COURSES SCHEME

&

SYLLABUS

FOR

B.E.

ELECTRONICS
&
COMMUNICATION ENGINEERING

2017

ELECTRONICS AND COMMUNICATION ENGINEERING DEPARTMENT

BE IN ELECTRONICS AND COMMUNICATION ENGINEERING

SEMESTER-I

SR. NO.	COURSE NO.	TITLE	L	T	P	CR
1	UCB008	APPLIED CHEMISTRY	3	1	2	4.5
2	UTA007	COMPUTER PROGRAMMING– I	3	0	2	4.0
3	UEC001	ELECTRONIC ENGINEERING	3	1	2	4.5
4	UEN002	ENERGY& ENVIRONMENT	3	0	0	3.0
5	UMA003	MATHEMATICS-I	3	1	0	3.5
6	UES009	MECHANICS	2	1	2*	2.5
		TOTAL	17	4	6	22.0

*** Each student will attend one Lab Session of 2 hrs in a semester for a bridge project in this course. (Mechanics)**

SEMESTER-II

SR. NO.	COURSE NO.	TITLE	L	T	P	CR
1	UPH004	APPLIED PHYSICS	3	1	2	4.5
2	UTA009	COMPUTER PROGRAMMING-II	3	0	2	4.0
3	UEE001	ELECTRICAL ENGINEERING	3	1	2	4.5
4	UTA008	ENGINEERING DRAWING	2	4	0	4.0
5	UHU003	PROFESSIONAL COMMUNICATION	2	0	2	3.0
6	UMA004	MATHEMETICS-II	3	1	0	3.5
		TOTAL	16	7	8	23.5

SEMESTER-III

SR. NO.	COURSE NO.	TITLE	L	T	P	CR
1	UTA010	ENGINEERING DESIGN PROJECT – I (6 SELF EFFORT HOURS) (Mangonel)	1	0	2	5.0
2	UES012	ENGINEERING MATERIALS	3	1	2	4.5
3	UMA007	NUMERICAL ANALYSIS	3	1	2	4.5
4	UECXXX	CIRCUIT ANALYSIS & SYNTHESIS	3	1	0	3.5
5	UEC 405	MICROPROCESSORS AND THEIR APPLICATIONS	3	1	2	4.5
6	UEC404	SIGNALS AND SYSTEMS	3	1	2	4.5
		TOTAL	16	5	10	26.5

SEMESTER-IV

SR. NO.	COURSE NO.	TITLE	L	T	P	CR
1	UTA011	ENGINEERING DESIGN PROJECT-II (6 SELF EFFORT HOURS)	1	0	4	6.0
2	UTA002	MANUFACTURING PROCESSES	2	0	3	3.5
3	UMA031	OPTIMIZATION TECHNIQUES	3	1	0	3.5
4	UES010	SOLIDS AND STRUCTURES	3	1	2	4.5
5	UES011	THERMO-FLUIDS	3	1	2	4.5
6	UEC301	ANALOG ELECTRONIC CIRCUITS	3	1	2	4.5
		TOTAL	15	4	13	26.5

SEMESTER-V

SR. NO.	COURSE NO.	TITLE	L	T	P	CR
1	UEC 307	ELECTROMAGNETIC FIELD THEORYAND TRANSMISSION LINES	3	1	0	3.5
2	UEC 401	ANALOG COMMUNICATION SYSTEMS	3	1	2	4.5
3	UEC 502	DIGITALSIGNAL PROCESSING	3	1	2	4.5
4	UEC 510	COMPUTER ARCHITECTURE	3	1	0	3.5
5	UEC 612	DIGITAL SYSTEM DESIGN	3	1	2	4.5
6	UCS 303	OPERATING SYSTEMS	3	0	2	4.0
		TOTAL	18	5	8	24.5

SEMESTER-VI

SR. NO.	COURSE NO.	TITLE	L	T	P	CR
1	UEC 512	LINEAR INTEGRATED CIRCUITS AND APPLICATIONS	3	0	2	4.0
2	UEC 607	DIGITAL COMMUNICATION	3	0	2	4.0
3	UEC 608	EMBEDDED SYSTEMS	2	0	2	3.0
4	UEC 747	ANTENNA AND WAVE PROPAGATION	3	0	2	4.0
5	UCS 613	DATA STRUCTURES AND ALGORITHMS (2 SELF EFFORT HOURS)	3	0	4	6.0
6	UTA012	INNOVATIONS & ENTERPENEURSHIP (5 SELF EFFORT HOURS)	1	0	2	4.5
7	UEC 797	CAPSTONE Project –STARTS (4 SELF EFFORT HOURS)	0	0	2	--
		TOTAL	15	0	16	25.5

SEMESTER-VII

SR. NO.	COURSE NO.	TITLE	L	T	P	CR
1	UEC 708	MICROWAVE ENGINEERING	3	0	2	4.0
2	UEC 709	FIBER OPTIC COMMUNICATION	3	0	2	4.0
3	UEC 858	MODERN CONTROL THEORY	3	0	0	3.0
4	UHU005	HUMANITIES FOR ENGINEERS	2	0	2	3.0
5	UEC	ELECTIVE – I	3	1	0	3.5
6	UEC	ELECTIVE – II	3	1	2	4.5
7	UEC 797	CAPSTONEPROJECT - COMPLETION (8 SELF EFFORT HOURS)	-	-	2	8.0
		TOTAL	17	2	10	30.0

SEMESTER-VIII

SR. NO.	COURSE NO.	TITLE	L	T	P	CR
1	UEC 892	PROJECT SEMESTER	-	-	-	20.0
		OR				
1		ELECTIVE – III	3	1	0	3.5
2		ELECTIVE – IV	2	1	2	3.5
3	UEC 894	PROJECT	-	-	20	13.0
		TOTAL				20.0
		OR				
1	UEC 896	START-UPSEMESTERBASEDON HANDS ON WORK ON INNOVATIONS& ENTERPENEURSHIP.	-	-	-	20.0

LIST OF ELECTIVES

ELECTIVE – I

SR. NO.	COURSE NO.	TITLE	L	T	P	CR
1	UEC 705	IMAGE PROCESSING & COMPUTER VISION	2	1	2	3.5
2	UEC 706	DATA COMMUNICATION AND PROTOCOLS	3	1	0	3.5
3	UEC 710	BIOMEDICAL SIGNAL PROCESSING	3	1	0	3.5
4	UEC XXX	MACHINE LEARNING	3	1	0	3.5
5	UEC 852	WIRELESS SENSOR NETWORKS	3	1	0	3.5
6	UEC 855	SPEECH PROCESSING	2	1	2	3.5
7	UEC 859	INTEGRATED SYSTEM DESIGN	2	1	2	3.5

ELECTIVE – II

SR. NO.	COURSE NO.	TITLE	L	T	P	CR
1	UEC 609	MOS CIRCUIT DESIGN	3	1	2	4.5
2	UEC 622	DSP PROCESSORS	3	1	3	4.5
3	UEC 721	ANALOG IC DESIGN	3	1	2	4.5
4	UEC 748	VIDEO SIGNAL PROCESSING	3	1	2	4.5
5	UEC 804	WIRELESS & MOBILE COMMUNICATION	3	1	2	4.5
6	UEC XXX	SOFT COMPUTING	3	1	2	4.5

ELECTIVE – III

SR. NO.	COURSE NO.	TITLE	L	T	P	CR
1	UEC 742	MEMS	3	1	0	3.5
2	UEC 854	ASIC and FPGA	3	1	0	3.5
3	UEC 860	POWER ELECTRONICS	3	1	0	3.5
4	UEC 861	CLOUD COMPUTING	3	1	0	3.5

ELECTIVE – IV

SR. NO.	COURSE NO.	TITLE	L	T	P	CR
1	UEC 851	VLSI DIGITAL SIGNAL PROCESSING	3	1	0	3.5
2	UEC 862	IC FABRICATION TECHNOLOGY	3	1	0	3.5
3	UEC 863	VLSI INTERCONNECTS	3	1	0	3.5
4	UEC 864	RADAR AND REMOTE SENSING	3	1	0	3.5
5	UEI	VIRTUAL INSTRUMENTATION	2	1	2	3.5

Total Credits: 198.5

UEC 001: Electronic Engineering

L	T	P	Cr
3	1	2	4.5

Course Objective: To enhance comprehension capabilities of students through understanding of electronic devices, various logic gates, SOP, POS and their minimization techniques, various logic families and information on different IC's and working of combinational circuits and their applications.

Semiconductor Devices: p- n junction diode: Ideal diode, V-I characteristics of diode, Diode small signal model, Diode switching characteristics, Zener diode

Electronics Devices and Circuits: PN Diode as a rectifier, Clipper and clamper, Operation of Bipolar Junction Transistor and Transistor Biasing, CB, CE, CC (Relationship between α, β, γ) circuit configuration Input-output characteristics, Equivalent circuit of ideal and real amplifiers, Low frequency response of amplifiers, Introduction to Field Effect Transistor and its characteristics, N and P channel MOS transistors, CMOS inverter

Operational Amplifier Circuits: The ideal operational amplifier, The inverting, non-inverting amplifiers, Op-Amp Characteristics, Op-amp as Summer.

Digital Systems and Binary Numbers: Introduction to Digital signals and systems, Number systems, Positive and negative representation of numbers, Binary arithmetic, Definitions and basic theorems of boolean Algebra**,** Algebraic simplification, Sum of products and product of sums formulations (SOP and POS), Gate primitives, AND, OR, NOT and Universal Gate, Minimization of logic functions, Karnaugh maps.

Combinational and Sequential Logic: Code converters, multiplexers, decoders, Adders , Master-slave and edge-triggered flip-flops,Synchronous and Asynchronous counters, Registers

Logic families: TTL and CMOS logic families and their interfacing.

Familiarity with standards IEEE 315A-1986, IEEE 754-2008, IRE 216-1960.

Laboratory Work:
Familiarization with CRO, DSO and Electronic Components, Diodes characteristics - Input-Output and Switching, BJT and MOSFET Characteristics, Zener diode as voltage regulator,Rectifiers, Clippers and Clampers, adder circuit implementation, Multiplexer & its application, Latches/Flip-flops, up/down counters.

Course learning outcomes (CLO): The student will be able to:
1. Demonstrate the use of semiconductor diodes in various applications.
2. Discuss and explain the working of transistors and operational Amplifiers, their configurations and applications.
3. Recognize and apply the number systems and Boolean algebra.
4. Reduce Boolean expressions and implement them with Logic Gates.
5. Analyze, design and implement combinational and sequential circuits.
6. Analyze and differentiate logic families, TTL and CMOS.

Text Books:

1. *Milliman, J. and Halkias, C.C., Electronic Devices and Circuits, Tata McGraw Hill, 2007.*
2. *M. M. Mano and M.D. Ciletti, Digital Design, Pearson, Prentice Hall, 2013.*
3. *Boylestad, R.L. and Nashelsky, L., Electronic Devices & Circuit Theory, Perason (2009).*

Reference Books:

1. *Donald D Givone, Digital Principles and Design, McGraw-Hill, 2003.*
2. *John F Wakerly, Digital Design: Principles and Practices, Pearson, (2000).*
3. *N Storey, Electronics: A Systems Approach, Pearson, Prentice Hall, (2009).*

Evaluation Scheme:

S.No.	Evaluation Elements	Weightage (%)
1.	MST	25
2.	EST	35
3.	Sessional (May include Assignments/Projects/Tutorials/Quiz(es)/Lab Evaluations)	40

UECXXX: CIRCUIT ANALYSIS AND SYNTHESIS

L	T	P	Cr
3	**1**	**0**	**3.5**

Introduction: Circuit components, Network graph, KCL, KVL, Circuit analysis and methods, Mutualinductance, Co-efficient of coupling (Dot analysis), Network Classification.

Network Theorems and Two Port Network Descriptions: Thevenins theorem, Nortons theorem,Maximum power transfer theorem, Superposition theorem, Tellengens theorem, Reciprocity theorem, Two port description in terms of open circuits impedance Parameters, Short circuit admittance parameters, Hybrid parameters, Image parameters, Inter-connection of two port network, Indefinites admittance matrix and its applications, Duality networks.

Network Functions: Concept of Complex frequency, Transform impedances, Network functions of oneport & two port networks.

Time Domain Analysis: Unit, Step, Impulse and ramp function, Solution of networks using LaplaceTransform, Steady state analysis of networks.

Attenuators: Image impedances-Image transfer coeff, Iterative impedances, Ladder network, Latticenetwork, Bridged T-network conversion, Insertion loss, Design of symmetrical-T & L section Attenuators.

Filters: Determination of pass and attenuation bands constant K-type, Low pass, High pass, Band pass,Band stop, M-derived filters, Lattice filter, Crystal filters.

Network Synthesis: Concept of Poles & Zero, Reliability of one port Networks, Positive real function(prf) Graphical Interpretation of positive realness, Properties of prf, Even & Odd parts of palimonies Necessary & Sufficient Condition for a function to be positive real function, Hurwitz polynomials, Hurwitz polynomials test, Foster & Caner form properties of driving point impedance function of one port passive lumped reactive element network, Properties of the driving point impedance function of RL Network Properties of the driving point Impedance function of RC Network, Minimum Function Realization of Driving point Function of two-element kind by Canonic Networks, Realization of LC driving point function, Synthesis of LC, RC and RL driving point immitance function using Foster and cauer first and second forms.

Course Learning Outcomes (CLO):
The students will be able to:

1. understand the basics of different types of circuit components and their analysis procedures.
2. do analysis based on network theorems and to determine the current, voltage and power.
3. analyze two port networks and to analyze time response of the circuit.
4. check stability of a circuit and to design the circuit using foster and cauer forms

Text Books:

1. *Vanvalkenberg, M.E., Networks Analysis, Prentice Hall of India (2007) 3rd ed.*
2. *Arshad, M., Network Analysis and Synthesis, Laxmi Publications (2008) 2nd ed.*

Reference Books:

1. *Kuo, F., Network Analysis and Synthesis, John Wiley (2003) 2nd ed.*
2. *Anderson, B.D.O., Vongpanitlerd, S., Network Analysis and Synthesis, Dover Publications (2006) 3rd ed.*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	30
2	EST	45
3	Sessionals (May include assignments/quizzes)	25

UEC404: SIGNALS AND SYSTEMS

L	T	P	Cr
3	1	2	4.5

Course Objective: The aim of this subject is to develop analytical capability of students, by which they would be able to handle real-time signal processing related problems and projects. The knowledge of various transforms will help students to work in multi-disciplinary fields of engineering in group activities.

Representation of Signals and Systems: Signals, Basic Continuous Time signals, Energy and power signals, System modeling concepts, Linear time invariant systems, Representation of signals in terms of impulses, Discrete time LTI systems continuous time LTI systems, Properties of LTI systems, Systems described by differential and difference equations, Introduction to Sampling theorem of sinusoidal and random signals, Quantization. Familiarization with Standaed IEEE 1641-2004 .

FourierAnalysis: Continuous and discrete time Fourier series, Trigonometric & exponential Fourier series, Properties of Fourier series, Parseval's theorem, Line spectrum, Rate of conversion of Fourier spectra, Continuous and discrete time Fourier transforms and its properties, Analysis of discrete time signals and systems, Correlation, Autocorrelation, Relation to Laplace transform. Standard IEEE 1139-1999.

