03	Hybrid Electric Vehicles	OE	3	0	0	3	40	60	100
4	22ESO04	Modern Automotive Electronics Systems	OE	3	0	0	3	40	60	100

AUDIT COURSES (Registration for any of these courses is optional to students, it will be mentioned in the Grade statement. However, it will not be considered for computation of CGPA)										
S. No	**Course Code**	**Course Title**	**Category**	**Periods / Week**			**Credits**	**Max. Marks**		
				L	**T**	**P**		**CA**	**SE**	**Tot.**
1	22AC01	English for Research Paper Writing	AC	2	0	0	0	100	0	100
2	22AC02	Disaster Management	AC	2	0	0	0	100	0	100
3	22AC03	Constitution of India	AC	2	0	0	0	100	0	100
4	22AC04	Pedagogy Studies	AC	2	0	0	0	100	0	100

L - Lecture Period
T - Tutorial Period
P - Practical Period

CA - Continuous Assessment
SE - Semester Examination
Tot - Total Marks

22MAT15	ADVANCED APPLIED MATHEMATICS (Common to ME - BM, AE & ES Programmes)	L	T	P	C
		3	1	0	4

Pre-requisites : Nil

Preamble

Matrices used to represent the system of equations and we can easily find the characteristics of the system. Fourier series and Fourier transforms are used to convert periodic and non periodic functions from one domain to another domain respectively. The syllabus is designed to familiarize mathematical formulation and solution of LPP. This course provides the knowledge and training using non- linear programming under limited resources for engineering and business problems.

UNIT 1 MATRIX THEORY **9+3**

Some important matrix factorizations – The Cholesky decomposition – QR factorization – Least squares method – Singular value decomposition – Toeplitz matrices and some applications.

UNIT 2 FOURIER SERIES **9+3**

Fourier Trigonometric series: Periodic function as power signals – Convergence of series – Even and odd function: cosine and sine series – Power signals: Exponential Fourier series – Parseval's theorem and power spectrum– Eigenvalue problems and orthogonal functions – Regular Sturm – Liouville systems – Generalized Fourier series.

UNIT 3 FOURIER TRANSFORM **9+3**

Statement of Fourier integral theorem – Fourier transform pair – Fourier sine and cosine transforms – Properties – Convolution theorem – Parseval's identity.

UNIT 4 LINEAR PROGRAMMING **9+3**

Formulation – Graphical solution – Simplex method –Transportation model – Initial basic feasible solution -North-west corner rule, Least-cost method, Vogel's approximation method and optimum solution of transportation problem.

UNIT 5 NON-LINEAR PROGRAMMING **9+3**

Constrained Problems – Equality constraints – Lagrangean Method – Inequality constraints – Karush – Kuhn-Tucker (KKT) conditions – Quadratic Programming.

Lecture : 45, Tutorial : 15, Total : 60 Periods

TEXT BOOKS:

1. Richard Bronson, "Matrix Operation", Schaum's outline series, 2nd Edition, McGraw Hill, 2011.
2. Grewal, B.S, "Higher Engineering Mathematics", 43rd Edition, Khanna publishers, Delhi (2016)
3. Kanti Swarup, Gupta PK and Manmohan, "Operations Research", 14th Edition, Sultan Chand & Sons, New Delhi,2014.

REFERENCES:

1. David C. Lay, "Linear Algebra and its applications",4th Edition, Pearson, New Delhi,2012.
2. Taha, H.A, "Operations Research, An introduction", 10th edition, Pearson education, New Delhi, 2013.
3. Ramana.B.V., "Higher Engineering Mathematics", First edition, Tata Mc-GrawHill Publishing Company limited, New Delhi, 2016.
4. Bali.N.P and Manish Goyal, "A Textbook of Engineering Mathematics", 7th Edition, University Press India (P) Ltd, Hyderabad (2015).

e-Resources:

1. https://nptel.ac.in/courses/111108157/52, "Matrix Theory" Pro. Chandra R. Murty Department of Electronics and Communication Engineering, Indian Institute of Science Bangalore.
2. http://nptel.ac.in/courses/111106046, "Fourier Series", Prof.R.Radha, and Prof S. Thangavelu, Department of Mathematics, Indian Institute of Technology Madras, Chennai.

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

CO1	Apply various methods in matrix theory to solve system of linear equations.
CO2	Compute Fourier series for periodic functions, exponential Fourier series, eigenvalue problems and orthogonal functions.
CO3	Compute the Fourier transform of elementary non-periodic wave forms using Fourier Transform properties.
CO4	Formulate and construct mathematical models for linear programming problems and solve the transportation problems.
CO5	Model various real life situations as optimization problems and effect their solution through Non-linear programming.

Mapping of COs with POs

Course Outcome	PO1	PO2	PO3
CO1	3	2	
CO2	3	2	
CO3	3	2	
CO4	3	2	
CO5	3	2	

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22RMT01	RESEARCH METHODOLOGY AND IPR	L	T	P	C
		3	0	0	3

Pre-requisites : -

Preamble

Research is a scientific and systematic search for information on a particular topic or issue. It is an attempt to pursue truth through the methods of study, observation, comparison and experiment. In sum, research is the search for knowledge, using objective and systematic methods to find solution to a problem. This course also focuses on Intellectual Property Rights and explain the process of patenting

UNIT 1 RESEARCH PROBLEM FORMULATION 9

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

UNIT 2 LITERATURE REVIEW 9

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

UNIT 3 TECHNICALWRITING /PRESENTATION 9

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

UNIT 4 INTRODUCTION TO INTELLECTUAL PROPERTY RIGHTS (IPR) 9

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

UNIT 5 INTELLECTUAL PROPERTY RIGHTS (IPR) 9

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

Total : 45 Periods

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

CO1 Understand the research problem and research process.
CO2 Understand research ethics.
CO3 Prepare a well-structured research paper and scientific presentations.
CO4 Explore on various IPR components and process of filing.
CO5 Understand the new developments in IPR.

TEXT BOOKS:

1. Ranjit Kumar, 2nd Edition, “Research Methodology: A Step by Step Guide for beginners” 2010
2. Halbert, “Resisting Intellectual Property”, Taylor & Francis Ltd ,2007.

REFERENCES:

1. Asimov, “Introduction to Design”, Prentice Hall, 1962.
2. Mayall, “Industrial Design”, McGraw Hill, 1992
3. Niebel, “Product Design”, McGraw Hill, 1974.

22AET11 **ADVANCED DIGITAL SIGNAL PROCESSING**

L	T	P	C
3	0	0	3

Pre-requisites: Digital Signal Processing

Preamble

Signal Processing plays a vital role in the field of Wireless and Mobile Communication, Television and Satellite Communication. Digital Signal Processing is very helpful in designing optimized filters.

UNIT 1 DISCRETE TIME RANDOM PROCESSES **9**

Discrete Random Processes – Ensemble Averages, Stationary processes, Autocovariance and Autocorrelation, Parseval's Theorem, White noise, Power Spectrum, Special types of Random Processes – Autoregressive Moving Average (ARMA) Processes, Autoregressive (AR) Processes, Moving Average (MA) Processes.

UNIT 2 WIENER FILTERING **9**

FIR Wiener Filter – Filtering, linear prediction, Noise cancellation, Lattice Representation for the FIR Wiener filter. IIR Wiener Filter – Non causal IIR Wiener Filter, Causal IIR Wiener Filter, Causal Wiener Filtering, Causal Linear Prediction, Wiener Deconvolution.

UNIT 3 SPECTRUM ESTIMATION **9**

Nonparametric Methods – Periodogram, Modified periodogram, Bartlett's method, Welch's method, Blackman – Tukey Approach – parametric methods – Autoregressive (AR) spectrum estimation, Moving average (MA) spectrum estimation, Autoregressive Moving Average (ARMA) spectrum estimation.

UNIT 4 MULTIRATE DIGITAL SIGNAL PROCESSING **9**

Decimation by a factor D – Interpolation by factor I – Sampling Rate Conversion by a Rational Factor I/D – filter design and implementation for sampling rate conversion – Direct form FIR filter structure – poly phase filter structure – Time Variant Filter Structures – Multistage Implementation of Sampling Rate Conversion – Applications – Implementation of digital filter banks – sub band coding.

UNIT 5 ADVANCED PROCESSORS **9**

Study of Texas Instruments Advanced processors –TMS320F280x and TMS320C280x. NXPs DSP56Fxx Family of DSP Processors. Comparison of the features of TI and NXP DSP family processors. DSP Processors in Mobile Phones.

Total : 45 Periods

REFERENCE:

1. Monson H. Hayes, "Statistical Digital Signal Processing and Modeling", John Wiley and Sons Inc.,New York, 2006.
2. John G. Proakis, Dimitris G. Manolakis, "Digital Signal Processing", Prentice Hall of India, New Delhi, 2005.
3. B. Venkataramani and M. Bhaskar, Digital Signal Processors – Architecture, Programming and Applications – Tata McGraw – Hill Publishing Company Limited. New Delhi, 2003.
4. P.P.Vaidyanathan, "Multirate Syatems and Filter Banks", Pearson Education, 2008.
5. Sophoncles J. Orfanidis, "Optimum Signal Processing", McGraw Hill, 2007.

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

CO1 Understand the concept of random processes and analyze various signal modelling methods.

CO2 Select linear filtering techniques to Engineering problems.

CO3 Describe the statistical properties of the conventional spectral estimators.

CO4 Acquire the basics of multi rate digital signal processing.

CO5 Learn the Advanced Processors.

Mapping of COs with POs and PSOs

Cos/POs	PO1	PO2	PO3
CO 1	2	1	3
CO 2	2	1	3
CO 3	2	1	3
CO 4	2	1	3
CO 5	2	1	3

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22AET12	ADVANCED DIGITAL SYSTEM DESIGN	L	T	P	C
		3	0	0	3

Pre-requisites: Digital Electronics

Preamble

The course focuses on analyze and designing of synchronous sequential, asynchronous sequential building blocks. The course emphasis on fault testing, fault diagnosis, fault testing algorithms, design of circuits using PLDs and programming using Verilog HDL.

UNIT 1 SYNCHRONOUS SEQUENTIAL CIRCUIT DESIGN 9

Analysis of Clocked Synchronous Sequential Circuits - Modelling- State Diagram, State Table, State Table Assignment and Reduction-Design of Synchronous Sequential Circuits- Design of Iterative Circuits-ASM Chart and Realization using ASM.

UNIT 2 ASYNCHRONOUS SEQUENTIAL CIRCUIT DESIGN 9

Analysis of Asynchronous Sequential Circuit – Flow Table Reduction-Races-State Assignment-Transition Table and Problems in Transition Table- Design of Asynchronous Sequential Circuit - Static, Dynamic and Essential hazards – Mixed Operating Mode Asynchronous Circuits – Designing Vending Machine Controller.

UNIT 3 FAULT DIAGNOSIS AND TESTABILITY ALGORITHMS 9

Fault Table Method-Path Sensitization Method – Boolean Difference Method - D Algorithm - Tolerance Techniques – The Compact Algorithm – Fault in PLA – Test Generation - DFT Schemes – Built in Self Test.

UNIT 4 CIRCUIT DESIGN USING PROGRAMMABLE DEVICES 9

Programming Logic Device Families – Designing a Synchronous Sequential Circuit using PLA/PAL – Designing ROM with PLA – Realization of Finite State Machine using PLD – FPGA –Xilinx FPGA - Xilinx 4000.

UNIT 5 SYSTEM DESIGN USING VERILOG 9

Hardware Modelling with Verilog HDL – Logic System, Data Types And Operators For Modelling In Verilog HDL - Behavioural Descriptions In Verilog HDL- Structural Modelling – Compilation And Simulation Of Verilog Code – Realization Of Combinational And Sequential Circuits Using Verilog – Registers – Counters – Sequential Machine – Serial Adder – Multiplier- Divider.

Total : 45 Periods

REFERENCES:

1. Charles H.Roth jr., “Fundamentals of Logic Design” Thomson Learning,2013
2. M.D.Ciletti , Modeling, Synthesis and Rapid Prototyping with the Verilog HDL, Prentice Hall, 1999
3. M.G.Arnold, Verilog Digital – Computer Design, Prentice Hall (PTR), 1999.
4. Nripendra N Biswas “Logic Design Theory” Prentice Hall of India,2001.
5. Paragk.Lala “Fault Tolerant and Fault Testable Hardware Design” B S Publications,2002.
6. Paragk.Lala “Digital System Design Using PLD” B S Publications,2003.
7. Palnitkar , Verilog HDL – A Guide to Digital Design and Synthesis, Pearson , 2003.

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

CO1 Analyse and design synchronous sequential circuits and realize using ASM chart.
CO2 Analyse and design asynchronous sequential circuits.
CO3 Apply testing procedure for combinational circuits and relate testability algorithms.
CO4 Design Combinational and Sequential circuits using PLA, PAL,ROM.
CO5 Write Verilog HDL program for combinational and sequential circuits.

Mapping of COs with POs and PSOs

Cos/POs	PO1	PO2	PO3
CO 1	3	1	2
CO 2	3	1	2
CO 3	3	1	2
CO 4	3	1	3
CO 5	3	1	3

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22AET13 ADVANCED MICROPROCESSOR AND MICROCONTROLLER

L	T	P	C
3	0	0	3

Preamble

This course provides concepts of CISC and RISC architectures, Pentium architecture and instruction set of ARM processors. It also provides architecture development and interfacing of PIC microcontroller.

UNIT 1 OVERVIEW **9**

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

UNIT 2 HIGH PERFORMANCE CISC ARCHITECTURE – PENTIUM **9**

CPU Architecture – Bus Operations – Pipelining – Branch predication – Floating Point Unit – Operating Modes – Paging – Multitasking – Exception and Interrupts – Instruction set – addressing modes – Programming the Pentium processor.

UNIT 3 HIGH PERFORMANCE RISC ARCHITECTURE – ARM **9**

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

UNIT 4 MOTOROLA 68HC11 MICROCONTROLLER **9**

Instruction set addressing modes – operating modes – Interrupt system – RTC – Serial Communication Interface – A/D Converter, PWM and UART.

UNIT 5 PIC MICROCONTROLLER **9**

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

Total : 45 Periods

REFERENCE:

1. Daniel Tabak, “Microprocessors”, McGraw Hill. Inc., 1995.
2. James L. Antonakos, “The Pentium Microprocessor”, Pearson Education, 1997.
3. Steve Furber, “ARM System – On – Chip architecture”, Addision Wesley, 2000.
4. Gene H.Miller, “Micro Computer Engineering,” Pearson Education, 2003.
5. John .B. Peatman, “Design with PIC Microcontroller”, Prentice hall, 1997.

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

CO1	Enumerate the concepts of CISC and RISC architectures.
CO2	Describe Pentium architecture and write program to perform basic processes.
CO3	Infer the architecture and instruction set of ARM processors.
CO4	Discuss the features of Motorola 68HC11 microcontroller.
CO5	Make use of PIC microcontroller architecture and interfacing methods to solve the real time problems.

