Vision of the Institution:

To create a centre for imparting technical education of international standards and conduct research at the cutting edge of technology to meet the current and future challenges of technological development.

Mission of the Institution:

To create technical manpower for meeting the current and future demands of industry: To recognize education and research in close interaction with industry with emphasis on the development of leadership qualities in the young men and women entering the portals of the Institute with sensitivity to social development and eye for opportunities for growth in the international perspective.

Vision (Department of ECE)

To create a centre for imparting technical education of international standards and conduct research at the cutting edge of Electronics & Communication technology to meet the current and future challenges of technological development.

Mission (Department of ECE)

To create technical manpower for meeting the current and future demands of industry and academia: to recognize education and research in close interaction with electronics & communication & related industry with emphasis on the development of leadership qualities in the young men and women entering the portals of the institute with sensitivity to social development and eye for opportunities for growth in the international perspective.

Program Outcomes

1) **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2) **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3) **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4) **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5) **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6) **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7) **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8) **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9) **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10) **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11) **Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12) **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes

1) Capability to analyse and design emerging electronic devices, circuits, and subsystems.
2) Ability to apply knowledge of modern and advanced tools to design hardware/software solutions.
3) Capability to analyse and design advanced wired and wireless communication systems.

CURRICULUM FIRST YEAR

First Semester COMMON to ALL Branches

S.No.	Semester	Course Code	Course Name	Category	Type	Credit	L-T-P
1	I		Technical Communication (Basic/ Advanced)	PC	Theory	2	2-0-0
2	I		Mathematics I	PC	Theory	4	3-1-0
3	I		Physics	PC	Theory	3	2-1-0
4	I		Computer Science and Programming	PC	Theory	2	2-0-0
5	I		Basics of Electronics Engg.	PC	Theory	2	2-0-0
6	I		Basics of Electrical Engg.	PC	Theory	2	2-0-0
7	I		Language Lab (Basic/ Advanced)	PC	Lab	1	0-0-2
8	I		Electrical Engineering Lab	PC	Lab	1	0-0-2
9	I		Electronics Engineering Lab	PC	Lab	1	0-0-2
10	I		Programming Lab	PC	Lab	1	0-0-2
11	I		Physics Lab	PC	Lab	1	0-0-2
					Total	20	

First Semester Dept. of ECE

S.No.	Semester	Course Code	Course Name	Category	Type	Credit	L-T-P
1	I	22ECT101	Electronic Measurement and Instrumentation	PC	Theory	3	3-0-0
2	I	22ECT102	Circuits and Networks	PC	Theory	3	3-0-0
					Total	6	

Second Semester COMMON to ALL Branches

S.No.	Semester	Course Code	Course Name	Category	Type	Credit	L-T-P
1	II		Basic Economics	PC	Theory	2	2-0-0
2	II		Mathematics II	PC	Theory	4	3-1-0
3	II		Chemistry	PC	Theory	3	2-1-0
4	II		Engineering Drawing and Sketching	PC	Theory	2	1-1-1
5	II		Environmental Science and Ecology	PC	Theory	2	2-0-0
6	II		Introduction to Mechanical systems	PC	Theory	2	2-0-0
7	II		Product Realization through Manufacturing	PC	Lab	1	0-0-2
8	II		Chemistry Lab	PC	Lab	1	0-0-2
					Total	17	

Second Semester Dept. of ECE

S.No.	Semester	Course Code	Course Name	Category	Type	Credit	L-T-P
1	II	22ECT103	Electronic Devices and Circuits	PC	Theory	3	3-0-0
2	II	22ECT104	Signals and Systems	PC	Theory	3	3-0-0
3	II	22ECP105	Electronic Devices and Circuits Lab	PC	Lab	1	0-0-2
4	II	22ECP106	Signals and Systems Lab	PC	Lab	1	0-0-2
					Total	8	

CURRICULUM SECOND YEAR

Third Semester Dept. of ECE

S.No.	Semester	Course Code	Course Name	Category	Type	Credit	L-T-P
1	III	22ECT201	Analog Communication	PC	Theory	3	3-0-0
2	III	22ECT202	Data Structures & Algorithms	PC	Theory	3	3-0-0
3	III	22ECT203	Digital Logic Design	PC	Theory	3	3-0-0
4	III	22ECT204	Electro-magnetic Field Theory	PC	Theory	3	3-0-0
5	III	22ECT205	Linear Integrated Circuits	PC	Theory	3	3-0-0
6	III	22ECT206	Operating System Concepts	PC	Theory	3	3-0-0
7	III	22ECP207	Analog Communication Lab	PC	Lab	1	0-0-2
8	III	22ECP208	Data Structures & Algorithms Lab	PC	Lab	2	0-0-4
9	III	22ECP209	Digital Logic Design Lab	PC	Lab	1	0-0-2
10	III	22ECP210	Linear Integrated Circuits Lab	PC	Lab	1	0-0-2
11	III	22ECP211	Operating System Concepts Lab	PC	Lab	1	0-0-2
					Total	24	

Fourth Semester Dept. of ECE

S.No.	Semester	Course Code	Course Name	Category	Type	Credit	L-T-P
1	IV	22ECT212	Analog CMOS IC	PC	Theory	3	3-0-0
2	IV	22ECT213	Computer Architecture	PC	Theory	3	3-0-0
3	IV	22ECT214	Digital Communication Systems	PC	Theory	3	3-0-0
4	IV	22ECT215	Digital Signal Processing	PC	Theory	3	3-0-0
5	IV	22ECT216	Microwave Engineering	PC	Theory	3	3-0-0
6	IV	22ECT217	Technical Documentation	PC	Theory	1	1-0-0
7	IV		Control Systems Engineering	PLEAS	Theory	3	3-0-0
8	IV	22ECP218	Analog CMOS IC Lab	PC	Lab	1	0-0-2
9	IV	22ECP219	Digital Communication Systems Lab	PC	Lab	1	0-0-2
10	IV	22ECP220	Digital Signal Processing Lab	PC	Lab	1	0-0-2
11	IV	22ECP221	Microwave Engineering Lab	PC	Lab	1	0-0-2
12	IV	22ECS222	Technical Report Writing & Presentation	PC	Seminar	1	0-0-2
					Total	24	

CURRICULUM THIRD YEAR

Fifth Semester Dept. of ECE

S.No.	Semester	Course Code	Course Name	Category	Type	Credit	L-T-P
1	V	22ECT301	Antenna & Wave Propagation	PC	Theory	3	3-0-0
2	V	22ECT302	Digital CMOS IC	PC	Theory	3	3-0-0
3	V	22ECT303	Embedded Systems	PC	Theory	3	3-0-0
4	V	22ECT304	Microprocessors	PC	Theory	3	3-0-0
5	V	22ECT305	VLSI Testing & Testability	PC	Theory	3	3-0-0
6	V	22ECP306	Antenna & Wave Propagation Lab	PC	Lab	1	0-0-2
7	V	22ECP307	Digital CMOS IC Lab	PC	Lab	1	0-0-2
8	V	22ECP308	Embedded Systems Lab	PC	Lab	1	0-0-2
9	V	22ECP309	Microprocessors Lab	PC	Lab	1	0-0-2
10	V	22ECP310	Project Lab I	PC	Lab	3	0-0-6
					Total	22	
11	V		HONS 1:	PE	Theory	3	3-0-0
12	V		HONS 2:	PE	Theory	3	3-0-0
13	V		Minor 1:	PE	Theory	3	3-0-0
14	V		Minor 2:	PE	Theory	3	3-0-0
			Earn 6 Credits HONS/Minor		Total	28	
15	V	22ECT801	Universal Human Values & Professional Ethics	Audit	Theory	2	2-0-0

Sixth Semester Dept. of ECE

S.No.	Semester	Course Code	Course Name	Category	Type	Credit	L-T-P
1	VI	22BMT302	Management Principles for Engineers	PC	Theory	3	3-0-0
2	VI	22ECT311	Neural Networks & Fuzzy Logic	PC	Theory	3	3-0-0
3	VI	22ECT312	Optical Communication Systems	PC	Theory	3	3-0-0
4	VI	22ECT313	Satellite & Radar Engineering	PC	Theory	3	3-0-0
5	VI	22ECT314	Wireless & 5G communication	PC	Theory	3	3-0-0
6	VI		Computer & Network Security	PLEAS	Theory	3	3-0-0
7	VI	22ECP315	Neural Networks and Fuzzy Logic Lab	PC	Lab	1	0-0-2
8	VI	22ECP316	Optical Communication Systems Lab	PC	Lab	1	0-0-2
9	VI	22ECP317	Wireless & 5G communication Lab	PC	Lab	1	0-0-2
10	VI	22ECP318	Project Lab II	PC	Lab	2	0-0-4
					Total	23	

11	VI		HONS 3:	PE	Theory	3	3-0-0
12	VI		HONS 4:	PE	Theory	3	3-0-0
13	VI		Minor 3:	PE	Theory	3	3-0-0
14	VI		Minor 4:	PE	Theory	3	3-0-0
			Earn 6 Credits HONS/Minors		Total	29	

CURRICULUM FOURTH YEAR

Seventh Semester Dept. of ECE

S.No.	Semester	Course Code	Course Name	Category	Type	Credit	L-T-P
1	VII		Programme Elective 1	PE	Theory	3	3-0-0
2	VII		Programme Elective 2	PE	Theory	3	3-0-0
3	VII		Programme Elective 3	PE	Theory	3	3-0-0
4	VII		Open Elect 1:/MOOCS#	OE	Theory	3	3-0-0
5	VII	22ECD402	Minor Project	PC	Project	3	0-0-6
6	VII	22ECI401	Training Seminar	PC	Lab	2	0-0-4
					Total	17	
7	VII		HONS 5:*	PE	Theory	3	3-0-0
8	VII		HONS 6:*	PE	Theory	3	3-0-0
9	VII		Minor 5:*	PE	Theory	3	3-0-0
10	VII		Minor 6:*	PE	Theory	3	3-0-0
			Earn 6 Credits HONS/OTH SP.		Total	23	

Eighth Semester Dept. of ECE

S.No.	Semester	Course Code	Course Name	Category	Type	Credit	L-T-P
1	VIII		Programme Elective 4	PE	Theory	3	3-0-0
2	VIII		Programme Elective 5	PE	Theory	3	3-0-0
3	VIII		Programme Elective 6	PE	Theory	3	3-0-0
4	VIII	22ECD403	Major Project	PC	Project	6	0-0-12
5	VIII		Open Elect 2:/MOOCS#	OE	Theory	3	3-0-0
					Total	18	
7	VIII		HONS 5:*	PE	Theory	3	3-0-0
8	VIII		HONS 6:*	PE	Theory	3	3-0-0
9	VIII		Minor 5:*	PE	Theory	3	3-0-0
10	VIII		Minor 6:*	PE	Theory	3	3-0-0
			Earn 6 Credits HONS/OTH SP.		Total	24	

Important Instructions

1) (*) Indicated subject can be taken in either VII/ VIII Semester.
2) The department elective list is attached as a separate sheet.
3) One Semester Industrial Internship is permitted for students either in VII/VIII Semester.
4) Waiver in internship will be given only for departmental program electives and open

electives for maximum 16 credits.

5) One Credit Courses will be offered by the department in addition to above credits.
6) (#) In exceptional cases, MOOCS courses can be allowed in lieu of OPEN Electives 1 and 2 with due permission from DUGC. MOOCS courses should preferably be chosen from NPTEL/SWAYAM/EDX or other reputed having proctored examination. The course approval and evaluation would be moderated by DUGC with respective faculty guide having freedom of evaluating upto 50% of the total weightage.
7) A student of plain BTech may be allowed to choose electives from any one or more of the Tables (programme electives, Honors' baskets)
8) A honors student can choose programme electives from any other one or more Tables except her/his own Honors
9) All courses of M.Tech. would be available to students as Program Elective

Seventh and Eighth Semester Program Elective List, Dept. of ECE

Each subject is 3 Credit (L-T-P as 3-0-0)

Sl. No.	Course Code	Course Name
1		GRAPH THEORY
2		ARTIFICIAL INTELLIGENCE & EXPERT SYSTEMS
3		ADVANCED ERROR CONTROL CODES
4		IMAGE PROCESSING
5		CAD ALGORITHMS FOR VLSI PHYSICAL DESIGN
6		CAD ALGORITHMS FOR SYNTHESIS OF VLSI SYSTEMS
7		SYSTEM LEVEL DESIGN & MODELLING
8		PROBABILITY THEORY & STATISTICS
9		ADVANCED MICROPROCESSORS & MICRO-CONTROLLERS
10		COMPUTER NETWORKS
11		ADV. MICROWAVE ENGG
12		DESIGN OF MICROSTRIP ANTENNA
13		ADVANCED ANTENNA SYSTEMS
14		MICROWAVE INTEGRATED CIRCUITS
15		POWER ELECTRONICS
16		SEMICONDUCTOR OPTO-ELECTRONICS
17		MEMORY DESIGN & TESTING
18		ELECTRONIC MANUFACTURING TECHNOLOGY
19		FORMAL VERIFICATION OF DIGITAL HARDWARE & EMBEDDED SOFTWARE
20		PARALLEL COMPUTING ARCH
21		BIO-MEDICAL ENGINEERING
22		CURRENT-MODE ANALOG SIGNAL PROCESSING
23		OPTICAL CODES AND APPLICATIONS
24		ADAPTIVE SIGNAL PROCESSING
25		VLSI SIGNAL PROCESSING ARCHITECTURES
26		FPGA PHYSICAL DESIGN
27		VLSI TECHNOLOGY
28		INFORMATION THEORY & CODING

29		SYSTEM DESIGN USING FPGAs
30		INSTRUMENTATION & CONTROL
31		WIRELESS AND MOBILE ADHOC NETWORKING
32		CRYPTOGRAPHY
33		DESIGN OF MIC AND MMIC'S
34		ADVANCED MOBILE SYSTEMS
35		SMART AND PHASED ARRAY ANTENNA DESIGN
36		ADVANCED TOPICS IN COMMUNICATION
37		PHOTONIC INTEGRATED DEVICES AND SYSTEMS
38		EMI/EMC
39		WIRELESS SENSOR NETWORKS
40		COMPUTATIONAL ELECTROMAGNETICS
41		ADVANCED PHOTONIC DEVICES AND COMPONENTS
42		TELECOMMUNICATION TECHNOLOGY AND MANAGEMENT
43		ADVANCED NETWORKING ANALYSIS
44		ADVANCED DIGITAL SIGNAL & IMAGE PROCESSING
45		MICROELECTRONIC DEVICES AND CIRCUITs
46		ADVANCED COMPUTER ARCHITECTURE
47		MICRO AND NANO ELECTRO MECHANICAL SYSTEMS
48		SYNCHRONOUS & ASYNCHRONOUS SEQUENTIAL CIRCUITS
49		ESTIMATION AND DETECTION
50		RF INTEGRATED CIRCUITS
51		PATTERN RECOGNITION AND MACHINE LEARNING
52		QUANTUM COMPUTING
53		PHOTONIC SWITCHING
54		SYSTEM LEVEL DESIGN & MODELLING
55		FUNDAMENTALS OF PHOTONICS
56		FOUNDATIONS OF MACHINE LEARNING
57		FOUNDATIONS OF DATA SCIENCE
58		ADVANCED SEMICONDUCTOR DEVICES & CIRCUITS
59		QUANTUM MECHANICS FOR ELECTRONICS ENGINEERING
60		EMBEDDED SoC & CYBER PHYSICAL SYSTEMS
61		MEDICAL ENGINEERING & SYSTEMS
62		MIXED SIGNAL IC DESIGN
	All courses of M.Tech. would be available to students as Program Elective	

HONORS AND MINOR SPECIALIZATION

A. The students will have the option to choose from a basket of multiple sub-domains within the parent department (through Honors) or sub-domains of departments other than the parent department (Minor Specialization).

B. Requirements for Honors and Minor Specialization programs

   i. Honors and Minor programs start from V Semester.

ii. Minimum CGPA requirements for registration shall be 7.50 at the end of IV semester. Students of a department will be allowed to register for Honors program offered by their parent department, while students of a department will be allowed to register for Minor program offered by any other department.

iii. Number of additional credits shall be 18 with 6 courses (or 5 courses + 1 mini project of 3 credits) as prescribed by the department offering Honors/Minor program.

iv. The student is required to plan registration for Honors/Minor program courses, in order to complete all the six courses by the end of VIII semester.

v. Maximum number of students enrolled in any course of a Minor program shall be 30. The allotment of students in the minor program shall be on the basis of CGPA.

vi. The student will not be allowed to continue/register for Honors/ Minor specialization if his/her CGPA falls below 7.50. In case, his/her CGPA improves to 7.50 or higher in subsequent semester(s), he/she may be allowed to continue.

vii. Students should be prepared to write more than one exam in a day.

C. After successful completion of the requirements of the Honors program, the student will be awarded a degree in "name of the discipline" with "Honors" (e.g. Bachelor of Technology in Civil Engineering with Honors or Bachelor of Technology in Mechanical Engineering with Honors etc.).

D. After successful completion of the requirements of the Minor program, the student will be awarded a degree in "name of the discipline" with minor specialization in "name of the minor specialization" (e.g. Bachelor of Technology in Electrical Engineering with Minor Specialization in Environmental Engineering or Bachelor of Technology in Computer Science and Engineering with Minor Specialization in Quantum Mechanics etc.).

Table-I: MINOR in Electronics and Communication Engineering

The student has to do 6 courses. The (*) indicated two subjects can be taken in either VII/VIII semester considering the provision for one semester industrial internship.

S.No.	Semester	Course Code	Course Name	Category	Type	Credit	L-T-P
1	V		Analog Communication		Theory	3	3-0-0
2	V		Digital Logic Design		Theory	3	3-0-0
3	VI		Signals and Systems		Theory	3	3-0-0
4	VI		Electronic Devices and Circuits		Theory	3	3-0-0
5	VII*		Linear Integrated Circuits		Theory	3	3-0-0
6	VII*		Wireless and 5G Communication		Theory	3	3-0-0
7	VIII*		Digital Communication Systems		Theory	3	3-0-0
8	VIII*		Embedded Systems		Theory	3	3-0-0

Honors offered by Department of Electronics and Communication Engineering

1) In all these honors courses the student has to do 6 courses. The (*) indicated two subjects can be taken in either VII/VIII semester considering the provision for one semester industrial internship.

Table-II Honors in Machine Learning and Signal Processing

S.No.	Semester	Course Code	Course Name	Category	Type	Credit	L-T-P
1	V		Modeling, Optimization and Transforms		Theory	3	3-0-0
2	V		Multirate Signal Processing		Theory	3	3-0-0
3	VI		Medical Engineering and Systems		Theory	3	3-0-0
4	VI		Computer Vision		Theory	3	3-0-0
5	VII*		Reduced order modeling, Optimization and Machine Intelligence		Theory	3	3-0-0
6	VII*		VLSI Signal Processing Architecture		Theory	3	3-0-0
7	VII*		Mini Project on Machine Learning and Signal Processing		Practical	3	0-0-6
8	VIII*		Adaptive Signal Processing		Theory	3	3-0-0
9	VIII*		Advanced Digital Signal and Image Processing		Theory	3	3-0-0
10	VIII*		Pattern Recognition and Machine Learning		Theory	3	3-0-0
11	VIII*		Mini Project on Machine Learning and Signal Processing		Practical	3	0-0-6

Table-III Honors in VLSI Design

S.No.	Semester	Course Code	Course Name	Category	Type	Credit	L-T-P
1	V		CAD ALGORITHMS FOR VLSI PHYSICAL DESIGN		Theory	3	3-0-0
2	V		CAD Algorithms for Synthesis of VLSI Systems		Theory	3	3-0-0
3	VI		Digital System Design & FPGA		Theory	3	3-0-0
4	VI		Formal Verification of Digital Hardware & Embedded Software		Theory	3	3-0-0
5	VII*		Micro-& Nano- electro-mechanical Systems (MEMS & NEMS)		Theory	3	3-0-0

6	VII*		Mixed Signal IC Design		Theory	3	3-0-0
7	VII*		Nanotechnology & Emerging Applications		Theory	3	3-0-0
8	VIII*		System Level Design & Modelling		Theory	3	3-0-0
9	VIII*		VLSI SIGNAL PROCESSING ARCHITECTURES		Theory	3	3-0-0
10	VIII*		VLSI Technology		Theory	3	3-0-0
11	VIII*		Quantum Computing		Theory	3	3-0-0
12	VIII*		Mini Project on VLSI Design		Practical	3	0-0-6

Tabel IV Honors in Embedded & Intelligent Systems

S.No.	Semester	Course Code	Course Name	Category	Type	Credit	L-T-P
1	V		Advanced Embedded software design		Theory	3	3-0-0
2	V		Advanced Microcomputer Systems & Interfacing		Theory	3	3-0-0
3	VI		CAD Algorithms for Synthesis of VLSI Systems		Theory	3	3-0-0
4	VI		Computer vision		Theory	3	3-0-0
5	VII*		Formal Verification of Digital Hardware & Embedded Software		Theory	3	3-0-0
6	VII*		Pattern Analysis & Machine Intelligence		Theory	3	3-0-0
7	VII*		Reduced order Modeling, Optimization & Machine intelligence		Theory	3	3-0-0
8	VIII*		Embedded SoC Design		Theory	3	3-0-0
9	VIII*		Quantum Computing		Theory	3	3-0-0
10	VIII*		Internet of Things & IoT		Theory	3	3-0-0
11	VIII*		Mini Project on Embedded Systems		Practical	3	0-0-6

Tabel V Honors in Advanced Communication Engineering

S.No.	Semester	Course Code	Course Name	Category	Type	Credit	L-T-P
1	V		Mathematical Modeling and Simulation for Communication Engineering Systems		Theory	3	3-0-0
2	V		Advanced Digital Communication Systems		Theory	3	3-0-0

3	VI		Advanced Antenna Engineering		Theory	3	3-0-0
4	VI		Advanced Mobile and Wireless Networking		Theory	3	3-0-0
5	VII*		Advanced Microwave Engineering		Theory	3	3-0-0
6	VII*		Advanced Optical Communication Systems		Theory	3	3-0-0
7	VIII*		Advanced Error Control Codes		Theory	3	3-0-0
8	VIII*		Computational Electromagnetics		Theory	3	3-0-0
9	VIII*		Mini Project on Communication Engineering		Practical	3	0-0-6

Exit Options

A. Students will have following exit options:

Table VI: Exit options and eligibility condition

S. No.	Exit option with	Eligibility Condition
1	Diploma Certificate	After successfully completing all courses of I to IV semesters or The student has earned 100 credits through graded courses
2	B.Sc. (engg.) Degree	After successfully completing all courses of I to VI semesters or The student has earned 142 credits through graded courses
3	B.Tech. Degree	After successfully completing all courses of I to VIII semesters

B. Maximum duration of completing a UG program shall be 6 years (12 semesters) from initial registration excluding semester withdrawals, if the student has not exercised any exit option and has completed his registration in every semester.

C. Maximum duration of completing a UG program shall be 8 years (16 semesters) from initial registration excluding semester withdrawals, for students who have exercised any exit option given in Table 1 above.

SYLLABUS FIRST YEAR

FIRST SEMESTER
SUBJECTS

Course Name : Basic Electronics Engineering
Course Code :
Credits : 2 (L-T-P : 2-0-0)

Syllabus:

Module I: Analog Electronics

Diode Circuits: Introduction to diodes, Current components in diode, Zener diode and applications. Half -wave and full -wave rectifiers & their analysis, comparison of bridge and center -tap rectifier, clipping & clamping circuits. (7)
Transistors: Bipolar Junction Transistor, Current components in transistor, transistor construction, various configurations (CE, CB. CC) and characteristics (Input and Output) of BJT configurations. The transistor as an amplifier and switch, Introduction to MOSFETs, Construction, characteristics and working principles of MOSFETs (depletion type MOSFET and Enhancement type MOSFET). (7)
Operational Amplifiers: Introduction, ideal and practical operational amplifiers, open and closed loop configurations, Applications of operational amplifiers. (4)

Module II: Digital Electronics

Digital Gates and Functions: Introduction to number systems and binary arithmetic, Logic Gates and universal gates, Boolean algebra, SOP & POS forms of a Boolean function, simplification of logical functions using Karnaugh map. (4)
Digital Circuits: Half and full adder, subtractor, multiplier, encoders, decoders, multiplexers, demultiplexers. (4)

Important Text Books/ References

Basic Electronics and linear Circuits, N N Bhagava, TMH
Integrated Electronics, Millman Halkias, TMH.
Electronic Devices and Circuit, David A. Bell, Oxford
Electronic Devices and Circuit Theory, R. L. Boylestad, Pearson Education
Digital Circuits and Design, S Salivahanan, Vikas Publishers
Digital Electronics, Moris-Mano, PHI

Course Code: ECP102
Course Title: Electronics Engineering Lab
Credits: 1 (0 0 2)

PREREQUISITE
None

COURSE OBJECTIVE(s)

To know about the working and operation of Multimeter, DSO, Function Generator and Power Supply.
To experimentally verify the diode characteristics
To analyze various diode applications and outputs of related circuits.

COURSE OUTCOMES :

CO1 To be able to know about various electronic instruments
CO2 To be able to generate and analyze the various waveforms on DSO
CO3 To be able to verify and analyze the diode characteristic
CO4 To be able to analyze the applications of diode

COURSE ASSESSMENT

The Course Assessment (culminating to the final grade), will be made up of the following three components;
S. No. Component Weightage
a) Continuous lab-based evaluation 50%
b) Mid-semester evaluation 20%
c) End-semester evaluation 30%

LIST OF EXPERIMENTS

1. Study of various electronic instruments such as Multimeter, DSO, Function Generator and Power Supply.
2. To observe sine, square and triangular waveforms on the DSO and to measure amplitude and frequency of the waveforms.
3. Familiarization of Electronics Components such as: - Resistor, Capacitor, Diode, Transistor, LED, Photodiode, Phototransistor, IC and also test them with the help of Multimeter.
4. To obtain V-I characteristics of PN junction diode.
5. To obtain V-I characteristics of Zener diode.
6. To observe waveform at the output of half wave rectifier with and without capacitor filter and also measure its DC voltage, DC current and ripple factor.
7. To observe waveform at the output of center tapped full wave rectifier with and without capacitor filter and also measure its DC voltage, DC current and ripple factor.
8. To observe waveform at the output of full wave bridge rectifier with and without capacitor filter and also measure its DC voltage, DC current and ripple factor.
9. To observe waveforms at the output of various clipper circuits.
10. To observe waveforms at the output of various positive and negative clamper circuits.

Course Name : Circuits and Networks
Course Code :
Credits : 3 (L-T-P : 3-0-0)

<u>Syllabus:</u>

Methods of Network Analysis: Mesh and node variable analysis; Star Delta transformation; Steady state analysis of AC circuits, Characteristics of the sinusoid: Average, peak and effective values, Impedance concept, Active, reactive and complex power, Power factor, Q of coils and capacitors, Series and parallel resonances, Series Parallel reduction of AC/DC circuits, Network Theorems (Superposition, Thevenin's, Norton's, Maximum Power Transfer, Reciprocity, Compensation, Tellegen's) in AC/DC circuits.

Two Port Networks Parameters: Open circuit impedance Z parameters, short circuit admittance Y parameters, Hybrid h parameters, Chain parameters ABCD and g parameters, Image Impedances, T and pie network, Relationship between different two port network, Interconnection of two-port network: cascade, series, parallel, series-parallel and parallel-series connections, Indefinite admittance matrix and applications.
Steady State & Transient Analysis: DC and sinusoidal response of R-L-C circuits, Laplace transforms and its properties, inverse transforms, initial and final value theorems, use of transfer function in network analysis. State Equations for Networks: Basic consideration in writing state equations, order of complexity, Formulation of state equations, Solutions of state equations, State transition matrix. Frequency domain analysis of RLC circuits, Poles & Zeros, Driving Point Function, Amplitude and Phase Response.
Passive Filters: Classification, Constant-K filters, m-Derived T-Section, Band pass filter, Band elimination filter, Tunable filter realization.
Network Graphs: Network Matrices, Incidence and Reduced Incidence matrix, Loop Matrix, Fundamental loop matrix, Cut set and cut set matrix, Fundamental cut set matrix, Relationship between network Matrices.

Course Outcomes :
CO1- Is able to understand different networking theorem.
CO2- Is able to understand methods of network matrixes, Incidence and reduced incidence matrix, loop matrix etc.
CO3- Is able to perform two port networks as Z parameter, ABCD parameter, T parameter, Y parameter etc.
CO4- Is able to know about state equation and solution of state equations.

References:

1) M. E. Valkenburg, Network Analysis, PHI, 1995
2) S. Ghosh, Network Theory: Analysis and Synthesis, PHI, 2005
3) T. S. K. Iyear, Circuit Theory, TMG Hill, 1985
4) Del Toro, Principles of Electrical Engg, PHI, 1994
5) A. Sudhakar & Shyammohan S. Palli, Circuits & Networks: Analysis & Synthesis, McGraw Hill, 2015

Course Name : Electronic Measurements and Instrumentation
Course Code :
Credits : 3 (L-T-P : 3-0-0)

Syllabus:

Measurements: Errors & classification.
Analog Ammeters and Voltmeters: PMMC and MI Instruments, Construction, Torque Equation, Range Extension, Effect of temperature,
Analog Wattmeters and Power Factor Meters: Electrodynamometer type wattmeter, power factor meter, Construction, torque equation, active and reactive power measurement in single phase and in three phase.
Analog Energy Meter: Single phase induction type energy meters, construction, Operation, lag adjustments, Max Demand meters/indicators, Measurement of VAH and VARh.
DC and AC Bridges: Measurement of resistance (Wheatstone Bridge, Kelvin's Bridge, Kelvin's Double Bridge), Measurement of inductance, Capacitance (Maxwell's Bridge, Desauty Bridge, Anderson Bridge, Schering Bridge, Wien Bridge).

Instrument Transformers: Current Transformer and Potential Transformer - construction, operation, phasor diagram, errors, testing and applications.
Transducers: Measurement of Temperature, RTD, Thermistors, LVDT, Strain Gauge, Piezoelectric Transducers, Tachometer.
Electronic Instruments: Electronic Display Device, Digital Millimeters, CRO/DSO, measurement of voltage and frequency, Wave Analyzers, Harmonic Distortion Analyzer.

Course Outcomes:

CO1: To understand the working principle of different measuring instruments.
CO2: Analyse the MC, MI and Dynamometer types of measuring instruments, Watt-meters and Energy-meters
CO3: Determine the values of components of circuits using AC and DC bridges
CO4: To know about transformers and transducers for the measurement of temperature, strain and speed

References:

1) J. B. Gupta: A course in Electrical and Electronic Measurements and Instrumentation, 13/E, Kataria and Sons, 2009.
2) U. A. Bakshi, A. V. Bakshi: Electrical Measurements and Instrumentation, Technical Publications, 2009.
3) A. K. Sawhney: A course in Electrical Measurements Electronic Measurements Instrumentation, Edition 11, Dhanpat Rai and Sons, 1996.
4) W.D. Coopers and Helfrick, Modern Electronic instrumentation and Measurements Techniques, Prentice Hall of India Pvt. Ltd, 2002.
5) E.W. Gowlding and F.C.Widdis, Electrical Measurements and Measuring Instruments 5/e, Wheeler Publications 1998.

SECOND SEMESTER

SUBJECTS

Course Name : Signals & Systems
Course Code :
Credits : 3 (L-T-P : 3-0-0)

Syllabus:

- Representation of Signals and Systems: Continuous & discrete time signals, LTI systems and their classification, System modelling using differential and difference equations
- Convolution, Transmission of signals through linear systems
- Analysis of signals: Fourier series, Fourier transforms and their properties
- Fourier Analysis for DTS: Discrete time Fourier series, Discrete time Fourier transform and their properties, DFT and its properties, Fast Fourier Transform
- Laplace transforms, Z-transforms & its properties, ROC, Inversion of Z-transform, application to System Analysis.

Course Outcomes :

CO1. Understand the handling of signals in different domains- time and frequency -through Fourier transforms. Analysis and synthesis of different basic signals to be used in the communication systems.

CO2. Acquire the basic mathematical understanding of the probability theory; methods of converting these results of the probability theory into different form of expressions-distribution and density functions, so as to be useful in the analysis of signals.

CO3. Extend the concepts of probability theory to random processes. Learn to evaluate the different type of estimates generated through the probabilistic methods for use in the analysis of noise.

CO4. After undergoing this course, the student will be able to analyze the different type of signals and noises in communication systems.

References:

1. Oppenheim A.V., Willsky A.S. and Nawab S.H..: Signals and Systems, 2/e, Prentice Hall of India, 1997

2.B.P. Lathi, Modern Digital and Analog. Communication Systems, 3rd ed., Oxford. University Press, 1998

Course Name : Electronic Devices & Circuits
Course Code :
Credits : 3 (L-T-P : 3-0-0)

Syllabus:

Transistor at low frequencies: Graphical Analysis of the CE configuration, Two-Port devices and the hybrid Model, Transistor hybrid model, The h-parameter, Conversion formulas for the parameters of the three transistor Configuration, Analysis of a transistor Amplifier Circuit using h parameters, The Emitter follower, Comparison of transistor amplifier configurations, Linear Analysis of a Transistor Circuit, Cascading Transistor Amplifiers, Simplified Common-Emitter Hybrid Model, Simplified calculations for the Common Collector Configuration, The Common-Emitter Amplifier with an emitter resistance, High input resistance transistor circuits, Multistage amplifier analysis.
Field Effect Transistors: The FET and MOSFET Small-Signal model, The Low-Frequency Common-Source and Common-Drain Amplifiers, The FET as a Voltage-variable Resistor (VVR). High frequency model of BJT: High frequency hybrid-π model of BJT, Common emitter and common collector configurations, Cascade configuration.
Feedback Amplifiers: General Feedback structure, Properties of negative Feedback, Four basic Feedback Topologies, Voltage series, Voltage shunt, Current series, Current Shunt, Effect of Feedback connection on various parameters. Analysis of above topology for BJT and FET. **Oscillators:** Basic principle of sinusoidal oscillator (phase shift, wein bridge), Hartley & Colpitts, Crystal Oscillator, nonlinear/pulse oscillator.