Z-Transform: Definition of Z-transform and Z-transform theorems, Relation between Z.T. and F.T., Transfer function, Inverse Z-transform, Discrete time convolution, Stability, Time domain and frequency domain analysis, Solution of difference equation.

Introduction to Fast Fourier Transforms: Discrete Fourier transform, Properties of DFT, Fast Fourier transforms, Divide and Conquer Approach, Decimation in time and decimation in frequency, Radix-4FFT, Linear Convolution, Circular Convolution, Power spectrum and correlation with FFT.

Random Signals: Probability, Random variables, Gaussian distribution, Transformation of random variables, Random processes, Stationary processes, Correlation and Covariance Functions, Regularity and Ergodicity, Gaussian Process, Transmission of deterministic and undeterministic signals through a linear time invariant system, Spectral density. Standard IEEE P1933.1

Laboratory work:
Signal generation, Solving difference equation, Calculating Z-transform, Linear and Circularconvolution, Correlation, DFT/IDFT, FFT algorithms using Matlab.

Course learning outcome (CLO): The student will be able to:

1. Analyze the properties of continuous and discrete time signals and systems.
2. Represent signals and systems in the frequency domain using Fourier tools.
3. Apply Z-transform to analyze discrete time signals and system
4. Obtain the Fast Fourier transform of a sequence and measure its computational efficiency.
5. Analyze random phenomena and compute probabilities of random events and moments of random variables.

Text Books:

1. *Oppenheim, A.V. and Willsky, A.S., Signal&Systems, PrenticeHallofIndia(1997).*
2. *Proakis, J.G. and Manolakis, D.G., Digital Signal Processing Principles Algorithm&Applications, PrenticeHall(2007).*

Reference Books:

1 *Lathi,B.P.,ModernDigitalandAnalogCommunicationSystems,OxfordUniv.Press, 1998*

2. *Papoulis,A.,ProbabilityRandomVariablesandStochasticProcesses,McGrawHill, 2008*

Evaluation Scheme:

S.No.	Evaluation Elements	Weightage (%)
1.	MST	25
2.	EST	35
3.	Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	40

UEC 405: Microprocessor and their Applications

L	T	P	Cr
3	1	2	4.5

Course Objective: To Introduce the basics of microprocessors and microcontrollers technology and related applications. Study of the architectural details and programming of 16 bit 8086 microprocessor and its interfacing with various peripheral ICs; Study of architecture and programming of ARM processor.

Introduction to Microprocessors: Need for Flexible Logic and Evolution of Microprocessors, Applications, Generic Architecture of a Microprocessor. Overview of 8085 microprocessor, Architecture, Instruction Set, Interrupts and Programming Examples

INTEL 8086 Microprocessor: Pin Functions, Architecture, Characteristics and Basic Features of Family, Segmented Memory, Interrupt Structures. INTEL 8086 System Configuration,Description of Instructions. Addressing Modes, Assembly directives. Assembly software programs with algorithms, Loops, Nested loops, Parameter Passing etc.

Interfacing with 8086: Interfacing of RAMs and ROMs along with the explanation of timing diagrams. Interfacing with peripheral ICs like 8255, 8254, 8279, 8259, 8251 etc.

ARM Processor Fundamentals: ARM core data flow model, Architecture, ARM General purpose Register set and GPIO's, CPSR, Pipeline, Exceptions, Interrupts, Vector Table, ARM processors family, ARM instruction set and Thumb Instruction set.

ARM programming in Assembly: Writing code in assembly, Instruction Scheduling, Register Allocation, Conditional Execution, Looping Constructs, Bit Manipulation, Efficient Switches, Optimized Primitives: Double-Precision Integer Multiplication, Integer Normalization and Count Leading Zeros, Division, Square Roots, Transcendental Functions like log, exp, sin, cos, Endian Reversal and Bit Operations, Saturated and Rounded Arithmetic, Random Number Generation, Exception and Interrupt Handling.

Familiarization with Standards IEEE 1754-1994 and IEEE 694-1985.

Laboratory Work: Introduction to INTEL kit, Programming examples of 8086 and ARM based processors. Interfacing of LED seven segment display, ADC, DAC, stepper motor etc. Microprocessor based projects.

Course learning outcome (CLO): The student will be able to:

1. acquire knowledge about Microprocessors and its need.
2. write the programs using 8086 microprocessor
3. understand the internal architecture and interfacing of different peripheral devices with 8086 microprocessor.
4. design the system using ARM processors.
5. understand the internal architecture and interfacing of different peripheral devices with 8086 and ARM processors.

Text Books

1. *Gaonkar, Ramesh., Microprocessor Architecture, Programming and Applications with the 8085, Penram International Publishing India PVT.LTD. (2005)*
2. *Hall, D.V., Microprocessor and Interfacing, Tata McGraw Hill Publishing Company, (2006)*
3. *Steve Furber, ARM System on chip Architecture* Addison Wesley (2000)

Reference Books

1. *Gibson, Glenn A., Liu, Yu-Cheng., Microcomputer Systems: The 8086/8088 Family Architecture Programming And Design, Pearson, (2001)*
2. *Andrew N. Sloss,ARM System Developer's Guide, Morgan Kaufmann publications (2004).*

Evaluation Scheme:

S.No.	Evaluation Elements	Weightage (%)
1.	MST	25
2.	EST	35
3.	Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	40

UEC301: Analog Electronic Circuits

L	T	P	Cr
3	1	2	4.5

Course Objective: The aim of this course is to familiarize the student with the analysis and design of basic transistor amplifier circuits, oscillators and wave shaping circuits.

Transistor Biasing and Thermal Stabilization: The Operating Point, Biasing Stability, Self-Biasing or Emitter Bias, Stabilization against Variations in I_{co}, V_{BE}, and β, General Remarks on Collector-Current Stability, Bias Compensation, Biasing Techniques for Linear Integrated Circuits, Thermistor and Sensistor Compensation, Thermal Runaway, Thermal Stability, The FET Small-Signal Model, The metal-oxide-semiconductor FET (MOSFET), The low-frequency common-source and common-drain amplifiers, Biasing FET

The Transistor at High Frequencies: The Hybrid-pi (II) Common-emitter Transistor Model, Hybrid-II conductances, The Hybrid-II Capacitances, Validity at Hybrid-II Model, Variation of Hybrid-II parameters, The CE short-circuit current gain, Current gain with resistive load, Single-stage CE transistor amplifier response, The gain-bandwidth product, Emitter follower at high frequencies

Multistage Amplifiers: Classification of amplifiers, Distortion in amplifiers, Frequency response of an amplifier, Bode plots, Step Response of an amplifier, Bandpass of cascaded stages, The RC-coupled amplifier, Low-frequency response of an RC-coupled stage, Effect of an emitter Bypass capacitor on low-frequency response, High-frequency response of two cascaded CE Transistor stages, Multistage CE amplifier cascade at high frequencies, Noise , Tuned Amplifiers.

Power Amplifiers: Class A, B, AB, Push pull & Class C amplifiers, Comparison of their Efficiencies, Types of distortion.

Feedback Amplifiers: Classification of Amplifiers, The feedback concept, The transfer gain with feedback, General characteristics of negative-feedback amplifiers, Input resistance, Output resistance, Method of Analysis of a Feedback Amplifier, Voltage-series feedback, A voltage-series feedback pair, Current-series feedback, Current-shunt feedback, Voltage-shunt feedback

Stability and Oscillators: Sinusoidal Oscillator, The phase-shift oscillator, Resonant-circuit oscillators, A General form of oscillator circuit, The Wien Bridge oscillator, Crystal oscillator, Frequency Stability

Wave shaping circuits: Multi-vibratotrs (Astable, Mono-stable, Bi-Stable), High pass and low pass filters using R-C Circuits and R-L, R-L-C Circuits & their response to step input, Pulse input, Square input and Ramp Input, Attenuators, Clamping Circuit theorem, Clipping and Clamping circuits, Schmitt Trigger, Comparator.

Laboratory Work: *Frequency response analysis of RC coupled amplifier, Tuned amplifiers, Push-pull amplifier, Feedback amplifier.Hartley and Colpitts Oscillator. RC Phase shift oscillator. Study of Multi-vibrators (Astable, Mono-stable, Bi-stable Multi-vibrator). Clipper and Clamper circuit, Schmitt Trigger.*

Course learning outcome (CLO): The student will be able to:

1. Determine operating point and various stability factors of transistor.
2. Analyse low and high frequency transistor model.
3. Evaluate the performance parameters of various multistage and power amplifiers.
4. Analyse the concept of feedback amplifier and its characteristics.
5. Design oscillator circuits and analyse its performance.
6. Analyse various filters and multi-vibrators circuits.

Text Books:

1. *Milliman, J. and Halkias, C.C., Intergrated Electronics, Tata McGraw Hill (2007).*
2. *Milliman, J. &Taub, H., Pulse, Digital and switching waveforms, Tata McGraw Hill (2007).*

Reference Books

1. *Malvino, L., Electronic principles, Tata McGraw Hill (1998).*
2. *Cathey, J. J., 2000 Solved Examples in Electronics, McGraw Hill (1991).*

Evaluation Scheme:

S.No.	Evaluation Elements	Weightage (%)
1.	MST	25
2.	EST	35
3.	Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	40

UTA011 ENGINEERING DESIGN PROJECT - II

((Includes project with 6 self effort hours)

L	T	P	Cr
1	0	4	6.0

Course Objective: Understanding of Arduino microcontroller architecture and programming, Interfacing of Arduino board with various I/O devices. Serial data transmission using Arduino board.Learning of ARM processor Instruction set and programming concepts.

Arduino Microcontroller:

Features of Ardunio Microcontroller, Architecture of Arduino, Different boards of Arduino, Arduino Interfacing and Applications, Anatomy of an Interactive Device like Sensors and Actuators, A to D converters and their comparison, Blinking an LED, LCD Display, Driving a DC and stepper motor, Temperature sensors, Serial Communications, Sending Debug Information from Arduino to Your Computer, Sending Formatted Text and Numeric Data from Arduino, Receiving Serial Data in Arduino, Sending Multiple Text Fields from Arduino in a Single Message, Receiving Multiple Text Fields in a Single Message in Arduino. Light controlling with PWM.

Introduction to ARM processor: Features of ARM processor, ARM Architecture, Instruction set, ARM Programming

Programming of Arduino: The Code designing step by step. Taking a Variety of Actions Based on a Single Variable, Comparing Character and Numeric Values, Comparing Strings, Performing Logical Comparisons, Performing Bitwise Operations, Combining Operations and Assignment, Using Embedded techniques to program Arduino microcontroller, Understanding the libraries of Arduino programming language and applying for circuit design

Familiarization with Standards IEEE 1451.2-1997 and IEEE 1212-2001.

Laboratory work: Introduction to Arduino board.Programming examples of Arduino board. Interfacing of LED, seven segment display, ADC and DAC with Arduino board. Introduction to ARM processor kit.

Projects: Arduino and ARM based projects to be allocated by concerned faculty.

Course Learning Outcomes: The student should be able to:

1. understand of features of Arduino board.
2. analyze of internal Architecture of Arduino board.
3. apply Arduino board programming concepts.
4. design and implement Buggy project based on different goals and challenges defined.

Text Books:

1. *Michael McRoberts, Beginning Arduino, Technology in action publications.*
2. *Alan G. Smith, Introduction to Arduino: A piece of cake, CreateSpace Independent Publishing Platform (2011)*

Reference Book:

1. *John Boxall, Arduino Workshop - A Hands-On Introduction with 65 Projects, No Starch Press; 1 edition (2013).*

Evaluation Scheme:

SNo.	Evaluation Elements	Weightage (%)
1.	Mid Semester evaluation 1	20
2.	Mid Semester evaluation 2	20
3.	Mid Semester evaluation 3	20
4.	End Semester Evaluation	40

UEC401: ANALOG COMMUNICATION SYSTEMS

L	T	P	Cr
3	1	2	4.5

Course Objective: The aim of this course is to build fundamental understanding of a communication system and its performance metrics. The course will describe the theory of modulation and its different counterparts with the help of mathematical analysis of their various characteristics. The generation of AM, FM and PM waves will be described. The course will also focus on the design of AM and FM receivers and will deal with various types of noises in the communication channel.

Introduction to Communication systems: Introduction to Communication system, analog and digital messages, signal to noise ratio, Noise, Resistor noise, Multiple resistor noise sources, Noise Temperature, Noise bandwidth, Effective input noise temperature, channel bandwidth, rate of communication, modulation, necessity for modulation, signal distortion over a communication channel, signal energy and signal energy density, signal power, power spectral density,

Amplitude Modulation: Baseband and carrier communication, Theory of amplitude modulation, DSB-AM, SSB-AM, Vestigial sideband transmission, carrier acquisition, , power calculations, Square law modulation, Amplitude modulation in amplifier circuits, Suppressed carrier AM generation (Balanced Modulator) ring Modulator, Product Modulator/balanced Modulator.

AM Reception: Tuned Ratio Frequency (TRF) Receiver, Super heterodyne Receiver, RF Amplifier, Image Frequency Rejection, AM diode detector, AM receiver using a phase locked loop (PLL), AM receiver characteristics. Standard IEEE/IHF 185-1975

Angle Modulation: Concept of instantaneous frequesncy, bandwidth of angle modulated waves, Theory of frequency modulation, Mathematical analysis of FM, Spectra of FM signals, Narrow band FM, Wide band FM, Phase modulation, Phase modulation obtained from frequency modulation, FM allocation standards, Generation of FM by direct method, Indirect generation of FM, The Armstrong method RC phase shift method,, Noise triangle. Comparison of AM, FM and PM

FM/PM Reception: Direct methods of Frequency demodulation, Travis detector/frequency discrimination (Balanced stop detector), Foster seely of phase discriminator, Ratio detector, Indirect method of FM demodulation, FM detector using PLL, Zero crossing detector as a Frequency Demodulator, Pre-emphasis / de-emphasis, Limiters, The FM receiver

Analog Pulse Modulation: Introduction, Pulse amplitude modulation (PAM), Pulse Time Modulation (PTM), Pulse Width Modulation (PWM), Pulse Position Modulation (PPM), Spectra of pulse modulated signals, SNR calculations for pulse modulation systems.

Laboratory work: Study of AM modulators / demodulators: (Balanced modulator, Ring modulator) / (Balanced modulator Super heterodyne Receiver), Study of FM/PM modulators/demodulators: (direct method, Varactor diode Modulator, Indirect generation of FM) / (Balanced stop detector, Foster seely of phase discriminator, Ratio detector), FM stereo receiver.

Course learning outcome (CLOs): The students will be able to

1. describe different types of noise and predict its effect on various analog communication systems.
2. analyze energy and power spectral density of the signal.
3. express the basic concepts of analog modulation schemes
4. evaluate analog modulated waveform in time /frequency domain and also find modulation index.
5. develop understanding about performance of analog communication systems
6. calculate bandwidth and power requirements for analog systems.
7. analyze different characteristics of receiver

Text Books:

1. Kennedy, G., Electronic Communication Systems, McGraw-Hill (2008) 4th ed.
2. Lathi.B.P.,Modern Digital and Analog Communications Systems 3rd ed.