Mapping of COs with POs and PSOs

Cos/POs	PO1	PO2	PO3
CO 1	3	2	2
CO 2	3	2	2
CO 3	2	2	2
CO 4	3	2	2
CO 5	2	2	2

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22AET14	DIGITAL CMOS VLSI DESIGN	L	T	P	C
		3	0	0	3

Pre-requisites: Nil

Preamble

This course introduces the fundamentals of the *VLSI* and implementation of *digital* circuit through the *CMOS* Transistors. To impart in-depth knowledge about digital CMOS circuits and design the various combinational circuits using VLSI Design Techniques.

UNIT 1 CMOS PROCESSING TECHNOLOGY AND DESIGN RULE 9

NMOS and PMOS Enhancement Transistors, Threshold Voltage, Body effect. Basic CMOS Technologies, P-Well Process, N-Well Process, Silicon on Insulator. MOS Layers Stick Diagrams and Layout Diagram, Layout Design Rules, Latch Up in CMOS Circuits.

UNIT 2 CMOS DESIGN METHODS 9

Design Strategies – CMOS Chip Design Options – Design Methods – Design Capture Tools – Design Verification Tools.

UNIT 3 CMOS TESTING 9

The Need For Testing – Manufacturing Test Principles – Design Strategies for Test – Chip Level Test Techniques – System Level Test Techniques – Layout Design for Improved Testability.

UNIT 4 CMOS SYSTEM DESIGN 9

A core RISC Microcontroller – Pipeline Architecture – Major Logic Blocks – A 6 Bit Flash A/D

UNIT 5 VLSI BUILDING BLOCK DESIGN 9

Arithmetic Building Block - Ripple Carry Adders, Carry Look Ahead Adders, High-Speed Adders, Multipliers, Shifters, On chip Clock generation and Distribution - Memory Design.

Total : 45 Periods

REFERENCES:

1. Neil H.E. Weste and Kamran Eshraghian, “Principles of CMOS VLSI Design”, Pearson Education ASIA, 2nd edition, 2000.
2. Douglas A. Pucknell and Kamran Eshraghian, “Basic VLSI Design”, Prentice Hall of India Publication, 1994.
3. John P.Uyemura, “Introduction to VLSI Circuits and Systems”, John Wiley & Sons, Inc.,2002.
4. Eugene D.Fabricius, “Introduction to VLSI Design”, McGraw Hill International Editions, 1990.
5. Wayne Wolf,“Modern VLSI Design System on chip”, Pearson Education, 2002.

E RESOURCES

1. https://nptel.ac.in/courses/108107129
2. https://onlinecourses.nptel.ac.in/noc21_ee09/preview

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

CO1 Understand the the significance of MOS transistor operations and their AC, DC characteristics.
CO2 Design the various CMOS methods.
CO3 Identify the design for testability techniques.
CO4 To impart the knowledge on CMOS system design.
CO5 Design memories with efficient architectures to improve access times, power consumption.

Mapping of COs with POs and PSOs

Cos/POs	PO1	PO2	PO3
CO 1	3	2	2
CO 2	3	2	2
CO 3	3	2	2
CO 4	3	2	2
CO 5	3	2	2

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22AEL11	ELECTRONIC SYSTEM DESIGN LABORATORY	L	T	P	C
		0	0	2	1

Preamble

The design of an embedded system with functional requirements for hardware and software components including processor, networking components, and sensors, along with applications, subsystem interfaces, networking, and middleware. To implement a subsystem and integrate this with a complete system to perform a complex task involving networked, mobile embedded systems.

LIST OF EXPERIMENTS

1. Interface LCD with LPC2148 and display your name
2. Interface 4*4 matrix keyboard and 7 Segment Display using I2C
3. Design of a 4-20 mA transmitter for a bridge type transducer.
4. Design of AC/DC voltage regulator using SCR and PCB layout design of Regulator.
5. Generation of RAMP wave using on-chip DAC
6. Interface of Zigbee and WiFi module with LPC2148
7. Getting started with uC/OS-II Real Time Operating System
8. Implementation of task management and delays in uC/OS on ARM7
9. Multitasking in uC/OS-II RTOS using minimum 3 tasks on ARM7
10. Implementation of Mailbox in uC/OS-II on ARM7

Total : 45 Periods

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

CO1 Apply the hardware design and development tools of ARM microcontroller.
CO2 Design an instrumentation amplifier and voltage regulator.
CO3 Abstract the architectural support for high level language and memory hierarchy.
CO4 Interpret the basic concepts of uC/OS-II and implement task management and delays.
CO5 Apply the multitasking techniques in real-time systems.

Mapping of COs with POs and PSOs

Cos/POs	PO1	PO2	PO3
CO 1	3	2	3
CO 2	3	2	3
CO 3	3	2	3
CO 4	3	2	3
CO 5	3	2	3

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22AEL12 **SIGNAL PROCESSING LABORATORY**

L	T	P	C
0	0	2	1

Pre-requisites: Advanced Digital Signal Processing

Preamble

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

LIST OF EXPERIMENTS:

1. Design of Adaptive channel equalizer
2. Realization of sub band filter using linear convolution
3. Realization of STFT using FFT
4. Demonstration of Bayes technique
5. Demonstration of Min-max technique
6. Realization of FIR Wiener filter
7. Generation of Multivariate Gaussian generated data with desired mean vector and the required co variance matrix
8. Design and Realization of the adaptive filter using LMS algorithm (solved using steepest-descent algorithm)
9. Representation of the 2D image signal as the linear combinations of PCA (Eigen faces)
10. Image compression using Discrete cosine transformation (DCT).

Total : 45 Periods

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

CO1	Obtain the ability to apply knowledge of linear algebra, random process and multirate signal processing in various signal processing applications.
CO2	Develop the student's ability on conducting engineering experiments, analyze experimental observations scientifically
CO3	Design digital filters by applying Transformation techniques and plot the pole-zero diagram and frequency response
CO4	Familiarize the basic operations of filter banks through simulations
CO5	Apply the principles of random process in practical applications

Mapping of COs with POs and PSOs

Cos/POs	PO1	PO2	PO3
CO 1	3	1	2
CO 2	3	1	2
CO 3	3	1	2
CO 4	3	1	2
CO 5	3	1	2

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22AET21	ANALOG INTEGRATED CIRCUITS DESGN	L	T	P	C
		3	0	0	3

Pre-requisites: CMOS VLSI Design

Preamble

To focus on the concepts of MOSFETs including the biasing circuit with frequency response as well as the Operational amplifiers circuit parameters, feedback and their stability with practical knowledge.

UNIT 1 SINGLE STAGE AMPLIFIERS 9

Common source stage - Source follower- Common gate stage - Cascode stage - Single ended and differential operation - Basic differential pair- Differential pair with MOS loads.

UNIT 2 BIASING CIRCUITS 9

Basic current mirrors, cascode current mirrors, active current mirrors- voltage references, supply independent biasing - temperature independent references-PTAT current generation- Constant-Gm Biasing.

UNIT 3 FREQUENCY RESPONSE AND NOISE ANALYSIS 9

Miller effect, Association of poles with nodes-frequency response of common source stage - Source followers- Common gate stage, Cascode stage, Differential pair - Statistical characteristics of noise, noise in single stage amplifiers, noise in differential amplifiers.

UNIT 4 OPERATIONAL AMPLIFIERS 9

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

UNIT 5 STABILITY AND FREQUENCY COMPENSATION 9

General considerations- Multipole systems - Phase Margin - Frequency Compensation- Compensation of two stage Op Amps- Slewing in two stage Op Amps- Other compensation techniques..

Total : 45 Periods

REFERENCE:

1. Behzad Razavi, “Design of Analog CMOS Integrated Circuits”, Tata McGraw Hill, 2014
2. Willey M.C. Sansen, “Analog design essentials”, Springer (India) Pvt. Ltd, 2011
3. A. Johns and Kenneth W. Martin, Tony Chan Carusone, David”, Analog Integrated Circuit Design” Wiley 2011
4. Phillip E.Allen, DouglasR.Holberg, “CMOS Analog Circuit Design”, Second Edition, Oxford University Press, 2002

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

CO1 Design a multistage amplifiers using single stage amplifier concept.
CO2 Select an appropriate biasing circuit for desired application circuit.
CO3 Analyze the frequency response and find out the poles and zeroes of a circuit..
CO4 Design an Operational amplifier to optimize its performance metrics.
CO5 Analyze the stability and frequency response in a multi pole system.

Mapping of COs with POs and PSOs

Cos/POs	PO1	PO2	PO3
CO 1	3	1	2
CO 2	3	1	2
CO 3	3	1	2
CO 4	3	1	2
CO 5	3	1	2

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22AET22 **INDUSTRIAL INTERNET OF THINGS**

L	T	P	C
3	0	0	3

Preamble

Industry 4.0 concerns the transformation of industrial processes through the integration of modern technologies such as sensors, communication, and computational processing. Technologies such as Cyber Physical Systems (CPS), Internet of Things (IoT), Cloud Computing, Machine Learning, and Data Analytics are considered to be the different drivers necessary for the transformation. Industrial Internet of Things (IIoT) is an application of IoT in industries to modify the various existing industrial systems

UNIT 1 INDUSTRY 4.0 **9**

Introduction: Sensing & actuation, Communication - Globalization and Emerging Issues - The Fourth Revolution, LEAN Production Systems, Smart and Connected Business Perspective, Smart Factories- Basics of Industrial IoT: Industrial Processes -Industrial Sensing & Actuation - Industrial Internet Systems

UNIT 2 INDUSTRIAL IOT **9**

IIoT-Introduction, Industrial IoT: Business Model and Reference Architecture - Industrial IoT Layers: IIoT Sensing- IIoT Processing - IIoT Communication.

UNIT 3 IIOT ANALYTICS **9**

Big Data Analytics and Software Defined Networks: IIoT Analytics - Introduction, Machine Learning and Data Science - R and Julia Programming - Data Management with Hadoop - Data Center Networks - Security and Fog Computing - Cloud Computing in IIoT

UNIT 4 INDUSTRIAL IoT- APPLICATION DOMAINS **9**

Healthcare, Power Plants, Inventory Management & Quality Control, Plant Safety and Security - Facility Management - Oil, chemical and pharmaceutical industry, Applications of UAVs in Industries

UNIT 5 REAL CASE STUDIES **9**

Milk Processing and Packaging Industries - Manufacturing Industries Student Projects -Virtual Reality Lab - Steel Technology Lab

Total : 45 Periods

REFERENCES :

1. "Industry 4.0: The Industrial Internet of Things", by Alasdair Gilchrist (Apress)
2. "Industrial Internet of Things: Cyber manufacturing Systems " by Sabina Jeschke, Christian Brecher, Houbing Song, Danda B. Rawat (Springer)
3. Dr. OvidiuVermesan, Dr. Peter Friess, "Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems", River Publishers
4. The Internet of Things in the Industrial Sector, Mahmood, Zaigham (Ed.) (Springer Publication)
5. Industrial IoT: Challenges, Design Principles, Applications, and Security by Ismail Butun (Springer)

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

CO1	Discover key IIoT concepts including identification, sensors, localization, wireless protocols, data storage and security.
CO2	Explore Industry 4.0 technologies, architectures and standards
CO3	Realize the data analytics techniques on real-world data sets using R and Julia Programming.
CO4	Examine technological developments that will likely shape the industrial landscape in the future
CO5	Develop and implement their own IoT technologies, solutions, and applications.

Mapping of COs with POs and PSOs

Cos/POs	PO1	PO2	PO3
CO 1	2	3	2
CO 2	2	3	2
CO 3	2	3	2
CO 4	2	3	2
CO 5	2	3	2

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22AET23	EMBEDDED AND REAL TIME SYSTEMS	L	T	P	C
		3	0	0	3

Pre-requisites: 22AET13-Advanced Microprocessor and Microcontroller

Preamble

Embedded and Real Time Systems introduces the issues related to the design and analysis of systems with Real-time constraints and gives the features of Real time OS.

UNIT 1 REAL TIME SYSTEMS 9

Introduction to real time computing – Concepts - Example of real-time applications - Structure of a real time system - Characterization of real time systems and tasks - Hard and Soft timing constraints - Design Challenges - Performance metrics - Prediction of Execution Time : Source code analysis, Micro-architecture level analysis, Cache and pipeline issues- Programming Languages for Real-Time Systems.

UNIT 2 KERNEL STRUCTURES 9

Real time OS - Threads and Tasks -Task assignment and Scheduling-Single-processor and Multiprocessor task scheduling - Clock-driven and priority-based scheduling algorithms-Fault tolerant scheduling- Structure of Microkernel - Time services - Event Notification and Software interrupt.

UNIT 3 PROCESSES AND OPERATING SYSTEMS 9

Introduction – Multiple tasks and multiple processes – Multirate systems- Preemptive real□ time operating systems- Priority based scheduling- Interprocess communication mechanisms – Evaluating operating system performance- power optimization strategies for processes –Example Real time operating systems-POSIX-Windows CE.

UNIT 4 DISTRIBUTED EMBEDDED SYSTEMS 9

Networks for embedded systems – I2C, CAN Bus, SHARC link supports, Ethernet, Myrinet and Internet - MPSoCs and shared memory multiprocessors. – Design Example – Audio player, Engine control unit – Video accelerator.

UNIT 5 REAL TIME DATA BASES 9

Real time v/s general purpose databases-main memory databases-transaction priorities-transaction aborts-concurrency control issues: pessimistic concurrency control and optimistic concurrency control-Disk scheduling algorithms -Case Studies: Vx Works and Micro OS-II

Total : 45 Periods

REFERENCE:

1. Wayne Wolf, “Computers as Components: Principles of Embedded Computing System Design”, Morgan Kaufman Publishers, 2008.
2. C. M. Krishna and K. G. Shin, “Real – Time Systems” , McGraw – Hill, 1997.
3. Jean J Labrosse, "MicroC/OS-II the Real Time Kernel" II Edition, CMP Books, 2002.
4. Jane.W.S. Liu, “Real – Time systems”, Pearson Education Asia, 2000.

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

CO1	Analyze the difference between general purpose operating systems and real time operating systems
CO2	Develop the knowledge about the task Schedulability analysis
CO3	Explain how the process and the operating system used to build applications with more complex functionality.
CO4	Analyze the important networks that are essential for the successful completion large embedded system projects.
CO5	Develop the case studies using the real time operating systems Vxworks and MicroC OS-II

Mapping of COs with POs and PSOs

Cos/POs	PO1	PO2	PO3
CO 1	3	2	
CO 2	3	2	
CO 3	3		
CO 4	3		2
CO 5	3		2

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22AET24	WIRELESS ADHOC AND SENSOR NETWORKS	L	T	P	C
		3	0	0	3

Preamble

A wireless ad hoc network introduces various design issues and challenges in the layered architecture along with designing of MAC & routing protocols. It also deals with data transmission technologies of the Ad hoc and sensor devices with focus on channel access routing, Quality of Services and security.