Course Outcomes:
CO1-Understand the modelling of bipolar junction transistors (BJTs), analyse the different amplifier configurations using these transistors models, learn to simplify these models and analyse the different transistor configurations.
CO2-Acquire the basic understanding of the Field effect transistor (FET) and its small signal model, analyse the low frequency configurations of the amplifier using FET. (I/3)
CO3-Understand the high frequency model of the bipolar junction transistors (BJTs) for the different configurations.
CO4-Learn the concept of feedback to stabilize the amplifiers, analyse the different topologies and

synthesise the same using BJTs and FETs (II/3)
CO5-Learn the principles of sinusoidal oscillators. (III/3)

References:

1) Electronic principles, Bolysted.
2) Millman, Halkias, Integrated Electronics- Analog & digital circuits, TMH.
3) Millman, Halkias & S. Jit. Electronics Devices & Circuits, TMH, 2009.
4) Microelectronic Circuits, Sedra Smith, Oxford press, India.
5) Electronic Devices and Circuits, David-A-Bell, Oxford Univ. Press 2008.

SECOND SEMESTER

LABORATORIES

Course Name :Signals & Systems Lab
Course Code :
Credits : 1 (L-T-P : 0-0-2)

List of Experiments

1. Introduction to MATLAB working environment and language fundamentals to create matrices and to do basic mathematical operations.
2. To study the shifting, time reversal and scaling of a signal.
3. To find convolution of two continuous time signals.
4. To generate a periodic square wave using Fourier series.
5. To generate a periodic Triangular waveform using Fourier series.
6. To compute the Fourier Transform of a continuous non-periodic signal (rectangular pulse).
7. To compute the inverse Fourier Transform of a continuous signal defined in frequency domain.
8. To compute the Discrete Time Fourier Transform of a discrete time signal.
9. To perform basic mathematical operations using symbolic computation.
10. To find inverse Z transform of a transfer function.

Course Name : Electronic Devices and Circuits Lab
Course Code :
Credits : 1 (L-T-P : 0-0-2)

List of Experiments

1. To study the Digital Storage Oscilloscope.
2. To observe and draw the Forward and Reverse bias V-I Characteristics of a P-N Junction diode.
3. Plot V-I characteristic of zener diode and study of zener diode as voltage regulator. Observe the effect of load changes and determine load limits of the voltage regulator.
4. Application of Diode as clipper & clamper.
5. Study half wave rectifier and effect of filters on wave. Also calculate theoretical & practical ripple factor, with Filter and without Filter
6. Study center tap rectifier and measure the effect of filter network on D.C. voltage output & ripple

factor.
7. Study bridge rectifier and measure the effect of filter network on D.C. voltage output & ripple factor.
8. To study Wein Bridge Oscillator and observe the frequency effect of Variation in R and C.
9. Study of R.C. phase shift oscillator and observe the effect in R and C oscillator frequency and obtain theoretical and practical value.
10. Plot frequency response curve for single stage amplifier and to determine gain bandwidth product.
11. To draw the input and output characteristics of transistor connected in CE configuration and find h-parameters.

SYLLABUS SECOND YEAR
THIRD SEMESTER
SUBJECTS

Course Name : Analog Communication
Course Code :
Credits : 3 (L-T-P : 3-0-0)

Syllabus:

- Amplitude Modulation: AM, Double Side Band Suppressed Carrier modulation, Single Side Band modulation, Vestigial Side Band modulation, AM receivers, Noise in AM receivers using envelope detection, SNR for coherent reception with SSB and DSBSC modulations, Frequency Division Multiplexing.
- Angle modulation: Frequency modulated & Phase modulated signals, NBFM/WBFM, Multitone FM, De-emphasis in FM, Noise in FM reception.
- Pulse Analog Modulation: Pulse Amplitude Modulation, Pulse time Modulation, Time Division multiplexing, Elements of Pulse Code modulation , Differential PCM, Delta Modulation, Adaptive Delta Modulation.
- Probability Theory & Random Variables : Self, joint & conditional probabilities, Statistically dependent & independent events, Discrete and continuous Random Variables (RV's) , their CDF's and PDF's, Functions of random variables, Joint RVs, Mean values and moments of some pdf's (Binomial, Poisson, Gaussian, Rayleigh, Maxwell), Correlation function and their properties, Random processes.
- Noise Analysis of Communication Systems.

Course Outcomes:
CO1-To familiarize the students about different analog modulation and demodulation schemes
CO2- To understand analog-digital conversion techniques.
CO3- To analyze the performance of different modulation techniques under noise.
CO4- To apply the concept of probability and random processes in analysis of communication systems.
CO5- To perform noise analysis of communication systems

References:
1. Haykin S.: Communication Systems, 2/e, Student Edition, Wiley India, 2007.
2. Oppenheim A.V., Willsky A.S. and Nawab S.H..: Signals and Systems, 2/e, Prentice Hall of India, 1997
3. Tan: Digital Signal Processing; Fundamentals and application, Elsevier

4. B.P. Lathi, Modern Digital and Analog. Communication Systems, 3rd ed., Oxford. University Press, 1998
5. Proakis and M. Salehi, Communication Systems Engineering, 2nd Edition

Course Name : Digital Logic Design
Course Code :
Credits : 3 (L-T-P : 3-0-0)

Syllabus:

Number System and Codes: Weighted Codes/Non Weighted codes, Error Correction/Detection Codes, BCD codes, Fixed point & floating point Number System

Boolean Algebra and Logic Gates: SOP and POS for Truth Table, K'Maps, Tabular method, NAND/NOR Universal Gates, Introduction to logic families

Combination Circuits: Adders, Subtractors, Magnitude comparators, Encoder/Decoders, Muxes/DeMuxes, BCD Adder, Logic Implementation using combinational blocks

Sequential Circuits: FlipFlops, Master-Slave FlipFlop, Type of Counters (Synchronous/Asynchronous), Types Registers, FSM concept, Examples of FSM

PLD Concept and Implementation: Basics of HDL (VHDL/Verilog) , Syntax and Semantics of HDL, Design Style using HDL, Basics of PAL,PLA, PROM, CPLD, FPGA

Course Outcomes:

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

CO1: Understand the concept and design of combinational and sequential (synchronous and asynchronous) digital logic circuits (knowledge)

CO2: Understand the concept of Testing and Testability of digital circuits (Knowledge)

CO3: Design and Implement Algorithmic State Machines (skills)

CO4 : Understand Symmetric and Iterative Circuits (Knowledge)

References:

1. Digital Design by Morris Mano

2. Switching Theory and Finite Automata by Zvi Kohvi

Course Name : Linear Integrated Circuits
Course Code :
Credits : 3 (L-T-P : 3-0-0)

Syllabus:

Operational Amplifiers and its applications: Op-amp and its parameters, Applications of Op-amps as integrator, differentiator, comparator, oscillators, digital-to-analog, analog-to-digital converter, log and antilog, rectifiers etc.

Active Filters: High pass filter, low pass filter, band pass filter, band stop filter, notch filter.

Waveform Generators: Astable Multivibrator, Monostable Multivibrator, Bistable Multivibrator, Schmitt trigger.

Power Amplifiers: Power Amplifier Circuits: Class A, Class B and Class AB output stages, Class A, Class B Push pull amplifiers with and without Transformers.

PLL and 555 Timer: Phase locked loop (PLL): Block diagram, working and its various applications; 555 Timer: Block diagram, working principle and its applications as Bistable, Monostable, and Astable mode.

Course Outcomes:

At the end of the course the student will be able to:
CO1: Understanding different modes of Schmitt trigger
CO2: Implementing circuits with Operational amplifier
CO3: Understanding different types of power amplifiers
CO4: Applying the voltage regulator in different configuration
CO5: Understanding PLL and its usage

References:

1. Sedra/Smith, Microelectronic Circuits, Oxford University Press.
2. L. Schilling and C. Belove, Electronic Circuits, McGraw-Hill.
3. S. Soclof, Applications & Design with analog IC's PH1
4. Jacob-Applications & Design with analog IC's, PH1
5. Coughlin Driscol-Operational Amplifiers & Linear IC's Pearson Education.
6. Millman, Halkias & Parikh. Integrated Electronics- Analog & digital circuits, TMH, 2009.

7. Current literature from reputed journals

Course Name : Data Structures & Algorithms
Course Code :
Credits : 3 (L-T-P : 3-0-0)

Syllabus:

Introduction to data structures: Static and dynamic aspects of memory allocation. Recursion and its applications. Introduction to complexity
analysis, measure and representation.

Algorithms for searching and Sorting: Non-recursive and recursive implementation of searching. Non-recursive and recursive sorting algorithms.

Creation and manipulation of data structures: arrays, stacks, queues and linked lists with static and dynamic memory allocation. Applications.

Creation, manipulation and analysis of trees. Binary search tree algorithms.

Graph problems: Shortest path implementation. Introduction to Max Flow-Min Cut and travelling salesman problem.

Introduction to height balanced trees: AVL and B Trees.

Course Outcomes:

CO1- Is able to grasp core concepts of space & time complexity analysis (knowledge)

CO2- Is able to analyze & design basic algorithms for sorting, searching etc. (knowledge)

CO3- Is able to analyze & solve for computing the order of time complexity of algorithms (Knowledge, skill)

CO4- Is able to learn and code for various search algorithms like divide & conquer, branch & bound, greedy (skills)

References:

1) Kruse R.L., Data Structure and Program Design, PHI.

2) Rivest, Cormen, Introduction to Algorithms, MIT Press

3) Horowitz and Sahni: Data Structure in C++ , Glagotia

4) Ellis Horowitz, Sartaj Sahni, Fundamentals of Data Structures

5) Aaron M. Tenenbaum, Y. Langsam, Moshe J. Augenstein, Data Structures Using C

Course Name : Operating System Concepts

Course Code :

Credits : 3 (L-T-P : 3-0-0)

Syllabus:

Introduction: H/W, S/W and Firmware, Process concepts, operations on processes, suspend and resume, System calls, Interrupts and Signals.

Deadlock and Indefinite Postponement:- Conditions of deadlock, deadlock prevention and avoidance, deadlock detection and deadlock recovery.

Process Scheduling and Synchronization:- Job and Process scheduling, Preemptive and Non-preemptive scheduling, FIFO, RR, SJF, SRT, HRN, etc scheduling techniques. Synchronization: Concepts, locks, and semaphores

Storage management:- Storage management & hierarchy, various strategies, storage allocation, Fixed and variable partitioning, Virtual storage concepts, Block mapping, Paging, Segmentation, Virtual storage management, Page replacement strategies, locality, Demand Paging, Program behaviour.

Case Studies:- UNIX systems, MS-DOS systems and Windows Architecture.

Course Outcomes:

CO1-To understand the objectives , structures and functions of modern operating systems
CO2- To understand the working of processes and threads and their scheduling algorithms
CO3-:To understand the problems of synchronization and deadlock in OS and its various solutions
CO4- To understand the memory and storage handling/allocation methods
CO5-To understand files, its structures, implementation and protection issues

References:

1. Operating system concept--Silberschatz and Galvin- John wiley
2. Operating system - Stalling by phi /pearson
3. Operating system -Tannenbaum by phi /pearsoned
4. An introduction to Operating Systems - H.M. Deitel ,Addison-Wesley Operating system - Godbole (TMH)

Course Name :Electro-magnetic Field Theory
Course Code :
Credits : 3 (L-T-P : 3-0-0)
Syllabus:

Unit I Introduction: Vector Relation in rectangular, cylindrical and spherical coordinate system. Concept and physical interpretation of gradient, Divergence and curl. Green's and Stokes theorems.
Unit II Steady Electric Field: Coulomb's Law, units, Electric field intensity, Relation between E and V, Electric flux and flux density, Gauss law, Boundary conditions: Dielectric-dielectric, Conductor – dielectric, Conductor-free space, scalar and vector potential, electric field in dielectric and conductor, Laplace and Poisson's equations, continuity equation, uniqueness theorem, energy stored in electric fields, equivalence theorem, method of image and numerical solution, energy storage and their applications
Unit III Magnetic field due to steady currents, force between current carrying wires, Ampere's circuit law, Bio-Savart's Law, Magnetic flux density, Stokes theorem, Magnetic static and Vector potential, magnetization vector and its relation to magnetic field, Magnetic boundary condition. Analogy between electric and magnetic fields
Unit IV Time Varying Fields, Faraday's law, Displacement currents and equation of continuity, their physical interpretation, Maxwell's equations, integral & differential form of Maxwell's equation, Time varying fields.
Unit V Uniform plane wave in free space, dielectrics and conductors, skin effect sinusoidal time variations, reflection of UPW, standing wave ratio. Potentials vector and power considerations.

Course Outcomes:

CO1- Apply vector calculus to static electro-magnetic fields in different engineering situation.
CO2- Describe static and dynamic electric and magnetic fields.
CO3- Use boundary conditions for electric and magnetic fields.
CO4- Understand Maxwell equations in different form and apply them to diverse engineering problems.
CO5- Analyze the behaviour of plane waves in different media. Examine the phenomenon of wave propagation and reflection in different media.

References:

1) Elements of Electromagnetics- Matthew N.O. Sadiku, Oxford University Press.
2) Electromagnetics- J.D. Kraus,Tata McGraw Hill
3) Electromagnetic Waves & Radiating Systems- E.C. Jordan & K.G. Balmain, Prentice Hall.
4) Fields and Wave Electromagnetics- David K. Cheng, Pearson.
5) Engineering Electromagnetics-W. H. Haytt, Tata McGraw Hill

THIRD SEMESTER
LABORATORIES

Course Name : Analog Communication Lab
Course Code :
Credits : 1 (L-T-P: 0-0-2)

List of Experiments

1. Basic commands and understanding of MATLAB.
2. To perform amplitude modulation using MATLAB.
3. To study Frequency Modulation (FM).
4. To perform DSB-SC amplitude modulation using MATLAB.
5. To perform Single Side Band Suppressed Carrier (SSB-SC) modulation.
6. Theoretical study of the receiver.
7. To study and analyze the Electromagnetic Spectrum.
8. To design different types of Analog filters and implement the design using MATLAB.
9. To study modulation and demodulation.
10. To study the different communication channels and signals.
11. To perform Frequency Division multiplexing (FDM).
12. To study and generate pulse amplitude modulation (PAM), pulse width modulation (PWM), and pulse position modulation (PPM).

Course Name : Digital Logic Design Lab
Course Code :
Credits : 1 (L-T-P: 0-0-2)

List of Experiments

1. Study of the Digital trainer kit and multi-output power supply.
2. Verify the truth table of AND, OR, NOT, NAND, NOR gates.
3. To derive all basic logic gates using NAND/NOR gates only.
4. To verify the truth table of half-adder and full-adder circuits.
5. To design a 2-bit multiplier and implement it.
6. To design and implement a latch using two NOR gates and verify its truth table.
7. Verify the operation of S-R, D, J-K and T flip-flops.
8. To implement a synchronous up/down counter.
9. To realize the following shift registers using IC7474. (a) SISO (b) SIPO (c) PISO.
10. To realize (a) 4:1 Multiplexer using gates (b) 3-variable function using IC 74151(8:1 MUX).

11. Realize 1:8 Demultiplexer and 3:8 Decoder using IC74138.

Course Name : Linear Integrated Circuits Lab
Course Code :
Credits : 1 (L-T-P: 0-0-2)

List of Experiments

1. To design op-amp in (a) Inverting mode (b)Non-inverting mode
2. To design op-amp as (a) Scalar (b) Summer (c) Voltage follower.
3. To design op-amp as integrator and differentiator.
4. To design opamp as voltage limiter and clipper.
5. To Design low pass filter using op-amp 741 IC
6. To Design high pass filter using op-amp 741 IC
7. To Design oscillator using op-amp- Wein Bridge Oscillator
8. To Design oscillator using op-amp- RC phase shift oscillator
9. To design opamp as log and antilog amplifier.
10. To Design astable multivibrators using 555 timer
11. To Design monostable multivibrators using 555 timer
12. To Design square wave generator using op-amp-741
13. To Design triangular wave generator using op-amp-741
14. Mini projects

All the experiments are performed using Breadboard and LT Spice simulator.

Course Name : Data Structures & Algorithms Lab
Course Code :
Credits : 2 (L-T-P : 0-0-4)

List of Experiments:

Using C language, implement the following programs/ data structures:

1. To find the roots of a quadratic equation for all cases.
2. To find the largest of N integers.
3. To find the factorial of an integer using a) non-recursive b) recursive functions.
4. To calculate the value of nCr.
5. To find the sum and difference of two integers in a single function.
6. To generate first N terms of a Fibonacci series using
   (a) non-recursive (b) recursive functions.
7. To multiply two matrices using a function.

8. To find the transpose of a matrix.
9. To make a structure for students in a class and use it.
10. To implement the problem of Tower of Hanoi.
11. To implement Linear search using a) non-recursive b) recursive functions.
12. To implement Binary search using a) non-recursive b) recursive functions.
13. To implement following sorting algorithms using functions:
    a) Selection b) Insertion c) Bubble
14. To implement functions of a stack using array.
15. To implement Infix to Postfix conversion.
16. To implement functions of a queue using array. (Linear and circular)
17. To implement functions of Linear Linked list using arrays.
18. Implement linked list using Dynamic Memory Allocation
    (a) linear (b) circular (c) doubly (d) multiply-linked
19. To implement quick sort.
20. To implement merge sort.
21. To implement the functions of a binary search tree.
22. To implement Heapsort.
23. To implement functions of string manipulation.
24. To implement the shortest path algorithm.

Course Name : Operating System Concepts Lab
Course Code :
Credits : 1 (L-T-P : 0-0-2)

<u>List of Experiments:</u>

1. To learn the basic commands of Linux- part 1 - file creation, paths, sub-directory, move copy, delete, access rights etc.
2. Learn of editor nano.
3. Learning of editor vi.
4. To learn Windows/ MS-DOS basic commands- file creation, paths, sub-directory, move copy, delete, file attributes etc.
5. To learn Linux commands- part II
6. To learn process creation part-I using system cell fork()
7. To learn process creation part-II - execution of a (new) programme (process) using system cell exec()
8. To learn interprocess communication using pipe, shared memory and implementation of process synchronization algorithms
9. To learn process synchronization- using open MP/ IPC
10. To learn signal handling system calls in Linux

11. To learn concurrent programming in Linux using threads
12. To write solution of a classical synchronization problem using thread and semaphores

SYLLABUS SECOND YEAR

FOURTH SEMESTER
SUBJECTS

Course Name :: Digital Communication Systems
Course Code :
Credits : 3 (L-T-P : 3-0-0)

Syllabus:

Line Codes: On-Off (RZ), Polar (RZ), Bipolar (RZ), on-off (NRZ),-Polar (NRZ) & their Power spectrum density (PSD), HDB coding, B8ZS signaling.
Baseband Pulse transmission: Inter-symbol Interference (ISI) & its Reduction. Techniques, Nyquist criterion for distortionless baseband binary transmission, correlative coding, eye pattern.
Digital Passband transmission: BPSK, BFSK, QPSK, QAM, MSK and M-ary, PSK, M-ary FSK transmitter and receiving systems and their detection , Probability of error, Power spectra, Matched filter. Introduction to Link Budget Analysis.
Spread spectrum Techniques: Spread Spectrum Overview, PN Sequences, DS-spread spectrum & Frequency- hop spread spectrum systems and their analysis, Introduction to W-CDMA and multiuser detection.

Course Outcomes:
Co1- Understanding of different types of modulation and demodulation techniques for digital communication
Co2- To learn the ISI and equalization techniques.
Co3-To analyse different types of channel coding schemes.
Co4-Understanding the performance of different digital communication systems

References:

1) Modern Digital & Analog Comm. systems 3/e B.P. Lathi; Oxford
2) Principles of Comm. Systems., Taub & Schilling, McGraw Hill publications.
3) Digital Comm.- By Proakis (TATA McGraw Hill) publications.
4) Digital Comm.-By Sklar (Pearson Education)
5) Comm. System 3/e Simon Haykin, Wiley Eastern Ltd.

Course Name :: Computer Architecture
Course Code :
Credits : 3 (L-T-P : 3-0-0)

Syllabus:

Single processor- basics of microprocessors,CPU control unit, Register Transfer and Micro-operations, assembler and Instruction set pipeline architecture.

16-bit, 32-bit /64-bit RISC and CISC processors ISA and assembly programming.

Memory organization- memory hierarchy, main memory, associative memory, cache memory, virtual memory, memory management .

Input-output organization- peripheral devices . Bus interface. Data transfer techniques. Direct memory access. I/O interrupts.

Multiprocessors- characteristics of microprocessors. Interconnection structures. Interprocessor arbitration. Digital computer arithmetic- fixed point addition,subtraction, multiplication and division. Decimal arithmetic. Floating point arithmetic.

Course Outcomes:

CO1-To understand the working of basic processor
CO2-To describe the 16,32,64-bit processors ISA (CISC and RISC)
CO3-To understand the memory and its management in computer system
CO4-To understand I/O interface and multiprocessor interconnect and other issues
CO5-To learn the arithmetic(fixed and floating point) algorithms and equivalent circuits
CO6-To write assembly programmes and design memory and arithmetic ckts. (analytically and design issues)

References:

1) Computer System Architecture-M. Morris Mano (PHI)
2) Computer Architecture- A quantitative approach (ARM ed) -Hennessy , Patterson (PHI) Computer Organization -V. Carl. Hamacher (TMH)
3) Computer Organization and Architecture -John P Hayes (McGraw -Hill) Computer Organization and Architecture – William Stallings (Pearson)
4) Computer System Organization-A. S. Tanenbaum (PHI).

Course Name : MICROWAVE ENGINEERING
Course Code :
Credits : 3 (L-T-P : 3-0-0)

Syllabus:

Unit I Introduction of Microwave Electromagnetic spectrum. Microwave signal propagation, Applications of Microwave and Microwave hazards. Transmission line, smith chart
Unit II Review of Maxwell's equation, Rectangular waveguides, characteristics of TE and TM wave in rectangular wave guides, Dominant mode in rectangular waveguide, Introduction to Cylindrical

waveguides, waveguide excitation.

Unit III Microwave resonator, Microwave Network representations. Scattering matrix. S-Matrix for two, three & four port networks such as E-plane tee, H-plane tee, Magic tee, directional coupler and other microwave components.

Unit IV Transit time effect, Tubes for very high frequency limitation of conventional tubes, Reflex klystron, two cavity klystron, Magnetron, Travelling Wave Tube.

Unit V Measurement of VSWR, impedance, frequency, dielectric constant power, attenuation and phase shift.

Course Outcomes :

CO1- Evaluate various parameters of transmission lines

CO2- Analyze modes and dominant mode in rectangular waveguide and cylindrical waveguide.

CO3- Explain and evaluate performance of multiport microwave networks

CO4- Design isolator, basic microwave amplifiers, particularly klystrons, magnetron, basic RF oscillator and mixer models.

CO5- Compute the measurement parameters such as VSWR, impedance, frequency, dielectric constant power, attenuation and phase shift etc related to microwave circuits

References:

1) Introduction to Microwaves -Wheeler G.J., Prentice-Hall
2) Microwave circuits & passive devices- Sisodia and Raghuvanshi, New Age International.
3) Microwave engineering-David M. Pozar, John Wiley & Sons, Inc.
4) Microwave Devices and Circuits- Samuel Y. Liao, Prentice Hall
5) Microwave and Radar Engineering- Kulkarni, McGraw Hill Education

Course Name : Control Systems Engineering

Course Code :
Credits : 3 (L-T-P : 3-0-0)

Syllabus:

Fundamentals of Control System: Concept of open loop and closed loop control systems. Applications of open loop and closed loop systems, Representation of physical system.

Transfer Function: Determination of transfer function by block diagram reduction technique and signal flow graph method.

Time domain Analysis: Time response analysis of first order and second order system: Transient response analysis, steady state error and error constants. Absolute and relative stability, Routh's stability criterion, Root locus method of analysis.

Frequency domain method: Bode plot, Polar plot, Compensator and Nyquist stability criterion.

State variable Approach: Representation of state equations, Relationship between state and differential equations, solution of state equations, state transition matrix. Controllability and observability of control systems.

Course Outcomes:

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

CO1- Ability to analyze the operation and modeling of closed loop feedback systems

CO2- Ability to analyze and compensate the steady- state and transient response of the systems.

CO3- Ability to investigate the stability of control systems

CO4- Ability to analyze control system using state variable technique.

References:

1) I.J. Nagrath & M. Gopal : Control Systems Engineering, III Edition, NAI Pub.
2) Katshuhiko Ogata : Modern Control Engineering, III Edition, PHI.
3) Banjamin C. Kuo : Automatic Control Systems, VII Edition, PHI.

Course Name : Analog CMOS IC
Course Code :
Credits : 3 (L-T-P : 3-0-0)

Syllabus:

Physics of MOS Transistors: Review of current equation, regions of operation, small signal model.

Amplifiers: Common Source, Source follower, Common Gate and Cascode amplifiers, Biasing Techniques.

Current Mirror: Basic Current Mirrors, Cascode Current mirror.

Differential Amplifier: Basic differential Pair, common mode response, CMRR, Differential Pair with MOS load, Active load, Cascode differential amplifier.

Frequency Response of Amplifiers: Miller Effect, Association of Poles with nodes, Frequency Response of all single stage amplifiers.

Feedback: Topologies, Stability and Compensation.

Two Stage OpAmp

Course Outcomes :

CO1-Understand the operation of MOSFET and its small signal model. (Cognitive- Understanding)
CO2-Analyze and design amplifiers, current mirrors and differential amplifiers. (Skills- Analyze)
CO3-Understand the significance of different biasing techniques and apply them aptly to different circuits. (Cognitive- Understanding)
CO4- Comparatively evaluate the frequency response of different single stage amplifiers (Cognitive- Analyze)
CO5- Analyze & design the compensation method of amplifiers for stability.(Skills- Evaluate)

References:

1. Behzad Razavi, Fundamentals of Microelectronics, Second edition, Wiley, 2013,
2. Sedra and Smith, Microelectronics Circuits, Oxford Univ. Press, 2004, Johns and Martin, Analog Integrated Circuit Design, John Wiley & Sons, 2002 AND Allen Holberg, CMOS Analog Integrated Circuit Design: Oxford University Press, 2002.

Course Name : Digital Signal Processing
Course Code :
Credits : 3 (L-T-P : 3-0-0)

Syllabus:

Z-Transform, Inverse Z-Transform, Properties of the Z-Transform, Inversion of the Z-Transforms (by Power Series Expansion, by Partial-Fraction Expansion), Analysis of Linear Time-Invariant Systems in the z-Domain, Response of Systems with rational System Functions, Transient and Steady-State Responses, Causality and Stability.

Frequency-Domain Sampling and Reconstruction of Discrete-Time Signals, The Discrete Fourier Transform, The DFT as a Linear Transformation, Relationship of the DFT to other Transforms, Properties of the DFT: Periodicity, Linearity, and Symmetry Properties, Multiplication of Two DFTs and Circular Convolution, Additional DFT Properties, Linear Filtering Based on DFT.

FFT Algorithms, Direct Computation of the DFT, Radix-2 FFT Algorithms: Decimation-In-Time (DIT), Decimation-In-Time (DIF); Applications of FFT Algorithms: Use of the FFT Algorithm in Linear Filtering and Correlation.

Structure for the Realization of Discrete-Time Systems, Structure for FIR Systems: Direct-Form Structure, Cascade-Form Structures, Structure for IIR Systems: Direct-Form Structures, Signal Flow Graphs and Transposed Structures, Cascade-Form Structures, Parallel-Form Structures.

Design of FIR Filters, Symmetric and Antisymmetric FIR Filters, Design of Linear-Phase FIR Filters by using Windows, Design of Linear-Phase FIR Filters by the Frequency-Sampling Method; Design of IIR Filters from Analog Filters: IIR Filter Design by Impulse Invariance, IIR Filter Design by the Bilinear Transformation

Course Outcomes:

CO1- The basic objective of the course is to introduce and familiarize some important & useful signal

processing techniques such as convolution, Fourier & Z-transform, filter design, structures for FIR and IIR systems.
CO2- Students will develop programming skills for implementing signal processing algorithms using MATLAB.

References:

1) Digital Signal Processing – Principles, Algorithms and Applications by J. G. Proakis and D. G. Manolakis, 4th Edition, Pearson.
2) Digital Signal Processing by A. V. Oppenheim and R. W. Schafer, PHI.
3) Principles of Signal Processing and Linear Systems by B.P. Lathi, Oxford.
4) Digital Signal Processing: A MATLAB-Based Approach by Vinay K. Ingle and John G. Proakis, Cengage Learning.
5) Fundamentals of Digital Signal Processing using MATLAB by Robert J. Schilling and Sandra L. Harris, Cengage Learning.

Course Name : Soft Skills & Personality Development (Audit)

Course Code :
Credits : 3 (L-T-P : 2-1-0)

FOURTH SEMESTER
LABORATORIES

Course Name : Digital Communication Systems Lab
Course Code :
Credits : 1 (L-T-P: 0-0-2)

List of Experiments

1. Study of BPSK Modulation and Demodulation
2. Study of DPSK Modulation and Demodulation
3. Study of QPSK Modulation and Demodulation
4. Study of QAM Modulation and Demodulation
5. Study of ADPCM Modulation and Demodulation
6. Study of Square waveform synthesis
7. Study of Triangular waveform synthesis
8. Study of Saw-tooth waveform synthesis
9. Study of Amplitude-Modulated signal synthesis
10. Simulation of ASK Generation and Detection Scheme
11. Simulation of BPSK Generation and Detection Schemes
12. Simulation of FSK generation and detection scheme
13. Simulation of DPSK, QPSK Generation Schemes
14. Observation (simulation) of signal constellations of BPSK, QPSK and QAM
15. Simulation of linear block coding scheme
16. Simulation of error control using cyclic code
17. Simulation of Convolutional coding scheme
18. Communication link simulations

Course Name :Microwave Engineering Lab
Course Code :
Credits : 1 (L-T-P: 0-0-2)

List of Experiments

1. To study and plot the radiation pattern of $\lambda/2$ Dipole antenna in azimuth plan on log/linear scale on polar plot.
2. To study and plot the radiation pattern of folded Dipole antenna in azimuth plan on log/linear scale on polar plot.

3. To study and plot the radiation pattern of Yagi (4el) antenna in azimuth plan on log/linear scale on polar plot.
4. To study and plot the radiation pattern of Square Loop antenna in azimuth plan on log/linear scale on polar plot.
5. To study and plot the radiation pattern of Helix antenna in azimuth plan on log/linear scale on polar plot.
6. To study and plot the radiation pattern of Micro strip antenna in azimuth plan on log/linear scale on polar plot.
7. To study and plot the radiation pattern of Log Periodic antenna in azimuth plan on log/linear scale on polar plot.
8. To study and plot the radiation pattern of End fire antenna in azimuth plans on Log/linear scale on polar plot.
9. To study and plot the radiation pattern of Broadside antenna in azimuth plans on Log/linear scale on polar plot.
10. To study resonant and non-resonant antenna and calculate the resonant frequency and estimate the VSWR of antenna.
11. To study the spectrum analyzer.

Course Name :Analog CMOS IC Lab
Course Code :
Credits : 1 (L-T-P: 0-0-2)

List of Experiments

1. To find 3dB frequency & gain for different values of load & W/L ratio in case of common source stage with resistive load using N-MOSFET.
2. To find 3 dB frequency & gain for different values of load & W/L ratio for common source stage with resistive load using P-MOSFET.
3. Simulation & analysis of diode connected load common source amplifier. Find edge of triode region & gm1, gm2, gain & 3 dB frequencies.
4. DC analysis of source follower using resistive & current source load.
5. AC analysis of common gate amplifiers and calculate input and output impedance.
6. AC analysis of cascade stage amplifier.
7. AC analysis differential amplifier & calculate CMRR.
8. Simulation of basic current mirrors using resistive load using N-MOSFET and P MOSFET.
9. Simulation of cascade current mirrors using resistive load using N-MOSFET and N-MOSFET and P-MOSFET.
10. Simulation of Wilson Current mirror circuit.
11. Mini project

Course Name : Digital Signal Processing Lab
Course Code :

Credits : 1 (L-T-P: 0-0-2)

List of Experiments

1. Write a program to find convolution of two vectors.
2. Write a program to find correlation of two vectors.
3. Write a program to find out circular convolution of two vectors.
4. Write a program to design FIR low pass filter.
5. Write a program to design FIR high pass filter.
6. Write a program to design FIR band pass filter.
7. Write a program to design FIR band stop filter.
8. Write a program to design IIR low pass filter.
9. Write a program to design IIR high pass filter.
10. Write a program to design IIR band pass filter.
11. Write a program to evaluate Discrete Fourier Transform (DFT) of a Signal.
12. Write a program to evaluate Inverse Discrete Fourier Transform (IDFT) of a Signal.
13. Writing a program to apply histogram equalization on an image to improve its brightness.
14. Write a program to compress an image using Discrete Wavelet transform and reconstruct the original image from the compressed image.