Reference Books:

1. Taub, H., Principles of Communication Systems, McGraw-Hill (2008) 3rd ed.
2. Haykin, S., Communication Systems, John Willey (2009) 4th ed.
3. Proakis, J. G. and Salehi, M., Fundamentals of Communication Systems, Dorling Kindersley (2008) 2nd ed.

Evaluation Scheme:

S.No.	Evaluation Elements	Weightage (%)
1.	MST	25
2.	EST	35
3.	Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	40

UEC 510: COMPUTER ARCHITECURE

L	T	P	Cr
3	1	0	3.5

Course Objectives: To introduce the concept of parallelism followed in the modern RISC based computers by introducing the basic RISC based DLX architecture. To make the students understand and implement various performance enhancement methods like memory optimization, Multiprocessor configurations, Pipelining and interfacing of I/O structures using interrupts and to enhance the student's ability to evaluate performance of these machines by using evaluation methods like CPU time Equation, MIPS rating and Amdahl's law.

Fundamentals of Computer Design: Historical Perspective, Computer Types, Von-Neuman Architecture, Harvard Architecture Functional Units, Basic Operational Concepts, Bus Structures, Performance metrics, CISC and RISC architectures, Control Unit, Hardwired and micro-programmed Control unit.

Instruction Set Principles: Classification of Instruction set architectures, Memory Addressing, Operations in the instruction set, Type and Size of operands, Encoding an Instruction set, Program Execution, Role of registers, Evaluation stacks and data buffers, The role of compilers, The DLX Architecture, Addressing modes of DLX architecture, Instruction format, DLX operations, Effectiveness of DLX.

Pipelining and Parallelism: Idea of pipelining, The basic pipeline for DLX, Pipeline Hazards, Data hazards, Control Hazards, Design issues of Pipeline Implementation, Multicycle operations, The MIPS pipeline, Instruction level parallelism, Pipeline Scheduling and Loop Unrolling, Data, Branch Prediction, Name and Control Dependences, Overcoming data hazards with dynamic scheduling, Superscalar DLX Architecture, The VLIW Approach.

Memory Hierarchy Design: Introduction, Cache memory, Cache Organization, Write Policies, Reducing Cache Misses, Cache Associatively Techniques, Reducing Cache Miss Penalty, Reducing Hit Time, Main Memory Technology, Fast Address Translation, Translation Lookaside buffer Virtual memory, Crosscutting issues in the design of Memory Hierarchies.

Multiprocessors: Characteristics of Multiprocessor Architectures, Centralized Shared Memory Architectures, Distributed Shared Memory Architectures, Synchronization, Models of Memory Consistency.

Input/ Output Organization and Buses: Accessing I/O Devices, Interrupts, Handling Multiple Devices, Controlling device Requests, Exceptions, Direct Memory Access, Bus arbitration policies, Synchronous and Asynchronous buses, Parallel port, Serial port, Standard I/O interfaces, Peripheral Component Interconnect (PCI) bus and its architecture, SCSI Bus, Universal Synchronous Bus (USB) Interface.

Course Learning Outcomes (CLO S): The students will be able to:

1. Understand and analyze a RISC based processor.
2. Understand the concept of parallelism and pipelining.

3. Evaluate the performance of a RISC based machine with an enhancement applied and make a decision about applicability of that respective enhancement as a design engineer.
4. Understand the memory hierarchy design and optimise the same for best results.Understand how input/output devices can be interfaced to a processor in serial or parallel with their priority of access defined.

Text Books:

1. *Hennessy, J. L., Patterson, D. A., Computer Architecture: A Quantitative Approach, Elsevier (2009) 4th ed.*
2. *Hamacher, V., Carl, Vranesic, Z.G. and Zaky, S.G., Computer Organization, McGraw-Hill (2002) 2nd ed.*

Reference Books:

1. *Murdocca, M. J. and Heuring, V.P., Principles of Computer Architecture, Prentice Hall (1999) 3rd ed.*
2. *Stephen, A.S., Halstead, R. H., Computation Structure, MIT Press (1999) 2nd ed.*

Evaluation Scheme:

S.No.	Evaluation Elements	Weightage (%)
1	MST	30
2	EST	45
3	Sessional (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	25

UEC502: DIGITAL SIGNAL PROCESSING

L	T	P	Cr
3	1	2	4.5

Course Objective: To enhance comprehension capabilities of students through understanding of designing procedure of digital filters both FIR and IIR using different approaches and their associated structures, linear predictors for adaptive signal processing, Different adaptive filtering algorithms and obtain results from multirate signal processing.

Review of Signals and Systems: Overview of the Frequency Analysis of the Signals and Systems, FFT algorithm, Properties of the DFT, Circular Convolution, Linear Convolution using the DFT. Standards IEEE 265-1966 , IEEE 1057-2007

Design of Digital Filters: Basic principles of Filters and Filtering, Different types of the filters, Problems associated with Passive filters, Difference between analog and digital filter design.

Design of FIR Filters: Symmetric and Antisymmetric FIR filters, Linear phase concept, Design of ideal and practical FIR filter (LPF, HPF, BPF and BRF) without using Window functions and with window functions, Comparison of window functions, Design of FIR filters using frequency sampling methods, Design of digital differentiator, Structure for realizing digital FIR filters.

Design of IIR Filters: Butterworth and Chebyshev approximation, Design of Butterwoth (Type 1 and II) Lowpass filters using approximation of Derivative, Impulse invariance and Bilinear Transformation, Frequency warping effect, Prewarping, Frequency transformation in both analog and digital domain. Difference between IIR and FIR filters, Structure for realizing digital IIR filters.

Multirate Signal Processing: Concept of multirate signal processing, Decimation and Interpolation, Upsampling and Downsampling in the Z-domain, FIR filter polyphase structure, Filters for decimation and interpolation, Multistage decimators and interpolators. Filter banks, Uniform DFT filter bank, Polyphase realization of the uniform DFT filter bank, Two channel QMF bank, FIR QMF banks with PR, Half-band filters, Different applications of the Multirate signal processing. ISO/IEC 11172-3

Laboratory Work:

Generation of multiple frequencies signal, Familiarization of the frequency transform as DTFT and DFT, Convolution process, Implementation of the different types of digital IIR and FIR Filters, Analyse the effects of filters with varying parameters, Some problems on the sample rate conversion, Implementation of the different adaptive filters and solve some practical problems.

Mini Project :

Implementationof the different filters studied in the duration of course of varying order and length of moving template. Also, analyse the effect of the designed filter after applying it on the,

a) Sinusoidal signal having multiple frequencies, different amplitude and different phases added with artificially generated noise of different types of distribution.

b) Real signal such as echo signal which is already noisy and analyse the effect of the changing in the length or order of the filter.

c) Two-dimensional noisy signal with different distribution and comment on the effect of the varying parameters and different types of the filters after applying. Two dimensional real data which is already noisy. Comment on the effect of the different filters.

Course Learning Outcomes (CLOs): The students will be able to:

1. Understand the concept of basic filters and filtering process and their realization.
2. Design both digital FIR and IIR filters using different approaches and their associated structures.
3. Understand the concept of multi-rate signal processing and sampling rate conversion.
4. Design a filtering algorithm for the real time application.

Text Books:

1. *J.G. Proakis, D.G. Manolakis and D. Sharma, Digital Signal Processing, Pearson, 3rd edition, (2013).*
2. *A.V. Oppenheim, and R.W. Schafer, Discrete-Time Signal Processing, Pearson, (2002).*

Reference Books:

1. *Li Tan, Digital Signal Processing: Fundamentals and Applications, Elsevier, (2008).*
2. *Tamal Bose, Digital Signal and Image Processing, Wielly, (2004).*
3. *S. K. Mitra, Digital Signal Processing: A computer based approach, Tata McGraw Hill, 2nd edition.*

Evaluation Scheme:

S.No.	Evaluation Elements	Weightage (%)
1.	MST	25
2.	EST	35
3.	Sessional (May include Assignments/Projects/Tutorials/ Quizes/Lab Evaluations)	40

UEC307: ELECTROMAGNETIC FIELD THEORY AND TRANSMISSION LINES

L	T	P	Cr
3	1	0	3.5

Course Objective: To enhance student's comprehensive capabilities in electromagnetic field theory bystudy the behavior of statics and time varying electric and magnetic field in a medium and transmission line.

Vector Analysis: Review of vector algebra, Review of Cartesian, Cylindrical and spherical coordinate systems,

Electrostatic fields: Introduction to coulomb's law, Gaussian law and its applications in determination of field of spherical and cylindrical geometries, Laplace's and Poisson's equation in various coordinate systems. Effect of dielectric on capacitance, Boundary conditions at electric interfaces, Method of images and its applications.
Magnetostatics: Introduction to ampere's law, Magnetic vector potential, Magnetic forces, Boundary conditions at magnetic interfaces.

Time Varying Fields and Maxwell's Equations: Continuity of charge, Concept of displacement current, Maxwell's equation in integral and differential form: For static fields, For time varying fields, For free space, For good conductors, For harmonically varying fields, Poynting theorem and power flow: Energy stored and radiated power, Complex poynting vector, Properties of conductor and dielectrics, Wave equations for free space, Wave equations for conductors.

Uniform Plane Waves: Introduction, Uniform plane wave propagation, Wave equations, Transverse nature of uniform plane waves, Perpendicular relation between and EM waves in charge free, Current free dielectric, Reflection by ideal conductor: Normal incidence, reflection and transmission with normal incidence at another dielectric, Plane wave in lossy dielectric, Wave impedance and propagation constant, Depth of penetration, Surface impedance and surface resistance. Standards IEEE 1128-1998 and IEEE 1302-1998.

Transmission Lines and Matching Networks: Introduction, Circuit representation of parallel plane transmission lines, Transmission lines with losses, Characteristic impedance, Characteristic impedance at radio frequencies, Propagation constant, Attenuation constant and phase constant, An infinite line equivalent to a finite line terminated in its characteristic impedance, Reflection, Reflection coefficient, Expression for input impedance in terms of reflection coefficient, Standing wave ratio (SWR), Relation between SWR and reflection coefficient, Location of voltage maxima and minima, Impedance matching devices, Principle of impedance matching devices, Smith Chart, lossy lines.

Wave Guides: Introduction, Simple waveguides between two infinite and parallel conducting plates, Transverse Electric (TE) Waves or H-Introduction, Simple waveguides between two infinite and parallel conducting plates, Transverse Electric (TE) Waves or Hc impedance, Characteristic impedance at radio frequencies, Propagation constant, Attenuation constant and phase constant, An infinite equencies, dispersion relation, field patterns, power flow. Standard IEEE 148-1959.

Course Learning Outcomes (CLO s): The students will be able to:

1. Analyse the vector and scalar behaviour of Electric and magnetic along.
2. Analyse the static behaviour of electric and magnetic fields
3. Analyse the time varying fields using Maxwell's Equation
4. Investigate the characteristics of electromagnetic wave and its propagation in free space and transmission line.
5. Analyse different modes of wave propagation (TE, TM and TEM) and guided media.

Text Books:

1. *Hayt, W.H., Engineering Electromagnetics, Tata McGraw-ayt, W.H., Enth ed.*
2. *Kraus, J.D., Electromagnetics, McGraw-raus, J.D., Eth ed.*
3. *Sadiku, M.N.O, Elements of Electromagnetics, Oxford University Press (2009) 4th ed*

Evaluation Scheme:

S.No.	Evaluation Elements	Weightage (%)
1.	MST	30
2.	EST	45
3.	Sessional (May include Assignments/Projects/Tutorials/ Quizes/Lab Evaluations)	25

UEC612: DIGITAL SYSTEM DESIGN

L	T	P	Cr
3	1	2	4.5

Course Objectives: To familiarize the student with the analysis, design and evaluation of digital systems of medium complexity that are based on SSI, MSI and Programmable logic devices. Also, to familiarize the students with the issues in the design of iterative networks, timing analysis of synchronous and asynchronous systems.

Binary Codes: Review of special binary codes, Error detection and correction codes.

Combinational Circuits: Q. M. Method, Variable Map Method, Ripple carry adder, BCD adder, High speed adder, Subtractor, Code conversion, Magnitude comparators, Applications of Encoders, Decoders, MUX, DEMUX, Implementations using ROM, PLA, PAL. Standard ICs and their applications.Using combinational modules to design digital systems, Iterative networks.

Sequential Circuits: Various types of latches and flip-flops and their conversions, Universal Shift Registers, Counters – Ring, Johnson, Design of Counters, Timing issues, Setup and hold times, operating frequency limitations, Static Timing Analysis, Standard ICs for their applications, Finite State Machines – Moore and Mealy, Design of Synchronous and Asynchronous sequential circuits, Races and hazards, hazard free design.

Logic Circuits: DTL, TTL, MOS, CMOS logic families their comparison, Detailed study of TTL & CMOS logic families and their characteristics i.e. Fan-in, Fan-out, Unit load, Propagation delay, Power dissipation, Current & voltage parameters, Tristate Logic, Interfacing of TTL & CMOS logic families, reading and analyzing Datasheets, Performance estimation of digital systems.

Familiarity with Standards IEEE 91a-1991 and IEEE 91-1984.

Laboratory Work: *To study standard ICs and their usage, To study latches and Flip-flops, Design of registers and asynchronous/synchronous up/down counters, Variable modulus counters, Design of Finite State Machines, Study of timing waveforms, Usage of IC tester.*

Course Learning Outcomes: The student will be able to:

1. Perform Logic Minimization for single/multiple output function(s).
2. Generate multiple digital solutions to a verbally described problem.
3. Evaluate the performance of a given Digital circuit/system.
4. Draw the timing diagrams for the identified signals in a digital circuit.
5. Assess the performance of a given digital circuit with Mealy and Moore configurations.
6. Perform static timing analysis of the digital circuits/systems.
7. Compare the performance of a given digital circuits/systems with respect to their speed, power consumption, number of ICs, and cost.

Text Books:

1. *Fletcher, W.I., Engineering Approach to Digital Design, Prentice Hall of India (2007) 4^{th} ed.*
2. *Wakerly, J.F., Digital Design Principles and Practices, Prentice Hall of India (2013) 5thed.*

Reference Books:

1. *Givone D. D., Digital Principles and Design, Tata McGraw Hill (2007) 2^{nd}ed.*
2. *Tocci, R.J., Digital Systems: Principles and Applications, Prentice-Hall (2006) 10th ed.*
3. *Mano, M.M. and Clitti M. D., Digital Design, Prentice Hall (2001) 3rd ed.*

Evaluation Scheme:

S.No.	Evaluation Elements	Weightage (%)
1	MST	25
2	EST	35
3	Sessional (May include Assignments/Projects/Tutorials/ Quizes/Lab Evaluations)	40

UEC 512: LINEAR INTEGRATED CIRCUITS AND APPLICATIONS

L	T	P	Cr
3	0	2	4.0

Course Objectives: To enhance comprehension capabilities of students through understanding of operational amplifiers, frequency response, various applications of operational amplifiers, active filters, oscillators, analog to digital and digital to analog converters and few special function integrated circuits.