UNIT 1 AD HOC NETWORKS AND MEDIA ACCESS CONTROL PROTOCOLS 9

Fundamentals of WLANs – IEEE 802.11 Architecture – Ad Hoc Wireless Networks- Itroduction,Issues in Ad Hoc Wireless Networks.MAC Protocols- Classifications –Contention Based Protocols- Contention Based Protocols with Reservation Mechanisms-DPRMA-CATA-HRMA.

UNIT 2 AD HOC ROUTING PROTOCOLS 9

Issues in Designing a Routing Protocol for Ad Hoc Wireless Networks – Classifications of Routing Protocols – Table–Driven Routing Protocols: DSDV, WRP and CGSR – On-Demand Routing Protocols: DSR, AODV, and TORA.

UNIT 3 INTERNET AND AD HOC SERVICE DISCOVERY 9

Resource Discovery in the Internet – Service Location Protocol (SLP) Architecture – SLP v2 Packet Format – Jini Protocol – Salutation Protocol – Simple Service Discovery Protocol – Service Discovery for Ad hoc - Ad hoc Service Location Architecture.

UNIT 4 QUALITY OF SERVICE IN AD HOC WIRELESS NETWORKS 9

Issues and Challenges in Providing QoS in Ad hoc Wireless Networks – Classifications of QoS Solutions – MAC Layer Solutions – Network Layer Solutions – QoS Routing Protocols-Ticket Based QoS Routing Protocol-PLBQR-TDR.

UNIT 5 WIRELESS SENSOR NETWORKS 9

Introduction-Sensor Network Architecture-Data Dissemination-Data Gathering- MAC Protocols for Sensor Networks-Location Discovery-Quality Of a Sensor Network.

Total : 45 Periods

REFERENCE:

1. C. Siva Ram Murthy and B. S. Manoj, “Ad Hoc Wireless Networks Architectures and Protocols”, Prentice Hall, PTR, 2004,Reprint 2012.
2. C.K.Toh, “Ad Hoc Mobile Wireless Networks”, Pearson Education, 2002.
3. Carlos De Morais Cordeiro, Dharma Prakash Agrawal “Ad Hoc and Sensor Networks: Theory and Applications (2nd Edition), World Scientific Publishing, 2011

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

CO1	Identify different issues in wireless ad hoc and sensor networks and analyze the performance of different MAC protocols.
CO2	Analyze the Performance of different types Routing protocols developed for ad hoc and sensor networks.
CO3	Discuss the different types Resource discovery and Internet discovery protocol architecture.
CO4	Illustrate the issues and challenges in QoS and QoS related performance measurements.
CO5	Establish a Sensor network environment for different type of applications

Mapping of COs with POs and PSOs

Cos/POs	PO1	PO2	PO3
CO 1	3	2	2
CO 2	3	2	2
CO 3	2	2	2
CO 4	3	2	2
CO 5	2	2	2

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22AEL21	VLSI DESIGN LABORATORY	L	T	P	C
		0	0	2	1

Preamble

FPGAs are important platform used throughout the industry both in their own right in building complete systems. They are also used as validation/verification platforms prior to undertaking cost and time intensive design and fabrication of custom VLSI designs. Starting from high level design entry in the formVHDL/Verilog codes, the students will be carrying out complete hardware level FPGA validation of important digital algorithms. In addition, exercises on the SPICE simulation of the basic CMOS analog building blocks will be carried out.

LIST OF EXPERIMENTS

1. Design and Implementation of serial-parallel multiplier in FPGA
2. Design and simulation of parameterizable cores on memory design
3. Design and Implementation of ALU in FPGA using HDL
4. Modeling of synchronous Sequential Digital system using HDL
5. Modeling of Asynchronous Sequential Digital system using HDL
6. Realization of DFT/FFT in HDL and observing the spectrum in simulation
7. Interfacing with Memory modules in FPGA Boards
8. Traffic Light Controller using FPGA
9. Layout generation, LVS of CMOS circuits using electric VLSI tool
10. Simulation of logic gates, Current mirrors, Current sources, Differential amplifier in Spice tool

Total : 45 Periods

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

CO1	Design entry and carry out a series of validations design starting from design entry to hardware testing.
CO2	Analyze the results of logic and timing simulations and to use these simulation results to debug digital systems.
CO3	Demonstrate design of ALU in FPGA using VHDL.
CO4	Design and carry out time domain and frequency domain simulations of simple analog building blocks.
CO5	Design and analysis of the physical design process of VLSI design flow.

Mapping of COs with POs and PSOs

Cos/POs	PO1	PO2	PO3
CO 1	3	2	3
CO 2	3	2	3
CO 3	3	2	3
CO 4	3	2	3
CO 5	3	2	3

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22AEE01 HIGH PERFORMANCE COMMUNICATION NETWORKS L T P C
3 0 0 3

Pre-requisites: Computer Communication and Networks

Preamble:
This course describes the fundamental principles to develop a comprehensive understanding of network architectures, control, performance, and wireless networks that explains current and emerging networking technologies.

UNIT 1 INTRODUCTION 9
Review of OSI, TCP/IP; Multiplexing, Modes of Communication, Switching, Routing. SONET – DWDM – DSL – ISDN – BISDN, ATM.

UNIT 2 MULTIMEDIA NETWORKING APPLICATIONS 9
Streaming stored Audio and Video – Best effort service – protocols for real time interactive applications – Beyond best effort – scheduling and policing mechanism – integrated services – RSVP- differentiated services.

UNIT 3 ADVANCED NETWORKS CONCEPTS 9
VPN-Remote-Access VPN, site-to-site VPN, Tunneling to PPP, Security in VPN.MPLS - operation, Routing, Tunneling and use of FEC, Traffic Engineering, MPLS based VPN, overlay networks-P2P connections.

UNIT 4 TRAFFIC MODELLING 9
Little's theorem, Need for modeling, Poisson modeling and its failure, Non - poisson models, Network performance evaluation.

UNIT 5 NETWORK SECURITY AND MANAGEMENT 9
Principles of cryptography – Authentication – integrity – key distribution and certification – Access control and: fire walls – attacks and counter measures – security in many layers. Infrastructure for network management – The internet standard management framework – SMI, MIB, SNMP, Security and administration – ASN.

Total : 45 Periods

REFERENCE:

1. J.F. Kurose & K.W. Ross,"Computer Networking- A top down approach featuring the internet", Pearson, 2nd edition, 2003.
2. Walrand .J. Varatya, High performance communication network, Morgan Kauffman – Harcourt Asia Pvt. Ltd. 2nd Edition, 2000.
3. LEOM-GarCIA, WIDJAJA, "Communication networks", TMH seventh reprint 2002.
4. Aunurag kumar, D. Manjunath, Joy kuri, "Communication Networking", Morgan Kaufmann Publishers, 2011.
5. Hersent Gurle & petit, "IP Telephony, packet Pored Multimedia communication Systems", Pearson education 2003.
6. Fred Halsall and Lingana Gouda Kulkarni,"Computer Networking and the Internet" fifth edition, Pearson education.

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

CO1. Apply the basic networking concepts in high performance communication networks.

CO2. Develop a comprehensive understanding of multimedia networking.

CO3. Analyze the types of VPN and tunneling protocols for security.

CO4. Design and model the network traffic and analyse the performance.

CO5. Investigate about network security in many layers and network management.

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3
CO 1	3	3	2
CO 2	3	3	2
CO 3	3	3	2
CO 4	3	3	2
CO 5	3	3	2

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22AEE02	APPLICATIONS SPECIFIC INTEGRATED CIRCUITS	L	T	P	C
		3	0	0	3

Pre-requisites: Digital CMOS VLSI Design

Preamble

To know the different programmable ASICs, logic cells, I/O cells and interconnect and to learn how synthesis and physical design flow in carried out in an ASIC design.

UNIT 1 INTRODUCTION TO ASICS, CMOS LOGIC AND ASIC LIBRARY DESIGN 9

Types of ASICs - Design Flow - Combinational Logic Cell – Sequential Logic Cell - Data Path Logic Cell - Transistors as Resistors - Transistor Parasitic Capacitance- Logical Effort.

UNIT 2 PROGRAMMABLE ASICS, PROGRAMMABLE ASIC LOGIC CELLS AND PROGRAMMABLE ASIC I/O CELLS 9

Anti Fuse - Static RAM - EPROM and EEPROM Technology - Actel ACT - Xilinx LCA –Altera FLEX - Altera MAX DC & AC Inputs and Outputs - Clock & Power Inputs - Xilinx I/O blocks.

UNIT 3 PROGRAMMABLE ASIC INTERCONNECT 9

Actel ACT -Xilinx LCA - Xilinx EPLD - Altera MAX 5000 and 7000 - Altera MAX9000 - Altera FLEX.

UNIT 4 DESIGN AND SYNTHESIS 9

Design Systems - Half Gate ASIC - Schematic Entry - Low Level Design Language - PLA Tools – EDIF - CFI Design Representation - Logic Synthesis - Logic Simulation - Design and Synthesis of Various Circuits.

UNIT 5 PHYSICAL DESIGN 9

ASIC Partitioning - floor planning- placement and routing – power and clocking strategies - DRC.

Lecture : 45 Periods

REFERENCES:

1. M.J.S.Smith, " Application - Specific Integrated Circuits", Pearson,2003
2. Steve Kilts, “Advanced FPGA Design,” Wiley Inter-Science
3. Roger Woods, John McAllister, Dr. Ying Yi, Gaye Lightbod, “FPGA-based Implementation of Signal Processing Systems”, Wiley, 2008
4. Farzad Nekoogar and Faranak Nekoogar, “From ASICs to SOCs: A Practical Approach”, Prentice Hall PTR, 2003.
5. Wayne Wolf, “FPGA-Based System Design”, Prentice Hall PTR, 2004.

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

CO1	Demonstrate ASIC Design flow and comprehend the types of ASIC.
CO2	Realize the issues involved in ASIC design, including design, role of transistor, logical effort and programming technology.
CO3	Analyze the issues involved in logic cells, I/O cells and interconnect.
CO4	Perform simulation and synthesis of the design using different programmable ASIC design software.
CO5	Analyze the algorithms used in partitioning, floorplanning, placement, routing, power and clock design for ASIC.

Mapping of COs with POs and PSOs

Cos/POs	PO1	PO2	PO3
CO 1	3	2	
CO 2	3		
CO 3	3	2	
CO 4	3		1
CO 5	3	2	1

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22AEE03 **COMPUTER ARCHITECTURE AND PARALLEL PROCESSING**

L	T	P	C
3	0	0	3

Pre-requisites: Nil

Preamble

Computer Architecture and Parallel Processing explores the design and implementation alternatives which utilizes both coarse and fine grained parallelism inherently present in data and computation of different applications. It also explores methodologies and measures to evaluate alternative processors architectures and their implementations.

UNIT 1 COMPUTER DESIGN AND PERFORMANCE MEASURES 9

Fundamentals of Computer Design – Parallel and Scalable Architectures – Multiprocessors – Multivector and SIMD architectures – Multithreaded architectures – Data – flow architectures – Performance Measures.

UNIT 2 PARALLEL PROCESSING, PIPELINING AND ILP 9

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

UNIT 3 MEMORY HIERARCHY DESIGN 9

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

UNIT 4 MULTIPROCESSORS 9

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

UNIT 5 MULTI – CORE ARCHITECTURES 9

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

Total : 45 Periods

REFERENCES:

1. Kai Hwang, “Advanced Computer Architecture”, McGraw Hill International, 2011.
2. John L. Hennessey and David A. Patterson, “Computer Architecture – A quantitative approach”, Morgan Kaufmann / Elsevier, Fourth edition, 2012.
3. William Stallings, “Computer Organization and Architecture – Designing for Performance”, Pearson Education, Seventh Edition, 2006.
4. John P. Hayes, “Computer Architecture and Organization”, McGraw Hill, 2002.
5. David E. Culler, Jaswinder Pal Singh, “Parallel Computing Architecture: A hardware/ software approach”, Morgan Kaufmann / Elsevier, 1999.

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

CO1 Analyze some of the design issues in terms of speed, technology, cost, performance
CO2 Demonstrate concepts of parallelism in hardware/software
CO3 Analyze the memory system Hierarchy, technology and performance
CO4 Interpret performance of different pipelined processors and multiprocessor system.
CO5 Analyze the efficiency of the multi-core processing system and evaluate the types of application.

Mapping of COs with POs and PSOs

Cos/POs	PO1	PO2	PO3
CO 1	2	3	2
CO 2	2	3	2
CO 3	2	3	2
CO 4	2	3	2
CO 5	2	3	2

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22AEE04	ADVANCED WIRELESS COMMUNICATION	L	T	P	C
		3	0	0	3

Pre-requisites: Wireless Communication

Preamble

This course introduces the basic concept of wireless communication and various propagation methods, Channel models, capacity calculations along with multiple user techniques used in the mobile communication.

UNIT 1 WIRELESS CHANNEL PROPAGATION AND MODEL 9

Propagation of EM signals in wireless channel – Reflection, diffraction and Scattering-free space, two ray. Small scale fading- channel classification- channel models – COST -231 Hata model, NLOS Multipath Fading Models: Rayleigh, Rician, Nakagami, 5G Channel model requirements and Measurements, propagation scenarios.

UNIT 2 CAPACITY OF WIRELESS CHANNELS 9

Capacity in AWGN, capacity of flat fading channel, capacity of frequency selective fading channels. Capacity of MISO, SIMO systems.

UNIT 3 DIVERSITY 9

Realization of independent fading paths, Receiver Diversity: Selection combining, Threshold Combining, Maximum-ratio Combining, Equal gain Combining. Transmitter Diversity: Channel known at transmitter, Channel unknown at the transmitter.

UNIT 4 MIMO COMMUNICATIONS 9

Narrowband MIMO model, Parallel decomposition of the MIMO channel, MIMO channel capacity, MIMO Diversity Gain: Beam forming, Diversity-Multiplexing trade-offs, Space time Modulation and coding: STBC, STTC, Spatial Multiplexing and BLAST Architectures.

UNIT 5 MULTI USER SYSTEMS 9

Introduction to MUD, Linear decorrelator, MMSE MUD, Adaptive MUD, MIMO-MUD Application of convex optimization to wireless design.

Total : 45 Periods

REFERENCES:

1. Mainak Chowdhury & Arumita Biswas "Wireless Communication: Theory and Applications 1st Edition" Cambridge University Press; 1st edition,2017
2. David Tse and Pramod Viswanath, "Fundamentals of wireless communications", Cambridge University Press, First Edition, 2012
3. Andreas F. Molisch "Wireless Communications," 2ed (An Indian Adaptation) Paperback – 1, wiley **india** , 2021.
4. Rappaport. T.S., "Wireless communications", Pearson Education,2010
5. Upena Dalal, "Wireless Communication", Oxford Higher Education, 2009.