Course Name : Technical Documentation
Course Code :
Credits : 1 (L-T-P : 0-0-2)

Syllabus

Introduction: Literature survey – Understanding journal metrics (impact factor, number of citations, h-index, i10 index), Identifying high impact articles, Problem identification, Ethics of publishing.
2 hours

Document Formatting: Advantages of LaTeX, Installation, Package manager, Editors, Typesetting, Classes – Book, Thesis, Article, Slide, Poster, Parts of a document - Chapters, Sections, Items, Fonts, Acronyms, Author kits, Debugging. 8 hours

Figures, Tables, and Equations: Figures, Subfigures, Tables, Types of tables, Spacing in tables, Captions, Equations, Equation arrays, Equation numbering, Labels. 8 hours

Referring articles: Using labels, Citing articles, Bibliography, Bibtex, Styles, Mendeley, JabRef.
4 hours

Artwork: Drawing with LaTeX, Flowcharts in LaTeX, Creating plots with Gnuplot/ Octave/ Matlab, Creating scalable vector graphics with Inkscape, Tikz. 4 hours

Reformatting documents, Reviewing technical documents.
2 hours

References:
World wide web

Similar courses at:

https://www.anadolu.edu.tr/en/academics/faculties/course/99276/documentation-with-latex/content (3 credit) Anadolu University, Turkey

https://www.training.cam.ac.uk/course/ucs-latex (2 half days) Cambridge, UK http://uva-fnwi.github.io/LaTeX/ (4 weeks) University of Amsterdam, Netherlands

https://www.bath.ac.uk/guides/getting-started-with-latex-an-introductory-course-for-doctoral-students/
(6 Hours) University of Bath, UK

Outcomes – The students will be able to
1. Identify high impact literature, understand the importance of ethical publishing
2. Use LaTeX to compile technical documents containing quality figures, tables, and equations.
3. Use bibtex for automatic referencing.
4. Create quality graphics.

SYLLABUS THIRD YEAR

FIFTH SEMESTER
SUBJECTS

Course Name :Microprocessors
Course Code :
Credits : 3 (L-T-P : 3-0-0)

Syllabus:

Introduction to 8085 Microprocessor: Block diagram, pins & their description, demultiplexing of buses, control signals & flags. Introduction to 8085 based microcomputer system.
Instruction & Timings: Instruction classification, instruction formats, addressing modes, Instruction timings and status.
Programming & Programming Techniques of the 8085: 8085 instruction set, data transfer instructions, arithmetic, logic & branch operations. Rotate & compare. Instructions related to stack operations. Looping, counting and indexing, counters & time delays.
Stack and Subroutines: Concept of stack in 8085 and its uses. Subroutines implementation in 8085 assembly language.
Interfacing Concepts: Basic interfacing concepts. Memory Interfacing. Memory mapped and peripheral mapped I/O. Interrupts in 8085 and their features. A/D and D/A converters. Interfacing A/D and D/A converters.
Programming & interfacing of Support ICs: Interfacing of 8155, 8255, 8279 with 8085.
Introduction to other support chips: Introduction of 8253 and 8259A with 8085 microprocessor. Direct memory Access: Basic concepts of DMA techniques and introduction DMA controller 8257.

Course Outcomes:

CO1- Is able to grasp the functioning of 8085 microprocessor.
CO2- Is able to appreciate the significance of demultiplexing for different application.
CO3- Is able to understand the development of codes with different data transfer methods.
CO4- Is able to understand the concept of memory mapping and I/O mapping.
CO5- Is able to understand the different interfacing ICs as 8255/8257/8259.
CO6- Design algorithm and writing the codes for different arithmetic, logical and control units.

References:

1) J.L. Antonakos, An Introduction to the Intel Family of Microprocessors, Pearson, 1999.
2) Barry B. Brey,The Intel Microprocessors, (7/e),Eastern Economy Edition , 2006.
3) M.A. Mazidi & J.C. Mazidi Microcontroller and Embedded systems using Assembly & C. (2/e), Pearson Education,

Course Name :Antenna & Wave Propagation
Course Code :
Credits : 3 (L-T-P : 3-0-0)

Syllabus:

1) Antenna Fundamentals :- Effective Aperture, Gain, Bandwidth, Beamwidths, Radiation Resistance, Polarization, Radiation Pattern, Reciprocity Theorem, Effective Length, Antenna Temperature

2) Antenna Arrays and Frequency Independent Antennas : Collinear, Broadside, Endfire Arrays, Binomial, Dolph Tschebyscheff Arrays, Spiral and Log Periodic Antennas
3) UHF and Microwave Antennas: Parabolic Reflector, Horn , Lens Antennas, Microstrip Antennas and Arrays, Analysis and feed networks
4) Radio Wave Propagation: Ground, Space and Sky wave Propagation, Ionospheric Layers, Analysis of EM wave Propagation in ionic medium, MUF and skip zone
5) Antennas for 5G Communication, Wave Propagation Models in Mobile Environment

Course Outcomes :

CO1- To learn the fundamentals of antenna and its characteristics.
CO2- To understand the concepts of Antenna Arrays, UHF & Microwave Antennas, Microstrip antennas.
CO3- To understand the radio wave propagation techniques.
CO4- To understand the free space communication, Reflection models, Diffraction model & Indoor propagation models.

References:

1. Antennas Theory and Analysis - By Balanis (Wiley Publisher)
2. Antennas and Wave Propagation by K. D. Prasad
3. Antennas by Krauss (TMH Publisher)

Course Name : VLSI Testing &Testability
Course Code :
Credits : 3 (L-T-P : 3-0-0)

Syllabus:

Introduction to Digital Testing: Introduction, Test process and Test economics,- Functional vs. Structural Testing Defects, Errors, Faults and Fault Modeling (Stuck at Faults, Bridging Faults, transitor fault, delay fault), Fault Equivalence, Fault Dominance, Fault Collapsing and Checkpoint Theorem
Fault Simulation and Testability Measures: Circuit Modelling and Algorithms for Fault Simulation, Serial Fault Simulation, Parallel Fault Simulation, Deductive Fault Simulation, Concurrent Fault Simulation, Combinational SCOAP Measures and Sequential SCOAP Measures, Critical Path Tracing
Combinational Circuit Test Pattern Generation: Introduction to Automatic Test Pattern Generation (ATPG) and ATPG Algebras, Standard ATPG Algorithms, D-Calculus and D-Algorithm, Basics of PODEM Random, Deterministic and Weighted Random Test Pattern Generation; Aliasing and its effect on Fault Coverage.
PLA Testing, Cross Point Fault Model and Test Generation. Memory Testing- Permanent, Intermittent and Pattern Sensitive Faults
Sequential Circuit Testing and Scan Chains: ATPG for Single-Clock Synchronous Circuits, Use of Nine-Valued Logic and Time-Frame Expansion Methods, Complexity of Sequential ATPG, Scan Chain based Sequential Circuit Testing, Scan Cell Design, Design variations of Scan Chains, Sequential Testing based on Scan Chains, Overheads of Scan Design, Partial-Scan Design Controllability and

Observability Scan Design, BILBO , Boundary Scan for Board Level Testing ; BIST and Totally self checking circuits

Self Repairing circuits and BIST: Introduction to BIST architecture BIST Test Pattern Generation, Response Compaction and Response Analysis, Memory BIST, March Test, BIST with MISR, Neighbourhood Pattern Sensitive Fault Test, Transparent Memory BIST, Totally self checking circuits, Concept of Redundancy, Spatial Redundancy, Time Redundancy, Error Correction Codes. Recent trends in VLSI Testing and Testability

Course Outcomes :

CO1- Distinguish Step Index, Graded index fibers and compute mode volume.
CO2- Explain the Transmission Characteristics of fiber and Manufacturing techniques of fiber/cable.
CO3- Classify the construction and characteristics of optical sources and detectors.
CO4- Discuss splicing techniques, passive optical components and explain noise in optical system.
CO5- Design short haul and long haul Analog/ Digital optical communication system and explain advanced optical transmission systems.

References:

1) Abramovici, M., Breuer, M. A. and Friedman, A. D. Digital systems testing and testable design. IEEE press (Indian edition available through Jayco Publishing house), 2001.
2) Bushnell and Agarwal, V. D. VLSI Testing. Kluwer.
3) Agarwal, V. D. and Seth, S. C. Test generation for VLSI chips. IEEE computer society press.
4) Hurst, S. L. VLSI testing: Digital and mixed analog/digital techniques. INSPEC/IEE, 1999
5) https://nptel.ac.in/courses/106103116/handout/mod7.pdf
6) http://ece-research.unm.edu/jimp/vlsi_test/slides/html/overview1.htm,
7) http://www.cs.uoi.gr/~tsiatouhas/CCD/Section_8_1-2p.pdf, Latest

Course Name : Embedded Systems
Course Code :
Credits : 3 (L-T-P : 3-0-0)
Syllabus:

Syllabus:

Embedded Computing- Microprocessors, embedded design process, system description formalisms. Instruction sets- CISC and RISC;
MBeD platform; ARM architectures and programming- Cortex M0 etc;

CPU fundamentals- programming I/Os, co-processors, supervisor mode, exceptions, memory management units and address translation, pipelining, superscalar execution, caching, CPU power consumption.

Embedded platform- CPU bus, memory devices, I/O devices, interfacing, debugging techniques. Realtime OS, timer & pulse width modulation, Serial and parallel communication, digital I/O, Analog I/O, interrupts, low power techniques

Hardware accelerators- CPUs and accelerators, accelerator system design. Networks- distributed embedded architectures, networks for embedded systems, network-based design, Internet-enabled systems.

Course Outcomes:

CO1- Appreciate difference between embedded and other types of computing and their specific hardware requirements.

CO2- Identify and interface embedded platform components.

CO3- ARM family processor architectures and their specific uses.

CO4- Program analysis and optimization

CO5- Able to compile programs,, download and run them on hardware

References:

1) Wolf, W. Computers as components- Principles of embedded computing system design. Academic Press (Indian edition available from Harcourt India Pvt. Ltd., 27M Block market, Greater Kailash II, New Delhi-110 048.)
2) Vahid and T. Givargis. Embedded System Design: A Unified Hardware/Software Introduction , Wiley, 2002.
3) Furber, ARM System-on-Chip Architecture, Pearson
4) ARM reference manuals for cortex M0+ .

Course Name : Digital CMOS IC
Course Code :
Credits : 3 (L-T-P : 3-0-0)

Syllabus:

Introduction to MOSFETs technology: Construction and working of MOSFET, Current-Voltage Characteristics, and Performance metrics for digital design, Fabrication flow of CMOS n-well process.

CMOS Inverter: Design and analysis of NMOS inverter (resistive, enhancement and depletion load) , CMOS inverters; Noise margins, rationing of transistor size, logic voltage levels, rise and fall of delays, Propagation Delay, Power Consumption.

Combinational Circuits: Design of basic gates in NMOS technology; CMOS logic design styles: static CMOS logic (NAND, NOR gates), complex gates, Pass Transistor logic, Transmission gate, Dynamic MOS design: pseudo NMOS logic, clocked CMOS (C2 MOS) logic, domino logic, NORA, Half and Full adder), Multiplexer, XOR, XNOR.

Logical Effort: Logical effort of different digital circuit design, parasitic delay, Single stage and Multistage with and without branch network.

Layout and stick diagram: Layout design rules: Lambda and micron based design rules- stick diagram, Layout design of different CMOS circuit, area estimation.

Sequential Circuits and Memory Design: Sequential MOS Logic and Memory Design: Static latches; Flip flops & Register.

Course Outcomes :

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

CO1- Understand the advancement of CMOS devices and circuits
CO2- Design CMOS circuits with specified noise margin and propagation delay.
CO3- Implement efficient techniques at circuit level for improving power and speed of combinational and sequential circuits.
CO4- Design and optimization of layout for Digital ICs.
CO5- Design and analysis of efficient memory architectures.

References:

1. Sung-Mo Kang & Yusuf Leblebici, CMOS Digital Integrated Circuits Analysis and Design, Second Edition, McGraw-Hill, 1999.
2. Rabaey, Chandrakasan and Milokic. Digital system design- A design perspective. Pearson education, India.
3. Neil H.E.Weste and Kamran Eshraghian, Principles of CMOS VLSI Design, A System Perspective, Pearson Education, India. 4. Ken Martin, Digital Integrated Circuits, Oxford Press.
4. CMOS Circuit Design, Layout and simulation: J. Baker, D.E. Boyce., IEEE press.

FIFTH SEMESTER
LABORATORIES

Course Name : Project Lab I
Course Code :
Credits : 3 (L-T-P: 0-0-6)

List of Experiments/ activities

Design, verification, prototyping and implementation of hardware/ software

Devices, circuits and systems based on software, hardware, algorithms, protocol, concepts in emerging areas such as AI, ML, IoT, Sensors, Smart Antennas, NOMA, Computer Vision, Computer Networking, Nano Devices, Smart Materials, Data Mining, Nano Photonics, Optical Wireless Communications, Embedded Systems, Chip Design, Drone Technology and related areas

Course Name : Microprocessors Lab
Course Code :
Credits : 1 (L-T-P: 0-0-2)

List of Experiments

1. A byte is stored in location 0x0100. Complement this byte and store the result in location 0x0101.
2. Two bytes are available in locations 0x0100 and 0x0101. Add them and store the result in 0x0102. Neglecting the carry generated.

3. Subtract using 2's complement 0x0100 (Subtrahend), 0x0101 (Minuend), Store result in location 0x0102, Neglect borrow.

4. Two 16 bit numbers are in locations 0x0100 and 0x0101 & 0x0102 and 0x0103. Add these 16 bit numbers and store the result in 0x0104-0x0105.

5. Evaluation of problem (4) using 16 bit instructions.

6. Two 8-bit packed BCD numbers are available in 0x0100 and 0x0101. Add them and store the result in 0x0102, Neglect carry.

7. Adding 3 consecutive bytes available in memory locations available in 0x0101, 0x0102, 0x0103. Neglect carry generated at each level and store the result in 0x0104.

8. A byte is available at location 0x0100. Separate out its nibbles and store them at locations 0x0101 and 0x0102.

9. Two nibbles are available at locations 0x0100 and 0x0101. Combine them to form a byte and store at location 0x0102.

10.Two bytes are available at location 0x0100 & 0x0101. Compare them for equality i.e. if they are equal than store the same value at 0x0102 else store 00 at 0x0102.

11.A byte is available at 0x0100. Check this byte for odd/even parity. If odd store 'OD' in 0x0101 else store 'EE' in 0x0101.

12.Multiplication by 2 using bit rotation. A byte is available at 0x0100. Multiply it by 2 and store the result generated in 0x0101. Neglect carry.

13.A group of N bytes are available from 0x0101 onwards. The no. of bytes in the group available in 0x0100. Add these bytes and store the result in 0x0200. Neglect carry generated.

14.Addition of N bytes starting from 0x0101 onwards. No. of bytes is available in 0x0100. Take carry into account. The result will be stored in 0x0200-0x0201.

15.Multiplication by repeated addition of two bytes is available in location 0x0100 and 0x0101. Multiply them and store the result in 0x0102-0x0103 (with minimum no. of addition).

16.Multiplication of 16 bit number by a 8 bit number. Let 16 bit number located at 0x0100 and 0x0101. 8-bit no. is stored at 0x0102. Store result in 0x0103, 0x0104 and carry at 0x0105.

17.Divide two 8-bit numbers by repeated subtraction. Dividend at 0x0100 and divisor at 0x0101 and store the quotient at 0x0102 (rounding off).

18.A group of N bytes are available from 0x0101 onwards. The value of N is available in 0x0100. Move these bytes from 0x0201 onwards.

19.Numbers from 0x00 to 0x0F are present in 0x0100. Squares of numbers are available from 0x0200 onwards. Store the result in 0x0101.

20.Multiplication by partial products (0x0100–Multiplicand,0x0101- Multiplier, 0x0102-0x0103 – Product).

21.To print "Hello World" in screen.

22.Read a character from keyboard and display it on monitor.

23.Adding two one digit numbers. The result should also be of one digit.

24.Find the factorial of numbers (factorial max value can be 65535).

25. Conversion of a byte from Hexadecimal to BCD.

Course Name : Antenna and Wave Propagation Lab
Course Code :
Credits : 1 (L-T-P: 0-0-2)

List of Experiments

1. To study and plot the radiation pattern of λ/2 Dipole antenna in azimuth plan on log/linear scale on polar plot.
2. To study and plot the radiation pattern of folded Dipole antennas in azimuth plan on log/linear scale on polar plot.
3. To study and plot the radiation pattern of Yagi (4el) antenna in azimuth plan on log/linear scale on polar plot.
4. To study and plot the radiation pattern of the Square Loop antenna in azimuth plan on log/linear scale on polar plot.
5. To study and plot the radiation pattern of Helix antenna in azimuth plan on log/linear scale on polar plot.
6. To study and plot the radiation pattern of Micro Strip antenna in azimuth plan on log/linear scale on polar plot.
7. To study and plot the radiation pattern of Log Periodic antenna in azimuth plan on log/linear scale on polar plot.
8. To study and plot the radiation pattern of the End Fire antenna in azimuth plans on Log/linear scale on polar plot.
9. To study and plot the radiation pattern of Broadside antenna in azimuth plans on Log/linear scale on polar plot.
10. To study resonant and non-resonant antenna and calculate the resonant frequency and estimate the VSWR of the antenna.
11. Familiarization with basic operation of Vector Network Analyzer (VNA) and Use the VNA to measure the complete S parameters of the components under test

Course Name : Digital CMOS IC Lab
Course Code :

Credits : 1 (L-T-P: 0-0-2)

List of Experiments

1. V characterization of Long channel N-MOSFET & P-MOSFET for using SPICE simulation.
2. V characterization of Short Channel N-MOSFET & P-MOSFET using a SPICE simulation.
3. VTC analysis of CMOS Inverter for different W/L Ratio of NMOS and PMOS.
4. Transient analysis of CMOS Inverter for input signal of equal rise and fall time.
5. Noise Margin Analysis of different NMOS based Inverter circuits such as Diode Connected Load, Depletion Load, PMOS Load, etc.
6. Connect a 2 I/P NAND Gate to an identical NAND Gate such that the fan out is 1,2,5,10,50,100. Plot the propagation Delay.
7. Connect a set of 7 inverters in a closed loop in the form of a clock. Estimate the clock frequency. Determined experimentally change in clock frequency without load (i.e Cout/Cin), varying from 1, 20, 100.
8. Connect 3 I/P NAND gate a, b, c and connect to a capacitor such that fan out is 1. Find the rise time of NAND gate for the I/P=000; 001; 011.
9. To design layout of CMOS inverter and followed by simulation.
10. To design a layout of 2 input NOR gate and followed by simulation.
11. To design a layout of 3 input NAND gate and followed by simulation.
12. Mini projects

Course Name : Embedded Systems Lab (Embedded Systems Design Lab)
Course Code :
Credits : 1 (L-T-P: 0-0-2)

List of Experiments

1. Write a C or Assembly program to interface 7 segments with 8051/ARM to display 0-9 and 0-99 on Universal embedded system Board.
2. Write a C or Assembly program to interface 16*2 Char LCD module with 8051/ARM on Universal embedded system Board.
3. Write a C or Assembly program to interface ADC 0809 IC with 8051/ARM and Read Value on LCD on Universal embedded system Board.
4. Write a C or Assembly program to interface DAC 0808 IC with 8051/ARM and Sine and triangular Wave on Universal embedded system Board.
5. Write a C or Assembly program to interface a DC motor with 8051/ARM and Control the RPM using PWM on Universal embedded system Board.
6. Write a C or Assembly program to interface Stepper Motor with 8051/ARM and study the angle of rotation on Universal embedded system Board.
7. Write a C or Assembly program to interface Serial Communication with 8051/ARM and Read the Value of ADC on PC.
8. Write a C or Assembly program to interface RTC with 8051/ARM and Read the Time on LCD and serial monitor on PC.

9. Write a C or Assembly program to interface Relay Buzzer with 8051/ARM and control and per instruction.
10. Write a C or Assembly program to interface HEX KEYPAD with 8051/ARM and Read the Values on LCD and serial monitor on PC.
11. Write a C or Assembly program to interface external EEPROM with 8051/ARM and store the values of ADC.

Universal Human Values & Ethics (Audit course)

L-T-P: 2-0-0 (2 Credits)

Syllabus

A. Universal Human Values-

- Need, Basic Guidelines, Content and Process for Value Education
- The problem Twin goals: happiness and just order; the role of value education
- Paradoxes of happiness Concepts of good life – quality of life and subjective well-being; happiness, life satisfaction, and positive affect; studying the quality of life through surveys; and findings of quality The problem of social transformation Moral and institutional approaches; and the inherent conflict between the two
- Human values and humanism: dilemmas and directions- Jeevan Vidya; human values, "I" and "Body" need for harmony in the self; harmony with the body; harmony in family, society, nature and existence; evaluation of Jeevan Vidya. Implications of the above Holistic Understanding of Harmony on Professional Ethics
- Conceptualizing the relationship between man and society- Man and society; theories of man and society such as methodological individualism, structuralism, Gidden's theory of structuration, and structural symbolic interactionism
- Religious and spiritual approaches to human happiness- Vedic, Jain and Buddhist philosophies; Christianity; Islam; Zoroastrianism, and Sikhism

B. Ethics & Professionalism-

- Possibilities of transformation- Hope and hopelessness; transforming society;
- Ethical Theories, Meta ethical theories- Consequentialist and Non-consequentialist Theories; Hedonism; Utilitarianism; Ethical Relativism: Is Anything Wrong at all? Ethical Naturalism; Non-naturalism; Non-cognitive or Non-descriptivist Theories; Intuitionism; Approach to an Adequate Theory; the Moral point of view; Why be Moral?
- Professional ethics- The liberal society's values; Professions' nature and traits; Professional Ethics' roots and conventions; Professionals require their own code of behaviour.
- The connection between professional and broader ethical standards; The topic of professional Ethics' autonomy and moral dilemma; Care practice, legal Ethics; Environmentalism; Computer Ethics; Business Ethics

Text:

1. Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi, 2010
2. Weston, Anthony. A 21st Century Ethical Toolbox. New York: Oxford University Press, 2008.
3. Hospers, John. An introduction to philosophical analysis. New Delhi: Allied Publishers Private Limited, 1967.

References (not limited to):

1. Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
2. Rediscovering India - by Dharampal
3. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
4. The Story of Stuff (Book).
5. The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi
6. Small is Beautiful - E. F Schumacher.
7. Slow is Beautiful - Cecile Andrews
8. Economy of Permanence - J C Kumarappa
9. Bharat Mein Angreji Raj – Pandit Sunderlal
10. Vivekananda - Romain Rolland (English)
11. Joshi, Harsiddh Maganlal. Traditional and Contemporary Ethics: Western and Indian. Bharatiya Vidya Prakashan, 2000.
12. Ranganathan, Shyam. Ethics and the history of Indian philosophy. Motilal Banarsidass Publishe, 2007.
13. MacIntyre, Alasdair. A short history of ethics: a history of moral philosophy from the Homeric age to the 20th century. Routledge, 2003.
14. Nussbaum, Martha C. The therapy of desire: Theory and practice in Hellenistic ethics. Vol. 33. Princeton University Press, 2013.

SYLLABUS THIRD YEAR
SIXTH SEMESTER
SUBJECT

Course Name : Management Principles for Engineers
Course Code :
Credits : 3 (L-T-P : 3-0-0)

Course Name : Optical Communication Systems
Course Code :
Credits : 3 (L-T-P : 3-0-0)

Syllabus:

Fundamentals of fiber optics: Ray propagation, waveguiding in optical fibers, step index and graded index fibers, Modes in optical fiber, mono mode & multimode fibers, fiber fabrication, dispersion relations. Signal degradation: Dispersion, attenuation & scattering in fibers, link analysis.

Fiber Measurement: Measurement of fiber attenuation, bandwidth, power, & cut-off wavelength, OTDR.

Opto electronic devices:- Light source materials, LEDs, Lasers, Photo-diodes, PIN diodes etc. Modulation capability. Photodetectors, PIN photodiode and Avalanche photodiodes,

Power launching and coupling: Fiber joints, cables and connectors, fiber splices, optical coupler and optical measurements.

Analog and Digital optical transmission systems: Link Analysis, system design considerations for point-topoint links, noise sources in optical communication, system architecture. WDM, Coherent optical systems. Methods of modulation, Heterodyne and Homodyne systems, Noise in coherent systems, Multichannel coherent systems, Optical amplifiers, Introduction to lightwave networks

Course Outcomes :

CO1: Distinguish Step Index, Graded index fibers and compute mode volume.

CO2: Explain the Transmission Characteristics of fiber and Manufacturing techniques of fiber/cable.

CO3: Classify the construction and characteristics of optical sources and detectors.

CO4: Discuss splicing techniques, passive optical components and explain noise in optical system.

CO5: Design short haul and long haul Analog/ Digital optical communication system and explain advanced optical transmission systems.

References:

1. Fiber Optics and Optoelectronics – R.P. Khare
2. Optical Communication-VK Jain, Franz
3. Optical Communication - Keiser
4. Optical fiber communication - J.M. Senior

Course Name : Wireless and 5G Communication
Course Code :
Credits : 3 (L-T-P : 3-0-0)

Syllabus:

Introduction to 5G: Fundamentals of Wireless Communication, Evolution from 1G to 5G, 5G spectrum, Wireless Standards: Overview of 2G 3G, 4G and 5G, Key capabilities of 5G, System Architecture, Performance measures- Outage, average snr, average symbol/bit error rate. System examples- GSM, EDGE, GPRS, IS-95, CDMA 2000 and WCDMA, 3G, 4G and 5G mobile communications.

Cellular System Design Fundamentals: Components of Mobile Cellular Systems: Cell structure, frequency reuse, cell splitting, Call origination & Termination. Cellular concepts- Signal propagation-Propagation mechanism, reflection, refraction, diffraction and scattering, large scale signal propagation and lognormal shadowing. Interference & System Capacity: Improving Capacity in Cellular Systems, Co-Channel Interference, Channel Assignment Strategies, Handoff Strategies.

Channel Fading and Diversity: Multipath Measurements, Parameters of Mobile Multipath Channels, Types of Fading: Multipath and small-scale fading- Doppler shift, power delay profile, average and rms delay spread, coherence bandwidth and coherence time, flat and frequency selective fading, slow and fast fading, average fade duration and level crossing rate. Impulse Response Model of a Multipath Channel, Channel State Information. Receiver structure- Diversity receivers- selection and MRC receivers, RAKE receiver, equalization: linear-ZFE and adaptive, DFE. Transmit diversity Altamonte scheme

5G Radio Standard: Orthogonal frequency division multiplexing (OFDM), Modulation schemes-BPSK, QPSK and variants, QAM, MSK and GMSK, multicarrier modulation, OFDM, MIMO and space time signal processing, spatial multiplexing, diversity/multiplexing tradeoff.

5G Enabling Technologies: Concept of 5G Communication, Multi-carrier with filtering, Filter-bank based multi-carrier, Non-orthogonal multiple access (NOMA). Principle and Spectrum Allocation, Power Control Mechanism in NOMA Techniques, 5G Applications.

Course Outcomes :

CO1- Appreciate and familiarize the world of mobile communications.

CO2- Develop requisite mathematical background for mobile systems using teletraffic theory, probability theory and stochastic processes as well as linear algebra.

CO3- Design parts of mobile communication system using mathematical models.

CO4- Develop proficiency in the subject by working on individual term papers and presenting their study to the entire class (Presentation Sessions).

References:

1) Wireless Communications: Principles & Practices by Theodore S. Rapport.
2) Mobile Cellular Telecomm. B y William C. Y. Lee.
3) Mobile Communication by Schiller, (Pearson Education India.
4) Osseiran, Afif, Jose F. Monserrat, and Patrick Marsch, eds. *5G mobile and wireless communications technology*. Cambridge University Press, 2016.
5) Rodriguez, Jonathan. *Fundamentals of 5G mobile networks*. John Wiley & Sons, 2015.

Course Name : Neural Networks and Fuzzy Logic
Course Code :
Credits : 3 (L-T-P : 3-0-0)

Syllabus: Biological basis for Neural Networks, Activation functions, Single neuron/ Perceptron networks, training methodology, typical application to linearly separable problems.
Various Neural Networks :

1. Multilayer Perceptron (MLP) :- Back propagation algorithm, virtues and limitation of BP algorithm, LMS algorithms.
2. ADALINE networks
3. Functional Link Artificial Neural Network (FLANN) : introduction to single layer structure, Trigonometric expansion, Polynomial expansion, Chebyshev expansion, Legendre expansion, FLANN learning algorithms.
4. Radial-basis function Networks : interpolation problem, Covers theorem, learning algorithm.
5. Recurrent Neural Networks : Fully Recurrent Network, Hopfield Network.
6. Clustering, Unsupervised learning methods, Support Vector Machines, Self Organizing Maps
7. Deep Learning Networks : Convolutional Neural Networks, LSTM, Auto Encoders and variants

Fuzzy Logics :
Fuzzification, Membership Functions, Fuzzy Rules, Fuzzy operations, De-fuzzification, Mamdani, Sugeno and Tsukamoto fuzzy models, Adaptive Neuro-Fuzzy Inference Systems (ANFIS).

Course Outcomes :
CO1- To learn biological bases and to understand basic mathematical modelling of single layer neuron.
CO2- To understand the development of neural structures (including Multilayer Perceptron, ADALINE, RBF, FLANN) and training algorithms (including Back Propagation, LMS etc).
CO3- To understand the Fuzzy Logic and De-fuzzyfication processes.
CO4- To explore the applications of neural networks and Fuzzy logic to Pattern Classification, Clustering, System Identification, Channel Equalization etc.
CO5- To develop MATLAB and Python programming skills for Neural Network and FuzzyModeling.

References:

1) Neural Network Design : Authors-Hagan, Demuth, Beale, Publisher-CENGAGE Learning
2) Neuro-Fuzzy and Soft Computing : J S R Jang, C T Sun and E Mizutani- Publisher-PHI
3) Neural Networks A Classroom Approach, Second Edition : Satish Kumar, McGraw Hill Education
4) Principle of Neurocomputing for Science and Engineering – Fredric M. ham, Ivica Kostanic- Tata McGraw Hill Edition

Course Name : Satellite & Radar Engineering
Course Code :
Credits : 3 (L-T-P : 3-0-0)

Syllabus:

Introduction: Introduction to satellite communication, LEO, GEO, MEO and higher orbits, Orbital Mechanics and Parameters.

Satellite subsystems: Transponders, Amplifiers and Receiver, Link Budget Analysis.

Navigation systems and Techniques: Multiplexing and Access Techniques for Satellite Communication, Introduction to Spread Spectrum; GPS, Global navigation satellite systems (GNSS).

Networking: Internet and Satellite Links; Very Small Aperture Antenna; Special Purpose Satellites

RADAR: Fundamentals of Radar Systems, Types of RADAR And Modalities, Radar System Components, Basic Operating Principles (Detection, Ranging, Doppler, Importance Of Phase) and Its Application.

Course Outcomes :
CO1-Understand the basic principles of satellite communication.
CO2-Design the satellite link to fulfil various power requirements Techniques
CO3-Discuss the multiplexing and multiple access techniques used in satellite and navigation systems.
CO4-Discuss special satellites and their subsystems.
CO5-Explain the basics of RADAR

References:
1) Introduction to Radar Systems: Merrill I. Skolnik, McGraw-Hill
2) Satellite communication systems, B. G. Evans, Published by IET
3) Satellite Communication, P. Banerjee, PHI

SIXTH SEMESTER
LABORATORIES

Course Name : Project Lab II
Course Code :
Credits : 2 (L-T-P: 0-0-4)

List of Experiments/ activities

Design, verification, prototyping and implementation of hardware/ software

Devices, circuits and systems based on software, hardware, algorithms, protocol, concepts in emerging areas such as AI, ML, IoT, Sensors, Smart Antennas, NOMA, Computer Vision, Computer Networking, Nano Devices, Smart Materials, Data Mining, Nano Photonics, Optical Wireless Communications, Embedded Systems, Chip Design, Drone Technology and related areas

Course Name : Optical Communication Systems Lab
Course Code :
Credits : 1 (L-T-P: 0-0-2)

List of Experiments

1. To Study of Optisystem and Optisystem component library.
2. To Design and study basic optical communication systems.
3. To study the length dependence of attenuation in the given optical fiber at different wavelengths.
4. To study indirect modulation technique with Mach-Zehnder modulator(MZM) using OptiSystem.
5. To observe variation in BER with respect to different sets of parameters in the OFC system.
6. To Optimize the length and power of an optical fiber for given system parameters.
7. To Calculation of minimum sensitivity of the optical receiver.
8. To study and Draw EDFA characteristic curves.
9. To Design optical NOT gate using MATLAB components.
10. To Design optical AND and NAND using MATLAB components.
11. To Design optical OR and NOR gate using MATLAB components.
12. To Design optical XOR and XNOR using MATLAB components.

Course Name : Wireless and 5G Communication Lab
Course Code :
Credits : 1 (L-T-P: 0-0-2)

Lab experiments associated with the theory course

Course Name :Neural Networks and Fuzzy Logic Laboratory
Course Code :
Credits : 1 (L-T-P: 0-0-2)

List of Experiments :

1) To study the Multi-layer perceptrn network and use it for design of OR, AND, NOR NAND gates.
2) To design a ADALINE network for identification of FIR system.
3) To design a Functional Link Artificial Neural Network (FLANN) for a tie series prediction.
4) To design a RBF network for function approximation.
5) To design a K-means algorithm for clustering.
6) To use Self Organizing Map for Clustering.
7) To do a Fuzzification and Defuzzification process using MAMDANI inference system.
8) To use CNN for Image classification.
9) Implementation of LSTM.

SYLLABUS FOURTH YEAR

Seventh and Eighth Semester Program Elective Syllabus

Course Name : Graph Theory
Course Code :
Credits : 3 (L-T-P : 3-0-0)

Syllabus:

Graph- basics, Planarization, triangulation, graph algorithms for shortest/longest paths, spanning tree, search etc.