Introduction to Differential Amplifiers: Differential Amplifier, configurations of differential amplifier, Analysis of single input balanced output, single input unbalanced output, dual input balanced output and dual input unbalanced output differential amplifiers

Operational amplifier: various characteristics of op-amp, CMRR, PSRR, Internal structure of Op-amp, Ideal Op-amp.Inverting and Non-Inverting Configuration, Ideal Open-Loop and CLO ssed-Loop Operation of Op-Amp, Feedback Configurations: Voltage-Series Feedback Amplifier, Voltage-Shunt Feedback Amplifier, Differential Amplifiers with One & Two Op-Amps

Frequency Response of an Op-Amp: Introduction to Frequency Response, Compensating Networks, Frequency Response of Internally Compensated Op-Amp, Frequency response of Non-compensated Op-Amp, CLO ssed-Loop Frequency Response. Standard IEEE 165-1977.

General Applications: DC & AC Amplifiers, Peaking Amplifier, Summing, Scaling and Averaging amplifier, Instrumentation Amplifier, The Integrator, The Differenti ator, Log and Antilog Amplifier, Comparator, Zero Crossing Detector, Schmitt Trigger, Sample and Hold Circuit, Clippers and Clampers etc.

Active Filters and Oscillators: Butterworth Filters, Band-Pass Filters, Band Reject Filters, All Pass Filters, Phase Shift Oscillator, Wien Bridge Oscillator, Voltage-Controlled Oscillator (VCO), Square Wave Generator.

Specialized IC Applications: Introduction, The 555 Timer, Monostable and Astable Multivibrator using IC 555, Phase-Locked Loop (PLL), Voltage Regulators,

Laboratory Work: Inverting and Non Inverting Characteristics of an Op-Amp,Measurement of Op-amp parameters, Op-amp as integrator & differentiator, comparator, Schmitt trigger, Converter (ADC, DAC), square wave generator, Sawtooth waveform generator, precision half wave and full wave rectifiers, log-antilog amplifier, 555 as an astable, monostable and bi-stable multivibrators, active filters.

Course Learning Outcomes (CLOs): The student will be able to:
1. know the importance and significance of Op-Amp.
2. apply the concepts in real time applications.
3. design Integrators, Differentiators, and Comparators using Op-Amp.
4. use Op-Amp to generate Sine and Square wave forms.
5. design active filters and oscillators using Op-Amp.

6. use IC 555 as an astable, monostable and bi-stable multivibrators.

Text Books:

1. *Ramakant A. Gayakwad, 'OP-AMP and Linear IC's', Prentice Hal, 1999.*
2. *Sergio Franco, 'Design with operational amplifiers and analog integrated circuits', McGraw-Hill, 2002.*

Reference Books:

1. *D. Roy Choudhry, Shail Jain, "Linear Integrated Circuits", New Age International Pvt. Ltd., 2000.*
2. *J. Michael Jacob, 'Applications and Design with Analog Integrated Circuits', Prentice Hall of India, 2002.*

Evaluation Scheme:

S. No.	Evaluation Elements	Weightage (%)
6.	MST	25
7.	EST	40
8.	Sessional (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	35

UCS613: DATA STRUCTURES AND ALGORITHMS (with Project)

L	T	P	Cr
3	0	4	6.0

Course Objectives: To become familiar with different types of data structures and their applications and learn different types of algorithmic techniques and strategies.

Linear Data Structures: Arrays, Records, Strings and string processing, References and aliasing, Linked lists, Strategies for choosing the appropriate data structure, Abstract data types and their implementation: Stacks, Queues, Priority queues, Sets, Maps.

Basic Analysis: Differences among best, expected, and worst case behaviours of an algorithm, Asymptotic analysis of upper and expected complexity bounds, Big O notation: formal definition and use, Little o, big omega and big theta notation, Complexity classes, such as constant, logarithmic, linear, quadratic, and exponential, Time and space trade-offs in algorithms, Recurrence relations , Analysis of iterative and recursive algorithms.

Searching and Sorting: Linear Search, Binary Search, Bubble Sort, Selection Sort, Insertion Sort, Shell Sort, Quick Sort, Heap Sort, Merge Sort, Counting Sort, Radix Sort.

Algorithmic Strategies with examples and problem solving: Brute-force algorithms with examples, Greedy algorithms with examples, Divide-and-conquer algorithms with examples, Recursive backtracking, Dynamic Programming with examples, Branch-and-bound with examples, Heuristics, Reduction: transform-and-conquer with examples.

Non-Linear Data Structures And Sorting Algorithms: Hash tables, including strategies for avoiding and resolving collisions, Binary search trees, Common operations on binary search trees such as select min, max, insert, delete, iterate over tree, Graphs and graph algorithms, Representations of graphs, Depth- and breadth-first traversals, Heaps, Graphs and graph algorithms, Shortest-path algorithms (Dijkstra and Floyd) , Minimum spanning tree (Prim and Kruskal).

Problem Clauses: P, NP, NP- Hard and NP-complete, deterministic and non-deterministic polynomial time algorithm approximation and algorithm for some NP complete problems. Introduction to parallel algorithms, Genetic algorithms, intelligent algorithms.

Laboratory work: Implementation of Arrays, Recursion, Stacks, Queues, Lists, Binary trees, Sorting techniques, Searching techniques. Implementation of all the algorithmic techniques.

Project: It will contain a Project which should include designing a new data structure/algorithm/ language/tool to solve new problems & implementation. It can also involve creating visualizations for the existing data structures and algorithms. Quantum of project should reflect at least 60 hours of Work excluding any learning for the new techniques and technologies. It should be given to group of 2-4 students. Project should have continuous evaluation and should be spread over different components. There should be a formal project report. Evaluation components may include a poster, video presentation as well as concept of peer evaluation and reflection component.

Course learning outcome (CLOs): The students will be able to

1. Implement the basic data structures and solve problems using fundamental algorithms.
2. Implement various search and sorting techniques.
3. Analyze the complexity of algorithms, to provide justification for that selection, and to implement the algorithm in a particular context.
4. Analyse, evaluate and choose appropriate data structure and algorithmic technique to solve real-world problems.

Text Books:

1. *Corman, Leiserson & Rivest, Introduction to Algorithms, MIT Press (2009), 3rd Ed.*
2. *Narasimha Karumanchi, Data Structures and Algorithms Made Easy" (2014), 2nd Ed.*

Reference Books:

1. *Sahni, Sartaj, Data Structures, Algorithms and Applications in C++, Universities Press (2005), 2nd ed.*

Evaluation Scheme:

S.No.	Evaluation Elements	Weightage (%)
1	MST	20
2	EST	40
3	Sessionals (Assignments/Projects/ Tutorials/Quizzes/Lab Evaluations)	40

UEC608: EMBEDDED SYSTEMS

L	T	P	Cr
2	0	2	3.0

Course Objective: The course provides ability to understand the basic concepts of embedded system its firmware design approaches, communication tasks such as Message Passing, Remote Procedure Call, and synchronization issues for embedded systems. Some of the topics to be covered include architecture and programming of Arduino Microcontroller and study of RTOS based embedded systems.

Prerequisites: Familiarity with basic concepts of programming (algorithms) and the ability to write program algorithms in a language of your choice (e.g., C++ or Matlab) in a windows environment.

Embedded System: Introduction to Embedded Systems, Definition, Embedded Systems Vs General Computing Systems, ASICs, PLDs, Commercial Off-The-Shelf Components (COTS), History of Embedded Systems, Classification, Major Application Areas, Purpose of Embedded Systems, Characteristics and Quality Attributes of Embedded Systems, Memory Shadowing, Memory selection for Embedded Systems.

Embedded Firmware: Reset Circuit, Brown-out Protection Circuit, Oscillator Unit, Real Time CLO sck, Watchdog Timer, Embedded Firmware Design Approaches and Development Languages.

Advanced Embedded Systems Architectures: Features of Arduino Microcontroller, Architecture of Arduino, Different boards of Arduino.Fundamental of Arduino Programming, in built functions and libraries.Serial Communication between Arduino hardware and PC and Arduino Interrupt Programming.Experimental embedded platform like Raspberry Pi.
Standards IEEE 1275.1-1994 snd IEEE 1754.

RTOS Based Embedded System Design: Operating System Basics, Types of Operating Systems, Tasks, Process and Threads, Multiprocessing and Multitasking, Task Scheduling, Task Operations, Structure, Synchronization, Communication and Concurrency. Defining Semaphores, Operations and Use, Exceptions, Interrupts and Timers Exceptions, Interrupts, Applications, Processing of Exceptions and Spurious Interrupts, Real Time CLO scks, Programmable Timers, Timer Interrupt Service Routines (ISR), Soft Timers.

Task Communication: Shared Memory, Message Passing, Remote Procedure Call and Sockets, Task Synchronization: Task Communication/Synchronization Issues, Task Synchronization, Techniques, Device Drivers, How to Choose an RTOS.

Laboratory Work: Introduction to Kiel Software, Programming examples of ARM processor, programs based on Arduino microcontroller, Raspberry Pi processor and Red Pitaya.

Micro Project:
The students shall work on micro projects based on ARM processor, Arduino microcontroller, Raspberry Pi processor and Red Pitaya kit. Each student will submit his/her micro project report to the course coordinator for its evaluation.

Course Learning Outcomes (CLO Ss): The students should be able to

1. Understand the Embedded system, Embedded Systems on a Chip (SoC) and the use of VLSI designed circuits.
2. Program the modules of Arduino Microcontroller with various interfaces like memory & I/O devices and Raspberry Pi based embedded platform.
3. Analyze the need of Real time Operating System (RTOS) in embedded systems.
4. Study the Real time Operating system with Task scheduling.
5. Understand the concept to communicate information through embedded system.

Text Books:

1. *Raj Kamal, Embedded System Architecture, Programming and Design, Tata McGraw Hill, (2004).*
2. *Introduction to Embedded Systems - Shibu K.V, Mc Graw Hill.*
3. *Simon, D.E., An Embedded Software Primer, Dorling Kindersley (2005).*

Reference Books:

1. *Embedded System Design - Frank Vahid, Tony Givargis, John Wiley*
2. *Embedded Systems – Lyla, Pearson, 2013.*
3. *Michael McRoberts, Beginning Arduino, Technology in action publications, 2nd Edition.*
4. *User manual of Raspberry pi and Red Pitaya embedded board.*

Evaluation Scheme:

S. No.	Evaluation Elements	Weightage (%)
1.	MST	25
2.	EST	35
3.	Sessional (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	40

UEC747: ANTENNA AND WAVE PROPAGATION

L	T	P	Cr
3	0	2	4.0

Course Objective: Students will be able to understand vector theory, antenna basic parameters, linear wire antennas, antenna arrays and their patterns, folded dipole, Yagi Uda, loop and Microstrip antenna, wave propagation over ground, through troposphere and ionosphere.

Review of vector theory: Vector algebra, Cartesian coordinate system, dot product, cross product, other coordinate systems.

Introduction to Basic Antenna parameters: Radiation pattern, Radiation intensity, Beam width, Gain, Directivity, Polarization, Bandwidth, Efficiency, Side lobes, Side lobe level, Antenna Vector Effective Length and Equivalent Areas, Maximum Directivity and Maximum Effective Area, Friss Transmission Equation and Radar Range Equation, Plane wave and Properties of uniform plane waves.

Radiation Integrals and Auxiliary Potential Functions: Retarded vector and scalar potential, Vector Potential A for an Electric Current Source J, Vector Potential F for a Magnetic Current Source M, Electric and Magnetic Fields for Electric (J) and Magnetic (M) Current Sources.

Linear Wire Antennas: Radiation from an infinitesimal small current element, Radiation from an elementary dipole (Hertzian dipole), Small Dipole, Finite length dipole, Half wave dipole,Linear Elements Near or on Infinite Perfect Conductors, Monopole antenna, Folded dipole and Yagi Uda antenna.

Antenna Arrays: Two-Element Array, Broadside arrays, End fire arrays. N-Element Linear Array: Uniform Amplitude and Spacing, N-Element Linear Array: Directivity, N-Element Linear Array: Uniform Spacing, Non uniform Amplitude, Binomial Array, Chebyshev Arrays, Principle of pattern multiplication. Array pattern Synthesis.

Microstrip Antennas: Microstrip Antennas & their advantages, Media: Dielectric effect, Dielectric Loss Tangent- tan δ, Substrates,

Propagation of Radio Waves: Different modes of propagation: Ground waves, Space waves, Space wave propagation over flat and curved earth, Surface waves and Troposphere waves, Wave propagation in the Ionosphere, Critical frequency, Maximum usable frequency (MUF), Skip distance, Virtual height.

Familiarization with Standards IEEE 145-2013, IEEE 1502-2007 and IEEE 211-1997.

Laboratory Work: Drive antenna by voltage, Radiation pattern of half wave dipole, Radiation pattern of monopole, Effective height of antenna, Radiation pattern of capacitance and inductive loaded antenna, Directional radiation from two composite antennas, Radiation from conducting sheet with slot, Matching stub in antenna, Measure the SWR, Radiation polar diagram of directional antenna.

Course Learning Outcomes (CLOs): The student will be able to:

1. identify basic antenna parameters
2. design and analyze wire antennas
3. design and analyze antenna arrays
4. to identify characteristics of radio wave propagation
5. perform various antenna measurements

Text Books:

1. *Antenna Theory, Ballanis, John Wiley & Sons, 2003.*
2. *Antennas and Radio Propagation, Collins, R. E, McGraw-Hill,1987.*

Reference Books:

1. *Antennas, Kraus and Ronalatory Marhefka, John D., Tata McGraw-Hill, 2002.*
2. *Microwave & RF Design, Michael Steer, Sci.Tech Publishing, 2009.*

Evaluation Scheme:

S.No.	Evaluation Elements	Weightage (%)
1	MST	25
2	EST	35
3	Sessional (May include Assignments/Projects/Tutorials/ Quizes/Lab Evaluations)	40

UEC858: MODERN CONTROL THEORY

L	T	P	Cr
3	0	0	3.0

Course Objective: This course provides the insight of the fundamentals of modern control theory by analysing time and frequency response of open and CLO ssed loop systems. Furthermore, the concept is extended to advanced concepts of modern control theory - centred on the system stability and state space methods. Emphasis is placed on concepts of controllability and observability in addition to fundamentals of digital control systems.

Mathematical Models, Block Diagrams and Signal Flow Graphs of Systems: Introduction of mathematical models and transfer function, Construction and reduction of block diagram and signal flow graphs, Application of Mason's gain formula. Standard IEEE 55-1960

Time-Domain Analysis of Control Systems: Transient and steady state response, time response of first and second-order systems, sensitivity to parameter variations, steady-state errors, Types of Systems and Error Constants.

System Stability: Conditions for stability of linear systems, Algebraic Stability criteria - Hurwitz criterion, Routh criterion, Root locus techniques, Frequency domain analysis, Correlation between frequency response and transient response, Polar plots, Nyquist plots, Bode plots.

Classical Controller Design Methods: General aspects of the CLO ssed-loop control design problem, Controller circuits design concepts for P, PD, PI and PID Controllers

State Variable Analysis: Introduction, state variable representation, conversion of transfer function model to state variable model, conversion of state variable model to transfer function model, Eigen values and Eigen vectors, solution of state equations. Concepts of controllability and observability,

Digital Control System: Basic structure of digital control systems, description and analysis of Linear Time-Invariant Discrete-time systems.

Course learning outcome (CLO S): The student will be able to:

1. Understand CLO sse and open loop control system representations in terms of block diagrams, signal flow graphs and transfer function,
2. Analyze the time and frequency response of the control systems and to establish the correlation between them,
3. Analyze the stability of the control systems and learn various methods to judge the stability criterion.
4. Understand the fundamentals of designing of P-I-D controllers,
5. Achieve knowledge about the concepts of the state space analysys and the concept of controllability and observability for classical and digital control system.