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

CO1 Analyze the wireless channel characteristics and identify appropriate channel models
CO2 Verify the concepts behind the capacity calculation under different channel conditions
CO3 Describe the implication of diversity combining methods and the knowledge of channel.
CO4 Illustrate the concepts of Parallel decomposition of the MIMO channel.
CO5 Describe multiple access techniques and their use in different multi-user scenarios.

Mapping of COs with POs and PSOs

Cos/POs	PO1	PO2	PO3
CO 1	2	2	2
CO 2	2	2	2
CO 3	2		
CO 4	1		
CO 5	3	2	2

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22AEE05	SOFT COMPUTING AND OPTIMIZATION TECHNIQUES	L	T	P	C
		3	0	0	3

Preamble

To expose the students to softcomputing, various types of soft computing techniques, and applications of soft computing, Artificial Intelligence, Various types of production systems, characteristics of production systems.

UNIT 1 NEURAL NETWORKS 9

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

UNIT 2 FUZZY LOGIC 9

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

UNIT 3 NEURO-FUZZY MODELING 9

Adaptive Neuro-Fuzzy Inference Systems – Coactive Neuro-Fuzzy Modeling – Classification and Regression Trees – Data Clustering Algorithms – Rule base Structure Identification – Neuro- Fuzzy Control – Case Studies.

UNIT 4 CONVENTIONAL OPTIMIZATION TECHNIQUES 9

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

UNIT 5 EVOLUTIONARY OPTIMIZATION TECHNIQUES 9

Genetic algorithm - working principle, Basic operators and Terminologies, Building block hypothesis, Travelling Salesman Problem, Particle swam optimization, Ant colony optimization.

Total : 45 Periods

REFERENCE:

1. Jyh – Shing Roger Jang, Chuen – Tsai Sun, Eiji Mizutani, "Neuro – Fuzzy and Soft Computing", Prentice – Hall of India, 2003.
2. S. N. Sivanandam, S.N. Deepa, "Principles of Soft Computing", John Wiley & Sons, 2011.
3. S. Rajasekaran, G. A. Vijayalakshmi Pai, "Neural Networks, Fuzzy Logic and Genetic Algorithm",PHI Learning Pvt. Ltd., 2003.
4. George J. Klir and Bo Yuan, Fuzzy Sets and Fuzzy Logic-Theory and Applications,Prentice Hall, 1995.
5. David E. Goldberg, Genetic Algorithms in Search, Optimization and Machine Learning, Addison wesley, 2009.

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

CO1 Implement machine learning through Neural networks.
CO2 Develop a Fuzzy expert system.
CO3 Model Neuro Fuzzy system for clustering and classification.
CO4 Apply the optimization techniques to solve the real-world problems.
CO5 Develop application on different soft computing techniques like Fuzzy, GA and Neural network.

Mapping of COs with POs and PSOs

Cos/POs	PO1	PO2	PO3
CO 1	3	2	2
CO 2	3	2	2
CO 3	3		
CO 4	3	2	2
CO 5	3	2	2

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22AEE06	ADVANCED DIGITAL IMAGE PROCESSING	L	T	P	C
		3	0	0	3

Pre-requisites:Nil

Preamble

In advanced digital image processing, the segmentation of images is applied by extracting various features by analyzing its fundamentals inorder to increase SNR. Proper selection of image features such as points, linesand regions is used for image fusion to enhance an image in 3D practical applications.

UNIT 1 FUNDAMENTALS OF DIGITAL IMAGE PROCESSING 9

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

UNIT 2 SEGMENTATION 9

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

UNIT 3 FEATURE EXTRACTION 9

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

UNIT 4 REGISTRATION AND IMAGE FUSION 9

Registration - Preprocessing, Feature selection - points, lines, regions and templates Feature correspondence - Point pattern matching, Line matching, Region matching, Template matching. Transformation functions - Similarity transformation and Affine Transformation. Resampling – Nearest Neighbour and Cubic Splines. Image Fusion - Overview of image fusion, pixel fusion, wavelet based fusion -region based fusion.

UNIT 5 3D IMAGE VISUALIZATION 9

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

Total : 45 Periods

REFERENCES BOOKS:

1. Rafael C. Gonzalez, Richard E. Woods, “Digital Image Processing”, Pearson,Education, Inc.,Second Edition, 2004.
2. Anil K. Jain, “Fundamentals of Digital Image Processing”, Pearson Education,Inc., 2002.
3. ArdeshirGoshtasby, “2D and 3D Image registration for Medical, Remote Sensing and Industrial Applications”,John Wiley and Sons,2005.
4. Mark Nixon, Alberto Aguado, “Feature Extraction and Image Processing”, Academic Press,2008.
5. Rick S.Blum, Zheng Liu, “Multisensor image fusion and its Applications“, Taylor& Francis,2006.

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

CO1 Summarize the image enhancement techniques by analyzing the fundamentals of digital image processing.

CO2 Analyze image segmentation by evaluating edge detection,texture feature, graph, wavelet based Segmentation of image.

CO3 Evaluate the performance of feature extraction techniques by analyzingshape skeletonization,image curvature.

CO4 Evaluate the concepts of image registration and image fusion by analyzing its features.

CO5 Analyze the constraints in image processing in 3D data sets and to applyimage processing algorithms in practical applications.

Mapping of COs with POs and PSOs

Cos/POs	PO1	PO2	PO3
CO 1	2	1	3
CO 2	2	1	3
CO 3	2	1	3
CO 4	3	1	3
CO 5	2	1	3

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22AEE07	ELECTROMAGNETIC INTERFERENCE AND COMPATIBILITY	L	T	P	C
		3	0	0	3

Pre-requisites: Electromagnetic Theory

Preamble

EMIC is of increasing importance as the number of wirelessly connected devices increase. Defining what EMI and EMC is and understanding the concepts enabling the electromagnetic interference and compatibility to be achieved from the outset.

UNIT 1 EMI/EMC CONCEPTS 9

EMI-EMC definitions and Units of parameters; Sources and victim of EMI; Conducted and Radiated EMI Emission and Susceptibility; Transient EMI, ESD; Radiation Hazards

UNIT 2 EMI COUPLING PRINCIPLES 9

Coupling paths, Coupling via the supply network, Common mode coupling, Differential mode coupling, Impedance coupling, Radiative coupling, Ground loop coupling, Cable related emissions and coupling, Transient sources, Automotive transients. Categorization of the electromagnetic interference: emission, susceptibility, transients, crosstalk, shielding and compatibility, signal integrity..

UNIT 3 EMI CONTROL TECHNIQUES 9

Shielding- Shielding Material-Shielding integrity at discontinuities, Filtering- Characteristics of Filters-Impedance and Lumped element filters-Telephone line filter, Power line filter design, Filter installation and Evaluation, Grounding- Measurement of Ground resistance-system grounding for EMI/EMC-Cable shielded grounding, Bonding, Isolation transformer, Transient suppressors.

UNIT 4 EMC DESIGN OF PCBS 9

EMI Suppression Cables-Absorptive, ribbon cables-Devices-Transient protection hybrid circuits, Component selection and mounting; PCB trace impedance; Routing; Cross talk control- Electromagnetic Pulse-Noise from relays and switches, Power distribution decoupling; Zoning; Grounding; VIAs connection; Terminations.

UNIT 5 EMI MEASUREMENTS AND STANDARDS 9

Open area test site; TEM cell; EMI test shielded chamber and shielded ferrite lined anechoic chamber; Tx /Rx Antennas, Sensors, Injectors / Couplers, and coupling factors; EMI Rx and spectrum analyzer; Civilian standards-CISPR, FCC, IEC, EN; Military standards-MIL461E/462. Frequency assignment - spectrum conversation. British VDE standards, Euro norms standards in japan - comparisons. EN Emission and Susceptibility standards and Specifications.

Total : 45 Periods

REFERENCES:

1. Clayton R. Paul, ”Introduction to Electromagnetic Compatibility”, John Wiley Publications, 2nd edition, ISBN: 9788126528752, 2010..
2. Henry W. Ott.,” Electromagnetic Compatibility Engineering”, John Wiley Publications, 2nd edition, ISBN: 9780470189306, 2009..
3. V. P. Kodali, “Engineering EMC Principles, Measurements and Technologies”, Wiley-Blackwell; 2nd edition, ISBN: 0780347439, 2001.
4. Daryl Gerke and William Kimmel, “Electromagnetic Compatibility in Medical Equipment”, IEEE & Interpharm press, ISBN: 0935184805, 1995.

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

CO1 Describe the concept of EMI/EMC related to product design & development.

CO2 Analyse the different EM coupling principles and its impact on performance of electronic system..

CO3 Analyse the electromagnetic interference, highlighting the concepts of both susceptibility and immunity.

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

CO5 Describe various EM radiation measurement techniques and the present leading edge industry standards in different countries.

Mapping of COs with POs and PSOs

Cos/POs	PO1	PO2	PO3
CO 1	3	1	2
CO 2	3	1	2
CO 3	3	1	2
CO 4	3	1	2
CO 5	3	1	2

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22AEE08 **NANO ELECTRONIC DEVICES**

L	T	P	C
3	0	0	3

Pre-requisites: Microprocessor and Microcontroller

Preamble

Nano electronics is the emerging area of electronics dealing with nanometer-sized devices used for electronic circuits and systems. Nano electronics is probably the most advanced of the nanotechnologies and products are starting to appear in the market utilizing Nano electronic devices.

UNIT 1 INTRODUCTION **9**

Recent past, the present and its challenges, Future, Overview of basic Nano electronics.

UNIT 2 NANOCOMPUTER ARCHITECTURES **9**

Introduction to Nano computers, Nano computer Architecture, Quantum DOT cellular Automata (QCA), QCA circuits, Single electron circuits, molecular circuits, Logic switches – Interface engineering – Properties (Self-organization, Size-dependent) – Limitations.

UNIT 3 NANO ELECTRONIC ARCHITECTURES **9**

Nanofabrication – Nano patterning of Metallic/Semiconducting nanostructures - e-beam/X-ray, Optical lithography, STM/AFM- SEM & Soft-lithography – Nano phase materials – Self- assembled Inorganic/Organic layers.

UNIT 4 SPINTRONICS **9**

Introduction, Overview, History & Background, Generation of Spin Polarization Theories of spin Injection, spin relaxation and spin dephasing, Spintronic devices and applications, spin filters, spin diodes, spin transistors.

UNIT 5 MEMORY DEVICES AND SENSORS **9**

Memory devices and sensors – Nano ferroelectrics – Ferroelectric random access memory –Fe-RAM circuit design –ferroelectric thin film properties and integration – calorimetric - sensors – electrochemical cells – surface and bulk acoustic devices – gas sensitive FETs – resistive semiconductor gas sensors –electronic noses – identification of hazardous solvents and gases – semiconductor sensor array.

Total : 45 Periods

REFERENCES:

1. Karl Goser, JanDienstuhl , "Nanoelectronics & Nanosystem",Springer, 2004th edition.
2. Rainer Waser , "Nano Electronics and Information Technology", Wiley vch, 2012 ,3rd edition.
3. Sadamichi Maekawa, "Concepts in Spintronics", Oxford Science Publication, 2006 , 3rd edition.
4. David Awschalom, "Spin Electronics", Springer; Softcover reprint of hardcover, 2004 ,1st edition.

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

CO1 Explain the fundamentals of nano electronics

CO2 Describe the architecture of nano computers and their limitations.

CO3 Illustrate the nano patterning of nano structures ,nano phase materials , inorganic and organic layers.

CO4 Analyse the Generation of Spin Polarization, spin Injection, spin relaxation and spin dephasing and spin diodes

CO5 Describe Nano ferroelectrics, calorimetric -sensors – electrochemical cells – surface and bulk acoustic devices and semiconductor sensor array.

Mapping of COs with POs and PSOs

Cos/POs	PO1	PO2	PO3
CO 1	1		2
CO 2		2	2
CO 3	1		2
CO 4	2	1	1
CO 5	2	2	1

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22AEE09	MULTIMEDIA COMPRESSION TECHNIQUES	L	T	P	C
		3	0	0	3

Pre-requisites: Digital Image processing

Preamble

This course aims at understanding characteristics of various multimedia data and Design a suitable coding/compression technique to efficiently represent the data. Prerequisite: 1D, 2D Signal Processing and transforms.

UNIT 1 INTRODUCTION **9**

Special features of Multimedia – Graphics and Image Data Representations – Fundamental Concepts in Video and Digital Audio – Storage requirements for multimedia applications -Need for Compression - Taxonomy of compression techniques – Overview of source coding.

UNIT 2 TEXT COMPRESSION **9**

Compaction techniques – Huffmann coding – Adaptive Huffmann Coding –Arithmetic coding – shannonFano coding – Dictionary techniques – LZW family algorithms.

UNIT 3 IMAGE COMPRESSION **9**

Transform Coding – JPEG Standard – Sub-band coding algorithms: Design of Filter banks – Wavelet based compression: Implementation using filters – EZW, SPIHT coders – JPEG 2000 standards - JBIG, JBIG2 standards.

UNIT 4 AUDIO COMPRESSION **9**

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

UNIT 5 VIDEO COMPRESSION **9**

Video compression techniques and standards – MPEG Video Coding I: MPEG – 1 and 2 – MPEG Video Coding II: MPEG – 4 and 7 – Motion estimation and compensation techniques – H.261 Standard – DVI technology – PLV performance – DVI real time compression – Packet Video.

Total : 45 Periods

REFERENCE:

1. Khalid Sayood,“Introduction to Data Compression”, Morgan Kauffman Harcourt India, Fourth Edition, 2012.
2. David Salomon,“Data Compression – The Complete Reference”, Springer Verlag, New York Inc., Fourth Edition, 2006.
3. Yun Q.Shi and HuifangSun,“Image and Video Compression for Multimedia Engineering - Fundamentals, Algorithms & Standards”, CRC press, Second Edition, 2008.
4. Peter Symes,“Digital Video Compression”, McGraw Hill, FirstEdition,2003., 2015.
5. Mark Nelson,“Data compression”, BPB Publishers, New Delhi, Second Edition, 1998

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

CO1 Analyze the requirement of compression in different real time applications
CO2 Apply various compaction techniques for text compression.
CO3 Analyze the performance of audio compression techniques.
CO4 Evaluate the performances of various algorithms employed for image compression
CO5 Analyze the different standards applicable for video compression.