Algorithms & complexity- shortest path, max-flow, Dijkshtra's algorithm, min-cost flow, algorithm for graph search and matching; spanning trees and matroids;

Integer Linear programming, Greedy algorithm, approximation algorithms; branch-and-bound; dynamic programming

Course Outcomes :

CO1-Is able to grasp core concepts, basic tenets of combinatorial graphs (knowledge)

CO2-Is able to grasp features, properties of special graphs (knowledge)

CO3-Is able to learn & apply graph algorithms and its applications into Circuits, computer problem solving etc. (Thinking, skills)

CO4-Is able in long perspective, to appreciate the significance of GRAPH as a versatile modeling entitiy; and the significance that it can be used for analysis, problem solving as well as synthesis- especially for chip design, wireless communication protocols & system design, computer problem solving, data structures etc. (skills)

CO5-Is able to write small C/C++ programmes related to implementation of graph algorithms (skills).

References:

1) Narsingh Deo, Graph theory, Prentice Hall India, 2008.
2) T. H. Cormen, C. E. Leiserson and R. L. Rivest, "Introduction to Algorithms," McGraw-Hill, 2007
3) S. Baase, Computer algorithms, Pearson India 2008.

Course Name : Artificial Intelligence & Expert Systems
Course Code :
Credits : 3 (L-T-P : 3-0-0)

Syllabus:

Introduction : Introduction to AI techniques, AI programming, Knowledge based systems.
Single Objective Algorithms :
Evolutionary Algorithms : Genetic Algorithm, Genetic Programing, Differential Evolution
Swarm Intelligence : Particle Swarm Optimization, Ant Colony Optimization, Gray Wolf Optimization, Cat swarm Optimization, Artificial Bee Colony, Social Spider Optimization
Bio-inspired Algorithms : Artificial Immune Systems, Bacterial Foraging Optimization, Whale Optimization, Moth-Flame Optimization, Cuckoo Search, Symbiotic Organism Search
Physical Algorithms : Simulated Annealing, Harmony search, Gravitational Search Algorithm, Colliding Bodies Optimization.
Multi Objective Algorithms :
Nondominated Sorted GA–II, Multi-objective Particle swarm Optimization, MOEA-D, NSGA-III
Applications :
System Identification, Channel Equalization, Multi-modal function Optimization, Classification, Clustering, Travelling Salesman Problem, Wireless Sensor Network

Course Outcomes :
CO1 - To learn the basics of Artificial Intelligence techniques including Evolutionary Algorithms, Swarm Intelligence, Bio-inspired techniques.
CO2 -To understand the various single objective Nature-inspired computing techniques.
CO3- To learn the multi-objective optimization techniques.
CO4- To explore the applications of artificial intelligence techniques to Function Optimization, Pattern Classification etc.

References :
1) Genetic algorithms in search, optimization, and machine learning, Author : David E. Goldberg, Pearson Education India, 2008.
2) Multi-Objective Optimization using Evolutionary Algorithms : Author : Kalyanmoy Deb, Publisher Wiley.
3) Ant Colony Optimization : Author : Marco Dorigo and Thomas Stützle, Publisher: Bradford
4) Swarm Intelligence : Principles, Advances, and Applications, Aboul Ella Hassanien, Eid Emary, CRC Press

Course Name : Advanced Error Control Codes
Course Code :
Credits : 3 (L-T-P : 3-0-0)

Syllabus:

Error Control coding for wireless fading channels, Channel Estimation and Adaptive channel coding, Joint Source and Channel coding

Binary & Non binary Linear Block Codes, Hard and soft decision decoding, Coding and Decoding of BCH, Reed Solomon Codes

Convolution codes: Coding and Decoding , Distance bounds, Performance bounds Turbo codes: Coding, Decoding Algorithms, Performance comparison , Interleaver design

Trellis coded Modulation, TCM Decoders, TCM for AWGN and Fading Wireless Channels, Performance comparison. LDPC Codes, Polar Codes

Error control codes for : Audio/video transmission, mobile communications, space and satellite communication, data transmission, data storage and file transfer.

Course Outcomes :

CO1. Appreciate the need of Error Correction in communication systems after going through the course

CO2. Develop requisite mathematical background for Error Correction using linear algebra

CO3. Design error correcting codes using mathematical models

CO4. Design encoders and decoders for a given error correcting capability

CO5. Validate theoretical results with simulation results

CO6. Use MATLAB software for simulation (TT)

References:

1) Stephen G. Wilson; Digital Modulation & Coding;. Prentice Hall Inc.
2) Ranjan Bose; Information Theory Coding and Cryptography, TMH
3) Blahut R.E. , Theory and practice of error control codes, AWL1983.
4) J.G.Proakis; Digital Communication.

Course Name : Image Processing
Course Code :
Credits : 3 (L-T-P : 3-0-0)

Syllabus:

Image Processing: Acquiring of Images using Video Camera. Digital Representation of Binary & Gray Scale Images, Linear operations on pictures. Two dimensional Discrete Fourier transform and Hadamard transforms & their applications to image processing. Sampling of pictures using an Array of points, Aliasing problem & its solution. Image Enhancement Techniques:- Gray scale modification Gray level correction, Gray scale transformation, Histogram modification, sharpening of Images using differentiation, the Laplaciam, High Emphasis filtering, sobel & kirsch operators. Smoothening:- Noise Removal, Averagins, Median, Min/Max. Filtering

Image Segmentation & Thresholding:- Thresholding, Multiband Thresholding, Thresholding from Textures, Selective histogram Technique, Boundary Lines & Contours. Image Compression:- Compression Techniques using K-L Transform, Block Truncation Compression. Error free Compression using Huffman coding & Huffman shift coding.

Course Outcomes :

References:

1) Signals and Systems- Oppenheim A.V., Willsky A.S. and Young I.J. PHE.
2) Digital Signal Processing- Oppenheim A.V. & Schafer R.W. PHI.
3) Digital Signal Processing- by LYONS, (Pearson Education)
4) Digital Signal Processing-by Mitra- (TATA McGraw Hill) Publications.
5) Digital Image Processing- by Gonzalez / Woods, (Pearson Education)
6) Digital Image Processing- by A.K. Jain
7) Digital Picture Processing- by Rosenfield & Kak

Course Name : CAD algorithms for VLSI physical design

Course Code :
Credits : 3 (L-T-P : 3-0-0)

Syllabus:

Unit 1: Introduction to CAD Algorithms Role of CAD in digital system design, levels of design, modelling & description and support of languages, RTL, gate and system level synthesis; Technological alternatives and technology mapping

Unit 2: CAD Tools for synthesis CAD tools for synthesis, optimization, simulation and verification of design at various levels as well as for special realizations and structures such as micro-programmes, PLAs, gate arrays etc. Technology mapping for FPGAs. Low power issues in high level synthesis and logic synthesis.

Unit 3: Architectural-Level Synthesis and Optimization Architectural Synthesis, Scheduling, Data path synthesis and control unit synthesis, scheduling algorithm, Resource Sharing and Binding

Unit 4: Logic-Level Synthesis and Optimization Two-Level Combinational Logic Optimization, Multiple-Level Combinational Logic Optimization, Sequential Logic Optimization

Unit 5: CAD Algorithms for VLSI Physical Design Introduction to VLSI Physical Design flow. Circuit partitioning, placement and routing algorithms. Design Ruleverification, Circuit Compaction; Circuit Extraction and post layout simulation. FPGA design flow- partitioning, placement and routing algorithms. Deep sub-micron issues; interconnects modeling and synthesis.

Course Outcomes :

CO1-Is able to grasp various operations on graphs, clique, coloring, partitioning etc

CO2-& apply graph algorithms and its applications into Boolean function representation (Knowledge)

CO3-Is able to grasp graph models for architecture representation (Knowledge)

CO4-Is able to analyse & implement two level/Multilevel/ sequential logic synthesis algorithms

CO5-(approximate & exact algorithms) (skills)

CO6-Is able to analyze & implement library binding algorithms- FSM equivalence & optimization (skills)

CO7. To able to grasp core concept of VLSI Physical Design. (Knowledge)

References:

1) G. D. Micheli. Synthesis and optimization of digital systems.
2) Dutt, N. D. and Gajski, D. D. High level synthesis, Kluwer, 2000.
3) T. H. Cormen, C. E. Leiserson and R. L. Rivest, “Introduction to Algorithms,” McGraw-Hill, 1990.
4) N. Deo, Graph Theory, PH India.
5) Sait, S. M. and Youssef, H. VLSI Physical design automation. IEEE press, 1995.
6) Sherwani, N. VLSI physical design automation. Kluwer, 1999.

Course Name : CAD ALGORITHMS FOR SYNTHESIS OF VLSI SYSTEMS

Course Code :
Credits : 3 (L-T-P : 3-0-0)

Syllabus:

Unit 1: **Introduction to CAD Algorithms**
Role of CAD in digital system design, levels of design, modeling & description and support of languages, RTL, gate and system level synthesis; Technological alternatives and technology mapping

Unit 2**: CAD Tools for synthesis**
CAD tools for synthesis, optimization, simulation and verification of design at various levels as well as for special realizations and structures such as microprogrammes, PLAs, gate arrays etc. Technology mapping for FPGAs. Low power issues in high level synthesis and logic synthesis.

Unit 3: **Architectural-Level Synthesis and Optimization**
Architectural Synthesis, Scheduling, Data path synthesis and control unit synthesis, scheduling algorithm, Resource Sharing and Binding

Unit 4: **Logic-Level Synthesis and Optimization**
Two-Level Combinational Logic Optimization, Multiple-Level Combinational Logic Optimization, Sequential Logic Optimization

Unit 5: **CAD Algorithms for VLSI Physical Design**
Introduction to VLSI Physical Design flow. Circuit partitioning, placement and routing algorithms. Design Rule-verification, Circuit Compaction; Circuit Extraction and post layout simulation. FPGA design flow- partitioning, placement and routing algorithms. Deep sub-micron issues; interconnects modeling and synthesis

Course Outcomes :

CO1: Is able to grasp various operations on graphs, clique, coloring, partitioning etc & apply graph algorithms and its applications into Boolean function representation (Skills- Apply)
CO2: Is able to grasp graph models for architecture representation (Cognitive- understanding)
CO3: Is able to analyze & implement two level/Multilevel/ sequential logic synthesis algorithms (approximate & exact algorithms) (skills- Analyze)
CO4: Is able to analyze & implement library binding algorithms- FSM equivalence & optimization (skills- Evaluate)
CO5: To able to grasp core concept of VLSI Physical Design algorithms. (Cognitive- Apply)

References:
1. G. D. Micheli. Synthesis and optimization of digital systems.
2. Dutt, N. D. and Gajski, D. D. High level synthesis, Kluwer, 2000.
3. T. H. Cormen, C. E. Leiserson and R. L. Rivest, “Introduction to Algorithms,” McGraw-Hill, 1990.
4. N. Deo, Graph Theory, PH India.
5. Sait, S. M. and Youssef, H. VLSI Physical design automation. IEEE press, 1995.
6. Sherwani, N. VLSI physical design automation. Kluwer, 1999.

Course Name : SYSTEM LEVEL DESIGN & MODELLING
Course Code :
Credits : 3 (L-T-P : 3-0-0)

Syllabus:

UNIT 1. Introduction: Embedded systems, electronic system-level (ESL) design, Models of Computation (MoCs): finite state machines (FSMs), dataflow, process networks, discrete event
UNIT 2. System-level design languages (SLDLs): SpecC, SystemC. System specification, profiling, analysis and estimation. System-level design: partitioning, scheduling, communication synthesis
UNIT 3. System-level modeling: processor and RTOS modeling, transaction-level modeling (TLM) for communication. System-level synthesis: design space exploration (DSE)
UNIT 4. Embedded hardware and software implementation: synthesis and co-simulation, case study. Application specific processors, Retargetable compilers, instruction set-simulation and co-simulation.
UNIT 5. System design examples and case studies. . Recent trends in system level design and modelling

Course Outcomes :

CO1- To model a problem at system level (Cognitive- Analyze)
CO2- Realize architecture for a design problem (Skills- Create)
CO3 -To model a system in System C language (Cognitive- Analyze)
CO4 -To generate system interface specifications and perform refinement (Skills- Create)
CO5- To appreciate HW-SW Co-design with latest trends (Cognitive- understanding)

References:

1) Gajski, S. Abdi, A. Gerstlauer, G. Schirner, Embedded System Design: Modeling, Synthesis, Verification,
2) Springer, September 2009. ISBN 978-1-4419-0503-1, ("Orange book", authors' site).
3) Gerstlauer, R. Doemer, J. Peng, D. Gajski, "System Design: A Practical Guide with SpecC",
4) Kluwer Academic Publishers, Boston, June 2001. ISBN 0-7923-7387-1 ("Yellow book")
5) T. Groetker, S. Liao, G. Martin, S. Swan, "System Design with SystemC", Kluwer Academic Publishers, Boston, May 2002. ISBN 1-4020-7072-1 ("Black book")
6) F. Vahid, T. Givargis, "Embedded System Design: A Unified Hardware/Software Introduction" (authors' site),
7) 7. John Wiley & Sons, 2001. ISBN 978-0-471-38678-0

Course Name : <u>Probability Theory & Statistics</u>
Course Code :
Credits : 3 (L-T-P : 3-0-0)

Syllabus:

Module 1
Probability
Counting, Random variables, distributions, quantiles, mean variance, Conditional probability, Bayes' theorem, base rate fallacy, Joint distributions, covariance, correlation, independence
Central limit theorem

Module 2
Probability Density Functions (PDFs)
Binomial distribution, Poisson distribution, Gaussian PDF, Rayleigh PDF, Bivariate Gaussian distribution
Functions and statistics of Random Variables
Sum of Random Variables, Functions of one random variable, joint and conditional RVs their means, moments

Module 3
Random Processes (Stochastic processes)- Representation of Signals and Systems
stationary and non stationary Random Process, Ergodic process,
Power spectral density (PSD) of a Random process,
Power of a Random process. Some practical applications of the theory.

Module 4
Statistics I:
Pure applied probability (data in an uncertain world, perfect knowledge of the uncertainty)
Bayesian inference with known priors, probability intervals
Conjugate priors

Module 5
Statistics II:
Applied probability (data in an uncertain world, imperfect knowledge of the uncertainty)
Bayesian inference with unknown priors
Frequentist significance tests and confidence intervals
Resampling methods: bootstrapping
Linear regression

Books:
1. Cooper, McGillem: Probabilistic methods of signal and system analysis, Oxford Univ.Press.
2. Peebles, P. Probability, random variables and random signal principles. Mc Graw Hill, 2001.
3. Papoulis, A. Probability, random variables and stochastic processes. Mc Graw Hill (international Students' edition), Singapore.
4. Childers, D. G. Probability and random processes using MATLAB. Mc Graw Hill, 1997.

Course Name : Advanced microprocessors & micro-controllers
Course Code :
Credits : 3 (L-T-P : 3-0-0)

Syllabus:

8086/8088 microprocessor: Hardware specifications, clock generator (8284A), bus interface & latching, bus timings, ready & wait states, minimum mode & maximum mode. 8088 based assembly language programming: linking & execution of a program, defining & moving data, COM programs, program logic & control, MACRO programming, linking to sub-programs. Memory interfaces: Memory devices, address decoding, 8088 memory interface, 8086, 80286, 80386Sx, 80386DX, 80486 memory interface, dynamic RAM. Basic I/O interface: 1/O port address decoding, programmable preiferal interface, 8079 programmable keyboard/display interface, 8254 programmable interval timer, 8251A porgrammable communication interface, A/D and D/A converters. Interrupts: Basic interrupt processing, hardware interrupts, 8259 A programmable interrupt controller, real clock. Direct memory access & DMA-controlled I/O; Basic DMA Controller, shared bus systems, Video systems. Architecture Cooprovessors: Data Formats 8087 architecture, Processor interface, Instruction set. 80186/80188 & 80286 Microprocessors: the 80186/80188 architecture, 80188-example interface, Introduction 80286. 80386 & 80486 Microprocessors: Introduction to 80386 architecture & its register structure. 80386 instruction set. 80386-memory management, Introduction to 80486 microprocessors & its architecture, 80486 instruction set. Microcontrollers.

Course Outcomes :

References:

1. HALL, PHI 2. LIU & GIBSON, PHI 3. BREY, PHI

Course Name : Computer Networks
Course Code :
Credits : 3 (L-T-P : 3-0-0)

Syllabus:

Introduction: Network structure, network architectures. The OSI reference model, services, standardization, example networks.

The Physical Layer: physical characteristics ,Data Link Layer protocols-MAC,DLL, Ethernet, LAN, VLAN, ARP , Bridges and routers. Network layer protocols, IPv4, IPv6, sub/supper netting, VLSM, ICMP, IGMP, Routing Algorithms. Transport layer protocolsTCP, UDP, Congestion control Algorithms. Application layer services: DNS, DHCP, FTP, TFTP, SMTP, SNMP, HTTP. Security and encryption.

Course Outcomes :

References:

1) Kurose and Ross :computer networks, pearson-india
2) Peterson and Devie : Computer Network, elsiever india
3) Tanenbaum : Computer Networks , PHI/pearson-india
4) Stallings: Data communication & Networking , PHI/pearson-india
5) Leon-Garcia,Widjaja: Communication Networks, TMH

Course Name : Advanced Microwave Engineering
Course Code :
Credits : 3 (L-T-P : 3-0-0)

Syllabus:

Unit 1: Review of Electromagnetic Theory, Transmission Lines and Waveguides, Impedance Matching and Tuning

Unit 2: Introduction to Baritt, Trapatt, Gunn diode, Pin diode and other microwave solid state devices.

Unit 3: Introduction to Microstrip lines, Parallel Striplines and other striplines. Slot lines, Integrated Fin line, Nonradiative guide, Transitions, Bends and Discontinuities.

Unit 4: Microwave amplifiers and oscillators. Measurement of VSWR, impedance, frequency, dielectric constant power, attenuation, power and other microwave circuit performance parameters.

Course Outcomes :

CO1-Evaluate various parameters of transmission lines and waveguides

CO2-Explain and evaluate performance of multiport microwave networks

CO3-Describe the working principles of different microwave solid state devices.

CO4-Explain different types of planar transmission lines and discontinuties.

CO5-Explain the working principles of microwave amplifiers and oscillators.

CO6-Compute the measurement parameters such as VSWR, impedance, frequency, dielectric constant power, attenuation and phase shift etc related to microwave circuits

References:

1) Microwave Devices and Circuits- Samuel Y. Liao, Prentice Hall
2) Microwave engineering-David M. Pozar, John Wiley & Sons, Inc.
3) Microwave Solid State Circuit Design- Inder Bahl, John Wiley & Sons.
4) Microwave circuits & passive devices- Sisodia and Raghuvanshi, New Age International.
5) Foundations of Microwave Engg.- Collin, John Wiley and Sons.
6) Microwave and Radar Engineering- Kulkarni, McGraw Hill Education
7) Introduction to Microwaves –Wheeler G.J., Prentice-Hall

Course Name : Design of Microstrip Antenna
Course Code :
Credits : 3 (L-T-P : 3-0-0)

Syllabus:

Fundamental Properties of Single layer Micro strip Patch Antenna. Micro strip Radiators Analytical Models for Micro strip Patch Antennas. Full wave Analysis of Micro strip Patch Antennas. Rectangular Micro strip Patch Antennas. Circular Dish and Ring Patch Antennas. Circularly Polarized Micro strip Patch Antennas. Enhancing the Bandwidth of Micro strip Patch Antennas. Improving the Efficiency of Micro strip Patch Antennas.

Course Outcomes :

CO1. Explain the working principle of microstrip antenna structures
CO2. Analyze different planar antenna geometries
CO3. Design planar antenna structures CO4. Improve antenna performance parameters

References:

1) Micro strip Antenna Design Handbook by Ramesh Garg, Prakash Bhartia, Inder Bahl, Apisak Ittipiboon. Artech House.
2) Handbook of Antennas in Wireless Communication by Lal Chand Godara,CRC Press.
3) CAD of Micro strip Antenna for Wireless Applications by Robert A. Sainati, Artech House.
4) Compact and Broadband Micro strip Antenna by Kin-Lu Wong, John Wiley & Sons.
5) Micro strip Patch Antennas by Robert B. Waterhouse, Kluwer academic Publishers.
6) Handbook of Micro strip Antennas by J.R. James and P.S. Hall, Peter Peregrinus Ltd.

Course Name : ADVANCED ANTENNA SYSTEMS
Course Code :
Credits : 3 (L-T-P : 3-0-0)

Syllabus:

Introduction: CAD of antennas, techniques for antenna analysis such as MOM, FDTD, Antenna Matching Techniques, smith chart Antennas for Mobile Systems: introduction, mobile terminal antennas, Performance Requirements Dipoles, Helical Antennas, Inverted-F Antennas, Mean Effective Gain (MEG), Human Body Interactions and Specific Absorption Rate(SAR), Mobile Satellite Antennas, Base Station Antennas Adaptive Antennas: basic concepts, applications, MIMO systems, Adaptive antenna in practical system Smart antennas: Introduction, Need for Smart Antennas, Configuration and architecture UWB Antennas: requirement, radiation mechanism, analysis, antenna mismatch

Course Outcomes :

References:
1) Antennas Theory & Practice- By Balani
2) Antennas & wave Propagation - By K.D. Prasad
3) Wireless Communications: Principles & Practice - By Theodore S. Rappaport.
4) RE Collin

Course Name : Microwave Integrated Circuits
Course Code :
Credits : 3 (L-T-P : 3-0-0)

Syllabus:
Introduction: Substrate Materials, Conductor materials, Dielectric materials, Mask Layouts & mask fabrication., Hybrid Microwave Integrated circuits, overview of Passive elements., R,L,C & Microstriplines, Active Components-Ga As MESFETS, HEMT, Equivalent circuits, PIN & Schottky Diodes.

Monolithic Microwave Integral Circuits: GaAs for MMICs, Design Considerations, procedure MMIC fabrication, Examples of MMICs. Hybrid Versus Monolithic MICs. Power MMICs.

Microwave Optic, Acoustic and Magnetostaic Circuits, Microwave Modulation of optical sources, fiber optic RF links, RF/optical interaction, optical control of Microwave Devices. Switching Application, oscllicator tuning, Injection Locking, optical techniques for Millimeter wave circuits.

Future trend in Microwave circuits: MMIC systems, Millimeter wave MICs., optics for Microwave Applications., Microwave Acoustic technology, Magnetostatic Wave Technology.

Course Outcomes :

References:

1) Microwave Solid state circuits Design by Inder Bahl & Prakash Bhartia WileyInterscience & Publication.
2) MMICs by S.K. Kaul & B. Bhat.
3) MMIC Design GaAs FETs and HEMTs by Peter H. Lad brooke Artech house Boston &London.

Course Name : Power Electronics
Course Code :
Credits : 3 (L-T-P : 3-0-0)

Syllabus:

Introduction to Solid State Power Devices & Operation : SCR, G.T.O., Power transistor, Classification of SCR triggering methods, design and operation of triggering circuits, commutation methods, pulse transfer and isolation scheme, protection of power devices. Series & parallel operation of SCRs.

Phase Controlled Converters : Single phase uncontrolled, half-controlled and fully controlled converters. Three-phase half-controlled and full controlled bridge converters.

Choppers : Different schemes and circuit configurations. Regulators : Single phase A.C. Regulators-different circuit configurations and their operation.

Inverters : Single-phase and Three-phase bridge converter operating as line-commutated inverters, force commutated inverters, pulse width modulated inverters. Cycloconverters : Three-phase to single-phase and three-phase to three-phase configurations

Course Outcomes :

References:

1) M. Ramamoorty: An Introduction to Thyristors and their Applications, East West Press Pvt Ltd.
2) Mohammad H. Rashid : Power Electronics Circuits, Devices and Applications, Prentice Hall of India Pvt Ltd.
3) B.R. Pelly : Thyristor Phase Controlled Converters and Cycloconverters, John Wiley & Sons.
4) P.C. Sen : Thyristor DC Drives, John Willey & Sons .
5) G.K. Dubey and etal : Thyristorized Power Controllers, Cenrro Wille Eastern.
6) Murphy & Turnbull : Power Electric Control of A.C. Motors, Pergawen Press

Course Name : Semiconductor Opto-Electronics
Course Code :
Credits : 3 (L-T-P : 3-0-0)

Syllabus:

Introduction to semiconductors, heterostructures, carrier transport, Semiconductor photoconductors for visible to far-infrared generation and detection

Radiation sources, Lasers—structures and properties, Edge emitting and vertical cavity lasers, LED designs, Nitride light emitters, light detectors

Optical sensors and opto-couplers

Optical amplifiers – SOA, EDFA, Raman amplifiers.

Course Outcomes :

References:

1) Semiconductor Optoelectronic Devices – P. Bhattacharya, Pearson,
2) Fiber Optics and Optoelectronics- R.P. Khare, Oxford University Press,
3) Optoelectronics—Endel Uiga, Prentice Hall
4) Photodetectors and Fiber Optics—HS Nalwa, Elsevier.

Course Name : Memory Design & Testing
Course Code :
Credits : 3 (L-T-P : 3-0-0)

Syllabus:

Processing technology for Memories: Multipoly Floating Gate and Control Gate, Trench Capacitors and thin Oxide. Memory Modeling and testing faults in SRAMs, Marching Tests; Delay Faults. Semiconductor memory architecture, Space of memory faults- fault primitives. Preparation of Circuit Simulation: Definition & location of open, short, and bridge fault, Simulation methodology. Test for single cell and two port SRAMs, Functional fault modeling and testing of RAMS, Fault Diagnosis & Repair Algorithms. Built –in self Test and design for testabiltity of RAMs. Built in self repair architecture. Trend in Embedded Memory testing.

Course Outcomes :

CO1: To know the basics of evaluation of elementary functions (Cognitive- Understand)
CO2: to understand fundamentals of Memory Modeling and testing faults (Cognitive- Understand)
CO3: To learn the techniques and algorithm for testing and fault diagnosis (Skills- Evaluate)
CO4: To understand basics of built-in self test and related issues (Skills- Design)

References:

1) Pinaki Mazumder, Kanad Chakraborty, Testing and Testable Design of High-Density Random-Access Memories (Frontiers in Electronic Testing), Kluwer academic pub.
2) Said Hamdioui, Testing Static Random Access Memories: Defects, Fault Models and Test Patterns (Frontiers in Electronic Testing), Kluwer academic pub 2004.
3) Pinaki Mazumder and Kanad Chakraborty, Fault –Tolerence and reliability techniques for High –Density Random- Acess Memories, Pearson India, 2002..

Course Name : Electronic Manufacturing Technology
Course Code :
Credits : 3 (L-T-P : 3-0-0)

Syllabus:

Overview of different technologies & future trends- (i) PCB, multilayer PCB, (ii) thin film, (iii) Thick film, (iv) Surface mount devices (v) monolithic- VLSI & MMIC (vi) packaging of semiconductor devices (vii) multichip modules & optoelectronic sub-system packaging (viii) system-on-package(ix) Micro-electro-mechanical systems & NEMS (x) Nanotechnology (xi) standards & procedures- MIL-M-38 510F, MIL-STD-883B, ISO-9000 etc.

Course Outcomes :

CO1- Gain a knowledge of different PCB layers. (Cognitive- understanding)
CO2- Understand challenges in PCB design technologies. (Cognitive - understanding)
CO3 –Analyze different method for improving packaging of chips. (Skills- analyze)
CO4- Design and optimization of system on package as per industry standards. (Skills- Create)

References:

1) Manufacturing Technology in the Electronics Industry: An introduction, Edwards P., Springer Netherlands, 1991
2) Handbook of Electronics Manufacturing Engineering, Bernard S. Matisoff, Springer Netherlands, 1991

Course Name : Formal Verification of Digital Hardware & Embedded Software
Course Code :
Credits : 3 (L-T-P : 3-0-0)

Syllabus:

UNIT 1. Introduction to Design Verification, OVM and UVM methodology, case studies using Verilog and System Verilog
UNIT 2. Static verification, Formal Verification of digital hardware systems- BDD based approaches, functional equivalence, finite state automata, FSM verification, Model checking
UNIT 3. Various industry & academia CAD tools for formal verification.
UNIT 4. Verification, validation & testing - Debugging techniques for embedded software, instructionset simulators, clear box technique, black box testing, evaluating function test
UNIT 5. Recent trends in Design verification, case study.

Course Outcomes :

CO1-To understand features of System Verilog (Cognitive- Understanding)
CO2-To study Assertion Based Verification and also be aware of functional coverage. (Cognitive- Analyze/Evaluate)
CO3-To apply language constructs of Bluespec for high level design/synthesis. (Skills- Apply) CO4- To understand the necessity of the verification methodology. (Affective- understanding) CO5-Ability to develop the test bench for DUT with verification methodology for scheduling, resource sharing and binding.(Skills- Creativity)

References:

1) Embedded systems Design- Artist Roadmap for Research & Development, LNCS-3436, Springer.
2) J. W. Valvano, Eembedded microcomputer systems- Real Time Interfacing, , Thomson press (Cengage India)
3) Computers as components- Principles of embedded computing system design. Wolf, W., Academic Press (Indian edition available from Harcourt India Pvt. Ltd., 27M Block market, Greater Kailash II, New Delhi110 048.)

4) Verification, validation & testing in software engineering, A. Dasso and A. Funes, Idea Group Inc.
5) Advanced Formal Verification, R. Drechsler, Kluwer.
6) Hardware-Software codesign for data flow dominated embedded systems, R. Niemann, Springer.
7) Readings in Hardware/Software codesign, Micheli, Ernst, Wolf, Morgan Kaufmann.

Course Name : Parallel Computing Architecture
Course Code :
Credits : 3 (L-T-P : 3-0-0)

Syllabus:

Introduction: Synchronous and asynchronous paradigms of parallel computing. Hardware taxonomy: Flynn's classification, Handler's classification; Software taxonomy: Kung's taxonomy, SPMD. Abstract parallel computational models: combinational circuits, sorting networks, PRAM models, interconnection RAMs. Parallel programming languages. Performance metrics: laws governing performance measurements; metrics- speed up, efficiency, utilization, communication overheads, single/multiple program performances, benchmarks. Processor arrays. Scheduling. Basic algorithms: Fast Fourier transform, Linear system solution, sorting etc.

Course Outcomes :

References:

1) Quinn, M. Parallel computing theory and practice. Mc Graw Hill (International Student Edition), 1994.
2) Hwang, K., Briggs, F. A. Computer architecture & parallel processing. McGraw hill.
3) Kumar, V., Grama, A., Gupta, A. and Karypis, G. An introduction to parallel computing. Addison Wesley, 2001. (Low price edition from Pearson Education, India), 2001.
4) Hwang, K. Advanced computer architecture- parallelism, scalability and programmability. McGraw hill, 2000

Course Name : Bio-Medical Engineering
Course Code :
Credits : 3 (L-T-P : 3-0-0)

Syllabus:

Basic Concepts of Medical Instrumentation
Basic sensors used in Bioinstrumentation, Sources of bioelectric potentials – resting and action potentials, the bioelectric potentials. Electrodes for measurement of bio-potentials.
Cardiovascular Systems The Heart blood pressure, Characteristics of blood flow, Heart sounds, Electrocardiography, Measurement of blood pressure, Measurement of blood flow and Cardiac output, Plethysmography, Measurement of Heart sounds.
Chemical Biosensors Blood gas and Acid base Physiology, Electrochemical sensors, Chemical fibro-sensors, Ionselective Field Effect Transistors (ISFET), Immunologically sensitive FET, Non invasive blood gas monitoring, Blood Glucose Sensors.
Physiological signals EEG, EMG, ECG, etc.
Electrical Safety Physiological effects of electricity.Macro-shock hazards, Micro-shock hazards, Electrical Safety codes and standards, Basic approaches to protection against shock. Electrical Safety analyses, Tests for electrical systems and appliances.

Course Outcomes :

References:
1) Leslie Cromwell, Fred J. Weibell& Enrich A. Pfeiffer, Biomedical Instrumentation and Measurements, 2nd edition, PHI.
2) John G. Webster, Medical Instrumentation, Applications & Design, 3rd edition, Wiley & Sons.

Course Name : Quantum Mechanics for Electronics Engineers
Course Code :
Credits : 3 (L-T-P : 3-0-0)

Syllabus:
Introduction and Motivation of Quantum Mechanics, Waves mechanics
Schrodinger's equation, Measurement and Expected Values, Functions and operators
Concepts of Angular Momentum, Spin, Pauli Exclusion Principle
Energy Band Diagrams, Semiconductors, Crystalline Materials, Harmonic Oscillators, Photons
Introduction to Quantum Computing and Quantum Information Theory

COURSE OUTCOMES
CO1. To understand the motivation behind the development of quantum mechanics
CO2. To develop an understanding of mathematical foundations.
CO3. To develop an understanding of the concepts of angular momentum and spin.
CO4. To apply key quantum mechanical concepts to electronics engineering problems.
CO5. To apply key quantum mechanics concepts in the area of computing and information theory.

Recommended Readings
Text Books:-
1. Miller, David AB. Quantum mechanics for scientists and engineers. Cambridge University Press, 2008.
2. Griffiths, David J., and Darrell F. Schroeter. Introduction to quantum mechanics. Cambridge university press, 2018.
3. Cohen-Tannoudji, Claude, Bernard Diu, and Frank Laloe. "Quantum Mechanics, Volume 1." Quantum Mechanics 1 (1986): 898.

Course Name : Fundamentals of Photonics
Course Code :
Credits : 3 (L-T-P : 3-0-0)

Syllabus:
Ray Optics, Wave Optics, Beam Optics, Fourier Optics, Electromagnetic Optics.
Polarization and Crystal Optics, Guided Wave Optics, Fiber Optics, Resonator Optics
Statistical Optics, Photon Optics, Photon and Atoms, Lasers.
Photons in Semiconductors, Photon Sources, Photon Detectors.
Photonic Switching and Computing.