Text Books:

1. *Nagrath, I. J., and Gopal, M., Control Systems Engineering, New Age International Publishers, 2006, 4th ed.*
2. *Benjamin C. Kuo, Automatic Control Systems, Pearson education, 2003*
3. *G F Franklin, J D Powell and M Workman 'Digital Control of Dynamic Systems', 1997, 3rd ed.*
4. *M. Gopal, Digital Control and State Variable Methods, McGraw-Hill, 2008.*

Reference Books:

1. *Ogata, Katsuhiko, Modern Control Engineering, Prentice-Hall, (2010) 5th ed.*
2. *Warwick, Kevin, An Introduction to Control Systems, World Scientific Publishing Co. Ptv. Ltd, (1996) 2nd ed.*
3. *Levine, W. S., Control System Fundamentals, CRC Press, (2000) 3rd ed.*
4. *Mutambara, Arthur G. O., Design and Analysis of Control Systems, CRC Press, (1999) 2nd ed.*

Evaluation Scheme:

S. No.	Evaluation Elements	Weightage (%)
1.	MST	30
2.	EST	50
3.	Sessional (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	20

UEC607: DIGITAL COMMUNICATION

L	T	P	Cr
3	0	2	4.0

Course Objective: The aim of this course is to build the foundation for communication systems design focusing on the challenges of digital communications. It will help to discuss the different types of digital pulse and band pass signalling techniques. It will give the idea to understand the statistical analysis from estimation and detection theory. Course will help to analyze error performance of a digital communication system in presence of noise and other interferences and it will help to improve the performance of the system. The course will also build fundamental understanding of information theory and coding.

Introduction: Elements of digital communication systems, continuous and discrete random variables, variance and expected value of a random variable, covariance, probability distribution and probability density functions, binomial, poisson, Gaussian and uniform distributions,central limit theorem, Sampling, quantization, reconstruction filter, PCM, Delta Modulation, Adaptive delta modulation, bandpass and low pass signal and system representations, Low pass equivalent of bandpass signals and systems, signal-space representation of waveforms.

Digital Modulation Schemes without memory: Unipolar and bipolar, Duo binary signaling, Modified duo binary signaling, NRZ, RZ, Manchester Coding,

Signal design or pulse shaping for band-limited channels for no inter-symbol interference and controlled ISI, Nyquist theorem for zero ISI, equalizers, Transmit pulse shaping, raised cosine spectrum, filter roll-off factors,

ASK, PSK,QPSK, M-ary modulation schemes, pulse amplitude modulation (PAM), correlator and matched filter, Additive white Gaussian noise channel model, MAP and ML receivers, decision regions, probability of error calculations for M-ary PAM, M-ary PSK and M-QAM, Receiver structures, correlation receivers, matched filter receivers, design issues in receiver structures, Minimum shift keying (MSK), continuous phase modulation (CPM), CPFSK, multi-dimensional signalling. Standard IEEE P802.11

Information Theory and Coding : Concept of information and entropy of a source, Rate of information Joint entropy, conditional entropy, mutual entropy, capacity of channel, Symmetric channel, BSC, BEC, Cascaded channel, Shannon theorem, Continuous channel, Shannon-Hartley theorem, Bandwidth-S/N trade-off.

Source coding: Shannon-Fano coding, Huffman coding.
Channel coding: Linear block codes, convolution codes.

Uniquely decodable and instantaneous codes, prefix codes, Kraft and mcmillan inequality, source coding theorem, Huffman and Hamming code, , Shannon channel coding theorem, Block codes,syndrome testing,covolutional codes, , (zero memory and markov sources), Baye's theorem, a-priori and a-posteriori information measures, chain rule, non-singular codes,viterbi algorithm for decoding convolutional codes.

Laboratory work: Practical's based upon hardware using communication kits and simulation with the help of simulation packages.

Course learning outcome (CLOs): The students will be able to :

1. identify, analyze, design (prototype) and simulate the pulse modulation systems working under the various capacity constraints.
2. Incorporate digital formats and m-ary baseband modulations for interference suppression /excision to enhance the signal to noise ratio.
3. Perform statistical analysis of transmitted and received modulated waveforms from estimation and detection point of view
4. evaluate different digital modulation techniques under non-zero probability of symbol error floor in the presence of AWGN and other channel characteristics
5. improve the overall performance of digital communication systems by implementing signal to noise ratio enhancement techniques.
6. design various receiver structures based on the principles of correlation and matched filtering.
7. Understand the concept of source coding for compression and channel coding to mitigate the effects of noise in the channel.

Text Books:

1. *Proakis John G.,Salehi M. Digital Communication System, McGraw, (2008) 5th ed.*
2. *Simon Haylein, Digital Communication Systems, Wiley India edition, (2009) 2nd ed.*
3. *Singh R P, Sapre S D. Communication Systems: Analog and Digital, Tata Mcgraw-Hill, 2007.*

Reference Books :

1. *Taub& Schilling, Principles of Communication Systems, McGraw Hill Publications, (1998) 2nd ed.*
2. *Simon Haykin, Communication Systems, John Wiley Publication, 3rd ed.*
3. *Sklar, Digital Communications, Prentice Hall-PTR, (2001) 2nd ed.*
4. *Lathi B. P., Modern Analog and Digital Communication, , Oxford University Press, (1998) 3rd*

Evaluation Scheme:

S. No.	Evaluation Elements	Weightage (%)
1.	MST	25
2.	EST	40
3.	Sessional (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	35

UEC708: MICROWAVE ENGINEERING

L	T	P	Cr
3	0	2	4.0

Course Objective: To enhance student's comprehensive capabilities in Microwave engineering through understanding of electromagnetic wavegeneration, transmission and measurementstheory and technology by study of microwave transmission medium, media and microwave devices and components.

Electromagnetic Plane Waves: Microwave Frequencies, IEEE microwave frequency bands, Microwave systems and measurements, Electromagnetic plane wave, Electric and magnetic wave equations, Poynting theorem, Uniform plane wave: reflection, Transmission and absorption, Plane wave in a good conductor, Poor conductor and lossy dielectric, Microwave radiation attenuation.

Wave Guides and Resonators: TE, TM Modes in rectangular & Circular wave guides, Wave guide excitation, characteristics impedance of waveguides, Rectangular, Circular and aperture coupling, Excitation of wave guides

Microwave Components: Waveguide Microwave Junctions, Scattering matrix and their properties, Microwave T junctions – H Plane Tee, E Plane Tee Rat Race Junction, Directional coupler – Two hole directional coupler, Single hole coupler and scattering matrix of a directional coupler, Waveguide joints, Bends, Corners, Transition & twists, Coupling probes & loops, Waveguide terminations, Reentrant cavities, Ferrite devices – faraday rotation in devices, Circulator & isolator, Microwave filter – YIG filter resonators, Phase shifters and microwave attenuators.

Microwave Tubes and Circuits: High frequency limitations of conventional tubes, Klystrons - two cavity klystron amplifier & oscillator, Multicity klystron, Reflex klystron, Travelling wave & MW characteristics, Microwave cross-field tube magnetron – operation and MW characteristics, Helix TWT construction, Operation and applications.

Microwave Measurements: General measurement setup, Microwave bench, Power measurement – low, Medium & high, Attenuation measurement, Measurement of VSWR, Measurement of dielectric constant, Measurement of Impedance: using Smith Chart, Measurement with spectrum analyzer, Scalar & vector network analyzer operation, S-parameter and Q measurement.

Microwave Solid State Devices & Their Applications: P-I-N devices, GUNN Diode, IMPATT, SB diodes parametric amplifier.

Familiarization with standards IEEE 521-2002, IEEE 147-1979, IEEE 470-1972 and IEEE 544-1975, IRE 2.S1-1955

Laboratory Work: To study the performance of mode characteristics of reflex klystrons circulator, Characteristics of Gunn diode, Directional coupler, Attenuator, Sliding screw tuner, Verify the relation of wavelength, finding unknown impedance, VSWR measurement, E-plane, H-plane, Magic Tee, Computer based simulation experiments.

Course Learning Outcomes (CLOs): The student will be able to:

1. Develop understanding about plane wave characteristic and its propagation in different medium.
2. Understand about different modes of wave propagation (TE, TM and TEM) and waveguide structure.
3. Have knowledge about different microwave components
4. Have understanding about devices used in microwave generation
5. Get aware with microwave measurement theory and technology
6. Have understanding about microwave solid state devices.

Text Books:

1. *Liao, S.Y., Microwave Devices & Circuits, Tata McGraw Hill (2006) 2nd edition.*
2. *David M. Pozar, Microwave Engineering, Willy-India(2011) 3nd edition*
3. *Collins, Robert, Foundation of Microwave Engineering, McGraw Hill (2005) 3rd edition.*

Reference Books:

1. *Wolf E.A., and kaul, R.., Microwave Engineering & Systems Applications, Wiley Interscience (2002) 4th edition.*
2. *Sze, S. M., Physics of Semiconductor Devices, Wiley Eastern (2003) 2nd edition.*
3. *Sarvate, V.V., Electromagnetic Fields & Waves, John Wiley & Sons (2004) 3rd edition.*

Evaluation Scheme:

S.No.	Evaluation Elements	Weightage (%)
1.	MST	25
2.	EST	40
3.	Sessional (May include Assignments/Projects/Tutorials/ Quizes/Lab Evaluations)	35

UEC709: FIBER OPTIC COMMUNICATION

L	T	P	Cr
3	0	2	4.0

Course Objectives: To understand the optical fiber communication system, transmitter section, medium- the optical fiber, reciever section, analyze system based on important parameters for characterizing optical fiber, optical source, detector and amplifier, fundamentals and advances in lasers, LEDs, photodiodes, advanced optoelectronics.

Optical fibers and Their characteristics: Introduction to High frequency communication, Nature of light, Advantages of Optical communication, Fiber Structures, Wave guiding, Basic optical laws and Definition, Optical fiber modes and Configuration, Mode theory for circular waveguides, Single mode fibers, Graded index fiber, Fiber materials, Fabrication and mechanical properties, Fiber optic cables; Joints, Splices, Connectors, Attenuation, Signal distortion, Nonlinear properties, Dispersion and Polarization mode dispersion in optical fibers, Mode coupling, Specialty optical fibers, Design optimization of single mode fibers.

Optical sources and Amplifiers: Light emitting diodes, Semiconductor Laser, Various configurations of Semiconductor Laser, Performance parameters of LEDs and Semiconductor Lasers, Light source linearity, Modal partition and reflection noise, Reliability consideration; Power launching and coupling, Optical amplifiers: erbium doped fiber amplifier, semiconductor optical amplifier, Raman amplifier.

Photo detectors: Operating principle and physical properties of photodiodes, p-n and pin photo diodes, Photodetector noise, Response time, Avalanche multiplication noise, **Temperature effect on avalanche gain, Photodiode material.**

Optical Communication Systems: Optical receiver operation- Fundamental receiver operation, Digital receiver performance calculation, Preamplifier types, Analog receivers. Digital transmission systems- Point to point links, Line coding, Eye pattern, Noise effects on system performance. Analog system: Overview of analog links, Carrier to noise ratio, Multichannel transmission techniques, WDM: basics and components, LAN, Coherent optical fiber communication- Classification of coherent system, Requirements on semiconductor lasers, Modulation techniques, Modulation techniques, Polarization control requirements.

Advanced Optoelectronics: Integrated Optoelectronics, Fundamentals of Photonic Crystals, Photonic Crystal fiber, Nonlinear optical effects and their applications, Optical modulation technologies, Photonic switching.

Familiarization with standards IEEE 404-1977, IEEE 812-1984, ITU G.651-G.657, ANSI Z136.2

Laboratory Work: Basic optical communication link experiments (analog & digital), measurement of numerical aperture, splicing, multiplexing experiments, bending losses, measurement with OTDR, design and performance analysis using simulation tools.

Micro-project: To design a single mode photonic crystal fiber with low dispersion at telecom wavelength.

Course Learning Outcomes (CLOs): The students will be able to:

1. understand the fundamentals, advantages and advances in optical communication system
2. acquire a detailed understanding of types, basic properties and transmission characteristics of optical fibers
3. understand configuration and architecture of advanced optical communication, advanced system techniques and nonlinear optical effects and their applications
4. gain the knowledge of knowledge of working and analysis of optical amplifiers and important devices/components at the transmitter (Semiconductor lasers/LEDs, modulators etc) as well as at the receiver sides (optical detector etc.) of the optical communications system.

Text Books:

1. *Senior, John M., and Yousif Jamro, M., Optical fiber communications: principles and practice, Prentice Hall, (2009) 2nd ed.*
2. *Keiser, Gred, Optical Fiber Communications, Tata McGraw-Hill, (2008) 2nd ed.*

Reference Books:

1. *Ajoy Kumar Ghatak and K. Thyagarajan, Optical Electronics, Cambridge University Press (2001) 2nd ed.*
2. *Bahaa E. A. Saleh, Malvin C. Teich, Fundamentals of Photonics, John Wiley & Sons, (2013) 2nd ed.*

Evaluation Scheme:

S. No.	Evaluation Elements	Weightage (%)
1.	MST	25
2.	EST	40
3.	Sessional (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	35

UEC 804: WIRELESSAND MOBILE COMMUNICATION

L	T	P	Cr
3	1	2	4.5

Course Objective: To impart knowledge about wireless communication systems and related design parameters to undergraduate students. To inculcate ability in students to design wireless communication systems, which can provide high data rate to a large number of users. The main goal is to utilize the concepts of analog/digital modulation techniques and signal processing in transmission and reception of wireless signals under static and dynamic channels, in the presence of noise.

Introduction to Wireless Communication Systems: History of Wireless Communication and Future Trends, Narrowband, Wideband, Ultra-Wideband Communication Systems, Description of 2G, 3G, 4G and Hybrid Communication Systems, Brief Introduction of Digital Modulation Techniques Like M-ary QAM and GMSK.

Cellular Concepts and System Design Fundamentals: Introduction to Cellular Concepts and Cellular System Design Fundamentals, Frequency Reuse, Channel Assignment Strategies, Handoff Strategies, Interference and System Capacity, Trunking and Grade of Service, Cell Splitting, Sectoring, Repeaters and Microcell Zone Concepts.

Mobile Radio Propagation and Fading: Introduction to Radio Wave Propagation, Free Space Propagation Model, Large-Scale Path Loss due to Reflection, Diffraction and Scattering, Practical Link Budget Design using Path Loss Models, Outdoor Propagation Models, Indoor Propagation Models, Signal Penetration into Buildings, Ray-Tracing and Site Specific Modelling; Small-Scale Fading and Multipath Propagation, Impulse Response Model of Multipath Channels, Parameters and Statistics, Doubly-Selective Wireless Fading Channels and Theory of Multipath Shape Factors, Nakagammi-m Fading Channel Model.

Multiple Access Techniques for Wireless Communications: Time-Division Multiple Access, Frequency-Division Multiple Access, Code-Division Multiple Access (DS-CDMA, WCDMA, Frequency-Hopped Spread Spectrum), Orthogonal-Frequency-Division Multiple Access, Space-Division Multiple Access and Multi-Carrier Communication Systems. Capacity and Probability of Symbol Error Calculations.