Mapping of COs with POs and PSOs

Cos/POs	PO1	PO2	PO3
CO 1	3	1	1
CO 2	3	3	2
CO 3	3	2	2
CO 4	3	2	-
CO 5	3	3	3

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22AEE10 **RF SYSTEM DESIGN**

L	T	P	C
3	0	0	3

Preamble

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

UNIT 1 CMOS PHYSICS, TRANSCEIVER SPECIFICATIONS AND ARCHITECTURES **9**

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

UNIT 2 IMPEDANCE MATCHING AND AMPLIFIERS **9**

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

UNIT 3 FEEDBACK SYSTEMS AND POWER AMPLIFIERS **9**

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

UNIT 4 MIXERS AND OSCILLATORS **9**

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

UNIT 5 PLL AND FREQUENCY SYNTHESIZERS **9**

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

Total : 45 Periods

REFERENCE:

1. B.Razavi, “Design of Analog CMOS Integrated Circuits”, McGraw Hill, 2017.
2. B.Razavi, “RF Microelectronics”, Pearson Education, 1997.
3. K.R.Valluvan, P.Senthil Kumar, “Linear Integrated Circuits”, Charulatha Publications, 1st Edition, 2019
4. T.Lee, “Design of CMOS RF Integrated Circuits”, Cambridge, 2004.
5. Reinhold Ludwig and Powel Bretchko, RF Circuit Design – Theory and Applications, Pearson Education Asia, First Edition, 2001.

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

CO1 Comprehend the performance of transmitter, receiver andtransceiver in RF circuits.
CO2 Design and analysethe basic impedance matching and amplifiersfor RF circuits.
CO3 Design and analysethefeedback systemsfor RF circuits.
CO4 Analyse the operation of mixers and oscillators in RF circuits.
CO5 Analyse the performance ofPLL and frequency synthesizers.

Mapping of COs with POs and PSOs

Cos/POs	PO1	PO2	PO3
CO 1	3	1	1
CO 2	3	3	2
CO 3	3	2	2
CO 4	3	2	
CO 5	3	3	3

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22ACT01	ENGLISH FOR RESEARCH PAPER WRITING	L	T	P	C
		2	0	0	0

UNIT 1 INTRODUCTION TO RESEARCH PAPER WRITING **9**

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

UNIT 2 PRESENTATION SKILLS **9**

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

UNIT 3 TITLE WRITING SKILLS **9**

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 4 RESULT WRITING SKILLS **9**

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 5 VERIFICATION SKILLS **9**

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

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.

22AC02	DISASTER MANAGEMENT	L	T	P	C
		2	0	0	0

Pre-requisites : NIL

Preamble

This course is useful to provide students an exposure to disasters- their significance and types and knowledge on relationship between vulnerability- disasters- disaster prevention and risk reduction.

UNIT 1 INTRODUCTION 9

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

UNIT 2 REPERCUSSIONS OF DISASTERS AND HAZARDS 9

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 3 DISASTER PRONE AREAS IN INDIA 9

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 4 DISASTER PREPAREDNESS AND MANAGEMENT 9

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 5 RISK ASSESSMENT 9

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

CO1	Identify and explain the types of disasters- causes and their impact on environment and society.
CO2	Identify and explain the vulnerability and various types of hazards.
CO3	Draw the hazard and vulnerability profile of India- Scenarios in the Indian context- Disaster damage assessment and management.
CO4	Apply the remote sensing and GIS techniques for predicting the natural disasters.
CO5	Discuss how to work on recovery & risk assessment due to disasters.

REFERENCES:

1. Singhal J.P, ―Disaster Management‖, Laxmi Publications- 2010.
2. Tushar Bhattacharya, ―Disaster Science and Management‖, McGraw Hill India Education Pvt. Ltd.- 2012.
1. Gupta Anil, K.Sreeja, S. Nair, ―Environmental Knowledge for Disaster Risk Management-NIDM‖, New Delhi- 2011.
2. Goel S. L., Disaster Administration And Management Text And Case Studies",Deep & Deep Publication Pvt. Ltd., New Delhi,2009.
3. NishithaRai, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'NewRoyal book Company,2007.

22AC03 **CONSTITUTION OF INDIA**

L	T	P	C
2	0	0	0

Preamble

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.

UNIT 1 HISTORY ANDPHILOSOPHY OF THE INDIAN CONSTITUTION 6

History: History, Drafting Committee, (Composition & Working), Philosophy: Preamble, Salient Features

UNIT 2 CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES 6

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 3 ORGANS OF GOVERNANCE 6

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 4 LOCAL ADMINISTRATION 6

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

UNIT 5 ELECTION COMMISSION 6

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

REFERENCES:

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.

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

CO1	Describe the emergence and evolution of Indian Constitution, structure and composition of Indian Constitution and federalism in the Indian context.
CO2	Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
CO3	List the functions of Centre, States and District Administrations, Fundamental rights needed to develop human personality in free society.
CO4	Identify different levels of Panchayat Raj system and its working.
CO5	Elaborate the role of Election Commission and its power to conduct free and fair election throughout India.

22AC04 **PEDAGOGY STUDIES**

L	T	P	C
2	0	0	0

Preamble

The general aims of the course are that the student should acquire knowledge of pedagogical theories of relevance to work with people. Learning outcomes On completion of the course, the student should - describe the basic view of different pedagogical orientations - apply concepts related to learning theory - describe and reflect on different theories of motivation and learning - account for different forms of supervision.

UNIT 1 Dimensions of Learning **9**

Dimensions of Individual development: Physical, Cognitive, Affective, Social and Moral their interrelationships and implications for teachers - Key Cognitive Processes: Perception, Attention, Memory, Language, Thinking, Problem Solving, Emotions and Motivation. - Stages of Development-Developmental tasks with focus on processes of growth and development across various stages from Infancy to Post Adolescence and their significance to Learning.

UNIT 2 Learning Theories **9**

Theories of Learning (Concepts, Principles and applicability is different learning situations): -Thorndike, Pavlov, Skinner, Kohler, Guthrie -Piaget, Rogers, Bandura ,Vygotsky - Distinction between learning as Construction of Knowledge and Learning as Transmission and Reception of Knowledge- Meaning of Cognition and its role in learning. Socio-Cultural factors influencing Cognition and Learning - Understanding processes that facilitate Construction of Knowledge : (i) Experiential Learning and Reflection (ii) Social Mediation (iii) Negotiability (iv) Situated Learning and Cognitive Apprenticeship (v) Meta-cognition - Role of a teacher in a teaching-learning context: (a) Transmitter of knowledge (b) Model (c) Facilitator (d) Negotiator (e) Learner

UNIT 3 Outcome Based Education **9**

Introduction – Accreditation – Approach to design Outcome based learning – Instructional design for active learning (ADDIE model,etc.,) – Accreditation - Framing Vision, Mission- Graduate attributes , Program outcomes and Program Educational Objectives - Bloom’s Taxonomy – Writing Learning outcomes for a course – Assessment and Evaluation – Assessment Methods - Evaluation.

Assignment/ Activity: Course Module development for a course.

UNIT 4 Teaching and Learning **9**

Traditional Teaching methods- Outcome based Modern teaching methods – Good Teaching Attributes - Active Learning methods (Problem based learning, Cooperative Learning, Focused groups) - Flipped classroom.

Assignment / Activity: Innovative Teaching methods

UNIT 5 Research in Education **9**

What is educational research – Overview of educational research process – Ethics in educational research- Qualitative research methods and Quantitative research methods.

Total : 30 Periods

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

CO1 Explain different dimensions of learning

CO2 Apply suitable learning theory for the class

CO3 Use outcome based education approaches to their class

CO4 Exhibit different teaching methods for active learning

CO5 Apply the concepts and tools of qualitative and quantitative research methods in education.

REFERENCES:

1. Dr.V V Rao, "Outcome based education and accreditation" , Notion press, 2015
2. Mukunda Sarma and Kishor Kumar, "Educational Theories and practices: Towards a new social", Mittal publications, January 2021.
3. Dale H. Schunk, "Learning Theories: An Educational Perspective", Springer 2007
4. Raymond P Perry , John C Smart, , "Scholarship teaching and learning in Higher education : An evidence based perspective", Springer 2007
5. Book chapter by Harry G Murray , "Low inference teaching behaviors and college teaching effectiveness: Recent developments and controversies" , 2012
6. Craig A Mertler, Thoudand oaks, California," Introduction to educational research", SAGE publications, 2016

22AEE11	CLOUD COMPUTING	L	T	P	C
		3	0	0	3

Pre-requisites:

Preamble

Cloud Computing is to understand the concept of virtualization and virtual machines, deploy practical virtualization solutions and enterprise solutions, various issues in cloud computing, the security issues in the grid and the cloud environment, and gain expertise in server, network, and storage virtualization, knowledge on the concept of virtualization that is fundamental to cloud computing.

UNIT 1 VIRTUALIZATION **9**

Basics of Virtual Machines - Process Virtual Machines – System Virtual Machines –Emulation – Interpretation – Binary Translation - Taxonomy of Virtual Machines. Virtualization –Management Virtualization — Hardware Maximization – Architectures – Virtualization Management – Storage Virtualization – Network Virtualization

UNIT 2 VIRTUALIZATION INFRASTRUCTURE **9**

Comprehensive Analysis – Resource Pool – Testing Environment –Server Virtualization – Virtual Workloads – Provision Virtual Machines – Desktop Virtualization – Application Virtualization - Implementation levels of virtualization – virtualization structure – virtualization of CPU, Memory and I/O devices – virtual clusters and Resource Management – Virtualization for data center automation.

UNIT 3 CLOUD PLATFORM ARCHITECTURE **9**

Cloud deployment models: public, private, hybrid, community – Categories of cloud computing: Everything as a service: Infrastructure, platform, software- A Generic Cloud Architecture Design – Layered cloud Architectural Development – Virtualization Support and Disaster Recovery – Architectural Design Challenges - Public Cloud Platforms : GAE,AWS – Inter-cloud Resource Management

UNIT 4 PROGRAMMING MODEL **9**

Introduction to Hadoop Framework - Mapreduce, Input splitting, map and reduce functions, specifying input and output parameters, configuring and running a job –Developing Map Reduce Applications - Design of Hadoop file system –Setting up Hadoop Cluster - Cloud Software Environments -Eucalyptus, Open Nebula, Open Stack, Nimbus

UNIT 5 CLOUD SECURITY **9**

Cloud Infrastructure security: network, host and application level – aspects of data security, provider data and its security, Identity and access management architecture, IAM practices in the cloud, SaaS, PaaS, IaaS availability in the cloud - Key privacy issues in the cloud –Cloud Security and Trust Management

Total : 45

REFERENCES:

1. Danielle Ruest, Nelson Ruest, ―Virtualization: A Beginner‟s Guide‖, McGraw-Hill Osborne Media, 2009.
2. Jim Smith, Ravi Nair , "Virtual Machines: Versatile Platforms for Systems and Processes", Elsevier/Morgan Kaufmann, 2005
3. John W.Rittinghouse and James F.Ransome, "Cloud Computing: Implementation, Management, and Security", CRC Press, 2010.
4. Kai Hwang, Geoffrey C Fox, Jack G Dongarra, "Distributed and Cloud Computing, From Parallel Processing to the Internet of Things", Morgan Kaufmann Publishers, 2012.
5. Tim Mather, Subra Kumaraswamy, and Shahed Latif ,"Cloud Security and Privacy", O‘Reilly

Media, Inc.,2009.
6. Toby Velte, Anthony Velte, Robert Elsenpeter, "Cloud Computing, A Practical Approach", McGraw-Hill Osborne Media, 2009.
7. Tom White, "Hadoop: The Definitive Guide", Yahoo Press, 2012.

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

CO1 Employ the concepts of storage virtualization, network virtualization and its management
CO2 Apply the concept of virtualization in the cloud computing
CO3 Identify the architecture, infrastructure and delivery models of cloud computing
CO4 Develop services using Cloud computing
CO5 Apply the security models in the cloud environment

Mapping of COs with POs and PSOs

Cos/POs	PO1	PO2	PO3
CO 1	3	1	2
CO 2	3	1	2
CO 3	3	1	2
CO 4	3	1	2
CO 5	3	1	2

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22AEE12	CAD FOR VLSI CIRCUITS	L	T	P	C
		3	0	0	3

Preamble

This course introduces the VLSI design methodologies and design methods, data structures and algorithms required for VLSI design. It explains algorithms for partitioning and placement, floor planning and routing. This also describes algorithms for modelling, simulation and synthesis.

UNIT 1 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 2 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 3 ALGORITHMS FOR PARTITIONING AND PLACEMENT 9

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

UNIT 4 ALGORITHMS FOR FLOORPLANNING AND ROUTING 9

Floor planning – Problem Formulation – Floor planning Algorithms – Routing – Area Routing – Global Routing – Detailed Routing.

UNIT 5 MODELLING, SIMULATION AND SYNTHESIS 9

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

Lecture : 45 Periods

REFERENCES:

1. Sabih H. Gerez, “Algorithms for VLSI Design Automation”, Wiley-India, Second Edition, 2017.
2. Naveed a. Sherwani, “Algorithms for VLSI Physical Design Automation”, Springer, 3rd Edition, 2017.
3. Charles J. Alpert, Dinesh P. Mehta and Sachin S Sapatnekar, “Handbook of Algorithms for Physical Design Automation, CRC Press, 1st Edition, 2017.
4. Steven M.Rubin, “Computer Aids for VLSI Design”, Addison Wesley Publishing, 1987.
5. Sadiq M. Sait, Habib Youssef, “VLSI Physical Design Automation: Theory and Practice”, World scientific, 1999.

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

CO1 Use VLSI design methodologies and measure physical measurement.
CO2 Write data structures and algorithms required for VLSI design.
CO3 Develop algorithms for partitioning and placement.
CO4 Develop algorithms for floor planning and routing.
CO5 Design algorithms for modeling, simulation and synthesis.

Mapping of COs with POs and PSOs

Cos/POs	PO1	PO2	PO3
CO 1	2	-	-
CO 2	2	1	1
CO 3	2	2	-
CO 4	2	-	2
CO 5	2	3	3

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22AEE13 **MEMS** **L T P C**
3 0 0 3

Preamble:

MEMS cover the concept of semiconductors and solid mechanics to fabricate MEMS devices and educate on the rudiments of Micro fabrication techniques. It deals with various sensors and actuators and introduce different materials used for MEMS and the applications of MEMS to disciplines beyond Electrical and Mechanical engineering.

UNIT I INTRODUCTION **9**

Intrinsic Characteristics of MEMS – Energy Domains and Transducers- Sensors and Actuators – Introduction to Micro fabrication - Silicon based MEMS processes – New Materials – Review of Electrical and Mechanical concepts in MEMS – Semiconductor devices – Stress and strain analysis – Flexural beam bending- Torsional deflection.