COURSE OUTCOMES

CO1. To learn the key principles of photonics
CO2. To develop the mathematical foundations of photonics.
CO3. To develop the understanding of the light matter interaction.
CO4. To analyse and design photonic structure.
CO5. To manipulate the fundamental properties of light.

Recommended Readings

Text Books:-

1. Saleh, Bahaa EA, and Malvin Carl Teich. Fundamentals of photonics. john Wiley & sons, 2019.
2. Yariv, A., & Yeh, P. (2007). Photonics: optical electronics in modern communications. Oxford university press.
3. Wartak, Marek S. Computational photonics: an introduction with MATLAB. Cambridge University Press, 2013.

Course Name : Current-Mode Analog Signal Processing
Course Code :
Credits : 3 (L-T-P : 3-0-0)

Syllabus:

Current-mode (CM) Processing: Advantages over voltage-mode processing; Supply-current Sensing, Trans linear circuits, Current- feedback op-amps.

Current-mode Circuits: Instrumentation Amplifiers and Precision Rectifiers, Current-mode Sinusoidal Oscillators and Function Generators, Issues in Current-Output Sensing.

Current-mode Active block based Filters: Circuit structure and analysis of operational trans –impedance Amplifier (OTIA) and various generations of current Conveyers, MOSFET-C Filters and techniques of non-linearity cancellation in MOS circuit, Log domain filters.

Advanced Current-mode building blocks: Current-Controlled Conveyor (CCCII), Current-Differencing Transconductance Amplifier (CDTA), etc. and their applications to high frequency, analog signal processing applications.

Current-mode Applications: Current-Mode Fractional-Order Circuits, Current-Mode Active Inductors, Current-Mode Capacitance Multiplier, Current-Mode Analog Multipliers/Squarers, Current-Mode Comparators, Current-Mode Schmitt Trigger.

Course Outcomes :

CO1- Gain a knowledge of different current mode sensing. (Cognitive- understanding)
CO2- Understand challenges in current-mode signal processing technologies. (Cognitive - understanding)
CO3 –Analyze different method for improving current-mode analog circuits. (Skills- analyze)
CO4- Design and optimization of Current-Differencing Transconductance Amplifier. (Skills- Create)

References:

1) Esteban Tlelo-Cuautle, "Integrated Circuits for Analog Signal Processing," Springer,2012, ISBN: 1461413834, 9781461413837.

2) Chris Toumazou, F. J. Lidgey, David Haigh, "Analogue IC Design: The Current-mode Approach," in Circuits, Devices and Systems, Issue 2 of IEE circuits and systems series, IET, 1993, ISBN: 0863412971, 9780863412974.
3) Fei Yuan, "CMOS Current-Mode Circuits for Data Communications," in Analog Circuits and Signal Processing, Springer, 2010, ISBN: 1441939997, 9781441939999.
4) P. V. Ananda Mohan, "Current-Mode VLSI Analog Filters: Design and Applications," Springer, 2003, ISBN: 0817642773, 9780817642778.
5) Latest research papers on the topics mentioned in the syllabus

Course Name : Optical codes and applications
Course Code :
Credits : 3 (L-T-P : 3-0-0)

Syllabus:

Introduction: Historical Perspective of Optical Communications, Optical Transmission and Optical Networking, Optical Communications Trends, Migration to 100 Gb/s Ethernet and Beyond.

Optical Coding Schemes: Unipolar and Bipolar codes, 1D time spread codes, phase encoding, spectral amplitude coding, 2D phase-wavelength, wavelength-time and space-time codes, spectral amplitude coding and 3D space- wavelength-time, polarization-wavelength-time and space-wavelength-phase codes. Performance Metrics for comparison of codes: Cardinality, Code dimension, Correlation functions, BER due to multiple access interference, received power & noise.

Enabling Hardware Technologies: Optical encoders/decoders using fiber optic components & integrated optics, Optical AND gate as a decoder, Realization of Optical logic gates, Potential Applications. Latest topics in optical codes and applications

Course Outcomes :

CO1. Is able to grasp historical perspective and recent trends of Optical Communications including Networking.
CO2. Is able to construct and analyze 1D, 2D and 3D codes.
CO3. Is able to design Optical encoders/decoders using fiber optic components & integrated optic technologies.
CO4. Is able to search and review latest topics.

References:

1) Optical code division multiple access: Fundamentals and Applications - Paul R. Prucnal (CRC Press)
2) Optical coding theory with prime - Wing C. Kwong; Guu-Chang Yang (CRC Press)
3) Spreading codes for all-optical code division multiple access communication systems – M. Ravi Kumar (Ph.D. Thesis, IIT Kharagpur)
4) Design and Performance Analysis of a New Family of Wavelength/Time Codes for Fiber-Optic CDMA Networks - E. S. Shivaleela (Ph.D. Thesis, IISc Bangalore)

Course Name : Adaptive Signal Processing
Course Code :
Credits : 3 (L-T-P : 3-0-0)

Syllabus:

Adaptive Filter Structures and Algorithms: Introduction to Adaptive systems, Adaptive Linear combiner, Minimum Mean-Square Error, Wiener-Hopf Equation, Error Performance Surface, LMS algorithm, Convergence of weight vector, Learning Curve, FX-LMS algorithm (Filtered X-LMS) and its application to ANC, Types of LMS, RLS algorithm, Matrix Inverse Lemma for RLS, Computational complexity of LMS and RLS, Convergence Analysis. IIR-LMS, Lattice Filter, FIR to Lattice conversion and vice-versa, Adaptive Lattice Filter Kalman Filter, Adaptive Kalman Filter Transformed domain adaptive filtering: Block Linear, Block Circular Filter Banks and multi-rate signal processing Distributed signal Processing: Incremental LMS, Diffusion LMS

Applications: Direct Modelling or System Identification, Inverse Adaptive Modelling (Equalization), Adaptive Noise Cancellation, Adaptive filters for time series and stock market prediction, Biomedical Applications (Cancellation of 50-Hz interference in Electro-Cardiography, Cancelling donor heart interference in heart-transplant electrocardiography, Cancelling Maternal ECG in Fetal Electrocardiography), Echo Cancellation in Long distance Telephone Circuits, Adaptive self-tuning filter, Adaptive line enhancer, Adaptive filters for classification and data mining.

<u>Course Outcomes :</u>

CO1- To learn the characteristics of adaptive system architecture and analyze Wiener-Hopf Equation.
CO2- To understand the machine learning algorithms including LMS, RLS, Fx-LMS etc. CO3- To learn the adaptive structures like : Adaptive Lattice Filter, Kalman Filter, Transformed domain adaptive filtering, Filter Banks.
CO4- To explore the applications of adaptive signal techniques to System Identification, Channel Equalization, time series prediction etc.
CO5- To develop MATLAB programming skills for adaptive systems

<u>References:</u>

1) B. Widrow and S. D. Stearns: Adaptive Signal Processing, Prentice Hall.
2) D. G. Manolakis, V. K. Ingle, S. M. Kogon : Statistical and Adaptive Signal Processing, McGraw Hill.
3) S. S. Haykin: Adaptive Filter Theory, 4th Edition, Prentice Hall.
4) H. Sayed: Fundamentals of Adaptive Filtering, John Wiley & Sons.

Course Name : VLSI Signal Processing Architectures
Course Code :
Credits : 3 (L-T-P : 3-0-0)

<u>Syllabus:</u>

Unit 1: Introduction to VLSI DSP Systems : Need of VLSI DSP algorithms. main DSP Blocks and typical DSP Algorithms. Fixed point /Floating point Representation; Floating point Arithmetic Implementation, Architectures of Adders/Multipliers; CORDIC, representation of DSP algorithms: Block Diagram, signal flow graph, data flow graph, dependence graph.
Unit 2: Iteration Bound Data flow graph representations, loop bound and iteration bound, longest path matrix algorithm, iteration bound of Multirate data flow graphs.
Unit 3: Pipelining and Parallel Processing: Pipelining and parallel processing of FIR digital filters, pipeline interleaving in digital filters: signal and multichannel interleaving.
Unit 4: Retiming, Unfolding and Folding: retiming techniques; algorithm for unfolding, Folding transformation, Techniques of retiming, Unfolding & Folding.
Unit 5: Systolic Array Architecture Systolic Array Architecture: Methodology of systolic array architecture, FIR based Systolic Array, Selection of Scheduling Vector, Matrix multiplication of systolic array
Unit 6: Low power Design Theoretical background , Scaling v/s power consumption, power analysis, Power reduction techniques, Power estimation approach

<u>Course Outcomes :</u>

CO1-To understand Graphical representation of DSP algorithms and Mapping algorithms into Architectures (Cognitive/Skills- Apply)
CO2-To study architecture for real time systems and parallel and pipelining for Low power design

(Cognitive- Remembering)
CO3-To be aware of systolic Array architecture and methodology for developing Architectures (Cognitive- Understanding)
CO4-To know different signal processing modules as convolution technique, retiming concept, folding /unfolding Transformation and CORDIC architecture. (Cognitive- Analyse)
CO5-To implement different low power Design techniques. (Skills- evaluate)

References:

1) VLSI Digital Signal Processing System : : Design and implementation by K.K. Parhi
2) Digital Signal Processing with Field Programmable Gate Arrays Uwe Meyer-Baese , Springer.
3) FPGA-based Implementation of Signal Processing Systems. by Roger Woods, John Mcallister, WILEY

Course Name : FPGA Physical Design
Course Code :
Credits : 3 (L-T-P : 3-0-0)

Syllabus:

Module 1: Introduction to FPGA Architectures, CLB, LUT, programming technology, routing, State of art architectures
Module 2: FPGA design flow, Physical design automation, Fabrication of devices, Design rules, Fabrication process and its impact on physical design, Basic data structure methods
Module 3 Partitioning : Classification, Group Migration Algorithms, Simulated Annealing and Evolution, Other Partitioning algorithms, Performance driven partitioning
Module 4: Floor Planning, Placement and routing algorithms: Types of Floor planning, Chip planning, pin assignment, Classification of Placement algorithms, Simulation based placement, Partitioning based placement, other placement, Global routing, Detailed routing, Clock and power routing etc.
Module 5: Technology mapping for FPGAs, case studies.

Course Outcomes :

CO1- Gain a knowledge of different FPGA Architectures (Cognitive- understanding)
CO2- Understand challenges in placement and routing algorithms. (Cognitive - understanding)
CO3 –Analyze different method for improving physical design. (Skills- analyze)
CO4- Evaluate Technology mapping for FPGAs (Skills- Evaluate)

References:

1) Naveed A. Sherwani, Algorithms for VLSI Physical Design Automation, Kluwer, 1999
2) Brown, S. D., Francis, R. J., Rose, J. and Vranesic, Z G. Field programmable Gate arrays. Kluwer, 1992.
3) Betz, V., Rose, J. and Marquardt, A. Architecture and CAD for Deep-submicron FPGAs. Kluwer, 1999.
4) Trimberger, S. M. FPGA Technology. Kluwer, 1992.
5) Oldfield, J. V. and Dorf, R. C. FPGAs: Reconfigurable logic for rapid prototyping and implementation of digital systems. John Wiley, 1995

Course Name: Foundations of Machine Learning
Course Code :
Credits : 3 (L-T-P : 3-0-0)

Syllabus:
Mathematical concepts for Machine Learning:
Linear Algebra (I): Scalars, Vectors, Matrices and Tensors, Multiplying Matrices and Vectors, Identity and Inverse Matrices, Linear Dependence and Span, Norms, Special Kinds of Matrices and Vectors, Eigen decomposition, Singular Value Decomposition.
Probability and Information Theory: Random Variables, Probability Distributions, Marginal Probability, Conditional Probability, The Chain Rule of Conditional Probabilities.
Machine Learning Basics:
Overview of AI, Problems, Problem space and searching techniques, Definition production system, Control strategies, and Heuristic Search Techniques.
Overview of machine learning, related areas, applications, challenges, and software tools.
Linear Regression (with one variable and multiple variables), Gradient Descent, Linear Classification- Perceptron Algorithm.
Supervised Machine Learning:
Logistic Regression- Overfitting, Regularization, Support Vector Machines (SVM), Decision Trees, KNN, Naive Bayes models, and probabilistic modeling. Ensemble methods: Bagging, random forests, boosting
Un-Supervised Machine Learning:
Clustering – K-Means, Gaussian Mixture Models and Expectation Maximization (EM), Dimensionality reduction, Principal Component Analysis (PCA), Linear Discriminant Analysis (LDA).
Course Outcomes:
1. Demonstrate a fundamental understanding of artificial intelligence and Machine Learning.
2. Understand fundamental concepts of linear algebra and probability for machine learning.
3. Understand a wide variety of machine learning algorithms.
4. Understand how to evaluate models generated from data.
5. Design and implement machine learning solutions to classification, regression, and clustering problems
References
1. Artificial Intelligence, A modern Approach, Stuart Russell and Peter Norvig PHI
2. Linear Algebra, Gilbert Strang, MIT Cambridge Press
3. Probability and Statistics for Machine Learning, Anirban Das Gupta, Springer

4. Pattern Recognition and Machine Learning. Christopher Bishop. Springer. 2006.
5. Pattern Classification, 2nd Ed., Richard Duda, Peter Hart, David Stork, John Wiley & Sons, 2001.
6. Research Articles from SCI & Scopus indexed Journals

Course Name : Foundations of Data Science
Course Code :

Credits : 3 (L-T-P : 3-0-0)

Syllabus:

Data Science Foundations: Applications of Data Science, Role and responsibilities of Data Scientists, Comparing Data Science with other domains, Challenges in the field of Data Science, Data Science Process, Data Scientists Toolbox
Data Prep and Exploratory Data Analysis: Type of Data and data sets, Data Quality ,Data Pre-processing, Feature Creation, Dimension Reduction, Feature Selection, Measures of Similarity and Dissimilarity, Descriptive Analysis, Data Visualizations.
Descriptive Modeling: Clustering, Association Rules, Principal Component Analysis, Interpreting Descriptive models
Predictive Modeling: Linear Regression, Logistic Regression, K-nearest neighbour, Decision Tree, Naïve Bayes, Support Vector Machines, Neural Networks, Model Ensembles, Assessing Predictive models.
Post-processing: General deployment considerations. The Narrative - report / presentation structure, Building narrative with Data, Effective storytelling.

Course Outcomes:
CO1 Applications of Data Science and the process of Data Science project life cycle
CO2 Techniques and tools effective in addressing the data preprocessing and exploratory data analysis stages
CO3 Applications of Descriptive and Predictive Data Analytics techniques
CO4 Hands-on experience of model building, evaluations and interpretations of results
CO5 Knowledge of post-processing involved in Data Science project including deployment considerations, importance of effective storytelling

Text Book(s)
T1 Data Science for Business, By Foster Provost & Tom Fawcett, O'REILLY
T2 Applied Predictive Analytics, By Dean Abbott, WILEY

Reference Book(s) & other resources
R1 Introduction to Data Mining, By Tan, Steinbach and Vipin Kumar, PEARSON
R2 Machine Learning using Python, Manaranjan Pradhan & U Dinesh Kumar, WILEY

Course Name : VLSI Techno
Course Code :
Credits : 3 (L-T-P : 3-0-0)

Syllabus:

Course Name : VLSI Technology
Course Code :
Credits : 3 (L-T-P : 3-0-0)

Syllabus:

Crystal growth & wafer preparation: Processing considerations: Chemical cleaning, getting the thermal Stress factors etc.

Epitaxy: Vapors phase Epitaxy Basic Transport processes & reaction kinetics, doping & auto doping, equipments, & safety considerations, buried layers, epitaxial defects, molecular beam epitaxy, equipment used, film characteristics, SOI structure.

Oxidation: Growth mechanism & kinetics, Silicon oxidation model, interface considerations, orientation dependence of oxidation rates thin oxides. Oxides. Oxidation technique & systems dry & wet oxidation. Masking properties of SiO2.

Diffusion: Diffusion –kinetics, Fick's law, sheet resistivity, methods of diffusion. Diffusion from a chemical source in vapor form at high temperature, diffusion from doped oxide source, diffusion from an ion implanted layer.

Lithography: Optical Lithography optical resists, contact & proximity printing, projection printing, electron lithography: resists, mask generation. Electron optics: roster scans & vector scans, variable beam shape. X-Ray, e-beam lithography.

Etching: Reactive plasma etching, AC & DC plasma excitation, plasma properties, chemistry & surface interactions, feature size control & apostrophic etching, ion enhanced & induced etching, properties of etch processing. Reactive Ion Beam etching, Specific etches processes: poly/polycide. Trench etching.

Thin Film Materials & their Deposition: Interlayer dielectrics in microelectronic devices, interconnections within and between different electronic devices. Packaging of Microelectronic Devices: Packaging materials, different types of packaging, Microelectronic devices reliability.

Course Outcomes :

CO1- An understanding of silicon and GaAs electronic device fabrication processes

CO2- Learn different types of operations involved in converting silicon wafer into a complex integrated circuit. Learn in detail basics of all operations used to manufacture a silicon-based monolithic integrate circuit.

CO3-Gain experience in the modelling and simulation of semiconductor manufacturing processes.

CO4-Develop an understanding of the working principle and operational details of semiconductor measurement device. DPGC Convener Head, ECE SPGB Chairman

CO5-Develop an understanding of industrially relevant and research intensive methods of electronic device fabrications. Students should develop understanding of silicon growth methods, thin film growth technologies, lithography and etching processes.

CO6-Become proficient in the measurements of key electrical parameters and characteristics of integrated circuits

References:

1) S. M. Sze, "VLSI Technology", McGraw Hill.
2) May, Sze, "Fundamentals of Semiconductor Fabrication", Wiley
3) Stephen A. Campbell, "The Science and Engineering of Microelectronic Fabrication", Oxford University Press, 1996.
4) Hong Xiao, "Introduction to Semiconductor Manufacturing", Prentice Hall, 2001.
5) SK Gandhi, "VLSI Fabrication Principles", John Wiley 1983.
6) AB Glaser, GE Subak-Sharpe, "Integrated Circuit Engineering", Reading MA, Addison Wesley 1977.
7) D. Nagchoudhuri, "Principles of Microelectronic Technology", Wheeler Publishing, 1998.
8) Plummer, Deal , Griffin, "Slilcon VLSI Technology: Fundamentals, Practice and Modeling" , Pearson
9) Research papers published in Applied Physics Letters and IEEE journals

Course Name : Information Theory & Coding
Course Code :
Credits : 3 (L-T-P : 3-0-0)

Syllabus:
Introduction to coding theory, channel capacity and channel Coding theorems, concepts of finite fields, Linear Block Codes, standard array, Syndrome decoding, Cyclic codes. Polynomial representation of codes. Error detection and correction capability of block codes . Reed Muller Codes, BCH codes, concatenated codes. Convolution codes; representation, coding and decoding. Introductin to Turbo Codes.

Course Outcomes :

References:
1) Information theory Coding and cryptography by Ranjan Bose, TMH
2) Modulation & Coding by Stephen G. Wilson. Prentice Hall Inc.
3) Digital Communication by – Bernard Sklar, Pearson Education Asia
4) Digital communication by- J.G. Proakis TMH

Course Name : System Design using FPGAs
Course Code :
Credits : 3 (L-T-P : 3-0-0)

Syllabus:
Introduction: Evolution: PROM, PLA, PAL, Architecture of PAL's, Applications, Programming PLD's., Design Flow, Programmable Interconnections, Complex PLD's: CPLD, Why FPGA ?, Applications, CAD Tools. Digital system Design: Top down Approach to Design, Bootom up approach,Case study, Data Path, Control Path, Controller behavior and Design, Case study Mealy & Moore Machines, Timing of sequential circuits., Pipelining, Resource sharing, FSM issues (Starring state, Power on Reset, State diagram optimization, State Assignment, Asynchronous Inputs, Output Races, fault Tolerance). FPGA Architecture: FPGA family, FPGA architectures, Logic Block Architecture., Routing Architecture, Placement of blocks. FPGA implementation: Synthesis of design, Hardware debugging using Chipscope PRO, Power control/ process control systems using FPGA’s, Design optimizations using Xilinx Plan ahead, DSP design flow using Xilinx FPGA’s. FPGA based Testing and Verification: Testing and Verification concept, Different level of verification, System level verification with system Verilog, Attributes of system Verilog, Fault coverage and ATPG based Testing, Boundary Scan and BIST based Testability.

Course Outcomes :
CO1. To be able to apply the basic design principles of sequential logic systems. (Cognitive- Applying) CO2. To understand the design concepts of synchronous state machines in Moore and Mealy architectures. (Cognitive- understanding) CO3. To analyze & design data path, control path design and various programmable devices (Skills- Create) CO4. To be able to implement a digital system using HDLs (Skills- Evaluate)

References:
1) Digital Design using Field Programmable Gate array by P.K.Chan,Samiha mourad, Printice Hall Series
2) Digital System Designs And Practices: Using Verilog Hdl And FPGAs by Ming Bo lin, Wiley India Edition

Course Name : Instrumentation & control
Course Code :
Credits : 3 (L-T-P : 3-0-0)

Syllabus:

Electronic Instrumentation: Definitions of Accuracy, Precision, Resolution, Sensitivity and Linearity, Standards of Resistance and EMF, Classification of Measuring Instruments. Theory and Constructional Details of PMMC Instruments, Moving Iron Instruments, Electrodynamometer Type Instruments, Electronic Voltmeter and its special features, Measurement of DC, RMS and Peak values of AC voltages by Electronic Voltmeter. Different Methods for the Measurement of Resistance, Inductance and Capacitance, Theory of Q-Meters and their Applications. Different Types of Transducers. Measurement of Linear Displacement, Strain, Temperature, Pressure and fluid flow.

Control Systems: Classification of control systems,Control system components, BIBO stability, methods of determining stability: Routh-Hurwitz criterion, Bode's Plot, gain and phase margins, Root-locus, Nyquist stability criterion. Concepts of compensation, Steady state errors, Design of phase lead and phase lag compensators, Effects of compensation on the systems performance. Industrial Controllers: P, PI, PD and PID controllers. Representation of state equations, Relationship between state equations and differential equations and transfer functions, solution of state equations, state transition matrix, state transition equation. Controllability and observability of control systems.

Course Outcomes :

References:

1) W.D. Cooper and A.D. Helfrick, Electronic Instrumentation and Measurement Techniques, Prentice Hall of India, 2005.
2) I. J. Nagrath and M. Gopal, Control System Engineering, New Age Int., 2007.
3) B.C. Kuo, Automatic Control Systems, Prentice Hall of India, 2004.
4) K. Ogatta, Modern Control Engineering, Prentice Hall of India, 2002.

Course Name : Wireless and Mobile Adhoc Networking
Course Code :
Credits : 3 (L-T-P : 3-0-0)

Syllabus:

Wireless Communication Standards, Characterization of the Wireless Channel, Receiver Techniques for Fading Dispersive Channels, Mobility Management in Wireless Networks, Mobile IP, Mobile Ad hoc Networks, Ad hoc Routing Protocols, Performance Analysis of DSR and CBRP, Cluster Techniques, Incremental Cluster Maintenance Scheme, Space time Coding for Wireless Communication.

Course Outcomes :

CO1- To understand the wireless communication standards and characterization of the Wireless Channels.
CO2- To analyze the Mobility Management in Wireless Networks, Mobile IP, Ad hoc routing protocols.
CO3- To understand the Performance Analysis of DSR and CBRP.
CO4- To analyze the Clustering Techniques and Incremental Cluster Maintenance Scheme

References:

1) Wireless Communication and Networking by John W. Mark, WeihuaZhuang.
2) Wireless Adhoc Networks by M. Ilyas, CRC Press

Course Name : CRYPTOGRAPHY
Course Code :
Credits : 3 (L-T-P : 3-0-0)

Syllabus:

Cryptography: Basic Terms and Concepts, Brief History of Cryptography and Cryptanalysis.

Uses and misuses. Basic Number Theory - Divisibility, Primarily, Bases, Congruence's, Modular Arithmetic, GCD'S, Euclidian algorithm, Fermat and Euler Theorems, Finding large primes, Pohlig-Hellman, RSA.

Elementary and Historical Ciphers - Caesar cipher, Transposition and Substitution, Poly- alphabetic ciphers, Product ciphers, DES, IDEA and Exponentiation ciphers. Cipher Modes - Block ciphers, Stream ciphers, Public vs. Private keys, Meet-in-the-middle, LFSRS.

Authentication methods - One-way ciphers, Authentication functions, Message digests, MDS, SHA, Tripwire, Kerberos. Privacy-enhanced communication - Privacy, non-repudiation, Digital signatures, Certificate hierarchies, X.509, PGP, PKI. Introduction to secure transaction standards.

Key Management - Threshold schemes, Random number generation, Key escrow, Key recovery. Applications - Mental Poker, Quadratic residues, Oblivious transfer and Zerknowledge proofs. Digital cash, Digital voting and Contract signing

Course Outcomes :

CO1- Understand the basics of Cryptography
CO2- Apply number theory concepts to study basic cryptographic algorithms
CO3- Differentiate various algorithms in terms of confidentiality, integrity and authenticity.
CO4- Understand the strengths and weaknesses of various ciphers.
CO5- Apply the concepts learnt to real world scenarios.

References:

1) Williain Stallings "Cryptography and Network Security: Principles and Practice", Pearson Education, 2000.
2) KernalTexpalan, "Communication network Management:, PHI, 1992.
3) D.E. Cormer," Computer Networks and Internet", 2nd Edition, Addison Wesley Publication, 2000.
4) Sharma, Vakul, "Handbook of cyber Laws", Macmillan India Ltd, 2002.

Course Name : DESIGN OF MIC AND MMIC'S
Course Code :
Credits : 3 (L-T-P : 3-0-0)

Syllabus:

- Introduction: Substrate Materials, Passive elements., R,L,C & Microstriplines, Active Components-Ga As MESFETS, HEMT.
- Monolithic Microwave Integral Circuits: GaAs for MMICs, Hybrid MICs, Power MMICs.
- Microwave Optic, Acoustic and Magnetostaic Circuits, Optical techniques for Millimeter wave circuits.
- MMIC systems, Microwave Acoustic technology, Magnetostatic Wave Technology.
- MMIC Measurements and Characterization.

Course Outcomes :

CO1- To understand the basics of the Passive and Active Components relevant for an MMIC.
CO2- To choose appropriate substrate materials for implementing an MMIC.
CO3- To analyse and design of an MMIC to increase the yield and reliability.
CO4-To test and detect odd and even mode instabilities.
CO5- To compute the lifetime of an MMIC in packaged assemblies.

References:

1) Microwave Solid state circuits Design by Inder Bahl & Prakash Bhartia Wiley Interscience & Publication.
2) MMICs by S.K. Kaul & B. Bhat.
3) MMIC Design GaAs FETs and HEMTs by Peter H. Lad brooke Artech house Boston &London

Course Name : ADVANCED MOBILE SYSTEMS
Course Code :
Credits : 3 (L-T-P : 3-0-0)

Syllabus:

Operation of Cellular Systems, Frequency reuse concept, Co-channel Interference, Techniques for reducing cochannel interference, Adjacent channel interference, Near end and Far end interference, Crosstalk, interference between systems.
Channel Assignment Techniques, Hand-off Techniques, Concept of smaller Cells, Trunking and Teletraffic Theory.
Orthogonal Frequency Division Multiplexing, Orthogonal Frequency Division Multiple Access, MIMO-OFDM, Effect of frequency offset in OFDM, Peak to average power ratio (PAPR) in OFDM.
Cognitive Radio and Software Defined Radio Concepts. Evolution of Mobile Communication Systems, Details of 3GUMTS, 4G-LTE and 5G Mobile Communication systems.

Course Outcomes :

CO1- Appreciate Components of Mobile Communication systems and Operation of cellular system.
CO2- Analyse Interference and Techniques for reducing Co-Channel Interference.
CO3- Evaluate Analog cellular Mobile Systems for Channel structures.
CO4- Design Digital Cellular Mobile Systems, compare the performance of Digital and Analog cellular systems.
CO5- Learn OFDM, OFDMA, MIMO, Cognitive radio systems CO6: Introduction to 3G-UMTS, 4G-LTE and 5G Mobile Communication systems.

References:

1) Mobile and Cellular Telecommunication by W C Lee
2) Wireless Communications by T S Rappaport, IEEE Press
3) Wireless and Mobile Communication Systems by D. P. Agarwal & Qing Anzen, Thomson Press

Course Name : Smart And Phased Array Antenna Design
Course Code :
Credits : 3 (L-T-P : 3-0-0)

Syllabus:

Review of Antenna Theory, Analysis and Design, Introduction, Smart Antenna analogy, Signal Propagation, Strengths and Shortcomings, Beamforming, Mobile Adhoc Networks, Design, Simulation and Results.
Phased Arrays in Radar and Communication Systems: System requirements for radar and communication antennas, Array characterization for radar and communication systems, Fundamental results from array theory, Array size determination, Time-delay compression.
Pattern characteristics of Linear and Planar Arrays: Array analysis, characteristics of linear and planer arrays, Scanning to endfire, Thinned arrays. Pattern Synthesis for Linear and Planar Arrays: Linear arrays and planar arrays with separable distributions, circular planar arrays and adaptive arrays. Electronic Scanning Radar Systems: Frequency and phase scanning, Phase design techniques.

Course Outcomes :

CO1- Understand and review the basics of the antenna design.
CO2- Understand the working principles of Smart antennas.
CO3- Analyse the phased array antenna systems.
CO4- Synthesize the radiation pattern of phased array antennas.
CO5- Understand the fundamentals of electronic scanning radar systems.

References:

1) Frank Gross, Smart antennas for wireless communications, McGraw-Hill, 2006.
2) R. J. Mailloux, Phased array antenna handbook, Artech house, 2005.
3) R.C. Hansen, Phased Array Antennas, Wiley, 1997.

Course Name : Advanced topics in communication
Course Code :
Credits : 3 (L-T-P : 3-0-0)

Syllabus:

Advanced topics in: Multiuser Detection Techniques, Wireless Networking, Optical Networking, Signal Processing, Mobile Communication, Computer Networking, and their applications.

Course Outcomes :

CO1- Review the fundamentals of communication technologies.
CO2- Apply the advanced communication topics to real world examples.
CO3- Master the state of the art techniques in the area of communication technologies.
CO4- Apply the mathematics to analyse and design the advanced communication system.
CO5- Develop an ability to read a scientific literature in the advanced communication technologies.

References:

1) William Stallings, “Wireless Communications & Networks”, ISBN: 0131918354, Prentice Hall; 2nd edition, November 12, 2004.
2) Mobile & Cellular Telecommunication by W.C.Y Lee. McGraw-Hill
3) Digital Signal Processing- Oppenheim A.V. & Schafer R.W. PHI.

Course Name : Photonic Integrated Devices and Systems
Course Code :
Credits : 3 (L-T-P : 3-0-0)

Syllabus:

Planar waveguides: Step-index and graded-index waveguides, guided and radiation modes. Strip and channel waveguides, anisotropic waveguides, segmented waveguide; electro-optic and acousto-optic waveguide devices. Directional couplers, optical switch; phase and amplitude modulators, filters, etc. Y-junction, power splitters, Arrayed waveguide devices, fiber pig tailing, Fabrication of integrated optical waveguides and devices. Waveguide characterization, end-fire and prism coupling; grating and tapered couplers, nonlinear effects in integrated optical waveguides.
New materials and process technologies for optical device fabrication, advanced optical sources & detectors, amplifiers, their reliability issues, Polymer waveguides, Surface Plasmon Devices, Optical integrated circuits, hybrid & monolithic systems, optical interconnects, materials and processing for OEIC.

Course Outcomes :

CO1- Develop understanding of design concepts related to optical planar waveguides, directional couplers and switches.
CO2- Analyze and Design components such as WDM couplers, filters, isolators, circulators, photonic crystal based waveguides.
CO3- Explore new materials and process technologies for optical device fabrication, reliability issues.

CO4- Develop understanding of design concepts related to hybrid and monolithic systems, optical interconnects.

References:

1) Integrated Optics, by Robert G. Hunsperger, Springer
2) Integrated Photonics: Fundamentals, By Ginés Lifante, John Wiley and Sons

Course Name : EMI/EMC
Course Code :
Credits : 3 (L-T-P : 3-0-0)

Syllabus:

Introduction to EMC-EMI standards, EMC Requirements for Electronic Systems, Digital Signal Spectra: Time and Frequency Domain. PCB Track as Transmission Lines, Signal Integrity, Non ideal behavior of Circuit Components, Antennas. Conducted Emissions and Susceptibility, Radiated Emissions and Susceptibility, Crosstalk, Shielding. System Design, Pre-compliance Measurements.

Course Outcomes :

CO1- Master the EMI/EMC concepts, terminologies, and compliances.
CO2- Analyze the crosstalk and electromagnetic coupling between various components of electronic system.
CO3- Apply standard EMI Reduction techniques and improve the noise immunity of a system.
CO4- Control and predict the EMI/EMC of a given system.
CO5- Design the appropriate electromagnetic material for a given EMI problem.

References:

1) Clayton Paul, Introduction to Electromagnetic Compatibility, Wiley
2) Henry W. Ott, Electromagnetic Compatibility Engineering, Wiley.
3) Bogdan Adamczyk, Foundations of Electromagnetic Compatibility: with Practical Applications, Wiley.