Equalization, Diversity and Channel Coding: Linear and Nonlinear Equalizers (Zero-Forcing and MMSE), Fractionally Spaced Equalizers, Wireless Diversity Techniques, RAKE Receiver, Brief Introduction of Channel Coding- Trellis Coding and Turbo-Coding, Interleaving and Viterbi Decoder.

Advanced Wireless Communication Systems: Brief Introduction of GSM Architecture, MIMO, STBC, STTC, BLAST Architectures, Cognitive Radio, Software Defined Radio and Reconfigurable-Hardware Applications in Wireless Communication Systems.

Familiarization with standards IEEE 1451.5-2007, IEEE 1900.6-2011 and IEEE 1900.6a-2014.

Laboratory Work: Minor Project, Experiments based on Contemporary Hardware and Software Tools (MATLAB).

Course Learning Outcomes (CLOs): The student will be able to:

1. Model Time-Invariant and Time-Variant Multipath Fading Channels
2. Use Different Multiple Assess Communication Strategies to Enhance System Capacity
3. Use Equalization and Coding Schemes to Control Bit Error Rate
4. Use Various Wireless Diversity and Reception Techniques to Improve Signal to Noise Ratio
5. Design High Data-Rate Indoor and Outdoor Wireless Communication Systems

Text Books:

1. *Rappaport, T.S., Wireless Communication-Principles and Practice, Pearson, (2000) 2nd Edition.*
2. *Haykin S & Moher M., Modern Wireless Communication, Pearson, (2005) 3rd Edition.*

Reference Books:

1. *Lee, William C. Y., Mobile Communication Design and Fundamentals, (1999) 4th Edition.*
2. *Pandya, R., Mobile and Personal Communication System, PHI (2002) 5th Edition.*
3. *IEEE Journal on Selected Areas in Communications*
4. *IEEE Communications Magazine*

Evaluation Scheme:

S.No.	Evaluation Elements	Weightage (%)
1	MST	25
2	EST	40
3	Sessional (May include Assignments/Projects/Quizes/Lab Evaluations)	35

UEC859: INTEGRATED SYSTEM DESIGN

L	T	P	Cr
2	**1**	**2**	**3.5**

Course Objective: To enhance comprehension capabilities of students through understanding on the use of VHDL and Verilog for the design, synthesis, modeling, and testing of VLSI devices. These are IEEE standards that are used by engineers to efficiently design and analyze complex digital designs.

Basic Digital Circuits: Lexical Elementsand data types, program skeleton, structural, dataflow and behavioural descriptions, testbench.

RTL Combinational circuit: Operators, Block statement, Concurrent assignment statements, Modelling with a process, Routing circuit with if and case statements, Constants and Generics

Regular Sequential Circuit: HDL code of Flip flops and Registers, simple design examples, testbench for sequential circuits, case study

FSM: Mealy and Moore FSMs, Design Examples

Synthesis: Register Transfer level description, Timing and CLO sck Constraints, technology libraries, Translation, Boolean optimization, Factoring, Mapping to gates

Xilinx FPGA Implementation Memory: Method to incorporate memory modules, HDL templates for memory interface

Laboratory Work: Modeling and simulation of all VHDL and Verilog constructs using ModelSim, their testing by modeling and simulating test benches, Logic Synthesis using FPGA Advantage, Mapping on FPGA Boards.

Micro Poject: Design & Simulate a digital system in VHDL or Verilog and its implementation on FPGA board.

Course Learning Outcomes (CLOs): The student will be able to:

1. Build a synchronous system in hdl and verify its performance.
2. Build and test complex FSMs
3. Automate testbenches for automatic pass/fail
4. Make design decisions for fixed point implementations given constraints
5. Analyse memory usage/requirements for FPGA
6. Target sequential designs to FPGA

Text Books:

1. *Bhaskar, J., A VHDL Primer, Pearson Education/ Prentice Hall (2006)3rd Ed.*
2. *Palnitkar, Samir, Verilog HDL, Prentice Hall, 2nd Edition,*

Reference Books:

1. *Ashenden, P., The Designer's Guide To VHDL, Elsevier (2008) 3rd Ed.*
2. *Donald E. Thomas, Philip R. Moorby, Donald B. Thomas, The Verilog HDL, Kluwer Academic Publication, 5th Edition, 2002,*
3. *Chu Pong P., FPGA Prototyping by VHDL / Verilog Examples, Wiley (2008)*

Evaluation Scheme:

S.No.	Evaluation Elements	Weightage (%)
1	MST	25
2	EST	35
3	Sessional (May include Assignments/Projects/Tutorials/ Quizes/Lab Evaluations)	40

UEC 710: Biomedical Signal Processing

L	T	P	Cr
3	1	0	3.5

Basic neurology: Nervous System, neuron, Resting potential, Nernst equation, electrical equivalents

Electrical activity of heart: Introduction to ECG Lead system and recording, ECG wave component detection and analysis, Vector cardiography, Inverse cardiography, Signal conditioning & processing.

Electrical activity of neuromuscular System: Muscular system, Electrical signals of motor unit and gross muscle, Human motor coordination system, Electrodes, Correlation of force and work; EMG integrators, Signals conditioning & processing.

Electrical activity of brain: Sources of brain potentials, Generation of signals, component waves, EEG recording electrodes, 10-20 electrode system, EEG under normal, Grand mal and Petit mal seizures, Signal conditioning & processing.

Electrical signals from Visual System: Sources of electrical signals in eye, Generation of signals, Electroretinogram, Electrooculogram,Analysis of signals.

Electrical signals from Auditory System: Generation of cochlear potentials and nature; Evoked responses, Auditory nerves, Signal conditioning & processing.

Noise and Interference: Sources of noise in bioelectrical signal recordings; Grounding & shielding, Problems related to noise and artifacts related to EEG and ECG signals

Filtering of Biomedical Signals: Filtering techniques-active and passive filters; Digital filtering, Order-statistic filters, Optimal Filtering, Adaptive Filters, Selection of an appropriate filter.

Frequency analysis of Signals: z-Transform; Fourier transform; Fast Fourier transform; Frequency analysis; Filtering of signals in frequency domain, Homomorphic filtering,Spectral analysis.

Course Learning Outcomes (CLOs): The student will be able to:

1. Describe bioelectric ECG, EMG, EEG signals and their measurements.
2. Describe the common properties of biosignals and identify the basic challenges in processing and analysing them.
3. Apply digital signal processing techniques in the analysis of bioelectric signals.
4. Explain and apply filtering and spectral analysis to evaluate the electroencephalographic biosignals and heart rate variability.

Text Books:

1. *Rangaraj M. Rangayyan, "Biomedical Signal Analysis", John Wiley & Sons.*
2. *Willis J. Tompkins, "Biomedical Digital Signal Processing: C Language Examples and Laboratory Experiments for the IBM PC", Prentice Hall India.*

Reference Books:

1. *Eugene N. Bruce, "Biomedical Signal Processing and Signal Modeling", John Wiley & Sons.*
2. *John L. Semmlow, "Biosignal and Biomedical Image Processing : MATLAB-Based Applications", CRC press.*
3. *S. Cerutti and C. Marchesi , "Advanced Methods of Biomedical Signal Processing", John Wiley & Sons.*

Evaluation Scheme:

S.No.	Evaluation Elements	Weightage (%)
1	MST	20
2	EST	40
3	Sessional (May include Assignments/Projects/Tutorials/ Quizes/Lab Evaluations)	40

UEC706: DATA COMMUNICATION AND PROTOCOLS

L	T	P	Cr
3	1	0	3.5

Course Objective: To introduce basic concepts of Data communication with different models. Enumerate the physical layer, Data Link Layer, Network Layer, Transport Layer and Application Layer, explanation of the function(s) of each layer. Understanding of switching concept and different types of switching techniques.

Overview of Data Communication and Networking: Data communications, Networks, The Internet, Protocols and standards, Layered tasks, OSI model, TCP /IP protocol Architecture.

Physical layer: Analog and digital, Analog signals, Digital signals, Analog versus digital, Data rate limit, Transmission impairments, Line coding, Block coding, Sampling, Transmission mode, Modulation of digital data, Telephone modems, Modulation of analog signal, FDM, WDM, TDM, Guided media, Unguided media, Circuit switching, Telephone networks, DSL technology, Cable modem, SONET

Data link layer: Types of errors, Detection, Error correction, Flow and error control, Stop and wait ARQ, go back n ARQ, Selective repeat ARQ, HDLC, Point to point protocol, PPP stack, Random access, Controlled access, Channelization, Traditional Ethernet, Fast Ethernet, Gigabit Ethernet, IEEE802.11, Bluetooth, Connecting devices, Backbone network, Virtual LAN, Cellular telephony, Satellite networks, Virtual circuit switching, Frame relay, ATM.

Network layer: Internetworks, Addressing, Routing, ARP, IP, ICMP, IPV6, Unicast routing, Unicast routing protocol, Multicast routing, Multicast routing protocols.

Transport layer: Process to process delivery, User datagram protocol (UDP), Transmission control protocol (TCP), Data traffic, Congestion, Congestion control, Quality of service, Techniques to improve QOS, Integrated services, Differentiated services, QOS in switched networks.

Application layer: Client server model, Socket interface, Name space, Domain name space, Distribution of name space, DNS in the internet, Resolution, DNS messages, DDNS, Encapsulation, Electronic mail, File transfer, HTTP, World wide web (WWW), Digitizing audio and video, Audio and video compression, Streaming stored audio/video, Streaming live audio/video, Real time interactive audio/video, Voice over IP.

Switching: Circuit Switching Networks, Concepts, Control Signaling, Softswitch Architecture, Packet switching, Packet size, X.25, Frame Relay, ATM, Message Switching.

Course Learning Outcomes (CLOs):
Upon completion of this course, the student will be able to:

1. give the basic information of how a network can be designed, possible choice of various models for designing a network.
2. understand the protocol layer specific communication between two trusted entities.
3. analyse the possible attacks on a network to interrupt the transmission and mislead the communication between different entities.

4. analyse the shortest path over which data can be transmitted, able to design a routing protocol implementing security mechanisms for secure transmission of data from sender to the receiver.
5. Understand the subject based on course work, assignments and through implementation on a specific platform.
6. design a network topology with the available networking elements and can implement a routing protocol along with a secure mechanism ensuring the error free transmission of data.

Text Books:

1. *Ferouzan, Behrouz A., Data Communications and Networking, TATA McGraw Hill (2002) 2nd ed.*
2. *Stallings William, Data and Computer Communication, Pearson Education (2000) 7th ed.*

ReferenceBooks:

1. *Black, Ulylers D., Data Communication and Distributed Networks, PHI (1999) 3rd ed.*
2. *Tanenbaum, Andrew S., Computer Networks, PHI (2000) 2nd ed.*

Evaluation Scheme:

S.No.	Evaluation Elements	Weightage (%)
1	MST	25
2	EST	35
3	Sessional (May include Assignments/Projects/Tutorials/ Quizes/Lab Evaluations)	40

UEC855: SPEECH PROCESSING

L	T	P	Cr
2	**1**	**2**	**3.5**

Course Objective: To provide students with the knowledge of basic characteristics of speech signal in relation to production and hearing of speech by humans. To describe basic algorithms of speech analysis common to many applications. To give an overview of applications (recognition, synthesis, coding) and to inform about practical aspects of speech algorithms implementation.

Introduction: Review of digital signal and systems, Transform representation of signal and systems, STFT, Goertzel algorithm, Chirp algorithm, Digital filters and filter banks.

Digital Models for Speech signals: Speech production and acoustic tube modeling, vocal tract and ear.

Digital Vocoders: Linear predictive coding (LPC), hybrid coders:–voice excited vocoders, and voice excited linear predictor, hybrid coders.

Speech Recognition: Isolated word recognition, continuous speech recognition, speaker (in) dependent, measures and distances, Dynamic time warping (DTW), HMM, Introduction to speaker recognition, Adaptive noise cancellation, Hands free system.

Advanced Topics: Introduction toemerging speech coding standards (e.g., 2400 bps MELP), Internet phone, audio signal generation, speech generation and recognition algorithms.

Laboratory Work: Frames, windows, spectrum, pre-processing, Linear prediction (LPC), Fundamental frequency estimation, Coding, Recognition - Dynamic time Warping (DTW)., Recognition - hidden Markov models (Hidden Markov Model)

Course Learning Outcomes (CLOs):

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

1. Characterise the speech signal in relation to production and hearing by humans.
2. Differentiate various mathematical techniques for speech recognition.
3. Analyse coders for speech signals.
4. Simulate a simple system for speech processing and its applications.

Text Books:

1. *L. R. Rabiner and R. W. Schaffer, "Digital Processing of Speech signals", Prentice Hall, 2010.*
2. *B. Gold and N. Morgan, "Speech and Audio Signal Processing", John Wiley and Sons Inc., 2011.*

Reference Books:

1. *T.F.Quatieri, "Discrete-Time Speech Signal Processing", Prentice Hall, 2002.*
2. *L.R. Rabiner and B. H. Juang, "Fundamentals of speech recognition", Prentice Hall, 1993.*

Evaluation Scheme:

S.No.	Evaluation Elements	Weightage (%)
1	MST	20
2	EST	40
3	Sessional (May include Assignments/Projects/Tutorials/ Quizes/Lab Evaluations)	40

UEC705: IMAGE PROCESSING & COMPUTER VISION

L	T	P	Cr
2	1	2	3.5

Course Objective: To make studets understand image fundamentals and how digital images can be processed, Image enhancement techniques and its application, Image compression and its applicability, fundamentals of computer vision, geometrical features of images, object recognition and application of real time image processing.

Introduction: Digital image representation, fundamental steps in image processing, elements of digital image processing systems digitisation.

Digital Image fundamentals: A Simple Image Model, Sampling and Quantization, Relationship between Pixel, Image Formats, Image Transforms.

Image Enhancement: Histogram processing, image subtraction, image averaging, smoothing filters, sharpening filters, enhancement in frequency and spatial domain, low pass filtering, high pass filtering.

Image Compression: Fundamentals, Image Compression Models, Elements of Information Theory, Error-Free Compression, Lossy Compression, Recent Image Compression Standards.

Computer Vision: Imaging Geometry; Coordinate transformation and geometric warping for image registration, Hough transforms and other simple object recognition methods, Shape correspondence and shape matching, Principal Component Analysis, Shape priors for recognition.

Laboratory Work: Introduction to image processing on MATLAB, Image effects based on image quantization, Image enhancement algorithms for histogram processing, filtering, Fourier transform of images and filtering in frequency domain, Realisation of any one image compression algorithm, Introduction to computer vision tools.

Minor Project: Image Compression and Facial Feature Detection with FPGA/ASIC/ARM/ DSP Processors.

Course learning outcome (CLOs):
Upon completion of the course, the student will be able to:

1. fundamentals of image processing.
2. basic skills to enhancing images.
3. fundamental and state of the art image compression standards.
4. real time image processing with computer vision.

Text Books:

*1.*Gonzalez, R.C., and Woods, R.E., Digital Image Processing, Dorling Kingsley (2009) 3rd ed.

*2.*Jain A.K., Fundamentals of Digital Image Processing, Prentice Hall (2007).

*3.*Sonka M., Image Processing and Machine Vision, Prentice Hall (2007) 3rd ed.