UNIT II SENSORS AND ACTUATORS-I **9**

Electrostatic sensors – Parallel plate capacitors – Applications – Inter digitated Finger capacitor – Comb drive devices – Micro Grippers – Micro Motors - Thermal Sensing and Actuation – Thermal expansion – Thermal couples – Thermal resistors – Thermal Bimorph - Applications – Magnetic Actuators – Micro magnetic components – Case studies of MEMS in magnetic actuators- Actuation using Shape Memory Alloys.

UNIT III SENSORS AND ACTUATORS-II **9**

Piezoresistive sensors – Piezoresistive sensor materials - Stress analysis of mechanical elements – Applications to Inertia, Pressure, Tactile and Flow sensors – Piezoelectric sensors and actuators – piezoelectric effects – piezoelectric materials – Applications to Inertia , Acoustic, Tactile and Flow sensors.

UNIT IV MICROMACHINING **9**

Silicon Anisotropic Etching – Anisotrophic Wet Etching – Dry Etching of Silicon – Plasma Etching – Deep Reaction Ion Etching (DRIE) – Isotropic Wet Etching – Gas Phase Etchants – Case studies - Basic surface micro machining processes – Structural and Sacrificial Materials – Acceleration of sacrificial Etch – Striction and Antistriction methods – LIGA Process - Assembly of 3D MEMS – Foundry process.

UNIT V POLYMER AND OPTICAL MEMS **9**

Polymers in MEMS– Polimide - SU-8 - Liquid Crystal Polymer (LCP) – PDMS – PMMA – Parylene – Fluorocarbon - Application to Acceleration, Pressure, Flow and Tactile sensors- Optical MEMS – Lenses and Mirrors – Actuators for Active Optical MEMS.

TOTAL: 45 PERIODS

REFERENCE BOOKS:

1. Chang Liu, ‘Foundations of MEMS’, Pearson Education Inc., 2012.
2. Stephen D Senturia, ‘Microsystem Design’, Springer Publication, 2000.
3. Tai Ran Hsu, “MEMS & Micro systems Design and Manufacture” Tata McGraw Hill, New Delhi, 2002.
4. NadimMaluf,“ An Introduction to Micro Electro Mechanical System Design”, Artech House, 2000.
5.Mohamed Gad-el-Hak, editor, “ The MEMS Handbook”, CRC press Baco Raton, 2001.

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

CO1: Demonstrate the concepts of semiconductors and solid mechanics to fabricate MEMS devices.
CO2: Implement MEMS devices using electrostatic sensors.
CO3: Develop MEMS devices using piezoelectric sensors.
CO4: Analyze different etching techniques and structural materials used for MEMS
CO5: Analyze the polymers for MEMS and design optical MEMS.

Mapping of COs with POs and PSOs

Cos/POs	PO1	PO2	PO3
CO 1	2	1	3
CO 2	2	2	3
CO 3	2	2	3
CO 4	2	1	3
CO 5	2	1	3

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22AEE14 **MACHINE LEARNING** **L T P C**
3 0 0 3

Preamble:
This course provides a basic concept of machine learning. The course gives the theoretical Knowledge on setting hypothesis for pattern recognition

UNIT 1 INTRODUCTION TO MACHINE LEARNING ***9***
Introduction- Components of Learning- Learning Models , Geometric Models, Probabilistic Models, Logic Models, Grouping and Grading- Designing a Learning System, Types of Learning, Supervised, Unsupervised-Reinforcement, Perspectives and Issues, Version Spaces-PAC Learning- VC Dimension.

UNIT 2 SUPERVISED AND UNSUPERVISED LEARNING ***9***
Decision Trees: ID3, Classification and Regression Trees-Regression: Linear Regression, Multiple Linear Regression, Logistic Regression- Neural Networks: Introduction, Perception, Multilayer Perception, Support-Vector Machines: Linear and Non-Linear, Kernel Functions, K Nearest Neighbors-n Introduction to clustering, K-means clustering, K-Mode Clustering.

UNIT 3 ENSEMBLE AND PROBABILISTIC LEARNING ***9***
Model Combination Schemes, Voting, Error-Correcting Output Codes, Bagging: Random Forest Trees, Boosting: Adaboost, Stacking. Gaussian mixture models - The Expectation-Maximization (EM) Algorithm, Information Criteria, Nearest neighbour methods - Nearest Neighbour Smoothing, Efficient Distance Computations: the KD-Tree, Distance Measures.

UNIT 4 REINFORCEMENT LEARNING AND EVALUATING HYPOTHESES ***9***
Introduction-Learning Task: Q Learning, Non deterministic Rewards and actions, temporal-difference learning, Relationship to Dynamic Programming, Active reinforcement learning- Generalization in reinforcement learning- Motivation, Basics of Sampling Theory: Error Estimation and Estimating Binomial Proportions, The Binomial Distribution, Estimators, Bias, and Variance

UNIT 5 GENETIC ALGORITHMS ***9***
Motivation, Genetic Algorithms: Representing Hypotheses, Genetic Operator, Fitness Function and Selection-An Illustrative Example-Hypothesis Space Search- Genetic Programming,-Models of Evolution and Learning: Lamarkian Evolution, Baldwin Effect, Parallelizing Genetic Algorithms.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Ethem Alpaydin, ”Introduction to Machine Learning”, MIT Press, Prentice Hall of India, 3rd Edition2014.
2. Mehryar Mohri, Afshin Rostamizadeh and Ameet Talwalkar, ” Foundations of Machine Learning”, MIT Press,2012

REFERENCES:

1. Stephen Marsland ,”MACHINE LEARNING - An Algorithmic Perspective”, Second Edition,2015.
2. CharuC.Aggarwal,“DataClassificationAlgorithmsandApplications”,CRCPress, 2014.

Course Outcomes: Upon completion of the course, students will be able to:
1. Apply Machine Learning techniques that enable to solve real world problems
2. Analyze supervised learning methods and apply appropriate problems
3. Create probabilistic and unsupervised learning models for handling unknown pattern
4. Identify and integrate more than one techniques to enhance the performance of learning
5. Analyze the co-occurrence of data to find interesting frequent patterns

CO-PO Mapping:

Cos/POs	PO1	PO2	PO3
CO 1	1	2	3
CO 2	1	2	3
CO 3	1	2	3
CO 4	1	2	3
CO 5	1	2	3

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22AEE15	WAVELET TRANSFORMS AND THEIR APPLICATIONS	L	T	P	C
		3	0	0	3

Preamble

A wavelet is a mathematical function used to divide a given function or continuous-time signal into different scale components. Usually one can assign a frequency range to each scale component. Each scale component can then be studied with a resolution that matches its scale. A practical application of the Wavelet Transform is analyzing ECG signals which contain periodic transient signals of interest.

UNIT 1 FUNDAMENTALS **9**

Vector Spaces – Properties– Dot Product – Basis – Dimension, Orthogonality and Orthonormality – Relationship Between Vectors and Signals – Signal Spaces – Concept of Convergence – Hilbert Spaces for Energy Signals- Fourier Theory: Fourier series expansion, Fourier transform, Short time Fourier transform, Time-frequency analysis.

UNIT 2 MULTI RESOLUTION ANALYSIS **9**

Definition of Multi Resolution Analysis (MRA) – Haar Basis – Construction of General Orthonormal MRA – Wavelet Basis for MRA – Continuous Time MRA Interpretation for the DTWT – Discrete Time MRA – Basis Functions for the DTWT – PRQMF Filter Banks.

UNIT 3 CONTINUOUS WAVELET TRANSFORMS **9**

Wavelet Transform – Definition and Properties – Concept of Scale and its Relation with Frequency – Continuous Wavelet Transform (CWT) – Scaling Function and Wavelet Functions (Daubechies Coiflet, Mexican Hat, Sinc, Gaussian, Bi Orthogonal)– Tiling of Time – Scale Plane for CWT.

UNIT 4 DISCRETE WAVELET TRANSFORM **9**

Filter Bank and Sub Band Coding Principles – Wavelet Filters – Inverse DWT Computation by Filter Banks – Basic Properties of Filter Coefficients – Choice of Wavelet Function Coefficients – Derivations of Daubechies Wavelets – Mallat's Algorithm for DWT – Multi Band Wavelet Transforms Lifting Scheme- Wavelet Transform Using Polyphase Matrix Factorization – Geometrical Foundations of Lifting Scheme – Lifting Scheme in Z –Domain.

UNIT 5 APPLICATIONS **9**

Wavelet methods for signal processing- Image Compression Techniques: EZW–SPHIT Coding– Image Denoising Techniques: Noise Estimation – Shrinkage Rules – Shrinkage Functions –Edge Detection and Object Isolation, Image Fusion, and Object Detection.

Total : 45 Periods

REFERENCE BOOKS:

1. Rao R M and A S Bopardikar,"Wavelet Transforms Introduction to theory and Applications", Pearson Education, Asia, 2000.
2. L.Prasad and S.S.Iyengar, "Wavelet Analysis with Applications to Image Processing", CRC Press, 1997.
3. J. C. Goswami and A. K. Chan, "Fundamentals of wavelets: Theory, Algorithms and Applications", WileyInterscience Publication, John Wiley & Sons Inc., 1999.
4. M. Vetterli and J. Kovacevic, "Wavelets and subband coding" Prentice Hall Inc, 1995.
5. Soman K P and Ramachandran K I, "Insight into Wavelets From Theory to practice", Prentice Hall, 2004.

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

CO1 Analyze the system based on time and frequency using transform techniques.
CO2 Design the concept of multi resolution analysis using Haar and wavelets.
CO3 Analyze and apply scaling and wavelet functions for the real time applications.
CO4 Derive wavelet coefficients and apply in the design of filter banks.
CO5 Apply wavelet transform for the real-time applications.

Mapping of COs with POs and PSOs

Cos/POs	PO1	PO2	PO3
CO 1	2	3	2
CO 2	2	3	2
CO 3	2	3	2
CO 4	-	3	2
CO 5	2	3	2

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22AEE16 CRYPTOGRAPHY AND INFORMATION SECURITY L T P C
3 0 0 3

Preamble:
A cryptosystem is an implementation of cryptographic techniques and their accompanying infrastructure to provide information security services. A cryptosystem is also referred to as a cipher system. The process of disguising a message in such a way as to hide its substance is encryption. An encrypted message is cipher text. The process of turning cipher text back into plaintext is decryption.

UNIT 1 NETWORK SECURITY CONCEPTS ***9***
Security Concepts: Introduction, The need for security, Security approaches, Principles of security, Types of Security attacks, Security services, Security Mechanisms, A model for Network Security Cryptography Concepts and Techniques: Introduction, plain text and cipher text, substitution techniques, transposition techniques, encryption and decryption, symmetric and asymmetric key cryptography, steganography, key range and key size, possible types of attacks.

UNIT 2 SYMMETRIC AND ASYMMETRIC KEY CIPHERS ***9***
Symmetric key Ciphers: Block Cipher principles, DES, AES, Blowfish, RC5, IDEA, Block cipher operation, Stream ciphers, RC4. Asymmetric key Ciphers: Principles of public key cryptosystems, RSA algorithm, Elgamal Cryptography, Diffie-Hellman Key Exchange, Knapsack Algorithm.

UNIT 3 AUTHENTICATION AND KEY MANAGEMENT ***9***
Cryptographic Hash Functions: Message Authentication, Secure Hash Algorithm (SHA-512), Message authentication codes: Authentication requirements, HMAC, CMAC, Digital signatures, Elgamal Digital Signature Scheme. Key Management and Distribution: Symmetric Key Distribution Using Symmetric & Asymmetric Encryption, Distribution of Public Keys, Kerberos, X.509 Authentication Service, Public – Key Infrastructure

UNIT 4 SECURITY PROTOCOLS ***9***
Transport-level Security: Web security considerations, Secure Socket Layer and Transport Layer Security, HTTPS, Secure Shell (SSH) Wireless Network Security: Wireless Security, Mobile Device Security, IEEE 802.11 Wireless LAN, IEEE 802.11i Wireless LAN Security

UNIT 5 E-MAIL AND IP SECURITY ***9***

E-Mail Security: Pretty Good Privacy, S/MIME IP Security: IP Security overview, IP Security architecture, Authentication Header, Encapsulating security payload, Combining security associations, Internet Key Exchange Case Studies on Cryptography and security: Secure Multiparty Calculation, Virtual Elections, Single sign On, Secure Inter-branch Payment Transactions, Cross site Scripting Vulnerability.

TOTAL : 45 PERIODS

REFERENCES:

1. William Stallings, "Cryptography and Network Security, Principles and Practice", Pearson, 7th Edition, 2017.
2. Behrouz A Forouzan, "Cryptography and Network Security", Tata Mcraw Hill, 2009.
3. Behrouz A Forouzan, Debdeep Mukhopadhyay, “Cryptography and Network Security”, Mc-GrawHill, 3rd Edition,2009.
4. Jason Albanese and Wes Sonnenreich, “Network Security Illustrated” Mcraw Hill Publishers, 2003
5. Mark Stamp, “Information Security, Principles, and Practice”, Wiley India, 2nd Edition,2009.

After the completion of this course, students will be able to

CO1 Encrypt and decrypt the cipher and simple text and generate the key for encryption.

CO2 Develop symmetric and Asymmetric key Ciphers to ensure the information security for client and server.

CO3 Analyze the current legal issues towards web authentication, key Management and Distribution to overcome the security problems.

CO4 Compare and Analyze Web security protocols and Firewalls for the quality of service over different wireless network standards.

CO5 Generate and distribute a PGP key pair and use the PGP package to send an encrypted e - Mail message.

Mapping of COs with POs and PSOs

Cos/POs	PO1	PO2	PO3
CO 1	1	2	2
CO 2	3	2	2
CO 3	3	2	2
CO 4	3	3	2
CO 5	3	3	2

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22AEE17	DSP INTEGRATED CIRCUITS	L	T	P	C
		3	0	0	3

Preamble

DSP Integrated Circuits to familiarize the concept of DSP and DSP algorithms and introduce Multirate systems and finite word length effects. This course gives the knowledge about DSP processor architectures and the synthesis of the processing elements

UNIT 1 INTRODUCTION TO DSP INTEGRATED CIRCUITS 9

Introduction to Digital signal processing -Sampling of analog signals- Selection of sample frequency, Signal processing systems- Frequency response,-Transfer functions,-Signal flow graphs -Filter structures-Adaptive DSP algorithms, DFT-The Discrete Fourier Transform FFT Algorithm, Image coding- Discrete cosine transforms, Standard digital signal processorsc-Application specific ICs for DSP, DSP systems, DSP system design-Integrated circuit design.

UNIT 2 DIGITAL FILTERS AND FINITE WORD LENGTH EFFECTS 9

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

UNIT 3 DSP ARCHITECTURES 9

DSP system architectures- Standard DSP architecture-Harvard and Modified Harvard architecture- Ideal DSP architectures-Multiprocessors and multi computers- Systolic and Wave front arrays- Shared memory architectures.