Course Name :WIRELESS SENSOR NETWORKS
Course Code :
Credits : 3 (L-T-P : 3-0-0)

Syllabus:

Network architecture, wireless communication: the physical layer in WSN, WSN medium access control and link layer protocols, WSN services: synchronization and localization, topology control and routing, data-centric and contentbased routing, Quality of Service and transport protocols, in-network aggregation and WSN security

Course Outcomes :

CO1-Master the fundamentals of wireless sensor network.
CO2- Understand the protocols and their design considerations.
CO3- Model and simulate different WSN parameters.
CO4- Understand the parameters to estimate the QoS.
CO5- Master key routing protocols and the associated design challenges.

References:

1) Murthy &Manoj, "Ad Hoc Wireless Networks: Architectures and Protocols," ISBN 0-13147023-X, Pearson 2004

2) William Stallings, "Wireless Communications & Networks", ISBN: 0131918354, Prentice Hall; 2nd edition, November 12, 2004.

Course Name : Advanced Photonic Devices and Components
Course Code :
Credits : 3 (L-T-P : 3-0-0)

Syllabus:

Components for Fiber optic Networks- Couplers/Splitters- -semiconductor optical amplifier- bandwidth of SOPAPolarization dependant gain noise-erbium doped fiber amplifiers- WD multiplexers / demultiplexers- Filters- isolatorcirculators- Optical switches-wavelength converters- Fiber gratings-tunable sources, tunable filters.
Photonic crystal structures and devices.
Homo-and hetero-junctions, quantum wells, advanced semi-conductor materials Semiconductor optical amplifiers, LEDs and LDs: Device structure and Characteristics, DFB, DBR, and quantum well lasers, VCSELS & Laser diode arrays.
Computer aided design of integrated optical waveguide devices. Application of photonics to microwave devices. Nonlinear optical waveguides.
Engineering of DWDM systems. ITU standards and nomenclature, channel capacity, bit rate and modulation, network topologies, current performance and future research issues.

Course Outcomes :

CO1- Develop understanding of design concepts related to photonic devices and components used in all-optical communication systems.
CO2- Analyze and Design components such as WDM couplers, filters, isolators, circulators, photonic crystal based waveguides.
CO3- Analyze advanced concepts in design of homo and hetero junction devices, quantum well
CO4- structures, DFB/DBR lasers.
CO5- Appreciate the comparative selection of devices for particular applications such as dispersion compensation, switching, multiplexing/demultiplexing, including AWG, diffraction gratings, Bragg gratings.

References:

1) Fiber Optic Communication systems, G.P.Aggarwal,Wiley Eastern
2) Introduction to Fiber Optics , A.Ghatak and K.Thyagrajan, Cambridge Univ. Press
3) Introduction to Optical Electronics, K.A. Jones, Harper & Row

Course Name : Telecommunication Technology and Management
Course Code :
Credits : 3 (L-T-P : 3-0-0)

Syllabus:

Introduction to existing telecommunication technologies GSM, WLL, CDMA, Circuit, packet, frame relay and ATM switching, Broadband ISDN, Evolution of IS-95 and third generation systems,
Microcell networks planning in CDMA, Indoor planning, Sectorization and smart antenna, Tariff rules and guidelines, Comparison of different wireless technologies.

Course Outcomes :

CO1-Apply different multiplexing techniques to share network bandwidth

CO2- Identify the design challenged related to indoor communication technologies.
CO3- Understand the role of smart antennas in modern communication technologies.
CO4- Design the efficient strategies for Tariff rules and Guidelines.
CO5- Identify the appropriate network planning strategy for a given design problem

References:

1) W. Stalling, Data Comm. & Networking

Course Name : Advanced Networking Analysis
Course Code :
Credits : 3 (L-T-P : 3-0-0)

Syllabus:

Advanced network analysis: Application analysis using the Application form (AAF), Binary-Hex-Decimal conversion, building test packets, Calculating the cost of network problems (Analysis ROI), Key network calculations: Throughput, Latency and Bandwidth, Unattended captures: Triggered starts/stops, Analysis ROI worksheet/calculation.

Course Outcomes :

CO1- Develop and revise the fundamentals of computer networks.
CO2-Build the test packets for advanced analysis techniques.
CO3-Assess the strengths and weakness of various protocols.
CO4-Identify the challenges in managing and configuring switches and routers.
CO5-Analyse the cost of network problems using ROI worksheets.

References:

1) CCNA Portable Command Guide, Second Edition by Scott Empson
2) Network Analysis by Laura Chappell

Course Name : Advanced Digital Signal & Image Processing
Course Code :
Credits : 3 (L-T-P : 3-0-0)

Syllabus:

Introduction to Multirate systems and filter banks, 2D systems and mathematical preliminaries, Digital Representation of Binary & Gray Scale and colour Images, Linear operations on images. Image sampling and quantization: 2D Sampling on rectangular and nonrectangular sampling lattice, Aliasing, LloydMax quantizer etc.
Image Transforms: 2D Discrete Fourier transform, DCT, DST and Hadamard ,Harr K-L Transforms & their applications to image processing.
Image restoration:Wiener filtering , smoothing splines and interpolation.
Image Enhancement Techniques: Gray scale transformation, Histogram matching and equalization, Smoothening:- Noise Removal, Averagins, Median, Min/Max. Filtering sharpening of Images using differentiation, the laplaciam, High Emphasis filtering,
Image analysis: Edge detection, Boundary Lines & Contours.
Image representation by Stochastic models: ARMA models, 2D linear prediction.
Image Segmentation &Thresholding: Multiband Thresholding, Thresholding from Textures, Selective histogram Technique.

Image Compression: Compression Techniques using K-L Transform, Block Truncation Compression. Error free Comprerssion using Huffman coding & Huffman shift coding.

Course Outcomes :

CO1-Ability to understand Multirate systems , Image sampling and quantization

CO2-Ability to understand Image Transforms , Image restoration and Image Enhancement Techniques

CO3- Ability to understand Image analysis , Image Segmentation & Thresholding, Image Compression.

References:

1) Digital Signal Processing- Oppenheim A.V. & Schafer R.W. PHI.
2) Digital Signal Processing-by Mitra- (TATA McGraw Hill) Publications.
3) Digital Image Processing- by Gonzalez / Woods, (Pearson Education)
4) Digital Image Processing- by A.K. Jain
5) Digital Picture Processing- by Rosenfield & Kak

Course Name : Microelectronic Devices and Circuits
Course Code :
Credits : 3 (L-T-P : 3-0-0)

Syllabus:

Brief recapitulation- band theory, FD statistics, recombination effects and bipolar junction devices. MOS devices-MOS capacitance, interface effects and characterization. MOSFET principles and characteristics, subthreshold region.

Various MOS structures-VMOS, DMOS etc. Parasitic effects in MOSFET and bipolar circuits. CCDs. High frequency devices-metal semiconductor contacts. MESFETS.

Hetero-junction devices-HEMTs, HBTs.

Device modeling: Bipolar devices-Gummel –Poon model and RC Distributed model.

MOS device modeling-long channel effects short channel structures scaled down device models, subthreshold conduction.

Course Outcomes:

CO.1. To appreciate band theory of semiconductors, Fermi Direac statistics

CO.2. To appreciate MOS device structure, and electrical characteristics

CO.3. To design and analyze various MOS structures including exotic strcutures

CO.4. To analyze various devices’ detailed models and perform device modeling/simulation on TCAD

References:

1. S.M.Sze, Physics of semiconductor devices, Wiley Eastern, 1981.
2. D. Nagchoudhuri, Microelectronic Devices, Pearson Education India.
3. Y.P.Tsividis, Operation and modeling of MOS transistor, McGraw-Hill, 1987.
4. M.S. Tyagi, Introduction to Semiconductor material and devices, John.
5. Antognetti and Massobrio, Device modeling with SPICE, McGraw-Hill.

6. Clifton G. Fonstad, Microelectronic devices and Circuits, McGraw-Hill
7. International Edition, 1994.
8. Edward S.Yang, Microelectronic devices, McGraw-Hill.
9. Streetman, Solid State Electronic Devices, PHI.

Course Name : Advanced Computer Architecture
Course Code :
Credits : 3 (L-T-P : 3-0-0)

Syllabus:

Advance micro-architecture & Instruction level parallelism- pipelining & superscalar techniques; Instruction formats, instruction sets and their design, Pipelining; dynamic scheduling, VLIW, EPIC;
Memory hierarchy; Bus cache & shared memory; multilevel cache design & performance; memory systems and error detection and error correction coding;
Data level parallelism- parallel and superscalar architectures- multivector, SIMD, GPU, CUDA/OpenCL programming etc.; heterogeneous SoC processors;
Thread level parallelism- scalable multithreaded architectures, Simultaneous muthithread architectures (SMT); multicore; hyper threading; dataflow, cluster architectures. VLIW, RISC,
parallel program development and environments;

Course Outcomes :

CO1-Analyze various performance characteristics of a computer system & trade-offs involved (cognitive- Analyze)
CO2-Apply digital design techniques to the microarchitecture construction of a processor (Skills- Apply)
CO3-understand I/O modules organization and operating system support (Skills- analyze)
CO4-perform the designing of instruction sets architecture (ISA with HW/SW) and evaluate using tools for statistical analysis of instruction set trade-offs (Skills- design)
CO5-Gain the ability to develop parallel GPGPU solutions of CUDA and OpenCL (Skills- analyze)
CO6-Apply knowledge of processor design to improve performance in algorithms and software systems. (AffectiveEvaluate)

References:

1) D. Patterson and J. Hennessy, Computer Organization and Design: The Hardware/Software Interface, Morgan Kaufmann Publishers, Inc., Second edition, 1998.
2) Computer Architecture: A Quantitative Approach, John L. Hennessy & David A Patterson, Morgan Kaufmann, 1996.
3) Structure Computer Organization, 4th Edition, Andrew S. Tanenbaum, Prentice Hall, 1999.
4) Computer Architecture and Organization, J. Hayes, McGraw Hill, 1988.
5) Computer Organization and Architecture, 5th Edition, William Stallings, Prentice Hall, 1996.

Course Name : Micro and Nano Electro Mechanical Systems
Course Code :

Credits : 3 (L-T-P : 3-0-0)

Syllabus:

Introduction to MEMS: Introduction: micro- and nano-scale size domains; scaling of physical laws; MEMS materials and processes; Miniaturization Issues. MEMS devices and applications, MEMS Market.

MEMS Fabrication Technology: Introduction to Submicron Technology: semiconductor materials; photolithography; doping; thin film growth and deposition; CVD, lithography and Ion Implantation, metallization; wet and dry etching; silicon micromachining; Bulk micromachining; Surface micromachining and LIGA.

MEMS Sensors and Actuators (Electrostatic, Thermal, piezoresistive): mechanics including elasticity, beam bending theory, membranes/plates; microactuators based on various principles, electrostatic, thermal, piezoresistive and applications e.g. acceleration, strain, tactile, temperature, IR detector flow; inkjet.

MEMS Sensors and Actuators (RF and Bio): MEMS Sensors and Actuators: mechanics including piezoelectric, magnetic, optical and its application. e.g. Microphone, micro speaker, nanogenerator, micro-motor, RF resonator, SAW filter. Materials and processes for BioMEMS, Applications.

MEMS Devices Packaging and Calibration: MEMS device Calibration and packaging techniques, Reliability. MEMS software training: COMSOL & Intellisuite.

Project The class project is to design reasonably complex MEMS devices. The project will be performed as a team of two or three students

Course Outcomes :

CO1- Gain a knowledge of basic approaches for various MEMS sensors and actuators design. (Cognitiveunderstaning)

CO2-Capability to critically analyze microsystems technology for technical feasibility as well as practicality. (Affective- Evaluate)

CO3 -Develop efficient design for improving device performance in terms of speed, sensitivity Selectivity and accuracy. (Skills- Create)

CO4- Design and optimization of RF MEMS sensors and actuators (Skills- Create)

CO5- Design and analysis of efficient MEMS presser sensor. (Skills- Analyze)

References:

1) Course notes – will be posted weekly on the course website
2) Foundations of MEMS, Chang Liu, Prentice Hall (2006)
3) Fundamentals of Micro fabrication, Marc Madou, CRC (2002)
4) Introduction to BioMEMS – Albert Folch, CRC (2012)

Course Name : Synchronous & Asynchronous Sequential Circuits
Course Code :
Credits : 3 (L-T-P : 3-0-0)

Syllabus:

Design of synchronous sequential circuits: state diagram, state table, minimization, minimization techniques, memory assignments and implementation
Classification of Synchronous sequential: Melay, Moore machine and implementation
Design of asynchronous sequential circuits : low power, performance, modularity. Historic difficulties with asynchronous design. Flow Table Reduction, The state-assignment Problem, Delays, Hazards, and Analysis, Feedback, other Modes of operation, Counters.
Design and implementation of Incompletely specified machine
Algorithmic State Machine: Design process and implementation
Circuit Classification: Bounded Delay, speed independent, and delay independent. Data models (single-rail, dual-rail). Handshaking protocols (2 phase, 4 phase)
Micropipeline Circuits: Basic building blocks. Pipelines, with and without data processing elements. The design of the Amulet processors.

Course Outcomes :

CO1- Gain a knowledge of asynchronous techniques. (Cognitive- understanding)
CO2-Evalvate delays and hazards in asynchronous design. (Affective- Evaluate)
CO3 –Analyze different method for improving digital design. (Skills- analyze)
CO4- Design and optimization of NCL logic. (Skills- Create)

References:

1) Asynchronous sequential circuits by Stephen H. Unger, John Wiley & Sons
2) Digital Integrated Circuits- A Design perspective, Jan M. Rabaey, PHI
3) Switching and Finite Automota Theory. Kohavi, Tata McGraw Hill

Course Name : Estimation and Detection
Course Code :
Credits : 3 (L-T-P : 3-0-0)

Syllabus:

Classical Detection Theory:
Decision Theory; Binary Decisions, Gaussian Noise; Detection in Gaussian Noise; Discrete Representation for Signals; Solution of the Integral Equations; Decisions among a Number of Known Signals, Performance Bounds and Approximations, Detection in Non-white Gaussian Noise Estimation of Parameters and Random Processes:
The theory of estimation; Bayes estimation; Estimation of (Non-random) signal parameter; Multiple parameter estimation, Estimation Bounds, ML estimation via Expectation-Maximization algorithm, Regularization Joint Estimation and Detection:
Composite Hypotheses, Linear Estimation, Elements of Modern estimation and detection theory (as the time permits).

Course Outcomes :

CO1-Master the fundamentals of estimation and detection theory.
CO2-Analyse the performance bounds of various detection schemes.
CO3-Master the estimation schemes using advanced techniques.
CO4-Analyse the strengths and shortcomings of existing estimation and detection techniques.
CO5- Study the state of the art in the estimation and detection.

References:

1) H. L. Van Trees, Detection, Estimation, and Modulation Theory, vol. 1, Wiley Interscience, 2001.

2) C. W. Helstrom, Elements of Signal Detection and Estimation, Prentice Hall, 1995.
3) H. V. Poor, An Introduction to Signal Detection and Estimation, Springer, New York, 1994.

Course Name : RF Integrated Circuits
Course Code :
Credits : 3 (L-T-P : 3-0-0)

Syllabus:

Fundamental concepts in RF Design – harmonics, gain compression, desensitization, blocking, cross modulation, intermodulation, inter symbol interference, noise figure, Friis formula, sensitivity and dynamic range; Receiver architectures – heterodyne receivers, homodyne receivers, image-reject receivers, digital-IF receivers and subsampling receivers; Transmitter architectures – direct-conversion transmitters, two-step transmitters;
Low noise amplifier (LNA) – general considerations, input matching, CMOS LNAs; Down conversion mixers – general considerations, spur-chart, CMOS mixers; Oscillators – Basic topologies, VCO, phase noise, CMOS LC oscillators;
PLLs – Basic concepts, phase noise in PLLs, different architectures.

Course Outcomes :

CO1- Knowledge of basic concepts in RF integrated circuit design (Cognitive- understanding)
CO2- Acquaintance with various architectures of receivers and transmitters (Cognitive- Analyze)
CO3- Awareness of several concepts of low noise amplifiers (Cognitive- understanding)
CO4- Knowledge of applications of mixers, oscillators and PLLs. (Skills- Applying)

References:

1) Behzad Razavi, RF Microelectronics, Prentice Hall PTR, 1997
2) Thomas H. Lee, The design of CMOS radio-frequency integrated circuit, Cambridge University Press, 2006
3) Chris Bowick, RF Circuit Design, Newnes, 2007.

Course Name : Pattern Recognition and Machine Learning
Course Code :
Credits : 3 (L-T-P : 3-0-0)

Syllabus:

UNIT I

Introduction to Pattern Recognition and Machine Learning, ML design cycle, types of learning: supervised, unsupervised and reinforced, introduction to feature extraction and classification, density and discriminant functions, decision surfaces. Review of probability theory: conditional probability, Bayes theorem, random variables, density and mass functions, expectation and variance, joint distribution function of multiple random variables, multivariate normal distribution.

UNIT II

Bayesian decision theory, Bayes Classifier, Naïve Bayes classifier, Euclidian distance and Mahalanobis distance-based classifiers, minimum-error-rate classification. Parameter estimation methods, Maximum-Likelihood estimation, Gaussian mixture models, Expectation maximization method, Bayesian estimation, Hidden Markov models for sequential pattern classification: discrete hidden Markov models, continuous density hidden Markov models.

UNIT III

K-nearest neighbour classification: Simple and distance weighed voting approach. Support vector machines: linear SVM, softmargin approach for non-separable data, kernel trick to learn non-linear SVM, radial basis function, polynomial, and sigmoidal kernel. Decision tree classifier: set of questions, splitting criterion, stop-splitting rule, and class assignment rule in decision tree. Introduction to neural networks: perceptron as linear classifier and multi-layer perceptron. Regression Analysis.

UNIT IV

Feature extraction methods: statistical features, Fourier and wavelet transforms for feature extraction, Data transformation and dimension reduction: Fisher's linear discriminant analysis, Bayesian LDA, step-wise LDA, principal component analysis, kernelPCA. Optimization in feature selection. Feature visualization. Ensemble of classifiers. Evaluation the performance of a classifier: holdout, random sampling, and cross validation methods, sensitivity, specificity, confusion matrix and ROC curve. Multi-class classification. Statistical analysis for comparison of significance of multiple classifiers over multiple dataset: Template matching and context dependent classification. The curse of dimensionality.

UNIT V

Unsupervised learning and clustering. Criterion functions for clustering, Prototype-based, Graph-based, Density-based clusters. Algorithms for clustering: K means, DBSCAN, Hierarchical clustering, Cluster validation.

Course Outcomes :

CO1-The students would have exposure to different algorithms for learning pattern classification methods and would also have explore to different datasets to get a feel for ML algorithms.

CO2- The statistical and mathematical formulation underlying different algorithms would be understood.

CO3- A background needed to study more advanced topics in ML will be developed (e.g. Deep Learning, Generative Adversarial Networks, etc.).

CO4-The course would help students to build a career in industry using ML, or to be a data scientist, or to pursue research in ML.

References:

Reference Text-Books

1) R. O. Duda, P. E. Hart and D. G. Stork, Pattern Classification, John Wiley, 2001
2) S. Theodoridis and K. Koutroumbas, Pattern Recognition, 4th Ed., Academic Press, 2009
3) C. M. Bishop, Pattern Recognition and Machine Learning, Springer, 2006
4) T. Pang-Ningm, V. Kumar, M. Steinbach. Introduction to data mining. Pearson Education India, 2018.

Programming Books

5) S. Theodoridis et. al., 'Introduction to Pattern Recognition, A MATLAB Approach'. Academic Press, 2010

Course Name : Quantum Computing
Course Code :
Credits : 3 (L-T-P : 3-0-0)

Syllabus:

Introduction to Quantum Computing

Basics of quantum mechanics, quantum postulates, superposition, entanglement, No cloning theorem, Qubits, measurement on single and multiple qubits, Hilbert space, state vector Bra ket notation, Bloch sphere,

Quantum Computing and Networking Components
Single and two Qubit quantum gates, unitary transformation, composite state tensor product, cascade and parallel quantum circuits, Quantum diode, quantum router, quantum memory

Potential Quantum Algorithms
Quantum key distributions, quantum teleportation, Grover's algorithm (data base search) and Shor's algorithm (integer factorization), Deutsch–Jozsa algorithm, quantum Fourier transform (QFT), overview of open-source software for working with quantum computers at the level of circuits, and algorithms

Physical Realization of Quantum Circuits
Physical representation of Qubit, Nuclear magnetic resonance (NMR), Trapped ion, linear optics quantum computing (LOQC), Quantum electrodynamics (QED), Superconducting quantum computer

Application of Quantum Computing
Quantum communication and Cryptography, Quantum error correction (QEC), Quantum Machine learning, Big data search, Drug simulation

Course outcomes:
CO1: Understand basic concepts of quantum computing
CO2: Understand and analyze quantum switching, storage and computing devices
CO3: Apply and analyze quantum algorithms
CO4: Understand various quantum circuit implementation techniques
CO5: Design various applications of quantum computing
Reference Books:
1. Quantum Computation and Quantum Information" by Michael Nielsen and Isaac Chuang
2. Quantum computing : a gentle introduction / Eleanor Rieffel andWolfgang Polak.
3. Quantum Computing for Everyone" by Chris Bernhardt
4. Quantum Computing: An Applied Approach" by John Preskill
5. Quantum Computing: From Linear Algebra to Physical Realizations" by Masahiro Hotta and Keiji Matsumoto

Course Name : Computational Electromagnetics
Course Code :
Credits : 3 (L-T-P : 3-0-0)

Syllabus:

- Review of Electromagnetic Theory
- Analytical Solution of Partial Differential Equations (PDE)
- Finite Difference Time Domain (FDTD) Techniques
- Finite Element Methods (FEM)

- Boundary Element Methods (BEM/MoM).

Course Outcomes :

CO1- To apply numerical methods in understanding electrostatics and high frequency electromagnetics.
CO2- To evaluate the numerical solution in terms of validity and accuracy.
CO3- To assess the limitations and applicability of the discussed numerical methods.
CO4- To understand the default parameters for efficient usage of commercial solvers.
CO5- To explore independently the scientific literature for state of the art techniques.

References:

Reference Text-Books

1) Numerical Techniques in Electromagnetics, by Matthew N.O. Sadiku, CRC Press.
2) Theory and *Computation of Electromagnetic Fields by Jianming Jin, Wiley.*

Course Name : Quantum Mechanics for Electronics Engineering
Course Code :
Credits : 3 (L-T-P : 3-0-0)

Syllabus:

- Introduction and Motivation of Quantum Mechanics, Waves mechanics
- Schrodinger's equation, Measurement and Expected Values, Functions and operators
- Concepts of Angular Momentum, Spin, Pauli Exclusion Principle
- Energy Band Diagrams, Semiconductors, Crystalline Materials, Harmonic Oscillators, Photons
- Introduction to Quantum Computing and Quantum Information Theory

COURSE OUTCOMES

CO1. To understand the motivation behind the development of quantum mechanics

CO2. To develop an understanding of mathematical foundations.

CO3. To develop an understanding of the concepts of angular momentum and spin.

CO4. To apply key quantum mechanical concepts to electronics engineering problems.

CO5. To apply key quantum mechanics concepts in the area of computing and information theory.

Recommended Readings

Text Books:-

1. *Miller, David AB. Quantum mechanics for scientists and engineers. Cambridge University Press, 2008.*

2. *Griffiths, David J., and Darrell F. Schroeter. Introduction to quantum mechanics. Cambridge university press, 2018.*

3. *Cohen-Tannoudji, Claude, Bernard Diu, and Frank Laloe. "Quantum Mechanics, Volume 1." Quantum Mechanics 1 (1986): 898.*

Course Name : Advanced Semiconductor Devices & Circuits
Course Code :
Credits : 3 (L-T-P : 3-0-0)

Prerequisites:1. Solid State Devices and Circuits
Course Objectives:

The course will provide adequate understanding of semiconductor devices and their modeling aspects, useful for designing devices in electronic, and optoelectronic applications.

Course Outcomes:

Upon Completion of the course, the students will be able to:
CO1 Analyse MOSFET functionalities and physics
CO2 Understand Short Channel Effects (SCEs)
CO3 Design Scaled MOSFETs.
CO4 MOSFET Modeling for scaled devices.
CO5 Familiarisation with state of art semiconductor devices.

Syllabus:

Introduction to Nano Electronics: Introduction to nanotechnology, mesostructures, Basics of Quantum Mechanics: Schrodinger equation, Density of States. Particle in a box Concepts, Degeneracy. Band Theory of Solids. Energy band diagram of Metal-Oxide-Semiconductor contacts, Mode of Operations: Accumulation, Depletion, and Inversion. CV characteristics of MOS, Non-idealities in MOSFET.

MOSFET Scaling: Basic physics of MOS transistors scaling, charge sharing effect (CSE), narrow and reverse narrow width effect, SCE, DIBL, GIDL, mobility degradation due to gate field, hot electron effect and velocity saturation, channel in-homogeneity, velocity overshoot, tunneling through oxide, system integration limits: interconnect issues, High field effects and MOSFET reliability issues.

Metal-semiconductor junctions: Rectifying and ohmic contacts, role of surface states, Comparison of p-n junction and Schottky diodes. MESFETS, Hetero-junction devices-HEMTs, HBTs.

MOSFET Modeling: MOS device modeling-long channel effects and short channel structures scaled down device models, SRH and Auger models of recombination, Threshold voltage and body effect, Long channel models for drain current, effect of non-uniform doping in the channel, channel length modulation and dynamic operation, modeling of SOI MOSFET.

Advanced/State of Art Semiconductor Devices: Introduction to nanoscale MOSFETs, Resonant Tunnelling Diode, optoelectronic and spintronic devices, Coulomb dots, Quantum blockade, Single electron transistors, Carbon nanotube electronics, 2D semiconductors and electronic devices, Graphene, atomistic simulation.

Text Books:

1. Solid State Electronic Devices, 6th Edition, Ben Streetman, University of Texas, Austin Sanjay Banerjee, University of Texas at Austin, 2006.
2. S.M. Sze & Kwok K. Ng, Physics of Semiconductor Devices, Wiley, 2007.
3. Semiconductor Physics and Devices, Basic Principles, Third Edition, Donald A. Neamen, 2004.

Reference Books:

1. Yuan Taur & Tak H. Ning, Fundamentals of Modern VLSI Devices, Cambridge 2013
2. Mark Lundstrom & Jing Guo, Nanoscale Transistors: Device Physics, Modeling & Simulation, Springer 2006
3. Yannis Tsividis, Operation and Modeling of the MOS Transistor, Oxford University Press, 2010

Course Name : Medical Engineering & Systems
Course Code :
Credits : 3 (L-T-P : 3-0-0)

Syllabus:
Module 1: Physiological Signal Processing
Physiology: Basics of ECG Signal and its Acquisition, Electrical activity of heart, ECG Waveform, Interpretation of ECG, Introduction of EEG Signal, EEG Acquisition, Neural activity in the brain, Signal Propagation in the brain, EMG signal, EMG recording, Signal processing and Filtering of EEG, ECG, EMG etc. **[8 Hours]**
Module 2: Wearable Device and Healthcare Technologies
Health monitoring with wearable sensors, Wearable electrodes of ECG, EEG & EMG, Accelerometer, Glucose sensing device, Smart healthcare components- cHealth, eHealth and mHealth. Role of IoT in Healthcare, Electronics Health Records, Concept of Bioinformatics, Security and Privacy of Health records [**8 Hours]**

Module 3: Machine Learning for Health information
Data & Modelling of Health information, Basics concepts of ML, Role of ML for Healthcare, Feature Extraction of real-world signals as speech, audio, text, image, video., Pre-processing Requirements of signals, Noise and artifacts, information retrieval, Optimization, Regression, Classification, Unsupervised Learning for Health data, Pattern Recognition, Gaussian models, Time series modelling. **[10 Hours]**
Module 4: Deep learning for healthcare
Basics of DL, MLP, Back Prorogation, Convolutional Neural Networks & Recurrent Neural network for digital health, Forward and Backward propagations, Architectures for sequence to sequence and sequence to vector mapping, Models for Healthcare using deep, recurrent and deep networks, LSTM, Medical Image analysis, Need for Deep Learning & Neuroimaging, Object Detection, Segmentation, Deep learning models. **[8 Hours]**
Module 5: Medical Devices and Systems
Risks of Integration and Healthcare Systems Testing & Evaluation, Vitro/Vivo testing, Regulatory requirements of medical devices, Standards of medical device, quality assurance Medical Device Classification, Risk management system for medical devices, Certification of medical device, Ethical regulation of medical devices & systems, Medical Devices regulation in India, USA and other countries**. [4 Hours]**
Course Outcomes:
CO1: To understand the basic concepts of various physiological signals and their processing (Knowledge)
CO2: To understand and design the medical devices and technologies for healthcare (Cognitive, Understanding)
CO3: To learn and develop the machine learning models for healthcare applications (Affective, creative)
CO4: To aware of various risk, ethical and regulatory rules for medical devices & systems (Cognitive- Analytic)
Textbooks:
References:
1. Introduction to Biomedical Engineering by John Enderle , Joseph Bronzino Academic Press
2. **Biomedical Engineering: Bridging Medicine and Technology by W. Mark Saltzman, Cambridge**
3. **Machine Learning and Analytics in Healthcare Systems: Principles and Applications (Green Engineering and Technology) by Himani Bansal, Balamurugan Balusamy, et al., CRC.**
4. **Machine Learning in Medicine by Ayman El-Baz and Jasjit S. Suri, Chapman & Hall/CRC Health Informatics,**

5. Demystifying Big Data, Machine Learning, and Deep Learning for Healthcare Analytics by Pradeep N, Sandeep Kautish, et al., Academic Press

Course Name : Mixed Signal IC Design
Course Code :
Credits : 3 (L-T-P : 3-0-0)

Syllabus:
Sample & Hold Circuits
Basic S/H circuits, effect of charge injection, compensating for charge injection, bias dependency, bias independent S/H

D/A Converter
General considerations, Static non-idealities & Dynamic non-idealities, Current steering DAC, Binary weighted DAC, Thermometer DAC, Design issues, Effect of mismatches

A/D Converter
General considerations, Static & Dynamic non-idealities, Flash ADC - Basic architecture, Design issues, Comparator & Latch, Effect of non-idealities, Interpolative and folding architectures, Successive approximation ADC, Pipeline ADC, Oversampling ADC - Noise shaping, Sigma-Delta modulator

PLLs
Basic Phase-Locked Loop Architecture, Voltage controlled oscillator, Divider Phase Detector,
Loop Filer, The PLL in Lock, Liberalized Small - Signal Analysis, Second - order PLL Model, Limitations of the second - order Small - Signal Model, PLL Design Example

References:
1. Behzad Razavi, "Principles of data conversion system design," S. Chand & Co. Ltd., 2000
2. Design of Analog CMOS Integrated Circuits: Behzad Razavi, Mc Graw Hill Education (India), 2018
3. VLSI Design techniques for Analog and digital Circuits: R. L. Geiger, P. E. Allen, D. R. Holberg, OUP, (2/E) McGrqw Hill (2002)
4. Jacob Baker, "CMOS Mixed-Signal Circuit design", A John Willy & Sons' inc' publications, 2003.
5. Analysis and Design of Analog ICs: Paul, Grey, et. al., J Willy and Sons, 4/E, 2001

Course Outcomes:
At the end of the course the student will be able to:
CO1: Understanding working of sample and hold circuits, compensation methods and bias independent design techniques.
CO2: Understanding basic of ADC, various design issues and their mitigation methods.
CO3: Understanding basic of DAC, various design issues and their mitigation methods.
CO4: Understanding the PLL principle of operation, working of its component, and the effects of the loop components on the system performance.
CO5: Design a phase-locked loop for application as a frequency synthesizer, frequency tracking filter, and demodulator for AM, FM.

Course Name : Photonic Switching
Course Code :
Credits : 3 (L-T-P : 3-0-0)

Syllabus:
Unit –I: Introduction to Photonic Switching: All Optical Switches, Comparison of OEO and OOO switches, Parameters used for switch

performance evaluation, applications of optical Switches, optical cross-connects, protection and restoration, optical Add/Drop multiplexing, optical signal monitoring, etc.

Unit –II: Switch Types & Structures: Optical Switch Fabrics, Opto-mechanical Switches, Optical Micro Electro-Mechanical Systems (Optical MEMS), Electro-Optic Switches, Thermo-Optic Switches, Liquid-Crystal Switches, Bubble Switches. Acousto-Optic Switches, Semiconductor Optical Amplifier Switches, grated switches and photonic crystal fibre based switches, etc.

Unit –III: Switch Architectures: Introduction to various architectures & algorithms for building large switches, Cross, Clos, Banyan architecture, Benes architecture, Spanke architecture, Spanke- Benes architecture, etc.

Unit –IV: Switching in Optical Networks, Opaque Switching, Challenges for Optical Switching, Optical Switching Paradigms, nano photonic switches.

COURSE OUTCOMES

CO1: Appreciate and evaluate all optical switches
CO2: Design various types of optical switches
CO3: Understand different switch architectures
CO4: Implementation of optical switches in optical networks

Recommended Readings

Text Books: -

1. Optical Switching by G.I Papadimitriou, C. Papazoglon and A.S Pomportsis, Wiley series in microwave & optical Engg.
2. Optical components for communications by Ching-Fuh Lin, Kluwer academic publishers.
3. Photonics by Ralf Menzel, Springer International Edition.