*4.*D. Forsyth and J. Ponce, Computer Vision - A modern approach, Prentice Hall.

*5.*B. K. P. Horn, Robot Vision, McGraw-Hill.

*6.*E. Trucco and A. Verri, Introductory Techniques for 3D Computer Vision, Prentice Hall.

*7.*Richard Szeliski, Computer Vision: Algos and Applications, Springer.

Reference Books:

1. Tekalp A.M., Digital Video Processing, Prentice Hall (1995).
2. Ghanbari M., Standard Codecs: Image Compression to Advanced Video Coding, IET Press (2003).

Evaluation Scheme:

S.No.	Evaluation Elements	Weightage (%)
1	MST	20
2	EST	40
3	Sessional (May include Assignments/Projects/Tutorials/ Quizes/Lab Evaluations)	40

UEC852: WIRELESS SENSOR NETWORKS

L	T	P	Cr
3	1	0	3.5

Course Objective: To provide a succinct introduction to the field of wireless sensor networks by introducing the fundamentals of network architectures, protocols and deployment methods. To familiarise with various networks platforms and tools for wireless sensor networks.

Introduction and Overview of Wireless Sensor Networks: Background of Sensor Network Technology, Application of Sensor Networks, Challenges for Wireless Sensor Networks, Enabling Technologies for Wireless Sensor Networks.

Sensor Node Hardware and Network Architecture: Single-node Architecture: Hardware Components, Operating Systems and Execution Environments, Network Architecture: Sensor Network Scenarios, Optimization Goals and Figures of Merit, Gateway Concepts.

Network Protocols: MAC Protocols: Requirement and design constraints for MAC Protocols, Important classes of MAC Protocols, MAC Protocols for Wireless Sensor Networks, Routing Protocols: Classification of Routing Protocols, Energy-Efficient Routing, Geographic Routing.

Deployment and Configuration: Localization and Positioning, Single-hop Localization, Positioning in Multi-hop environments, Coverage and Connectivity, Naming and Addressing in Sensor Networks, Assignment of MAC addresses.

Sensor Network Platforms and Tools: Sensor Node Hardware – Berkeley Motes, Programming Challenges, Node-level Software Platforms, Node-level Simulators

Micro Project: WSN based monitoring of Temperature

Course Learning Outcomes (CLOs):
Upon completion of the course, the student will be able to:

1. introduced to the concept of Wireless Sensor Networks and its applications
2. able to understand various architectures of Wireless Sensor Networks, its related hardware and protocols
3. familiarised with deployment and configuration methods.
4. acquainted to Node-level Software Platforms.

Text Books:

1. *HolgerKarl andAndreasWillig, Protocols andArchitecturesforWireless Sensor Networks,JohnWiley,2005.*
2. *FengZhao&LeonidasJ.Guibas,WirelessSensorNetworks - An Information ProcessingApproach,Elsevier,2007.*

Reference Books:

1. *Kazem Sohraby, Daniel Minoli, and Taieb Znati, Wireless Sensor Networks-Technology, Protocols and Applications, John Wiley, (2007).*
2. *Raghavendra, Cauligi S, Sivalingam, Krishna M., Zanti Taieb, Wireless Sensor Network, Springer 1st Ed, (2004) (ISBN: 978-4020-7883-5).*
3. *Anna Hac, Wireless Sensor Network Designs, John Wiley, (2003).*

Evaluation Scheme:

S.No.	Evaluation Elements	Weightage (%)
1	MST	30
2	EST	45
3	Sessional (May include Assignments/Projects/Tutorials/ Quizes/Lab Evaluations)	25

UEC XXX: MACHINE LEARNING

L	T	P	Cr
3	0	0	3.0

Course Objective:
The aim of this course is to familiarize students with machine learning and its applications. The course will make students ready for understanding data, extracting relevant features and developing algorithms for machine learning.

Introduction:
Data acquisition, pre-processing, feature extraction and processing, feature ranking/selection, feature reduction, model learning, evaluation, deployment. Matrix algebra.

Supervised Learning:
Decision trees, Inductive bias, Classification, Regression, Perceptron, Tree learning algorithms.

Unsupervised learning:
Clustering, K-means algorithm, Univariate linear modeling function, Cost function and its minimization, Logistic regression, Softmax regression.

Neural Networks: Artificial neurons, Gradients and back propagation, Gradient decent, Convolution neural networks: continuous convolution, discrete convolution, pooling. Recurrent neural networks. Deep neural networks.

Advanced topics:
Development of an application of machine learning; for example, Optical Character Recognition, Email spam identification, etc.

Course Learning Outcomes: The student will be able to:

1. Setup and solve typical machine learning problems, by implementation or by using simulation tools.
2. Design supervised learning models.
3. Design unsupervised learning models.
4. Develop machine learning algorithms for an application.

Text Books:

1. *Mitchell T.M., Machine Learning, McGraw Hill (1997) 2nd ed.*
2. *Alpaydin E., Introduction to Machine Learning, MIT Press (2010) 2nd ed.*

Reference Books:

1. *Peter Flach, Machine Learning: The Art and Science of Algorithms that Make Sense of Data, Cambridge University Press.*
2. *Chris Bishop, Pattern Recognition and Machine Learning, Springer.*
3. *Michael Kearns and Umesh Vazirani, An Introduction to Computational Learning Theory, MIT press.*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	20
2	EST	40
3	Sessional (May include Assignments/Projects/Tutorials/ Quizes/Lab Evaluations)	40

UEC721: ANALOG IC DESIGN

L	T	P	Cr
3	1	2	4.5

Course Objectives: The goal is to achieve a basic understanding and knowledge of the driving and limiting factors in circuit performance, of circuit design techniques, and of technology issues important to integrated amplifier circuits. To familiarize the design and analysis of basic analog integrated circuits i.e. single ended amplifiers, differential amplifiers, current sources and mirrors, reference circuits, etc. in a standard flow with consideration of performance and power. The course will also familiarize with the issues like noise analysis, OP-Amp design, stability and compensation.

Basic MOS Device Physics: MOS IV Characteristics, Second order effects, Short-Channel Effects, MOS Device Models, Review of Small Signal MOS Transistor Models, MOSFET Noise.

Single Stage Amplifiers: Common Source Stage, Source Follower, Common Gate Stage, Cascode, Folded Cascode.

Differential Amplifier: Single ended and Differential Operation, Qualitative and Quantitative Analysis of Differential pair, Common Mode response, CMRR,Gilbert Cell.

Current Sources and Mirrors: Current Sources, Basic Current Mirrors, Cascode Current Mirrors, Wilson Current Mirror, Large Signal and Small-Signal analysis.

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

Voltage References: Different Configurations of Voltage References, Major Issues, Supply Independent Biasing, Temperature-Independent References.

Feedback: General Considerations, Topologies, Effect of Loading.

Operational Amplifier: General Considerations, Theory and Design, Performance Parameters, Single-Stage Op Amps, Two-Stage Op Amps, Design of 2-stage MOS Operational Amplifier, Gain Boosting, Comparison of various topologies, slew rate, Offset effects, PSRR.

Stability and Frequency Compensation: General Considerations, Multi-pole systems, Phase Margin, Frequency Compensation, Compensation Techniques.

Noise: Noise Spectrum, Sources, Types, Thermal and Flicker noise, Representation in circuits, Noise Bandwidth, Noise Figure.

Switched-Capacitor Circuits: Sampling Switches, Speed Considerations, Precision Considerations, Charge Injection Cancellation, Switched-Capacitor Amplifiers, Switched-Capacitor Integrator, Switched-Capacitor Common-Mode Feedback.

Laboratory Work: Review of Mentor Tools; Analysis of Various Analog Building Blocks such as, Current Sources, Current Mirrors, Differential Amplifier, Output Stages; Design and

Analysis of Op-Amp (closed loop and open loop) and its Characterization, Switched-Capacitor Integrator.

Course Learning Outcomes(CLOs):

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

1. Fluently use the MOS structure in basic circuits.
2. Analyze low-frequency characteristics of single-stage amplifiers and differential amplifiers.
3. Analyze and design current sources/sinks/mirrors.
4. Analyze high-frequency response of amplifiers.
5. Design Voltage references.
6. Design a simple Operational Amplifier.

Text Book(s)

1. *Razavi, B., Design of Analog CMOS Integrated Circuits, Tata McGraw Hill (2008).*
2. *Gregorian, R. and Temes, G.C., Analog MOS Integrated Circuits for Signal Processing, John Wiley (2004).*

Reference Book(s)

1. *Allen, P.E. and Holberg, D.R., CMOS Analog Circuit Design, Oxford University Press (2002) 2nd ed.*
2. *Johns, D.A. and Martin, K., Analog Integrated Circuit Design, John Wiley(2008).*
3. *Gray, P.R., Hurst, P.J., Lewis, S.H., and Meyer, R.G., Analysis and Design ofAnalog Integrated Circuits, John Wiley (2001) 5th ed.*

Evaluation Scheme:

S.No.	Evaluation Elements	Weightage (%)
1	MST	25
2	EST	35
3	Sessional (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	40

UEC609: MOS CIRCUIT DESIGN

L	T	P	Cr
3	0	2	4.0

Course Objective: The course aims to present the principles and techniques of both MOS based digital and analogcircuit design, connecting digital circuits, logic design, and analog components with the fundamental device physics, processing techniques and transistor level characteristics of Silicon integrated circuits, both in theoretical and practical aspects.

MOS Transistor Theory: MOS Structure and its operation, I-V Characteristics, Threshold Voltage Equation, Body Effect, Second Order Effects, Scaling Theory and Limitations of Scaling, Short-Channel Effects,MOS Device Models, Small Signal operation and Equivalent Circuit of MOS Transistor, MOS Capacitors, MOS switch, Noise in MOS transistors.

NMOS & CMOS Process technology: Evolution of ICs. Masking sequence of NMOS and CMOS Structures, Latch up in CMOS, Electrical Design Rules, Stick Diagram, Layout Design. Standard IEEE 1181-1991

Circuit Characterization: Resistive Load & Active Load MOS Inverters, NMOS Inverters, CMOS Inverters : Static Characteristics, Switching Characteristics, Interconnect Parasitics, Propagation Delay, Static and Dynamic Power Dissipation, Noise Margin, Logic Threshold Voltage, Logical effort, Driving large loads.

Combinational Circuits: MOS Logic Circuits with Depletion NMOS loads, CMOS Logic Circuits, CMOS logic Styles, Realization of simple gates, Complex logic circuits, Pass Gate, Transmission Gate.

Operation of MOS Circuits: Behaviour ofMOSCircuits at DC, MOS as an Amplifier, Calculation of the DC Bias Point, Voltage Gain, Transconductance, T Equivalent Circuit Model, Modeling the Body Effect, Biasing of Discrete MOS Amplifiers and Integrated Circuit MOS Amplifiers.

Laboratory Work: *Familiarization with Circuit design/simulation tools (Cadence/Mentor/Tanner Tools) for schematic and layout entry, Circuit simulation using SPICE. DC transfer Characteristics of Inverters, Transient response, Calculating propagation delays, rise and fall times, Circuit design of inverters, Complex gates with given constraints.*

Course Learning Outcomes (CLOs):

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

1. Use MOS structures in basic digital and analog circuits.
2. Describe the general processing steps required to fabricate an integrated circuit.
3. Analyse the fundamental static and dynamic performance of CMOS inverter.
4. Analyse the fundamental static and dynamic performance of logic gateswith given constraints.
5. Implement various CMOS logic circuits.
6. Design simple circuits to meet stated operating specifications.

Text Books:

1. *Kang ,Sung-Mo (Steve) &Leblebici, Yusuf., CMOS Digital Integrated Circuits Analysis & Design, McGraw Hill, (1999) 2nd ed.*
2. *S. Sedra and K. C. Smith, Microelectronic Circuits. 4th ed. New York, NY: Oxford University Press, 1998.*

Reference Books:

1. *Gregorian, R. and Temes, G.C., Analog MOS Integrated Circuits for Signal Processing, John Wiley (2004).*
2. *Jan Rabaey, A. Chandrakasan&Nikolic, B., Digital Integrated Circuits – A Design Perspective, Pearson, (2003) 2nd ed.*
3. *CMOS VLSI Design: A Circuits and Systems Perspective, 4th ed., Neil Weste and David Harris, Pearson Addison Wesley, 2011.*
4. *Pucknell D. A., &Eshraghian, K., Basic VLSI Design, Prentice Hall of India, (2007) 3rd ed.*

Evaluation Scheme:

S. No.	Evaluation Elements	Weightage (%)
1.	MST	25
2.	EST	35
3.	Sessional (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	40

UEC622: DSP PROCESSORS

L	T	P	Cr
3	1	2	4.5

An Introduction to DSP Processors: Advantages of DSP, characteristics of DSP systems, classes of DSP applications, DSP processor embodiment and alternatives, Fixed and floating point number representation, IEEE 754 format representation Fixed Vs Floating point processors,.

DSP Architecture: An introduction to Harvard Architecture, Differentiation between Von-Neumann and Harvard Architecture, Quantization and finite word length effects, Bus Structure, Central Processing Unit, ALU, Accumulators, Barrel Shifters, MAC unit, compare, select, and store unit (CSSU), data addressing and program memory addressing.

Memory Architecture: Memory structures, features for reducing memory access required, wait states, external memory interfaces, memory mapping, data memory, program memory and I/O memory, memory mapped registers.

Addressing and Instruction Set: Various addressing modes - implied addressing, immediate data addressing, memory direct addressing, register direct and indirect addressing, and short addressing modes, Instruction types, various types registers, orthogonality, assembly language and application development.

Interrupts and Pipelining: Interrupts, pipelining and performance, pipelining depth, interlocking, interrupt effects, instruction pipelining.

Processors: Architecture and instruction set of TMS320C3X, TMS320C5X, TMS320C67XX, some example programs. Development tools for Programmable DSPs, An introduction to Code Composer Studio.

Micro Project: Audio amplification with the help of DSP kit.

Laboratory Work: Introduction to code composer studio, Using CCS write program to compute factorial, dot product of two arrays, Generate Sine, Square and Ramp wave of varying frequency and amplitude, Design various FIR and IIR filters, Interfacing of LED, LCD, Audio and Video Devices with the DSP processor.

Course Learning Outcomes (CLOs):

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

1. Differentiate between generalised processor and DSP processor.
2. Analyze special characteristics and features of generalized DSP processors.
3. Understand the software model and pipelining for generalized DSP processor.

4. Understand detailed architectures and instruction sets of TMS 320C3X, 5X and 67XX.
5. Understand the Programming concepts for TMS 320C3X, 5X and 67XX.

Text Books:

1. *Lapsley, P., Bier, J., Shoham, A. and Lee, E.A., DSP Processor Fundamentals: Architecture and Features, IEEE Press Series on Signal Processing, IEEE (2000).*
2. *Venkataramani, B. and Bhaskar, M., Digital Signal Processor: Architecture, Programming and Applications, Tata McGraw Hill (2003).*
3. *TI DSP reference set (www.ti.com).*

Reference Books:

1. *Padmanabhan, K., Ananthi, S. and Vijayarajeswaran, R., A practical Approach to Digital Signal Processing, New Age International Pvt. Ltd (2001).*
2. *Babast, J., Digital Signal Processing Applications using the ADSP-2100 family, PHI (1992).*

Evaluation Scheme:

S.No.	Evaluation Elements	Weightage (%)
1	MST	25
2	EST	35
3	Sessional (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	40

UECXXX: SOFT COMPUTING

L	T	P	Cr
3	1	2	4.5

Course Objective: To familiarize with soft computing concepts. Introduce the ideas of Neural networks, fuzzy logic and use of heuristics based on human experience. Familiarize the concepts of Genetic algorithm. Apply the soft computing concepts to solve practical problems.