UNIT 4 SYNTHESIS OF DSP ARCHITECTURES 9

Synthesis: Mapping of DSP algorithms onto hardware, Implementation based on complex PEs, Shared memory architecture with Bit- serial PEs. Combinational & sequential networks- Storage elements – clocking of synchronous systems, Asynchronous systems -FSM

UNIT 5 ARITHMETIC UNIT AND PROCESSING ELEMENTS 9

Conventional number system- Redundant Number system-Residue Number System, Bit-parallel and Bit-Serial arithmetic- Digit Serial arithmetic- CORDIC Algorithm- Basic shift accumulator- Reducing the memory size- Complex multipliers- Improved shift-accumulator-Case Study: DCT and FFT processor

Total : 45 Periods

REFERENCE BOOKS:

1. B.Venkatramani, M.Bhaskar, “Digital Signal Processors”, Tata McGraw-Hill, 2002.
2. John J. Proakis, Dimitris G. Manolakis, “Digital Signal Processing”, Pearson Education, 2002.
3. Keshab Parhi, “VLSI Digital Signal Processing Systems design & Implementation”, John Wiley & Sons, 1999.
4. Lars Wanhammer, “DSP Integrated Circuits”, Academic press, New York, 1999.

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

CO1 Apply DFT and FFT algorithms for Digital Signal Processing applications.
CO2 Apply multi rate concepts into digital filters and analyze finite word length effects.
CO3 Compare DSP architectures.
CO4 Implement the DSP algorithms into processor based on PE, storage elements and memory.
CO5 Design arithmetic unit and processing elements using bit and digital serial arithmetic.

Mapping of COs with POs and PSOs

Cos/POs	PO1	PO2	PO3
CO 1	3	1	2
CO 2	3	1	2
CO 3	3	1	2
CO 4	3	1	2
CO 5	3	1	2

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22AEE18	OPTICAL SENSORS	L	T	P	C
		3	0	0	3

Preamble

Optical sensors introduce the basic concept and process of optical modulator along with fabrication process of the grating sensor and also acquire the knowledge in applications of interferometer.

UNIT 1 OPTICAL MODULATORS, FABRY-PEROT INTERFEROMETER AND MAGNETIC SENSORS 9

Introduction - Electro optic effect - Bulk modulators - Integrated optical modulators - All-fiber optical modulators - Intensity based and Fabryperot interferometer sensors - Intensity sensors - Band edge temperature sensors - Encoder-based position sensors - Multimode fabry-perot sensors

UNIT 2 GRATING SENSORS 9

Introduction - Theoretical background - Sensors based on relative movement of opposed gratings -Sensors based on grating period modulation - Development status of sensors - Fiber optic grating- Introduction - Fabrication of fiber grating sensors - Single-parameter fiber bragg gratings - Multiparameter fiber grating strain sensors - Applications of multiparameter fiber bragg gratings .

UNIT 3 POLARIZATION, MACH-ZEHNDER AND MICHELSON INTERFEROMETER SENSORS 9

Introduction - Theoretical background of polarization sensors - Sensors based on the photoelastic effect - Sensors based on retardation plates - principle of operation of Mach-Zehnder interferometer - Fiber interferometer configurations - Applications of interferometer sensors.

UNIT 4 DISTRIBUTED FIBER OPTIC SENSORS AND FIBER OPTIC SMART STRUCTURES 9

Introduction - Distributed sensing - Basic principles of sensor multiplexing – Interferometric sensor multiplexing - Fiber Optic Sensors Based on the Sagnac Interferometer and Passive Ring Resonator - Fiber optic sensor systems - Applications of fiber optic smart structures and skins -Example of the application of a fiber optic sensor to smart structures.

UNIT 5 INDUSTRIAL APPLICATIONS AND FIBER OPTIC BIOSENSORS 9

Introduction - Background - Temperature measurement - Pressure measurement - Fluid-level measurement - Flow measurement - Position measurement - Vibration measurement - Chemical analysis - Current-voltage measurement - Important issues for industrial application - Bio sensors: Sensor classes and transducer mechanisms - Biomedical needs for fiber optic biosensors - Historically demonstrated applications - New sensor concepts .

Total : 45 Periods

REFERENCES:

1. Shizhuo Yin, Paul B. Ruffin Francis T.S. Yu, " Fiber Optic Sensors ", CRC Press Taylor & Francis Group, 2nd Edition, 2019.
2. Eric Udd, William B. Spillman, JR. (edited), "Fiber Optic Sensors: An Introduction for Engineers and Scientists", John Wiley & Sons, 2nd Edition, New York, 2011.
3. Matias , Ignacio R. Matias , Satoshi Ikezawa & Jesus Corres “ Fiber Optic Sensors: Current Status and Future Possibilities” Kindle Edition, 1st Edition, 2017.
4. Eric Udd, "Fiber Optic Smart structures", John Wiley, 1995.
5. B.P.Pal, "Fiber Optics in Telecommunication and sensor", Wiley Eastern, 1995.

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

CO1	Demonstrate basic concept and the process of the optical modulator, interferometer and the magnetic sensors.
CO2	Analyze grating sensors and define the single and multi parameter of the Bragg grating.
CO3	Use polarization sensors in the design of optical system.
CO4	Apply fiber optic sensors and use in the applications of the fiber optic smart structure.
CO5	Measure physical measurements using fiber optic biosensors applications and biomedical needs for fiber optic biosensors.

Mapping of COs with POs and PSOs

Cos/POs	PO1	PO2	PO3
CO 1	2	2	2
CO 2	2	2	2
CO 3	2	-	-
CO 4	2	-	-
CO 5	3	2	2

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22AEE19	DSP ARCHITECTURE AND PROGRAMMING	L	T	P	C
		3	0	0	3

Pre-requisites: Nil

Preamble

This Course impart the knowledge of basic DSP concepts and number systems to be used, different types of A/D, D/A conversion errors. It gives the architectural differences between DSP and General purpose processor. It enables the students to learn about interfacing of serial & parallel communication devices to the processor. Implement the DSP & FFT algorithms.

UNIT 1 INTRODUCTION TO DIGITAL SIGNAL PROCESSING 9

Introduction: Digital signal-processing system, discrete Fourier Transform (DFT) and fast Fourier transform (FFT), differences between DSP and other micro processor architecture: Number formats: Fixed point, floating point and block floating point formats, IEEE-754 floating point, dynamic range and precision, relation between data word size and instruction word size: Sources of error in DSP implementations: A/D conversion errors, DSP computational errors, D/A conversion errors, Q-notation.

UNIT 2 ARCHITECTURE OF PROGRAMMABLE DSPs 9

Multiplier and multiplier accumulator, modified bus structures and memory access in PDSP's, multiple access memory- multiport memory- SIMD- VLIW architectures, pipelining-special addressing modes in PDSPs, on-chip peripherals.

UNIT 3 OVERVIEW OF TMS320C54XX PROCESSOR 9

Architecture of TMS320C54XX DSPs, addressing modes, memory space of TMS320C54XX processors. Program control, instruction set and programming, on-chip peripherals, interrupts of TMS320C54XX processors, pipeline operation.

UNIT 4 INTERFACING MEMORY AND I/O PERIPHERALS TO PDSPs 9

Memory space organization,-external bus interfacing signals- memory interface- parallel I/O interface, programmed I/O, interrupts and I/O- direct memory access (DMA).

UNIT 5 IMPLEMENTATIONS OF BASIC DSP ALGORITHMS 9

The Q-notation, convolution- correlation: FIR filters, IIR filters, interpolation filters, decimation filters, an FFT algorithm for DFT filters computation of the signal spectrum.

Total : 45 Periods

REFERENCES:

1. Avtar Singh and S. Srinivasan, "Digital Signal Processing", Thomson Publications, 1st Edition, 2004.
2. Lapsley "DSP Processor Fundamentals, Architectures & Features", S. Chand & Co, 1st Edition, 2000.
3. B. Ventakaramani and Bhaskar, "Digital Signal Processors Architecture Programming and Applications", Tata McGraw-Hill, 1st Edition, 2006.
4. Jonatham Stein, "Digital Signal Processing" John Wiley, 1st Edition, 2000.
5. Sen M. Kuo&WoonSergGan, "Digital Signal Processors Architectures, Implementation and Application", Pearson Practice Hall, 1st Edition, 2013.
6. Ifeachor E. C and Jervis B. W, "Digital Signal Processing: A practical approach", Pearson Education, PHI/, 2nd Edition, 2002.

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

CO1 Convert the data into the suitable DSP processor implementation.

CO2 Distinguish between the architectural features of General purpose processors and DSP processors.

CO3 Write the program for TMS320C54xx devices using addressing modes of DSP TMS320C54XX.

CO4 Organize memory and interface with I/O peripherals

CO5 Design and implement basic DSP algorithms.

Mapping of COs with POs and PSOs

Cos/POs	PO1	PO2	PO3
CO 1	2	2	2
CO 2	2	2	2
CO 3	2	-	-
CO 4	-	2	2
CO 5	2	2	2

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22AEE20	DEEP LEARNING	L	T	P	C
		3	0	0	3

Pre-requisites: Nil

Preamble

Deep learning covers the basics of machine learning, neural networks, Model for deep learning technique and the various optimization and generalization mechanisms are included. It also deals with dimensionality reduction and optimization techniques with real time application

UNIT I INTRODUCTION **9**

Introduction to machine learning- Linear models (SVMs and Perceptrons, logistic regression)- Intro to Neural Nets: What a shallow network computes- Training a network: loss functions, back propagation and stochastic gradient descent- Neural networks as universal function approximates

UNIT 2 DEEP NETWORKS **9**

History of Deep Learning- A Probabilistic Theory of Deep Learning- Backpropagation and regularization, batch normalization- VC Dimension and Neural Nets-Deep Vs Shallow Networks- Convolution Networks- Generative Adversarial Networks (GAN), Semi-supervised Learning.

UNIT 3 DIMENTIONALITY REDUCTION **9**

Linear (PCA, LDA) and manifolds, metric learning - Auto encoders and dimensionality reduction in networks - Introduction to Convnet - Architectures – AlexNet, VGG, Inception, ResNet - Training a Convnet: weights initialization, batch normalization, hyperparameter optimization.

UNIT 4 OPTIMIZATION AND GENERALIZATION **9**

Optimization in deep learning– Non-convex optimization for deep networks- Stochastic Optimization- Generalization in neural networks- Spatial Transformer Networks- Recurrent networks, LSTM - Recurrent Neural Network Language Models- Word-Level RNNs & Deep Reinforcement Learning - Computational & Artificial Neuroscience

UNIT 5 CASE STUDY AND APPLICATIONS **9**

Imagenet- Detection-Audio Wave Net-Natural Language Processing Word2Vec - Joint Detection- Bioinformatics- Face Recognition- Scene Understanding- Gathering Image Captions

Total : 45 Periods

REFERENCES:

1. Ian J. Goodfellow, YoshuaBengio and Aaron Courville, “Deep Learning”, MIT Press, 2017.
2. Francois Chollet, “Deep Learning with Python”, Manning Publications, 2018
3. Cosma Rohilla Shalizi, “Advanced Data Analysis from an Elementary Point of View”, 2015.
4. Deng & Yu, “Deep Learning: Methods and Applications”, Now Publishers, 2013.
5. Michael Nielsen, “Neural Networks and Deep Learning”, Determination Press, 2015

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

CO1 Analyze mathematical, statistical and computational challenges of building neural networks.
CO2 Implement various concepts of deep learning models
CO3 Implement different dimensional reduction techniques in networks
CO4 Analyze optimization and generalization in neural networks using deep learning
CO5 Implement deep learning concepts for real time applications.

Mapping of COs with POs and PSOs

Cos/POs	PO1	PO2	PO3
CO 1	2	1	3
CO 2	2	2	3
CO 3	2	1	3
CO 4	2	1	3
CO 5	2	2	3

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22AEE21	SYSTEM ON CHIP DESIGN	L	T	P	C
		3	0	0	3

Pre-requisites: Embedded System Design

Preamble

System on Chip integrates the complete multi-processor systems on a single die at core of most embedded computing system. The functional and nonfunctional performance of the system in designing process and processor is analyzed effectively.

UNIT 1 INTRODUCTION TO THE SOC APPROACH 9

System Architecture- Processor Architectures- Memory and Addressing- Review of Moore's law and CMOS Scaling- Comparison on System-on-Board- System-on-Chip- and System-in-Package- benefits of system-on-chip integration in terms of cost- power- and performance.

UNIT 2 PROCESSORS AND SYSTEM ON CHIP DESIGN PROCESS 9

SOC Design- Platform-Based SoC Design- Multiprocessor SoC and Network on Chip- Low-Power SoC Design- System Architecture and Complexity SoC Design-Processor Selection for SOC- Robust Processors- Vector Processors and Vector Instructions extensions- VLIW Processors- Superscalar Processors.

UNIT 3 EMBEDDED MEMORIES 9

Overview of SOC external memory- Internal Memory- Scratchpads and Cache memory- Cache Organization- Cache data- Write Policies- Types of Cache- Split – I- and D – Caches- Multilevel Caches- Virtual to real translation - SOC Memory System- memory interaction- Cache coherence- MESI protocol and Directory-based coherence

UNIT 4 NOC-BASED SOC 9

Network on Chip (NOC)- Architecture of NoC -Network on Chip topologies-Mesh-based NoC.- Routing in an NoC- Packet switching and wormhole routing- NoC Protocol Design- Low-Power Design for NoC- Low-Power Network on Chip Protocol- Low-Power Channel Coding- Low-Power Clocking- Low-Power Signaling- On-Chip Serialization.

UNIT 5 NOC / MPSOCS 9

Real Chip Implementation-BONE Series- Industrial Implementations--Intel's Tera-FLOP 80-Core NoC- MPSoCs- Techniques for designing MPSoCs- Performance and flexibility for MPSoCs design-Case study: A Low Power Open Multimedia Application Platform for 3G Wireless

Total : 45 Periods

REFERENCES:

1. Furber, "ARM System-on-Chip Architecture", Pearson Education India, 2014.
2. Michael J. Flynn and Wayne Luk, "Computer System Design System-on-Chip", Wiely India Pvt. Ltd., 2011.
3. Hoi-junyoo Kangmin Lee and Jun Kyoungkim, "Low power NOC for high performance SoC Design", CRC Press, 2008.
4. Vijay Madisetti and Chonlameth Arpnikanondt, "A Platform-Centric Approach to System-on-Chip (SOC) Design", Springer, 2010.
5. Sudeep Pasricha and NikilDutt, "On-Chip Communication Architectures: System on Chip Interconnect", Morgan Kaufmann Publishers, 2008.
6. Ahmed Amine Jeraya and Wayne Wolf, "Multiprocessor System On chip", Morgan Kauffmann, 2010.
7. James K. Peckol, "Embedded Systems: A Contemporary Design Tool", Wiley Student Edition, 2009.