Course Name : Embedded SoC & Cyber Physical Systems
Course Code :
Credits : 3 (L-T-P : 3-0-0)

Syllabus:

Embedded SoC

Design methodology- high performance embedded computing, and real-time operating system; HW-SW codesign, FPGA for embedded Systems design, programmable SoC (Zynq SoC); Advanced Computing Models & Architectures [8 hrs]
ARM, interfacing, Microkernels and exokernels, monolithic kernels, Domain specific architectures,
Zynq SoC based design methodology- boot image, flash; advanced Cortex™-A9 processor services; DMA
controller in the Zynq SoC; Ethernet and USB controllers; [8 hrs]
Software organization, scheduling, and execution; Energy management and low-power design; Safety and reliability in embedded systems; Emerging Memory Technologies; Fault Resilient Chip Design; Energy Efficient Exascale Systems; [8 hrs]

Cyber physical Systems
Algorithms, hardware and software components integration with Internet; conceptual understanding of techniques to
translate application non-functional requirements to middleware and hardware functionality, as well as practical implementation of these techniques; Interfacing to the external world through sensors and actuators [8 hrs]
(a) Case studies: Low-end systems (medical devices, smart cards, sensors) [3 hrs]
(b) Case studies: High-end systems (automobiles, home electronics, robotics) [3 hrs]

References:

1. Jonathan W. Valvano, Embedded Systems: Real-Time Operating Systems for ARM® Cortex™-M
Microcontrollers, Volume 3, Fourth edition, January 2017, ISBN: 978-1466468863. Outline: http://www.ece.utexas.edu/~valvano/arm/outline3.htm
2. Edward Lee and Sanjit Seshia, Introduction to embedded systems: A cyber-physical systems approach, MIT Press, 2016. (Free PDF: http://leeseshia.org/download.html)
3. Philip Koopman, Better embedded system software, Drumnadrochit Education, 2010.
4. Embedded System Design: A Unified Hardware/Software Introduction, Frank Vahid and Tony Givargis, John Wiley and Sons, 2001, ISBN No. 04711386782.
5. High-Performance Embedded Computing: Architectures, Applications, and Methodologies, Wayne Wolf, Morgan Kaufmann Publishers, 2006, ISBN No. 012369485.
6. J .Fitzgerald, P.G. Larsen, M. Verhoef (Eds.): Collaborative Design for Embedded Systems: Co-modelling and Co-simulation. Springer Verlag, 2014, ISBN 978-3-642-54118-6.
7. Suh, S.C., Carbone, J.N., Eroglu, A.E.: Applied Cyber-Physical Systems. Springer, 2014.
8. Hennessy and Patterson, Computer Architecture- A Quantitative Approach, 4th or later Edition (ISBN-13: 978-0123704900 ISBN-10: 0123704901 Edition: 4th)

Further reading

1. Edward A. Lee, Cyber-Physical Systems - Are Computing Foundations Adequate?
2. Paulo Tabuada, Cyber-Physical Systems: Position Paper
3. Rajesh Gupta, Programming Models and Methods for Spatio-Temporal Actions and Reasoning in Cyber-Physical Systems
4. E. A. Lee and S. A. Seshia, Introduction to Embedded Systems - A Cyber-Physical Systems Approach, http://LeeSeshia.org, 2011.
5. Altawy R., Youssef A., Security Trade-offs in Cyber Physical Systems: A Case Study Survey on Implantable Medical Devices
6. Ahmad I., Security Aspects of Cyber Physical Systems
7. "US National Science Foundation, Cyber-Physical Systems (CPS)"
8. ^ Jump up to: a b Khaitan et al., "Design Techniques and Applications of Cyber Physical Systems: A Survey", IEEE Systems Journal, 2014.

Course outcomes:
Is able to:
CO1: Understand significance of embedded HW/SW, computing models & architectures (Cognitive-Understand)
CO2: Understanding of CPU operation, I/O devices and their interfacing (Cognitive- Understand)
CO3: Develop C/C++ programs in real-time operating systems for memory management, interrupt handling, thread
management, task scheduling and software/hardware interfacing. (Skills- Apply, Create)
CO4: Learn program and system design and analysis methodologies (Skills- analyze and design)
CO5. Relate to the real-world applications of embedded systems and associate it with emerging areas such as Cyber-Physical Systems (CPS), Internet-of-Things (IoT), and robotics.

Course Name :Computer and Network Security
Course Code :
Credits : 3 (L-T-P : 3-0-0)

Prerequisite: : Cryptography, Computer networks,

Unit - I Introduction: Introduction (a) Security(b) Malware(c) OWASP top ten and other major security issues in the world(d) CVE and other information
(e) Introduce various types of security areas 5

Unit - II Software and OS Security : OS Security: Common Bugs, Buffer Overflow, Runtime Defences against memory safety vulnerabilities, program verification and other vulnerabilities, Principles in OS Security; Mechanisms for confining bad code, Mechanisms for confining bad code
: isolation, sandboxing, SFI and Virtualization, Trusted Computing 8

Unit - III Web Security: Secure web site design (SQL injection, XSS, etc.), Browser Security, 7

Unit - IV Network Security: TCP/IP, DDoS Attacks, Network worms and bot-nets: attacks and defences, DNS and BGP security, Network defence tools – Firewall and Intrusion Detection. 11

Unit - V Future/Advanced Security: Introduction - The Security in Existing wireless Networks, Upcoming wireless networks and challenges, Thwarting and malicious behaviour – Naming and addressing, security association and secure neighbour discovery, secure routing in multichip wireless networks and privacy protection. Mobile OS Security and Privacy: Android, IOS security challenges, processor security, privacy, anonymity and censorship and other security issues according to the current situations and future requirements
9

References

1. Security in Computing (3rd edition)
2. Cryptography and Networks 7 edition

3. The course materials are mainly from the lecturing slides I?ve made and research papers from top conferences like NDSS, USENIX, SIGCOMM, MOBICOM, NSDI, MobiSys etc.

Course Name: Principles of Communication Engineering (for B.Tech. EE)
Course Code :
Credits : 3 (L-T-P : 3-0-0)

SYLLABUS :

Introduction of Communication System and Amplitude Modulation: Overview of communication systems, Orthogonal representation of the signal, Double sideband suppressed carrier (DSB-SC) modulation, Double sideband carrier (DSB-C), Single sideband (SSB) modulation, Other AM techniques and frequency division multiplexing, Radio transmitter, and receiver.

Frequency Modulation: Spectrum of tone-modulated signal, arbitrary modulated FM signal FM modulated and demodulated signal, stereophonic FM broadcasting.

Pulse Modulation and Phase-Locked Loops (PLL): Pulse amplitude modulation, Pulse width and Position modulation, Differential pulse code modulation, Delta modulation, voice coders, Analog PLL, digital PLL, and Application of PLL.

AM and FM Reception Performance under Noise: Single Sideband Suppressed Carrier (DSB-SC) Modulation, Comparisons of AM System: A figure of Merit, Threshold Effect in AM and FM Reception. Signal-to-Noise Ratio, Pre-emphasis and De-emphasis and SNR Improvement, The Threshold in an FM Discriminator, FM Demodulation using Feedback (FMFB)

STUDY MATERIAL:
A. TEXT / REFERENCES:
1. Lathi B.P, Modern Digital and Analog Communication Systems, 3rd Ed, Oxford University Press, 2005.
2. H. Taub, D. L. Schilling and Gautam Saha, Principles of Communication Systems, 3rd ed, TMH, 2008.
3. Haykin, Communication Systems, 4th Ed, John Wiley & Sons, 2004.

Course Outcomes:
CO1-To familiarize the students about different analog modulation and demodulation schemes
CO2- To understand analog-digital conversion techniques.
CO3- To analyze the performance of different modulation techniques under noise.
CO4- To apply the concept of probability and random processes in analysis of communication systems.
CO5- To perform noise analysis of communication systems

Syllabus for Honours Courses

Honors in Machine Learning and Signal Processing

Course Name: Modeling, Optimization and Transforms
Course Code :
Credits : 3 (L-T-P : 3-0-0)

SYLLABUS :
Unit I- Advancements in Transforms: Discrete Fourier Transform, FFT, Short time Fourier Transform (STFT), Multi Resolution Analysis, Wavelet Transform, Continuous Wavelet Transform (CWT), Inverse CWT, Discrete Wavelet Transform, Sub-band coding and implementation of DWT, Applications (signal and image compression, de-noising, detection of discontinuous and breakdown points in signals), Discrete Cosine Transform, Stockwell-transform, Frequency selective filtering with wavelet and S-transform.

Unit II- Modelling: Direct Modeling (identification), Inverse Modeling (Equalization), Classification and Clustering, Prediction/Forecasting, Auto regressive models (AR, MA, ARMA).

Unit III- Optimization: Problem formulation, Linear Programming Problems, Solution by Graphical Methods, Symmetric Dual Problems, Slack and Surplus Variables, Simplex Method, Convex- Concave Problems.

Unit IV- Data Mining Techniques: Higher Order Statistics, Principal Component Analysis, Linear Discriminant Analysis, Independent Component Analysis

COURSE OUTCOMES
CO1: To learn the advancement in transforms
CO2: To understand the mathematical modeling and optimization techniques.
CO3: To learn the data mining techniques
CO4: To explore the engineering applications of the mathematical techniques.
CO5: To develop MATLAB and other programming skills for the mathematical techniques realization.

Recommended Readings
Text Books:-
1. Digital Signal Processing: Principles, Algorithms, and Applications 4 Edition, Author: John G. Proakis, Dimitris G Manolakis Publisher: Pearson.
2. Wavelets and Signal Processing, Author: Hans-Georg Stark, Publisher: Springer
3. Stockwell, Robert Glenn, Lalu Mansinha, and R. P. Lowe. "Localization of the complex spectrum: the S transform." IEEE Transactions on Signal Processing 44.4 (1996): 998-1001.

Reference books:-
1. Engineering Optimization: Theory and Practice, Third Edition SINGIRESU S. RAO, New Age Publishers
2. Data Mining - Concepts and Techniques, Authors : Jain Pei, Jiawei Han, Micheline Kamber, Publisher : Elsevier
Online/E resources:-
1. The Wavelet Tutorial : The Engineer's Ultimate Guide to Wavelet Analysis, Author : Robi Polikar, University of Rowan : Online : http://users.rowan.edu/~polikar/WTtutorial.html

Course Name: Multirate Signal Processing
Course Code :
Credits : 3 (L-T-P : 3-0-0)

SYLLABUS :
Unit I- Introduction to Multirate Signal Processing; Overview of Sampling and Reconstruction, Review Discrete-Time Systems, Digital filters, FIR and IIR Filter, Oversampling techniques, DT processing of continuous time signals.

Unit II- Fundamentals Blocks of Multirate Systems, Basic building blocks – Up sampling, Down sampling, Aliasing, Interference, Reconstruction, Sampling Rate Change and filtering, Fractional sampling rate alteration, Different Applications.

Unit III- Interconnection of Multirate DSP blocks, Multiplexer and De-multiplexer functionality, Polyphase decomposition, Noble Identities, Efficient implementation of sampling rate conversion, Classification of Realization Techniques, Direct Form Realization.

Unit IV- Classification of Filterbank, Two channel maximally decimated filter bank, Signal impairments - Aliasing, Magnitude distortion, Phase distortion, M-Channel Filterbank, Uniform Filterbank, Non-Uniform Filterbank, Perfect reconstruction Filterbank, Aliasing cancellation, Tree Structure, Parallel

Structure, Modulation based Methods.

Unit V- Applications of Multirate DSP - DFT-based Filterbank, Interpolated FIR filter design, Delta Sigma A/D conversion, Transmultiplexers Design, Recent Advancement in Multirate System.

COURSE OUTCOMES

- Analysis of Recent Signal Processing Techniques and Algorithms in Filterbank Systems
- Design FIR filters for multi rate signal processing, Appreciate Components of Multirate System
- Design PR and NPR Filterbank and Transmultiplexers Systems
- Characteristics of Multirate systems
- Evaluate sampling rate conversions and learn different Applications

Recommended Readings

Text Books: -

1. Vaidyanathan, Parishwad P., "Multirate systems and filter banks", Pearson Education India, 2006
2. Rabiner, Lawrence R., "Multirate digital signal processing", Prentice Hall PTR, 1996

Reference books:-

1. 1. N.J. Fliege, "Multirate digital signal processing", John Wiley 1994
2. S. K. Mitra and Y. Kuo, " Digital signal processing: a computer-based approach", McGraw-Hill, 2006.

Online/E resources:-

1. https://nptel.ac.in/courses/117/102/117102060/
2. https://onlinecourses.nptel.ac.in/noc19_ee50/

Course Name: Medical Engineering and Systems
Course Code :
Credits : 3 (L-T-P : 3-0-0)

SYLLABUS :

Module 1: Physiological Signal Processing
Physiology: Basics of ECG Signal and its Acquisition, Electrical activity of heart, ECG Waveform, Interpretation of ECG, Introduction of EEG Signal, EEG Acquisition, Neural activity in the brain, Signal Propagation in the brain, EMG signal, EMG recording, Signal processing and Filtering of EEG, ECG, EMG etc.

Module 2: Wearable Device and Healthcare Technologies
Health monitoring with wearable sensors, Wearable electrodes of ECG, EEG & EMG, Accelerometer, Glucose sensing device, Smart healthcare components- cHealth, eHealth and mHealth. Role of IoT in Healthcare, Electronics Health Records, Concept of Bioinformatics, Security and Privacy of Health records

Module 3: Machine Learning for Health information
Data & Modelling of Health information, Basics concepts of ML, Role of ML for Healthcare, Feature Extraction of real-world signals as speech, audio, text, image, video., Pre-processing Requirements of signals, Noise and artifacts, information retrieval, Optimization, Regression, Classification, Unsupervised Learning for Health data, Pattern Recognition, Gaussian models, Time series modelling.

Module 4: Deep learning for healthcare
Basics of DL, MLP, Back Prorogation, Convolutional Neural Networks & Recurrent Neural network for digital health, Forward and Backward propagations, Architectures for sequence to sequence and sequence to vector mapping, Models for Healthcare using deep, recurrent and deep networks, LSTM, Medical Image analysis, Need for Deep Learning & Neuroimaging, Object Detection, Segmentation, Deep learning models.

Module 5: Medical Devices and Systems
Risks of Integration and Healthcare Systems Testing & Evaluation, Vitro/Vivo testing, Regulatory requirements of medical devices, Standards of medical device, quality assurance Medical Device Classification, Risk management system for medical devices, Certification of medical device, Ethical regulation of medical devices & systems, Medical Devices regulation in India, USA and other countries.

Course Outcomes:
CO1: To understand the basic concepts of various physiological signals and their processing (Knowledge)
CO2: To understand and design the medical devices and technologies for healthcare (Cognitive, Understanding)
CO3: To learn and develop the machine learning models for healthcare applications (Affective, creative)
CO4: To aware of various risk, ethical and regulatory rules for medical devices & systems (Cognitive- Analytic)

Textbooks:

References:

1. Introduction to Biomedical Engineering by John Enderle , Joseph Bronzino Academic Press
2. **Biomedical Engineering: Bridging Medicine and Technology by W. Mark Saltzman, Cambridge**
3. **Machine Learning and Analytics in Healthcare Systems: Principles and Applications (Green Engineering and Technology) by Himani Bansal, Balamurugan Balusamy, et al., CRC.**
4. **Machine Learning in Medicine by Ayman El-Baz and Jasjit S. Suri, Chapman & Hall/CRC Health Informatics,**
5. Demystifying Big Data, Machine Learning, and Deep Learning for Healthcare Analytics by Pradeep N, Sandeep Kautish, et al., Academic Press

Course Name: Computer Vision
Course Code :
Credits : 3 (L-T-P : 3-0-0)

SYLLABUS :

Course Name: Reduced order modeling, Optimization and Machine Intelligence
Course Code :
Credits : 3 (L-T-P : 3-0-0)

SYLLABUS :

A. Reduced order modelling & large Eigen value methods-

(i) (a) Large Matrix analysis and large Eigen value problem– Groups, fields and rings; vector spaces; basis & dimensions; canonical forms; inner product spaces- orthogonalization, Gram-Schmidt orthogonalization, unitary operators, change of orthonormal basis, diagonalization; (b) Eigenvalues & eigen vectors- Gerschghorin theorem, iterative method, Sturm sequence, QR method, introduction to large eigen value problems.

(ii) Reduced order modelling of systems- Taylor's polynomial, least square approximation, Chebyshev series/polynomial, curve fitting & splines, Pade & rational approximation

B. Discrete Structures, algorithms & Combinatorial optimization- counting methods, algorithm analysis, graph algorithms, dynamic algorithms, randomized algorithms, probabilistic algorithms, combinatorial optimization

C. Digital arithmetic & machine intelligence-

(i) Number theory & computer arithmetic- unconventional number systems, residue number system, logarithmic number system, Chinese remainder theorem; fast evaluation of elementary & transcendental arithmetic functions.

(ii) Preface to AI- first order logic & inferencing, uncertainty, probabilistic reasoning systems, making decisions under uncertainty.

Suggested references (not limited to)-

1. Schaum's outline on Linear Algebra, McGraw Hill
2. Topics in Algebra, I. N. Herstein, Wiley.
3. Advanced Model Order Reduction Techniques in VLSI Design, Sheldon Tan, Lei He, Cambridge Univ. Press, 2007.
4. Model Order Reduction: Theory, Research Aspects and Applications edited by W. H. A. Schilders, Henk A. Van Der Vorst, Joost Rommes, Springer.
5. Gerald, C F; Wheatley P O; Applied Numerical Analysis, Pearson, 2017
6. Theory and Applications of Numerical Analysis, G. M. Phillips, Peter J. Taylor, Academic press
7. Discrete Structures, Schaum outline
8. Cormen, Rivest, Leiserson, Introduction to Algorithms, PHI
9. Combinatorial optimization, Papadimitriou and Steiglitz, PHI (I)
10. Israel Koren, Computer Arithmetic- Academic Press
11. Russel and Norvig- Artificial Intelligence: A Modern Approach, Pearson, 3rd Ed. 2017

Further references

1. Luigi FORTUNA, Guiseppe NUNNARI, Antonio GALLO, MODEL ORDER REDUCTION TECHNIQUES WITH APPLICATIONS IN ELECTRICAL ENGINEERING, Springer, 1992.
2. Y. Saad, Numerical methods for large Eigenvalue problems, www.umn.edu
3. Matrix Analysis & linear algebra, Meyer, SIAM
4. H. A. van der Vorst, Iterative methods for large linear systems, citeseerx.ist.psu.edu
5. Cheng et al, Symbolic analysis and reductions of VLSI circuits, Springer, 2005

Course outcomes

- CO1. Is able to grasp core concepts, basic tenets of linear algebraic structures- groups, fields and rings;vector spaces (knowledge)
- CO2. Is able to grasp features, properties and operations on vector spaces- orthogonalization, change of basis, diagonalization (knowledge)
- CO3. Is able to learn & apply problem solving for computing eigen values and eigen vectors etc. (Thinking, skills)
- CO4. Is able to demonstrate application of algorithms (Gerschgorin, Sturm sequence method, QR method) for eigen value computation/estimation and MATLAB/SCILAB validation(skills)
- CO5. Is able to describe algorithms for function approximation, fitting (rational, Chebychev, Pade etc.) using MATLAB (skills)
- CO6. Develops appreciation for combinatorial optimization algorithms, AI probabilistic approaches & implements through MATLAB/C++/SCILAB (skills)

Course Name: VLSI Signal Processing Architecture
Course Code :
Credits : 3 (L-T-P : 3-0-0)

SYLLABUS :
Unit 1: Introduction to VLSI DSP Systems : Need of VLSI DSP algorithms. main DSP Blocks and typical DSP Algorithms. Fixed point /Floating point Representation; Floating point Arithmetic Implementation, Architectures of Adders/Multipliers; CORDIC, representation of DSP algorithms: Block Diagram, signal flow graph, data flow graph, dependence graph.
Unit 2: Iteration Bound Data flow graph representations, loop bound and iteration bound, longest path matrix algorithm, iteration bound of Multirate data flow graphs.
Unit 3: Pipelining and Parallel Processing: Pipelining and parallel processing of FIR digital filters, pipeline interleaving in digital filters: signal and multichannel interleaving.
Unit 4: Retiming, Unfolding and Folding: retiming techniques; algorithm for unfolding, Folding transformation, Techniques of retiming, Unfolding & Folding.
Unit 5: Systolic Array Architecture Systolic Array Architecture: Methodology of systolic array architecture, FIR based Systolic Array, Selection of Scheduling Vector, Matrix multiplication of systolic array
Unit 6: Low power Design Theoretical background , Scaling v/s power consumption, power analysis, Power reduction techniques, Power estimation approach

Course Outcomes :
CO1-To understand Graphical representation of DSP algorithms and Mapping algorithms into Architectures (Cognitive/Skills- Apply)
CO2-To study architecture for real time systems and parallel and pipelining for Low power design (Cognitive- Remembering)
CO3-To be aware of systolic Array architecture and methodology for developing Architectures (Cognitive- Understanding)
CO4-To know different signal processing modules as convolution technique, retiming concept, folding /unfolding Transformation and CORDIC architecture. (Cognitive- Analyse)
CO5-To implement different low power Design techniques. (Skills- evaluate)

References:
1) VLSI Digital Signal Processing System : : Design and implementation by K.K. Parhi
2) Digital Signal Processing with Field Programmable Gate Arrays Uwe Meyer-Baese , Springer.
3) FPGA-based Implementation of Signal Processing Systems. by Roger Woods, John Mcallister, WILEY

Course Name: Mini Project on Machine Learning and Signal Processing
Course Code :
Credits : 3 (L-T-P : 0-0-6)

List of Experiments/ activities

Design, verification, prototyping and implementation of hardware/ software

Circuits and systems based on software, hardware, algorithms, protocol, concepts in emerging areas such as Artificial Intelligence, Machine Learning, Deep Learning, Neural Networks, Intelligent Algorithms, Signal Processing, Image Processing, Computer Vision, Data Mining, Optimization Techniques, Transforms and related areas on Machine Learning and Signal Processing.

Course Name: Adaptive Signal Processing
Course Code :
Credits : 3 (L-T-P : 3-0-0)

SYLLABUS :
Adaptive Filter Structures and Algorithms: Introduction to Adaptive systems, Adaptive Linear combiner, Minimum Mean-Square Error, Wiener-Hopf Equation, Error Performance Surface, LMS algorithm, Convergence of weight vector, Learning Curve, FX-LMS algorithm (Filtered X-LMS) and its application to ANC, Types of LMS, RLS algorithm, Matrix Inverse Lemma for RLS, Computational complexity of LMS and RLS, Convergence Analysis. IIR-LMS, Lattice Filter, FIR to Lattice conversion and vice-versa, Adaptive Lattice Filter Kalman Filter, Adaptive Kalman Filter Transformed domain adaptive filtering: Block Linear, Block Circular Filter Banks and multi-rate signal processing Distributed signal Processing: Incremental LMS, Diffusion LMS

Applications: Direct Modelling or System Identification, Inverse Adaptive Modelling (Equalization), Adaptive Noise Cancellation, Adaptive filters for time series and stock market prediction, Biomedical Applications (Cancellation of 50-Hz interference in Electro-Cardiography, Cancelling donor heart interference in heart-transplant electrocardiography, Cancelling Maternal ECG in Fetal Electrocardiography), Echo Cancellation in Long distance Telephone Circuits, Adaptive self-tuning filter, Adaptive line enhancer, Adaptive filters for classification and data mining.

<u>Course Outcomes :</u>
CO1- To learn the characteristics of adaptive system architecture and analyze Wiener-Hopf Equation.
CO2- To understand the machine learning algorithms including LMS, RLS, Fx-LMS etc. CO3- To learn the adaptive structures like : Adaptive Lattice Filter, Kalman Filter, Transformed domain adaptive filtering, Filter Banks.
CO4- To explore the applications of adaptive signal techniques to System Identification, Channel Equalization, time series prediction etc.
CO5- To develop MATLAB programming skills for adaptive systems

<u>References:</u>
5) B. Widrow and S. D. Stearns: Adaptive Signal Processing, Prentice Hall.
6) D. G. Manolakis, V. K. Ingle, S. M. Kogon : Statistical and Adaptive Signal Processing, McGraw Hill.
7) S. S. Haykin: Adaptive Filter Theory, 4th Edition, Prentice Hall.
8) H. Sayed: Fundamentals of Adaptive Filtering, John Wiley & Sons.

Course Name: Advanced Digital Signal and Image Processing
Course Code :
Credits : 3 (L-T-P : 3-0-0)

SYLLABUS :
Introduction to Multirate systems and filter banks, 2D systems and mathematical preliminaries, Digital Representation of Binary & Gray Scale and colour Images, Linear operations on images.
Image sampling and quantization: 2D Sampling on rectangular and nonrectangular sampling lattice, Aliasing, Lloyd-Max quantizer etc.
Image Transforms: 2D Discrete Fourier transform, DCT, DST and Hadamard ,Harr K-L

Transforms & their applications to image processing.
Image restoration:Wiener filtering , smoothing splines and interpolation.
Image Enhancement Techniques: Gray scale transformation, Histogram matching and equalization, Smoothening:- Noise Removal, Averagins, Median, Min/Max. Filtering sharpening of Images using differentiation, the laplaciam, High Emphasis filtering,
Image analysis: Edge detection, Boundary Lines & Contours.
Image representation by Stochastic models: ARMA models, 2D linear prediction.
Image Segmentation & Thresholding: Multiband Thresholding, Thresholding from Textures, Selective histogram Technique.
Image Compression: Compression Techniques using K-L Transform, Block Truncation Compression. Error free Comprerssion using Huffman coding & Huffman shift coding.

COURSE OUTCOMES
CO1: Ability to understand Multirate systems, Image sampling and quantization
CO2: Ability to understand Image Transforms, Image restoration and Image Enhancement Techniques
CO3: Ability to understand Image analysis, Image Segmentation & Thresholding, Image Compression

Recommended Readings
Text Books: -
1. Digital Signal Processing- Oppenheim A.V. & Schafer R.W. PHI.
2. Digital Signal Processing-by Mitra- (TATA McGraw Hill) Publications.
3. Digital Image Processing- by Gonzalez / Woods, (Pearson Education)

Reference books: -
1. Digital Image Processing- by A.K. Jain
2. Digital Picture Processing- by Rosenfield & Kak

Online/E resources: -
1. https://nptel.ac.in/courses/117/105/117105135/

Course Name: Pattern Recognition and Machine Learning
Course Code :
Credits : 3 (L-T-P : 3-0-0)

SYLLABUS :
UNIT I
Introduction to Pattern Recognition and Machine Learning, ML design cycle, types of learning: supervised, unsupervised and reinforced, introduction to feature extraction and classification, density and discriminant functions, decision surfaces. Review of probability theory: conditional probability, Bayes theorem, random variables, density and mass functions, expectation and variance, joint distribution function of multiple random variables, multivariate normal distribution.
UNIT II
Bayesian decision theory, Bayes Classifier, Naïve Bayes classifier, Euclidian distance and Mahalanobis distance-based classifiers, minimum-error-rate classification. Parameter estimation methods, Maximum-Likelihood estimation, Gaussian mixture models, Expectation maximization method,

Bayesian estimation, Hidden Markov models for sequential pattern classification: discrete hidden Markov models, continuous density hidden Markov models.

UNIT III

K-nearest neighbour classification: Simple and distance weighed voting approach. Support vector machines: linear SVM, softmargin approach for non-separable data, kernel trick to learn non-linear SVM, radial basis function, polynomial, and sigmoidal kernel. Decision tree classifier: set of questions, splitting criterion, stop-splitting rule, and class assignment rule in decision tree. Introduction to neural networks: perceptron as linear classifier and multi-layer perceptron. Regression Analysis.

UNIT IV

Feature extraction methods: statistical features, Fourier and wavelet transforms for feature extraction, Data transformation and dimension reduction: Fisher's linear discriminant analysis, Bayesian LDA, step-wise LDA, principal component analysis, kernelPCA. Optimization in feature selection. Feature visualization. Ensemble of classifiers. Evaluation the performance of a classifier: holdout, random sampling, and cross validation methods, sensitivity, specificity, confusion matrix and ROC curve. Multi-class classification. Statistical analysis for comparison of significance of multiple classifiers over multiple dataset: Template matching and context dependent classification. The curse of dimensionality.

UNIT V

Unsupervised learning and clustering. Criterion functions for clustering, Prototype-based, Graph-based, Density-based clusters. Algorithms for clustering: K means, DBSCAN, Hierarchical clustering, Cluster validation.

Course Outcomes :

CO1-The students would have exposure to different algorithms for learning pattern classification methods and would also have explore to different datasets to get a feel for ML algorithms.

CO2- The statistical and mathematical formulation underlying different algorithms would be understood.

CO3- A background needed to study more advanced topics in ML will be developed (e.g. Deep Learning, Generative Adversarial Networks, etc.).

CO4-The course would help students to build a career in industry using ML, or to be a data scientist, or to pursue research in ML.

References:

Reference Text-Books

5) R. O. Duda, P. E. Hart and D. G. Stork, Pattern Classification, John Wiley, 2001
6) S. Theodoridis and K. Koutroumbas, Pattern Recognition, 4th Ed., Academic Press, 2009
7) C. M. Bishop, Pattern Recognition and Machine Learning, Springer, 2006
8) T. Pang-Ningm, V. Kumar, M. Steinbach. Introduction to data mining. Pearson Education India, 2018.

Programming Books

5) S. Theodoridis et. al., 'Introduction to Pattern Recognition, A MATLAB Approach'. Academic Press, 2010

Course Name: Mini Project on Machine Learning and Signal Processing
Course Code :
Credits : 3 (L-T-P : 0-0-6)

List of Experiments/ activities

Design, verification, prototyping and implementation of hardware/ software

Circuits and systems based on software, hardware, algorithms, protocol, concepts in emerging areas such as Artificial Intelligence, Machine Learning, Deep Learning, Neural Networks, Intelligent Algorithms, Signal Processing, Image Processing, Computer Vision, Data Mining, Optimization Techniques, Transforms and related areas on Machine Learning and Signal Processing.

Honors in VLSI Design

Course Name: Digital System Design & FPGA
Course Code :
Credits : 3 (L-T-P : 3-0-0)

SYLLABUS :

Sequential Logic Design- Introduction, Basic Bistable Memory Devices, additional bistable devices, reduced characteristics and excitation table for bistable devices.

Synchronous Sequential Logic Circuit Design- Introduction, Moore, Mealy and Mixed type Synchronous State Machines. Synchronous sequential design of Moore, Melay Machines,

Algorithmic State Machine- An Algorithm with inputs, digital solution, Implementation of traffic light controller, ASM charts, Design Procedure for ASMs.

Data path and Control design.

Introduction to VHDL/Verilog- Data types, Concurrent statements, sequential statements, behavioral modeling.

Introduction to programmable logic devices- PALs, PLDs, CPLDs and FPGAs.

FPGA mapping of combinational & sequential designs

Books:

1. Digital System Design, Ercegovac, Wiley.
2. Richard S. Sandige, *Modern Digital Design*, McGraw-Hill, 1990.
3. Zvi Kohavi, Switching and Finite Automata Theory, Tata McGraw-Hill.
4. Navabi. Analysis and modeling of digital systems. McGraw Hill, 1998.
5. Perry. Modeling with VHDL. McGraw Hill, 1994.
6. Navabi. Verilog Digital Design. McGraw Hill, 2007.

Course Name: Micro-& Nano- electro-mechanical Systems (MEMS & NEMS)
Course Code :
Credits : 3 (L-T-P : 3-0-0)

SYLLABUS :

Introduction to MEMS: Introduction: micro- and nano-scale size domains; scaling of physical laws; MEMS materials and processes; Miniaturization Issues. MEMS devices and applications, MEMS Market .

MEMS Fabrication Technology: Introduction to Submicron Technology: semiconductor materials; photolithography; doping; thin film growth and deposition; CVD, lithography and Ion Implantation, metallization; wet and dry etching; silicon micromachining; Bulk micromachining; Surface micromachining and LIGA .

MEMS Sensors and Actuators (Electrostatic, Thermal, piezoresistive): mechanics including elasticity, beam bending theory, membranes/plates; microactuators based on various principles, electrostatic, thermal, piezoresistive and applications e.g. acceleration, strain, tactile, temperature, IR detector flow; inkjet.

MEMS Sensors and Actuators (RF and Bio): MEMS Sensors and Actuators: mechanics including piezoelectric, magnetic, optical and its application. e.g. Microphone, micro speaker, nanogenerator, micro-motor, RF resonator, SAW filter. Materials and processes for BioMEMS, Applications .

MEMS Devices Packaging and Calibration: MEMS device Calibration and packaging techniques, Reliability. MEMS software training: COMSOL & Intellisuite .

References:

1. Course notes – will be posted weekly on the course website
2. Foundations of MEMS, Chang Liu, Prentice Hall (2006)
3. Fundamentals of Micro fabrication, Marc Madou, CRC (2002)
4. Introduction to BioMEMS – Albert Folch, CRC (2012)

Course Outcomes:

At the end of the course the student will be able to:
CO1- Gain a knowledge of basic approaches for various MEMS sensors and actuators design. (Cognitive- understaning)
CO2-Capability to critically analyze microsystems technology for technical feasibility as well as practicality. (Affective- Evaluate)
CO3 -Develop efficient design for improving device performance in terms of speed, sensitivity Selectivity and accuracy. (Skills- Create)
CO4- Design and optimization of RF MEMS sensors and actuators (Skills- Create)

CO5- Design and analysis of efficient MEMS presser sensor. (Skills- Analyze)

Course Name: Nanotechnology & Emerging Applications

Course Code :
Credits : 3 (L-T-P : 3-0-0)
SYLLABUS : Introduction: concept of nanotechnology, Origin of nanotechnology: change in optical, mechanical, electronic and magnetic behavior at nanoscale, Advantages of nanostructures in comparison to macrostructures, Scope of nanotechnology.

Categories of nanostructures and nanomaterials and their properties: Classification based on dimensionality: zero, one, two and three dimensional nanostructures:-Quantum Dots and Wells, nanowires, nanorods, nanoparticles, thin films, Carbon-based nano materials (buckyballs, nanotubes, graphene), Metallic nano materials (nanogold, nanosilver and metal oxides), Nanocomposites, Nanopolymers, Biological nanomaterials.

Synthesis of nanostructures and nanomaterials: Synthesis of nanoparticles, nanorods and nanowires, thin films: Ball Milling, Electrodeposition, Spray Pyrolysis, Flame Pyrolysis, Sol-Gel Processing, Solution Precipitation, Molecular Beam Epitaxy (MBE), Metal Nanocrystals by Reduction, Solvothermal Synthesis, Fundamental aspects of VLS and SLS growth, VLS growth of Nanowires, Control of the size of the nanowires, Template based synthesis, Chemical Vapor Deposition (CVD), Metal Oxide - Chemical Vapor Deposition (MOCVD), Physical vapor Deposition (PVD), Chemical vapour Deposition (CVD), DC/RF Magnetron Sputtering, Atomic layer Deposition (ALD).

Characterization of nanostructures and nanomaterials: Scanning Electron Microscopy (SEM), Field Emission Scanning Electron Microscopy (FESEM), High Resolution Transmission Electron Microscope (HRTEM), Scanning Tunneling Microscope (STM), Atomic Force Microscopy (AFM), X-ray Photoelectron Spectroscopy (XPS), Raman Spectroscopy, Infrared Spectroscopy, X-Ray Diffraction, Photoluminescence Spectroscopy, X-ray Fluorescence Method, Energy Dispersive Analysis of X-rays (EDAX), Thermogravimetry, Differential Thermal Analysis and Differential scanning calorimetry.

Applications: Application of nanotechnology in various domains: nano and molecular electronics, nano-devices like FinFETs, Tunnel-FETs, nanochemistry, nanobiotechnology, nanomedicine, nanomagnetism, nanorobotics, nanophotonics, smart nanosensors, MEMS/NEMS, nanotechnololgy for energy systems

References:

1. Nabok A., “Organic and Inorganic Nanostructures”, Artech House, 2005.
2. Dupas C., Houdy P., Lahmani M., “Nanoscience: Nanotechnologies and Nanophysics”, Springer-Verlag Berlin Heidelberg, 2007.
3. Edelstein A S and Cammarata R C, “Nanomaterials: synthesis, Properties and Applictions”,Taylor and Francis, 2012.
4. Michael Wilson, Kamali Kannangara and Geoff Smith, “NANOTECHNOLOGY - Basic Science and Emerging Technologies”, A CRC Press Company, D.C, 2002.;

Course Outcomes:

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

CO1: Knowledge of vast scope and capabilities of nanotechnology (Cognitive- understanding)

CO2: Acquaintance with various kinds of nanostructures and nanomaterials (Cognitive- Analyze)

CO3: Awareness of several kinds of synthesis and characterization techniques for nanostructures and nanomaterials (Cognitive- understanding)

CO4: Knowledge of applications of nanotechnology in various diverse domains.(Skills- Applying)

Course Name: Mini Project on VLSI Design

Course Code :
Credits : 3 (L-T-P : 0-0-6)

List of Experiments/ activities

Design, verification, prototyping and implementation of hardware.

Circuits and systems based on software, hardware, algorithms, concepts in emerging areas such as design of digital logic (combinational and sequencial circuit)on FPGA Boards, design of test bench using System C, System verilog for functional verification, modeling using TCAD and similar software, modeling and characterization of new devices/materials.

Honors in Embedded & Intelligent Systems

Course Name:Pattern Analysis & Machine Intelligence
Course Code :
Credits : 3 (L-T-P : 3-0-0)

SYLLABUS :

UNIT I

Introduction to Pattern Recognition and Machine Learning, ML design cycle, types of learning: supervised, unsupervised and reinforced, introduction to feature extraction and classification, density and discriminant functions, decision surfaces.

Review of probability theory: conditional probability, Bayes theorem, random variables, density and mass functions, expectation and variance, joint distribution function of multiple random variables, multivariate normal distribution.

UNIT II

Bayesian decision theory, Bayes Classifier, Naïve Bayes classifier, Euclidian distance and Mahalanobis distance-based classifiers, minimum-error-rate classification. Parameter estimation methods, Maximum-Likelihood estimation, Gaussian mixture models, Expectation maximization method, Bayesian estimation,

Hidden Markov models for sequential pattern classification: discrete hidden Markov models, continuous density hidden Markov models.

UNIT III

K-nearest neighbour classification: Simple and distance weighed voting approach. Support vector machines: linear SVM, soft-margin approach for non-separable data, kernel trick to learn non-linear SVM, radial basis function, polynomial, and sigmoidal kernel. Decision tree classifier: set of questions, splitting criterion, stop-splitting rule, and class assignment rule in decision tree. Introduction to neural networks: perceptron as linear classifier and multi-layer perceptron. Regression Analysis.

UNIT IV

Feature extraction methods: statistical features, Fourier and wavelet transforms for feature extraction, Data transformation and dimension reduction: Fisher's linear discriminant analysis, Bayesian LDA, step-wise LDA, principal component analysis, kernel-PCA. Optimization in feature selection. Feature visualization.

Ensemble of classifiers. Evaluation the performance of a classifier: holdout, random sampling, and cross validation methods, sensitivity, specificity, confusion matrix and ROC curve. Multi-class classification. Statistical analysis for comparison of significance of multiple classifiers over multiple dataset: Template matching and context dependent classification. The curse of dimensionality.

UNIT V

Unsupervised learning and clustering. Criterion functions for clustering, Prototype-based, Graph-based, Density-based clusters. Algorithms for clustering: K means, DBSCAN, Hierarchical clustering, Cluster validation.

Reference Text-Books

1: R. O. Duda, P. E. Hart and D. G. Stork, Pattern Classification, John Wiley, 2001

2: S. Theodoridis and K. Koutroumbas, Pattern Recognition, 4th Ed., Academic Press, 2009

3: C. M. Bishop, Pattern Recognition and Machine Learning, Springer, 2006

4: T. Pang-Ningm, V. Kumar, M. Steinbach. Introduction to data mining. Pearson Education India, 2018.

Programming Books

1: S. Theodoridis *et. al.*, 'Introduction to Pattern Recognition, A MATLAB Approach'. Academic Press, 2010

Course Name:Internet of Things & IIoT
Course Code :
Credits : 3 (L-T-P : 3-0-0)

SYLLABUS :

i) Introduction to IoT;
IoT sensors, devices, networks & protocols; Cyber physical Systems

ii) IoT programming & big data
Machine-to-Machine Communications; Interoperability in IoT, Introduction to Arduino Programming; Integration of Sensors and Actuators with Arduino; Introduction to Python programming, Introduction to Raspberry Pi, Implementation of IoT with Raspberry Pi; Data Handling and Analytics, Cloud Computing;

iii) Cybersecurity & privacy in IoT (optional)

iv) Low energy, secure hardware for IoT/sensors

v) Global applications (selected only)
Smart Cities and Smart Homes; Connected Vehicles, Smart transportation; Smart Grid, Industrial IoT; Case Study: Agriculture, healthcare including Smart monitoring of critical diseases & point of care; Activity Monitoring, supply chain & semiconductor manufacturing;

vi) Industrial IoT (IIoT): (selected only)
Enabling Factors; CPS, Energy Market; Example Deployment: Building Automation; Automotive and Transportation; Industrial (Manufacturing); building automation, agriculture, Oil & Gas; RTOS; Network Functions Virtualization; Long-range Wireless Protocols; LoRa WAN; Satellite Communications; ANT+, WiFi, ZigBee, WHART, EnOcean, Z-Wave, NFC; SECURITY: Encryption algorithms- Diffie-Hellman, Encryption Algorithms; Threat Vectors, Attacks: Man-in-the-middle, Replay, Protection Methods, Side-Channel Attacks, Chain of Trust; Hash and MAC Functions; Secure Firmware Updates, Random Number Generation; Predictive and Preventive Maintenance, IIOT deployment and Industrial Internet

Course Outcomes:

1. Able to grasp the concept of IoT and embedded systems, cyber physical systems
2. Exposing for the end-to-end design of Internet-of-Things applications from sensors to cloud, as well as hardware design/security aspects
3. Building in confidence and capability regarding electronics, sensors, and software through hands-on labs.
4. Providing exposure to practical problems and their solutions, through case studies

using EDA Tools (Electronic Design Automation tools).

5. Enhancing the knowledge to Security and privacy needs, and the analysis required to address these needs.

Books:

1. "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", by Pethuru Raj and Anupama C. Raman (CRC Press)
2. "Internet of Things: A Hands-on Approach", by Arshdeep Bahga and Vijay Madisetti (Universities Press)

Course Name:Formal Verification of Digital Hardware & Embedded Software
Course Code :
Credits : 3 (L-T-P : 3-0-0)

SYLLABUS :

UNIT 1. Introduction to Design Verification, OVM and UVM methodology, case studies using Verilog and System Verilog, Static verification,

UNIT 2. Formal Verification of digital hardware systems- BDD based approaches, functional equivalence, finite state automata, FSM verification, Model checking, Various industry & academia CAD tools for formal verification.

UNIT 3. Verification, validation & testing - Debugging techniques for embedded software, instruction set simulators, clear box technique, black box testing, evaluating function test

UNIT 4. Recent trends in Design verification, case study

Course Outcomes:

CO1: To understand features of System Verilog (Cognitive- Understanding)

CO2: To study Assertion Based Verification and also be aware of functional coverage. (Cognitive-Analyze/Evaluate)

CO3: To apply language constructs of Bluespec for high level design/synthesis. (Skills- Apply)

CO4: To understand the necessity of the verification methodology. (Affective- understanding)

CO5: Ability to develop the test bench for DUT with verification methodology for scheduling, resource sharing and binding.(Skills- Creativity)

Additonal/optional Outcomes:

6) Understand significance of formal verification methodologies vis-à-vis simulation/ABV (Knowledge)

7) To perform equivalence check for combinational as well as sequential digital circuits (Thinking)

8) To develop Kripe structure based Model for sequential circuits and write PROPERTIES for Model Checking (Thinking)

9) To be able to use Model checking CAD tool- SMV or Cadence/Synopsys tool (SMV or Formality)

(Skills)

Textbooks:

1. Discrete Structures, Logic and Computability- James L. Hein, Jones & Barlett India.
2. Logic- Schaum Series
3. [Chapter 2, Micheli, Synthesis of Digital Systems, McGrawHill]
4. Articles by Bryant, Eap, Akers on BDDs.
5. Advanced Formal Verification, R. Drechsler, Kluwer.
6. Algorithms & Data structures in VLSI Design, C. Meinel and T. Theobald, Springer.

References:

1. SystemVerilog IEEE standard;
2. BlueSpec user guide/standard;
3. Embedded systems Design- Artist Roadmap for Research & Development, LNCS-3436, Springer.
4. J. W. Valvano, Embedded microcomputer systems- Real Time Interfacing, , Thomson press (Cengage India)
5. Computers as components- Principles of embedded computing system design. Wolf, W., Academic Press (Indian edition available from Harcourt India Pvt. Ltd., 27M Block market, Greater Kailash II, New Delhi-110 048.)
6. Verification, validation & testing in software engineering, A. Dasso and A. Funes, Idea Group Inc.
7. Hardware-Software codesign for data flow dominated embedded systems, R. Niemann, Springer.
8. Readings in Hardware/Software codesign, Micheli, Ernst, Wolf, Morgan Kaufmann.
9. Advanced Formal Verification, R. Drechsler, Kluwer.
10. Readings in Hardware/Software codesign, Micheli, Ernst, Wolf, Morgan Kaufmann.

Course Name: Computer Vision
Course Code :
Credits : 3 (L-T-P : 3-0-0)

SYLLABUS :

Unit 1: Introduction and Overview: Overview of image processing systems, image formation and perception, continuous and digital image representation, image contrast enhancement, histogram equalization, affine transformations, model of image degradation/restoration process, Image Filtering

Unit 2: Feature Detection and Matching: Interest point detection, Edge, Blob, Corner detection; SIFT, SURF, HoG descriptors, Local Image Features and Feature Matching, RANSAC, Bag-of-words

Unit 3: Machine Learning and Deep Learning Quick course: Supervised & Unsupervised Machine Learning, Clustering , Classification, Review of Neural Networks, Convolutional Neural Network, CNN Architectures: AlexNet, VGG, InceptionNets, ResNets, DenseNets, Transfer Learning, Recurrent Neural Network, Long Short Term Memory(LSTM) , Visualization with CAM, Grad-CAM

Unit 4: CNNs for Computer Vision Tasks: Image Classification: CIFAR, MNIST, ImageNet Datasets, Object Detection: R-CNN, Fast R-CNN, Faster R-CNN, YOLO, SSD; Segmentation: FCN, U-Net, Mask-RCNN

Unit 5: Recent Trends and Applications: Deep Generative Models, Generative Adversarial Networks (GANs), Attention Models, Graph Convolutional Networks, Zero-shot, One-shot, Few-shot Learning, Visual Question Answering, Image Captioning

Course Outcomes:

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

CO1: Describe different image representation, their mathematical representation and different their data structures used. (Cognitive- Remembering, Understanding)

CO2: Implement feature extraction techniques for developing computer vision applications (Skills - Apply, create)

CO3: Recognize the object using the concepts of machine vision (Cognitive + Skill- Analyze)

CO4: Grasp the principles of state-of-the-art deep neural networks (Skills- Apply, Evaluate)

CO5: Develop the practical skills necessary to build computer vision applications (Skills- Apply, Evaluate)

References:

1. Computer Vision: Algorithms and Applications, by Richard Szeliski
2. Computer Vision: A Modern Approach, Forsyth and Ponce, Pearson Education.
3. Christopher Bishop, Pattern Recognition and Machine Learning, Springer, 2008
4. Concise Computer Vision by Reinhard Klette
5. Deep Learning, by Goodfellow, Bengio, and Courville.
6. NPTEL Course Deep Learning for Computer Vision By Prof. Vineeth N Balasubramanian (IIT Hyderabad)

Course Name: Advanced Embedded Software Design
Course Code :
Credits : 3 (L-T-P : 3-0-0)

SYLLABUS :

Unit-1: Processor micro-architecture, application-specific architecture,

Unit-2: Embedded OS, middleware, graphics libraries,

Unit-3: Software Development Tools, graphics IPs, virtual prototyping solutions,

RTOS, Embedded linux, concurrency & concurrent programming languages;

Unit-4: Design automation of such systems including methodologies, techniques and tools for their design as well as novel designs of software components

Course Outcomes:

CO1. Is able to grasp core concepts, basic tenets of micro-architecture vis a vis embedded operating systems, Unix shell programming (Cognitive- understanding) PO1

CO2. Is able to grasp features, properties of Embedded OS(Cognitive- understanding) PO1

CO3. Is able to learn & apply scheduling, deadlock avoidance algorithms and its applications into process scheduling, deadlock avoidance related problem solving etc. (Skills- evaluate) PO2, PO4, PO5, PO11

CO4. Is able in long perspective, to appreciate the significance of virtual memory, file management, security & privacy in OS (Skills- Analyze) PO1, PO4, PO12

CO5. Is able to write programmes for RTOS- scheduling, concurrency, deadlock prevention, etc.; and the significance that it can be used for analysis, problem solving as well as design of OS kernels (Skills- Evaluate) PO5

CO6. Is able to use Embedded OS CAD tools & development environment- VxWorks Windriver, RTLinux, Micrivision (ARM) (Skills- Create) PO2, PO13

Textbooks:

1. Unix Shell Programming, Kernighan & Pike, PHI
2. Lex & Yacc
3. Linux for Embedded and Real-time Applications, Doug Abbott, Newnes, Elsevier, 2003.
4. An Embedded Software Primer, David E. Simon, Addison Wesley, 1999.
5. Embedded Linux, Pearson.
6. Operating systems principles, Silberchatz, Galvin, Wiley
7. Short, K, Embedded Microprocessor System Design, Prentice Hall, 1998.
8. Embedded Linux, Pearson
9. Edward A. Lee, "Embedded Software", Advances in Computers (M. Zelkowitz, editor) 56, Academic Press, London, 2002.
10. Testing Embedded Software, by Bart Broekman and Edwin Notenboom, Pearson/Addison-Wesley (UK), ISBN: 0-321-15986-1

References:

11. Design Patterns for Embedded Systems in C: An Embedded Software Engineering, Bruce Powel Douglass, Newnes, Elsevier.
12. Software Engineering for Embedded Systems: Methods, Practical Techniques, Robert Oshana, Mark Kraeling, Newnes, Elsevier.
13. Embedded Software, Newnes know it all series, Jean J. Labrosse, ISSN 1879-8683, Elsevier.
14. Programming Embedded Systems in C and C++, O'Reilly Series, Michael Barr.
15. Real-Time Concepts for Embedded Systems, CMP books, R and D Developer Series, Qing Li, Caroline Yao, CRC press.
16. Testing Embedded Software, Broekman Bart, Pearson Education India, ISBN 813172509X, 9788131725092.
17. Performance Analysis of Real-Time Embedded Software, Yau-Tsun Steven Li, Sharad Malik, Kluwer.
18. Embedded Software for SoC, Ahmed Amine Jerraya, Springer.

Course Name:Advanced Microcomputer Systems & Interfacing
Course Code :
Credits : 3 (L-T-P : 3-0-0)

Course contents:

Unit-1: Introduction; Processor-processor (Intel/ARM) and micro controller (Intel/ARM), assembly language programming,

Unit-2: Interfacing methods-protocols, synchronization, parallel I/O, serial I/O, Memory interfacing, Digital/Analog interfacing, high speed I/O interfacing, data acquisition systems, CAN, I2C, USB, ESSI (Enhanced Synchronous Serial Interface) protocols; General Purpose Input/Output (GPIO)

Unit-3: Interrupt Synchronization & Timing generation- Features of interrupts, interrupt vectors & priority, polling, priority algorithms; frequency measurement, frequency and period conversion.

Unit-4: Miscellaneous- Serial and parallel port interfaces; State machine & concurrent process models.

Unit-5: System examples- camera etc; Debugging: JTAG, ISP, BDM Port, BITP, and DB9 ports.

Course outcomes:

CO1. To Understand the 16,32,64-bit processors ISA (CISC and RISC)
CO2. To understand the language and use of micro controller (ARM/Atmega 328)
CO3. To understand different I/O interface protocols and write programs for ARM interfaces
CO4. To understand memory and different transducers and interfacing
CO5. To write assembly programmes interfacing and design issues of embedded system(analytically and design issues)

Textbooks:

1. Jonathan W. Valvano, Embedded Microcomputer Systems: Real-Time Interfacing, Brookes/Cole, Pacific Grove, 2000.
2. Douglas V. Hall , Microprocessors and interfacing, McGraw Hills,
3. K.Ayala, The 8051 Microcontroller, Thompsons, Mazidi,Naimi, Naimi , avr microcontroller and embedded system, pearsons.
4. David A. Patterson and John L. Hennessy, Computer Organization and design ARM ed.,Morgan Kaufmann,
5. F. Vahid & T. Givargis, Embedded System Design, Wiley.
6. Wolf, W., Computers as Components: Principles of Embedded Computing System Design, Morgan Kaufmann, San Francisco, 2001.
7. Furber, S., ARM: system-on-chip architecture, 2nd Edition, Addison-Wesley, London, 2000.
8. Hayes, J. P., Computer Architecture and Organization, 3rd Edition, McGraw-Hill
9. Manuals- Intel 32/64 Architectures , ARM manual - 32/64-bit architecture, Intel 8051 and ATmega328P datasheet

Course Name:Embedded SoC Design
Course Code :
Credits : 3 (L-T-P : 3-0-0)

Course contents:

Unit-1: Embedded computing- Microprocessors, embedded design process, system description formalisms. Instruction sets- CISC and RISC; CPU fundamentals- programming I/Os, co-processors, supervisor mode, exceptions, memory management units and address translation, pipelining, super scalar execution, caching, CPU power consumption.

Unit-2: Embedded computing platform- CPU bus, memory devices, I/O devices, interfacing, designing with microprocessors, debugging techniques.

Unit-3: Program design and analysis- models of program, assembly and linking, compilation techniques, analysis and optimization of execution time, energy, power and size.

Unit-4: Processes and operating systems- multiple tasks and multiple processes, context switching, scheduling policies, inter-process communication mechanisms.

Unit-5: Hardware accelerators- CPUs and accelerators, accelerator system design.

Unit-6: Networks- distributed embedded architectures, networks for embedded systems, network-based design, Internet-enabled systems.

Unit-7: System design techniques- design methodologies, requirements analysis, system analysis and architecture design, quality assurance.

Course Outcomes:

CO1: knowledge of embedded processors, RISC and CISC (Cognitive- Understand)

CO2: Basic concepts in CPU operation (Cognitive- Understand)

CO3: Understanding of I/O devices and their interfacing (Cognitive- Understand)

CO4: To learn program and system design and analysis methodologies (Skills- analyze and design)

Textbooks:

1. Wolf, W. Computers as components- Principles of embedded computing system design. Academic Press (Indian edition available from Harcourt India Pvt. Ltd., 27M Block market, Greater Kailash II, New Delhi-110 048.)

Course Name: Mini Project on Embedded Systems

Course Code :
Credits : 3 (L-T-P : 0-0-6)
<u>List of Experiments/ activities</u>

Design, verification, prototyping and implementation of hardware.

Circuits and systems based on software, hardware, algorithms, concepts in emerging areas such as design of digital logic (combinational and sequencial circuit) on FPGA Boards, design of test bench using System C, System verilog for functional verification, modeling of sensors, microcontroller .

Honors in Advanced Communication Engineering

Course Name: Mathematical Modeling and Simulation for Communication Engineering Systems
Course Code :
Credits : 3 (L-T-P : 3-0-0)

SYLLABUS :
Mathematical Foundational concepts for Communication Engineering: Basics of Linear Algebra, Probability and Random Variables, Stochastic Processes, Spectral Representation, Mean Square Estimation, Entropy, Markov Chains, Processes and Queuing Theory, Mathematical modelling of digital modulations, channels and detection, Channel estimation and equalization, MIMO-OFDM design concepts,Research initiatives in 4G, 5G Mobile Systems
Mathematical Foundations for Photonics/Electromagnetics: Vector Analysis, Vector Calculus, Theory of complex variables, Series Solution of Differential Equations, Sturm Liouville Theory, Bessel Functions, Legendre Functions, Fourier Series and Fourier Transforms, Solving surface integral equations by method of moments, Introduction to finite element methods, Finite element method in 2D, Finite difference time domain method – introduction, Finite difference time domain method - materials and boundary conditions, Finite difference time domain method Design concepts in Microstrip Antennas and Arrays, Beam forming Techniques, SIW
Partial Differential Equations: Laplace and Poisson’s Equations, Wave Equations. Analytical and Numerical Solutions of the PDEs. Green’s Function, Optimization techniques.
Simulation Tools: Various open source/commercial software for solving problems in the area of Antennas, Communication, Photonics and Microwave Engineering

Recommended Readings
1. Text books-
a. Probability, random variables and stochastic processes. - Papoulis, Athanasios, and H. Saunders.
b. The theory of information and coding - Robert J. McEliece, Cambridge University Press.
c. Advanced engineering electromagnetics - Constantine A. Balanis, John Wiley & Sons.
d. Computational Methods for Electromagnetics - Peterson, Ray, Mitra, IEEE Press
e. Microstrip Antennas: The Analysis and Design of Microstrip Antennas and Arrays - David M. Pozar, Daniel H. Schauber, Wiley-IEEE Press.
2. Reference books-
a. Microstrip Antennas - I. J. Bahl and P. Bhartiya, Artech House.
b. Mathematical methods for physics and engineering: A Comprehensive Guide - K. F. Riley, M. P. Hobson and S. J. Bence, Cambridge University Press, 2002.

Course Name: Advanced Digital Communication Systems

Course Code :

Credits : 3 (L-T-P : 3-0-0)

SYLLABUS :

Review: Signals and Systems with focus on Random Signals, Sampling Theorem, Signal Space and Constellation Diagrams and Orthogonal Signal Sets. Baseband modulation and Demodulation: Detection of binary signals in Gaussian Noise, ISI, Equalization, Carrier and symbol synchronization, and Signal Design for bandlimited channels.

Bandpass modulation and Demodulation: Modulation Techniques, Coherent and Non Coherent Detection, Error performance for binary system, and Symbol error performance for M-ary systems.

Communication link analysis: Link budget analysis, Simple link analysis, system trade-offs, and Modulation coding trade-offs.

Spread Spectrum: signal PN sequences, DS-CDMA, FH-CDMA, and Jamming consideration. Communication through Fading Channels

References :

1. Text books-
    a. Digital Communications-Bernard Sklar, Fredric Harris, Pearson Education
    b. Digital Communications- John G.Proakis, McGraw Hill Education.
    c. Modern Digital and Analog Communication-B.P. Lathi, Oxford University Press.
2. Online resources-
    a. https://nptel.ac.in/courses/108/102/108102120/

Course Name: Advanced Antenna Engineering

Course Code :

Credits : 3 (L-T-P : 3-0-0)

SYLLABUS :

Revision of radiation mechanism of antenna, basic performance parameters of antennalike radiation pattern, near- and far-field regions, reciprocity, directivity and gain, effective aperture, polarization, input impedance, efficiency, etc. Basic theorems related to antenna. Introduction to the working principles and analysis of different kinds of antenna geometries like microstrip, broadband, frequency independent, travelling wave antennas etc.

Recommended Readings

1. Text book- a. Antenna Theory:Analysis and Design - C. A. Balanis, Wiley Publication,2000.

b. Antenna Theory- J. D. Kraus, 4th Edition, Tata Mc-Graw Hill.

c. Antenna Theory and Design - W. L.Stutzman, and G. A. Thiele, John Wiley & Sons., 1998.

d. Antenna Theory and Design - R. S. Elliot, Revised edition, Wiley-IEEE Press, 2003.

e. Antennas and Radio Wave Propagation - R. E. Collin, McGrawHill., 1985.

f. Smart Antennas for Wireless Communications - F. B. Gross, McGraw-Hill., 2005

g. Micro strip Antenna Design Handbook - Ramesh Garg, Prakash Bhartia, Inder Bahl, Artech House.

h. Handbook of Antennas in Wireless Communication - Lal Chand Godara, CRC Press.

2. Reference book-

a. CAD of Microstrip Antenna for Wireless Applications - Robert A. Sainati, Artech House.

b. Compact and Broadband Micro strip Antenna - Kin-Lu Wong, John Wiley & Sons.

c. Microstrip Patch Antennas - Robert B. Waterhouse, Kluwer academic Publishers.

d. Handbook of Microstrip Antennas - J.R. James and P.S. Hall, Peter Peregrinus Ltd.

3. Online resources-

a. https://nptel.ac.in/courses/108/101/108101092/

b. https://nptel.ac.in/courses/108/105/108105114/

c. https://nptel.ac.in/courses/117/107/117107035/

Course Name: Advanced Mobile and Wireless Networking

Course Code :

Credits : 3 (L-T-P : 3-0-0)

SYLLABUS :

Operation of Cellular Systems, Frequency reuse concept, Co-channel Interference, Techniques for reducing co-channel interference, Adjacent channel interference, Near end and Far end interference, Crosstalk, interference between systems.

Channel Assignment Techniques, Hand-off Techniques, Concept of smaller Cells, Trunking and Teletraffic Theory

Orthogonal Frequency Division Multiplexing, Orthogonal Frequency Division Multiple Access, MIMO-OFDM, Effect of frequency offset in OFDM, Peak to average power ratio (PAPR) in OFDM

Cognitive Radio and Software Defined Radio Concepts. Evolution of Mobile Communication Systems, Details of 3G-UMTS, 4G-LTE and 5G Mobile Communication systems.

Mobility Management in Wireless Networks, Mobile IP, Mobile Ad hoc Networks, Ad hoc Routing Protocols, Performance Analysis of DSR and CBRP, Cluster Techniques, Incremental Cluster Maintenance Scheme,

Recommended Readings

1. Text book-
   a. Mobile Cellular Telecommunications- William C.Y. Lee, TMH.
   b. Wireless Communications - T S Rappaport, IEEE Press.
   c. Wireless Communication and Networking - John W. Mark, WeihuaZhuang.
   d. Wireless Adhoc Networks - M. Ilyas, CRC Press.
2. Reference book-
   a. Wireless and Mobile Communication Systems - D. P. Agarwal & Qing Anzen, Thomson Press

Course Name: Advanced Microwave Engineering

Course Code :

Credits : 3 (L-T-P : 3-0-0)

SYLLABUS :

Review of Electromagnetic Theory, Transmission Lines and Waveguides, Impedance Matching and Tuning; Analysis of microwave networks and components based on different parameters of two port network; Microwave linear beam and crossed field tubes; Introduction to different microwave solid state devices; Introduction to striplines; Microwave filters, amplifiers and oscillators

Recommended Readings

1. Text books-
    a. Microwave Devices and Circuits- Samuel Y. Liao, Prentice Hall
    b. Microwave and Radar Engineering- Kulkarni, McGraw Hill Education
    c. Microwave Solid State Circuit Design- Inder Bahl, John Wiley & Sons.
    d. Microwave circuits & passive devices- Sisodia and Raghuvanshi, New Age International.
    e. Radio-Frequency And Microwave Communication Circuits-Devendra K. Mishra, Wiley
2. Reference books-
    a. Microwave engineering-David M. Pozar, John Wiley & Sons, Inc.
    b. Introduction to Microwaves –Wheeler G.J., Prentice-Hall
    c. Foundations of Microwave Engg.- Collin, John Wiley and Sons
3. Online resources
    a. https://nptel.ac.in/courses/108/103/108103141/
    b. https://nptel.ac.in/courses/108/105/108105181/
    c. https://nptel.ac.in/courses/108/101/108101112/
    d. https://nptel.ac.in/courses/117/105/117105138/
    e. https://nptel.ac.in/courses/117/105/117105130/
    f. https://nptel.ac.in/courses/117/101/117101119/
    g. https://nptel.ac.in/courses/117/105/117105122/

Course Name: Advanced Optical Communication Systems

Course Code :

Credits : 3 (L-T-P : 3-0-0)

SYLLABUS :

Review of optical fiber waveguiding concepts, Advanced fiber design: Dispersion issues, Dispersion shifted, Dispersion flattened, Dispersion compensating fiber, Design optimization of single mode fibres. Nonlinear effects in fiber optic links. Concept of self-phase modulation, group velocity dispersion and soliton based communication.
Transmitter design, Receiver - PIN and APD based designs, noise sensitivity and degradation. Receiver amplifier design. Transceivers for fiber optic communication pre amplifier type- optical receiver performance calculation – noise effect on system performance receiver modules.
Coherent, homodyne and heterodyne keying formats, BER in synchronous- and asynchronous- receivers, sensitivity degradation, system performance, Multichannel, WDM, multiple access networks, WDM Components, TDM, Subcarrier and Code division multiplexing. Semiconductor laser amplifiers, Raman - and Brillouin - fiber amplifiers, Erbium doped fiber amplifiers, pumping phenomenon, LAN and cascaded in-line amplifiers. Limitations, Post- and Pre-compensation techniques, Equalizing filters, fiber based gratings, Broad band compression.
Next Generation Optical Communications: Multi-core MMF based SDM transmission, Optical wireless communications.
Optical networks- Basic networks-SONET/ SDH-wavelength routed networks - Nonlinear effects on network performance, performance of various systems (WDM, DWDM + SOA).

Recommended Readings

1. Text book-
a. Fiber-Optic Communication Systems - Govind P. Agrawal,Wiley.
b. Optical communication systems - Franz and Jain, Narosa Publications, New Delhi
2. Online resources-
a. https://nptel.ac.in/courses/117101002/

Course Name: Advanced Error Control Codes

Course Code :

Credits : 3 (L-T-P : 3-0-0)

SYLLABUS :

Error Control coding for wireless fading channels, Channel Estimation and Adaptive channel coding, Joint Source and Channel coding. Non binary Linear Block Codes, Hard and soft decision decoding, Coding and Decoding of BCH, Reed Solomon Codes, Convolution codes: Coding and Decoding, Distance bounds, Performance bounds Turbo codes: Coding, Decoding Algorithms, Performance comparison,Interleaver design Trellis coded Modulation, TCM Decoders, TCM for AWGN and Fading Wireless Channels, Performance comparison.

LDPC Codes, Polar Codes, Error control codes for: Audio/video transmission, mobile communications, space and satellite communication, data transmission, data storage and file transfer.

Text book-

a. Digital Modulation &Coding - Stephen G. Wilson, Prentice Hall Inc.
b. Information Theory Coding and Cryptography - Ranjan Bose, TMH
c. Theory and practice of error control codes -R. E. Blahut, AWL1983.
d. Digital Communication - J. G. Proakis, McGraw Hill Education.

Online resources-

https://nptel.ac.in/courses/117/108/117108044/

Course Name: Computational Electromagnetics

Course Code :

Credits : 3 (L-T-P : 3-0-0)

SYLLABUS :

Review of Electromagnetic Theory, Classification of EM Problems.Analytical Methods-Separation of Variables. Finite Difference Methods. Variation Methods. Method of Moments. Finite element Method.

Text Books :

a. Numerical Techniques in Electromagnetics - Matthew N.O. Sadiku, CRC Press.
b. Theory and Computation of Electromagnetic Fields – Jianming Jin, Wiley.

Online : **https://nptel.ac.in/courses/108/106/108106152/**

Course Name: Mini Project on Communication Engineering
Course Code :
Credits : 3 (L-T-P : 0-0-6)

List of Experiments/ activities

Design, verification, prototyping and implementation of hardware/ software

Communication systems based on software, hardware, algorithms, protocol, concepts in emerging areas on 5G/6G communication, optical communication, wireless communication, satellite communication, modulation and demodulation techniques, microwave and antenna, signal processing and artificial intelligence algorithms application in communication and related areas.