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

CO1 Demonstrate the function of components in architecture and addressing mode.
CO2 Analyze the processor and its architecture used for SoC design.
CO3 Interface memories, cache, MESI protocol of SoC design.
CO4 Analyze on network on chip topologies, routing, low power design protocol and signaling.
CO5 Design on real chip implementation in BONE series, FLOP and MPS platform.

Mapping of COs with POs and PSOs

Cos/POs	PO1	PO2	PO3
CO 1	2	1	3
CO 2	2	1	3
CO 3	2	1	3
CO 4	3	1	3
CO 5	3	1	3

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22AEE22 **AUTOMOTIVE ELECTRONICS** **L T P C**
3 0 0 3

Preamble:

Automotive Electronics is designed for imparting knowledge and skills required to meet the evolving needs of the automotive industry in its quest for integrating technological advances in hardware, power electronics, cyber systems and machine intelligence. It is intended for engineering professionals working in the automotive embedded systems and controls, automotive cyber systems, electric and hybrid architectures, autonomous vehicles, machine intelligence and related industries desiring to broaden their knowledge horizons as they fulfill their career aspirations by contributing to this growing field.

UNIT 1 INTRODUCTION ***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 2 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 3 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 4 AUTOMOTIVE TRANSMISSION CONTROL SYSTEMS ***9***

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

UNIT 5 ELECTRONIC 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.

TOTAL(L:45) : 45 PERIODS

REFERENCES:

1. Allan Bonnick, “Automotive Computer Controlled Systems”, Butterworth- Heinemann, Elsevier, Indian Edition, 2011.
2. James Halderman, “Automotive Electricity and Electronics” Pearson, 2016.
3. Robert Bosch, “Automotive Electronic Handbook”, John Wiley Sons, 2004.
4. Ronard K Jurgen, “Automotive Electronics Handbook”, 2nd Edition, McGraw-Hill, 1999.
5. William B Ribbens, “Understanding Automotive Electronics”, 5th edition - Butter worth Heinemann Woburn, 1998.

PO-CO Mapping: 22AEE22 – AUTOMOTIVE ELECTRONICS

After the completion of this course, students will be able to

CO1	Acquire an overview of automotive components, subsystem and basics of engine management systems.
CO2	Enumerate the principles, application, construction and specification of different sensors usable in typical automobile by suitable testing.
CO3	Demonstrate the working and operational characteristics generators, regulators and rectifiers of charging system.
CO4	Describe the electronic engine control systems problem with appropriate diagnostic tools in an automobile related to instrumentation.
CO5	Design and implement the electronics that attribute the reliability, safety and smartness to automobiles and providing idea on future automotive electronic systems.

Mapping of COs with POs and PSOs

Cos/POs	PO1	PO2	PO3
CO 1	2	2	
CO 2	2	2	
CO 3	2	2	
CO 4	2	2	
CO 5	2	2	

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22AEE23 SIGNAL INTEGRITY FOR HIGH SPEED DESIGN

L	T	P	C
3	0	0	3

Preamble

With constant progress of electronic technologies, increasing high frequency of clock in digital system, increasingly short rising edge time, PCB system has become a system structure with high performance, far more than just a platform supporting components. From the perspective of electric performance, the interconnection between high-speed signals is no longer expedite or transparent and the influence of interconnection between leads on high-speed PCB and board plane properties can't be neglected any longer. It deals with problems of signal integrity including reflection, crosstalk, delay, calling & impedance matching caused by high-speed signal interconnection and ensures the quality of signal transmission.

UNIT 1 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 2 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 Lossles models.

UNIT 3 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 4 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 5 CLOCK DISTRIBUTION AND CLOCK OSCILLATORS 9

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

Total : 45 Periods

REFERENCES:

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

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

CO1 Measure transmission line and wave propagation parameter..
CO2 Find the solution to Improve the signal transmission characteristics.
CO3 Identify sources affecting the speed of digital circuits.
CO4 Introduce methods to improve the signal transmission characteristics
CO5 Design a clock signal, Clock Distribution and Clock Oscillators

Mapping of COs with POs and PSOs

Cos/POs	PO1	PO2	PO3
CO 1	3	2	-
CO 2	3	2	1
CO 3	3	2	1
CO 4	3	2	-
CO 5	3	2	-

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

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22AEE24	PCB DESIGN	L	T	P	C
		3	0	0	3

Pre-requisites: Semiconductor devices and circuits

Preamble

This course explains different types of Printed Circuit Boards, design concepts, steps to fabricate PCB, different tools for PCB design and component tracing in assembled PCBs

UNIT 1 INTRODUCTION TO PACKAGING &PCB DESIGN 9

Types of Components used in PCB- Terminologies in PCB Designing- Types of PCBs: Single Sided (Single Layer), Double Layer and Multi-Layer PCB- Flexible PCB- Materials for PCB manufacturing.

UNIT 2 PCB DESIGN CONSIDERATIONS 9

PCB Design flow- General, Mechanical and Electrical considerations, Design rules for Analog, Digital and High frequency circuits. Electromagnetic interference/ Compatibility (EMI/ EMC).

UNIT 3 DESIGN AND SIMULATION OF PCB 9

Electronic Design Automation (EDA) Tools – Single layer PCB, Two layer PCB- Circuit Design and simulation- creating footprint, placement and routing- Generating Gerber file for single layer PCB.

UNIT 4 INTRODUCTION PRINTED CIRCUIT BOARD PRODUCTION TECHNIQUES 9

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 5 PCB DESIGN FOR EMI/EMC 9

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

Total : 45 Periods

TEXT BOOK:

1. Khandpur R.S., "Printed Circuit Board: Design, Fabrication, Assembly and Testing", McGraw Hill Education Pvt. Ltd., 1st Edition, New Delhi, 2017.

REFERENCES:

1. Mehta S.D, "Electronic Product Design", S Chand Publications,1st Edition, New Delhi, 2011.
2. Clyde Coombs, "Printed Circuits Handbook", McGraw Hill Professional, 6th Edition, New Delhi, 2007.

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

CO1 Design single layer and multilayer PCB.
CO2 Check and measure the electrical limitations and design rules.
CO3 Develop the Design and Simulation process of PCB
CO4 Demonstrate the PCB production Techniques
CO5 Demonstrate the PCB design for EMI/EMC considering NEMA and IPC standards.

Mapping of COs with POs and PSOs

Cos/POs	PO1	PO2	PO3
CO 1	3	2	-
CO 2	3	2	-
CO 3	2	3	1
CO 4	2	3	1
CO 5	2	1	3

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22AEE25	BIOMEDICAL SIGNAL PROCESSING	L	T	P	C
		3	0	0	3

Pre-requisites: Digital Signal Processing

Preamble

Biomedical Signal Processing provides an introduction to the basic concepts of signal processing methods and to acquire knowledge of analysis of systems using various transformation techniques. It provides students to realize about different filter structure and also to develop algorithm for signal processing. This course gives an in-depth analysis of the origin and processing of bioelectrical signals in humans. The analysis is related to differentiating between healthy and pathological conditions and emerges from clinical situations and issues.

UNIT 1 FUNDAMENTALS OF SIGNAL PROCESSING 9

Sampling and aliasing- Signal reconstruction- Signal conversion systems- Circular convolution Correlation- Autocorrelation – Cross correlation- FFT-decimation in time algorithm- Decimation in Frequency algorithm.

UNIT 2 DIGITAL FILTER DESIGN 9

Basics of filter, Design of IIR filter-impulse invariant method – Bilinear Transformation Method Warping and pre-warping effect- Frequency transformation, Characteristics of FIR filter, FIR filter design using windowing techniques- Rectangular window – Hamming window – Hanning window.

UNIT 3 WAVELET AND SPEECH PROCESSING 9

Introduction to wavelets- Scaling and wavelet functions- Multi resolution analysis, Filter Banks and Discrete wavelet transform- and wavelets based signal processing and applications- Denoising, compression.

UNIT 4 ANALYSIS OF BIO-SIGNALS 9

Introduction to biomedical signals (ECG,EEG,PCG and EMG), Objectives of biomedical signal analysis, Filtering for removal of artifacts, Adaptive noise canceller; Cancellation of 60 Hz interference in electrocardiography, Time Domain filters, frequency domain filters, wiener filtering, adaptive filters , Illustration of the Problem with Case-studies, canceling method to enhance fetal ECG monitoring, Event detection, Heart rate variability-analysis.

UNIT 5 DIGITAL IMAGE PROCESSING 9

Digital Image fundamentals- Image enhancement in spatial domain- Image enhancement in frequency domain, Image restoration- Image segmentation and wavelets based image processing.

Total : 45 Periods

TEXT BOOKS:

1. John G. Proakis and Dimitris G.Manolakis, “Digital Signal Processing – Principles, Algorithms & Applications”, Pearson Education / Prentice Hall, Fourth Edition, 2007.
2. Rangaraj M Rangayyan, ”Biomedical Signal Analysis A Case Study Approach”, John Wiley, 2002.

REFERENCES:

1. Rafael C. Gonzalez and Richard E. Woods,“Digital Image Processing”, Pearson Education Hall,4thedition 2018.
2. Willis J. Tompkins, Biomedical Digital Signal Processing, (Prentice Hall). illustrated, reprint,1993
3. A Primer, C. Sidney Burrus, Ramesh A. Gopinath and Haitao Guo (Prentice Hall),Introduction to Wavelets and Wavelet Transforms, Upper Saddle River, N.J. : Prentice Hall, c1998

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

CO1 Convert the signal to frequency domain using transforms.
CO2 Design of Digital FIR/IIR filters.
CO3 Apply Wavelet functions to medical signals and images.
CO4 Acquire the biomedical signals and analyze the bio signals artifacts in biomedical signals.
CO5 Enhance the image and extract the features from the images.

Mapping of COs with POs and PSOs

Cos/POs	PO1	PO2	PO3
CO 1	3	2	-
CO 2	3	2	-
CO 3	3	2	1
CO 4	3	2	1
CO 5	3	2	-

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22AEO01	HARDWARE SOFTWARE CO-DESIGN	L	T	P	C
		3	0	0	3

OBJECTIVES:

1. To impart the concepts of Co-design in Embedded system.
2. To familiarize the different IDEs available.
3. To provide a comparative study of various tools for Co-design.

UNIT 1 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- Multiprocessor Architectures - Comparison of Co- Design Approaches - Models of Computation- Requirements for Embedded System Specification.

UNIT 2 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 3 HARDWARE/SOFTWARE CO-SYNTHESIS 9

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

UNIT 4 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 5 DESIGN SPECIFICATION AND VERIFICATION 9

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

TOTAL: 45 PERIODS

REFERENCES:

1. Ralf Niemann, “Hardware/Software Co-Design for Data Flow Dominated Embedded Systems”, Kluwer Academic Pub, 1998.
2. Jorgen Staunstrup, Wayne Wolf, “Hardware/Software Co-Design: Principles and Practice”, Kluwer Academic Pub, 1997.
3. Giovanni De Micheli, Rolf Ernst Morgon, “Reading in Hardware/Software Co-Design”, Kaufmann Publishers, 2001.

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

1.Analyze and explain the control-flow and data-flow of a software program and a cycle-based hardware description
2.Evaluate the partition of simple software programs into hardware and software components, and create appropriate hardware-software interfaces to reflect this partitioning
3.Identify performance bottlenecks in a given hardware-software architecture and optimize them by transformations on hardware and software components.
4.Design prototype for target architectures and based on the architecture specialization techniques
5.Make use of simulation software to co-simulate software programs with cycle-based hardware descriptions

Mapping of COs with POs and PSOs

Cos/POs	PO1	PO2	PO3
CO 1	3	3	3
CO 2	3	3	3
CO 3	3	3	3
CO 4	3	3	3
CO 5	3	3	3

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

21AEO02 **EMBEDDED C** **L T P C**
3 0 0 3

Preamble:
This course provides a basic concept of embedded C programming for microcontroller. The course gives the knowledge for anyone interested in working with embedded systems, as it provides the necessary tools and techniques to develop efficient, real-time applications for a wide range of industries.

UNIT 1 INTRODUCTION ***9***

Why C in Embedded– ANSI Standard – Fundamentals of C- Conditional statements - Loops- Functions- Arrays –strings – Storage classes- Structure & unions – Enumerated Data types –Bit Operations.

UNIT 2 EMBEDDED PROGRAMMING ***9***

Pointers–Dynamic Memory Allocation – File Handling Concepts – compiler in practical –Data Structures – concepts and real time exposure – Industry coding standards –Objects/Executable file format – Debugging large programs.

UNIT 3 HIGH LEVEL PROGRAMMING ***9***

Cross compiler –Linking - Debugging – Memory models – Library Reference – Pragma Directive – Emulators –simulators – working with flash memory

UNIT 4 EMBEDDED SYSTEMS ***9***

Interrupts and Interrupt Handling - Timers and Counters - Real-time Operating Systems (RTOS) and Scheduling - Peripheral Interfacing- Communication Protocols for Embedded Systems - UART, SPI, I2C and CAN.

UNIT 5 PROJECT DEVELOPMENT USING EMBEDDED C ***9***

A/D & D/A converter – Stepper motor and DC motor - RTC: DS1307 – ADC: MCP3201 – IR-ZIGBEE – GSM – GPS – USB – MMC – SD – Ethernet MAC – CAN protocol.

TOTAL : 45 PERIODS

REFERENCES:

1. Mark Siegesmund, “Embedded C Programming: Techniques and Applications of C and PIC MCUS”, Newnes, First Edition, 2014.
2. Michael Barr, “Programming Embedded Systemsin C and C++”, O'Reilly Media, Inc, First Edition, 2001.
3. Larry O'Cull, Richard H. Barnett, and Sarah Cox, “Embedded C Programming and the Atmel AVR”, Cengage Learning India Private Limited, 3rd Edition, 2007.
4. James W Grenning, “Test Driven Development for Embedded C”, O′Reilly; 1st edition, 2011.
5. Richard H. Barnett, “Embedded C Programming and the Microchip PIC”, Cengage Learning, Inc, 2003.

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

1. Understand the basic programming concepts such as variables, data types, operators, expressions, and control structures.
2. Demonstrate knowledge how to program microcontrollers using Embedded C. They should be able to write code that interacts with peripheral devices, handles interrupts, and manages memory.
3. Demonstrate knowledge how to use debugging and testing tools to identify and fix errors in their code and able to design and perform tests to validate the functionality of their embedded systems.
4. Develop knowledge on communication protocols such as UART, SPI, I2C, and CAN for embedded system development.
5. Design and implement embedded systems that meet specific requirements of customers.

Mapping of COs with POs and PSOs

COs/POs	PO 1	PO 2	PO 3
CO 1	2	2	3
CO 2	2	2	3
CO 3	2	2	3
CO 4	2	2	3
CO 5	2	2	3
Mapping Average	2	2	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) "-"No correlation