Introduction: Introduction to soft computing, Problem complexity, Problem complexity classification, Types of soft computing techniques, Soft computing versus hard computing, Advantages of soft computing.

Artificial Neural Networks: Biological neuron, Artificial Neural Network, Mathematical Models, McCulloch Neural Model, Perceptron, Adaline and Madaline, Learning & Training in ANN, Hopfield Neural Network, Self-Organizing Networks, Recurrent Networks, Associative memories

Fuzzy Logic System: Crisp Vs Fuzzy set theory, Membership functions, Fuzzy set operations, Fuzzy rules, Mamdani and Sugeno fuzzy inference systems, Defuzzification methods.

Genetic Algorithms: Introduction and biological background of GA, String Encoding of chromosomes, Selection methods, Single & multi-point crossover operation, Mutation, Adjustment of strategy parameters such as Population size, Mutation & Crossover probabilities

Tools & Applications: MATLAB Toolboxes: Fuzzy Logic Toolbox, Neural Network Toolbox, FLS for Antilock Breaking System (ABS), GA in route planning for Travelling Sales Person, Time-Series forecasting using ANN.

Laboratory Work: Familiarization of MATLAB toolboxes for neural network and fuzzy logic. Implementing neural networks and fuzzy logic in MATLAB for different applications.Familiarization of GA toolbox MATLAB and implementing it to find optimal solution of optimization problems.

MicroProject: The student shall work on any micro project based on various learning schemes of their choice. Every student will verify results of his/her micro project using MATLAB and submit report to the course coordinator for its evaluation.

Course Learning Outcomes:

Upon completion of this course, the student should be able to:

1. Understand the characteristics of Soft Computing Techniques
2. Explain neural networks and their applications.
3. Demonstrate proficient performance in the application of neural nets.
4. Apply fuzzy logic and fuzzy reasoning for decision making
5. Explain genetic algorithms and their applications.
6. Demonstrate proficient performance in the application of genetic algorithms.

Text Books

1. *Jang, J.S.R., Sun, C.T., and Mizutani, E., Neuro-Fuzzy and Soft Computing, Pearson Education (2004) 2nd ed.*
2. *Eberhart, R., Simpson, P., and Dobbins, R., Computational Intelligence - PC Tools, AP Professional (1996) 3rd ed.*

Reference Books:

1. *Jacek M. Zurada – Introduction to Artificial Neural Systems*
2. *S N Sivanandam, S N Deepa – Principles of Soft Computing, Wiley Publications*
3. *John Yen, Reza Langari – Fuzzy Logic Intelligence, Control, and Information*
4. *Goldberg, Davis E., Genetic Algorithms: Search, Optimization and Machine Learning, Wesley Addison (1989) 3rd ed*

Evaluation Scheme:

S.No.	Evaluation Elements	Weightage (%)
1	MST	25
2	EST	35
3	Sessional (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	40

UEC748: VIDEO SIGNAL PROCESSING

L	T	P	Cr
3	1	2	4.5

Course Objective: To make students acquainted with state-of-the-art video processing techniques, their technical details and challenges. To develop algorithms for video compression.

Prerequisite(s): Digital Signal Processing

Introduction: Video formats, Capturing of video signals, Color space, Quality.

Video Compression: Introduction to H.264 & HEVC, H.264 encoding and decoding process, H.264 Profiles and Levels .

Prediction and Transform Model: Macroblock prediction, Intra and Inter prediction, Loop filter, Transform and Quantization, Block scan orders.

H.264 Standardization Process: Conforming, Transport support, Licensing.

Advanced Topics: Scalable video coding, Multiview video coding, reconfigurable video coding.

Laboratory work and Project: Students have to write MATLAB® programs for dividing raw video into frames, divide them into macroblocks. Compression of macroblock and reframing the video.Various operations on video frames.Introduction to Video Processor.

Course Learning Outcomes (CLOs):

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

1. Understand video formats and color spaces.
2. Understand video prediction model and compression.
3. Understand standardization process.
4. Get acquaintance state-of-the-art video topics.

Text Books:

1. *Iain E. Richardson, THE H.264 ADVANCED VIDEO COMPRESSION STANDARD, John Wiley and Sons, Ltd., 2003.*

Reference Books:

1. *Alan C. Bovik, The Essential Guide to Video Processing, Academic Press; 2009*
2. *J. W. Woods, Multidimensional Signal, Image, and Video Processing and Coding, Academic Press, 2011.*

Evaluation Scheme:

S.No.	Evaluation Elements	Weightage (%)
1	MST	30
2	EST	45
3	Sessional (May include Assignments/Projects/Tutorials/ Quizes/Lab Evaluations)	25

UEC742: MEMS

L	T	P	Cr
3	1	0	3.5

Course Objective: To educate the student to understand the fundamentals of Micro Electro Mechanical Systems (MEMS), different materials used for MEMS, semiconductors and solid mechanics to fabricate MEMS devices, various sensors and actuators, applications of MEMS to disciplines beyond Electrical and Mechanical engineering.

Introduction: History of Micro-Electro-Mechanical Systems (MEMS), Market for MEMS, MEMS materials: Silicon, Silicon Dioxide, Silicon Nitride, Polysilicon, Silicon Carbide, Polymers, Thin metal films, Clean rooms.

Process Technologies: Wafer cleaning and surface preparation, Oxidation, Deposition Techniques: Sputter deposition, Evaporation, Spin-on methods and CVD, Lithography: Optical, X-ray and E-Beam, Etching techniques, Epitaxy, Principles of bulk and surfacemicromachining, Lift-off process, Doping: Diffusion and Ion Plantation, Wafer Bonding: Anodic bonding and Silicon fusion bonding, Multi User MEMS Process (MUMPs), Introduction to MEMS simulation and design tools, Lumped element modeling and design, Electrostatic Actuators, Electromagnetic Actuators, Linear and nonlinear system dynamics.

Sensing and Actuation Principles: Mechanical sensor and actuation: Principle, Beam and Cantilever, Microplates, Capacitive effects, Piezoelectric Materials as sensing and actuating elements, Starin Measurement, Pressure measurement, Thermal sensor and actuation, Micro-Opto-Electro mechanical systems (MOEMS), Radio Frequency (RF) MEMS, Bio-MEMS.

Application case studies: Pressure Sensor, Accelerometer, Gyroscope, Digital Micromirror Devices (DMD), Optical switching, Capacitive Micromachined Ultrasonic Transducers (CMUT)

Course Learning Outcomes (CLO S):
Upon completion of this course, the student will be able to:
1. integrate the knowledge of semiconductors and solid mechanics to fabricate MEMS devices.
2. analyze operation of micro devices, micro systems and their applications
3. design the micro devices using the MEMS fabrication process
4. apply different materials used for MEMS

Text Books:

1. *Franssila Sami, Introduction to Micro Fabrication, WILEY, 2nd Edition, 2010*
2. *NadimMaluf, An Introduction to MicroelectromechanicalSyatemsEngineering,Artech House, 3rd edition, 2000.*
3. *MahalikNitaigourPremchand,MEMS, McGraw-Hill, 2007.*

Reference Books:

1. *Senturia Stephen D., Microsystem Design, Springer US, (2013).*
2. *Madou Marc J., Fundamentals of Microfabrication, CRC Press, (2002).*
3. *StephrnBeeby, Graham Ensell, Michael Kraft, Neil White, MEMS Mechanical Sensors, artech House (2004).*
4. *Chang Liu, Foundations of MEMS, Pearson Education Inc., (2012)*
5. *Tai Ran Hsu,MEMS& Micro systems Design and Manufacture Tata McGraw Hill, NewDelhi, 2002.*

Evaluation Scheme:

S.No.	Evaluation Elements	Weightage (%)
1.	MST	30
2.	EST	45
3.	Sessional (May include Assignments/Projects/Tutorials/ Quizes/Lab Evaluations)	25

UEC860: POWER ELECTRONICS

L	T	P	Cr
3	1	0	3.5

Course Objective: To enhance comprehension capabilities of students through understanding power electronics devices,phase controlled converters,choppers,inverters,AC voltage controllers and CyCLO sconverters with their operation and types.

Introduction: Review of power semiconductor devices, Their characteristics, Thyristors, Their static and dynamic characteristics, Turn-on and Turn - off methods and circuits, Ratings and protection of SCR'S, Other members of thyristorfamily, Series and parallel operation of thyristors, Firing circuits for SCRs.

Phase Controlled Converters: Principle of phase control, Single phase half wave circuit with different types of loads, Single phase and three phase semi converter and full converter bridge circuits with line commutation, Continuous and discontinuous conduction effect of source inductance on single phase and three phase full converters, Single phase and three phase dual converters and their operation with circulating and non circulating currents.

DC Choppers: Principle of chopper operation, Control strategies, Types of choppers, Step up and step down choppers, Types of choppers, Steady state time domain analysis with R, L, and E type loads, Voltage, Current and Load commutated choppers.

Inverters: Single phase VSI, Half bridge and full bridge inverters and their steady state analysis, Modified Mc Murray half bridge inverter, Series and parallel inverters, and Three phase bridge inverters with 180^0 and 120^0 modes. Single-phase PWM inverters. Current source inverters, CSI with R load (qualitative approach).

AC Voltage Controllers: Types of single-phase voltage controllers, Single-phase voltage controller with R and RL type of loads. Three phase voltage controller configurations R Load.

Cyclo Converters: Principles of operation, Single phase to single phase step up and step down cyclo sconverters. Three phase to single phase and three-phase to three-phase cyclo sconverters, Output voltage equation for a cyclo sconverter.

Course Learning Outcomes (CLOs):
Upon completion of this course, the student will be able to:

1. analyze the characteristics of power semiconductor devices.
2. understand the operation and types of Phase Controlled Converters.
3. understand the operation and types of DC Choppers.
4. understand differences between different types of inverters
5. understand the operation and types of AC Voltage Controllers and Cyclo sconverters.

Text Books:

1. *Dubey, G.K., Doradla, S.R., Joshi, A. and Sinha, R.N.K., Thyristorised Power Controllers, New Age International (P) Limited, Publishers (2004).*
2. *Rashid, M., Power Electronics, Prentice-Hall of India Private Limited (2006).*

Reference Books:

1. *Mohan,N., Undel, T.M. and Robbins, W. P., Power Electronics: Converter Applications and Design, John Wiley and Sons (2007).*
2. *Jain,A., Power Electronics and its Applications, Penram International Publishing (India) Pvt. Ltd. (2008).*

Evaluation Scheme:

S.No.	Evaluation Elements	Weightage (%)
1	MST	30
2	EST	45
3	Sessional (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	25

UEC861:CLOUD COMPUTING

L	T	P	Cr
3	1	0	3.5

Course Objective: To appreciate the benefits of Cloud computing and apply Cloud paradigms for evolving businesses. To familiarize with Cloud architectural models and resource allocation strategies. The student should comprehensively be exposed to Cloud based services.

Introduction: Basics of the emerging Cloud computing paradigm, Cloud computing history and evolution, Cloud enabling technologies, practical applications of Cloud computing for various industries, the economics and benefits of Cloud computing.

Cloud Computing Architecture: Cloud Architecture model, Types of Clouds: Public rivate & Hybrid Clouds, Resource management and scheduling, QoS (Quality of Service) and Resource Allocation, Clustering.

Cloud Computing delivery Models: Cloud based services: Iaas , PaaS and SaaS Infrastructure as a Service (IaaS):Introduction to IaaS, Resource Virtualization i.e. Server, Storage and Network virtualization Platform as a Service (PaaS):Introduction to PaaS, Cloud platform & Management of Computation and Storage, Azure, Hadoop, and Google App. Software as a Service (SaaS):Introduction to SaaS, Cloud Services, Web services, Web 2.0, Web OS Case studies related to IaaS, PaaS and SaaS.

Data Processing in Cloud: Introduction to Map Reduce for Simplified data processing on Large clusters, Design of data applications based on Map Reduce in Apache Hadoop

Advanced Technologies: Advanced web technologies (AJAX and Mashup), distributed computing models and technologies (Hadoop and MapReduce), Introduction to Open Source Clouds like Virtual Computing Lab (Apache VCL), Eucalyptus

Cloud Issues and Challenges: Cloud computing issues and challenges like Cloud provider Lock-in, Security etc.

Introduction to Python Runtime Environment: The Datastore, Development Workflow

Course learning outcome (CLOs):

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

1. Familiarization with Cloud architectures.
2. Knowledge of data processing in Cloud.
3. Ability to apply clustering algorithms to process big data real time.
4. Ability to address security issues in Cloud environment.
5. Understand the nuances of Cloud based services.

Text Books:

1. *Rajkumar Buyya, James Broberg and Goscinski Author Name, Cloud Computing Principles and Paradigms, John Wiley and Sons 2012, Second Edition*

2. *Gerard Blokdijk, Ivanka Menken,The Complete Cornerstone Guide to Cloud Computing Best Practices, Emereo Pvt Ltd, 2009, Second Edition*

Reference Books:

1. *Anthony Velte, Toby Velte and Robert Elsenpeter , Cloud Computing: A practical Approach Tata McGrawHill, 2010, Second Edition*
2. *Judith Hurwitz, Robin Bllor, Marcia Kaufmann, Fern Halper, Cloud cOmputing for Dummies, 2009, Third Edition*

Evaluation Scheme:

S.No.	Evaluation Elements	Weightage (%)
1.	MST	30
2.	EST	45
3.	Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	25

UEC854: ASICs and FPGAs

L	T	P	Cr
3	1	0	3.5

Course Objective: This course covers the different types of programming technologies and logic devices, the design flow of different types of ASIC and the architecture of different types of FPGA. To gain knowledge about partitioning, floor planning, placement and routing including circuit extraction of ASIC. To know about different high performance algorithms and its applications in ASICs.

Introduction: Course outline, Logistics introduction to ASICs, FPGAs, Economics.

HDL: Logic design Review, Behavior, Dataflow, Structural modeling, Control statements, FSM modeling.

CMOS Review: Classical, CMOS (Deep Sub-micron), ASIC Methodologies (classical) ASIC Methodologies (aggressive).

Combinational Circuit Design: Components of Combinational Design - Multiplexer and Decoder, Multiplexer Based Design of Combinational Circuits, Implementation of Full Adder using Multiplexer, Decoder Implementation of Full Adder using Decoder.

Programmable Logic Devices: Types of Programmable Logic Devices, Combinational Logic Examples, PROM - Fixed AND Array and Programmable OR Array, Implementation of Functions using PROM, PLA - Programmable Logic Array (PLA) – Implementation Examples.

Programmable Array Logic: PAL - Programmable Array Logic, Comparison of PROM, PLA and PAL, Implementation of a Function using PAL, Types of PAL Outputs, Device Examples.

Introduction to Sequential Circuits: R-S Latch and CLO scked R-S Latch, D Flip Flop, J-K Flip Flop, Master Slave Operation, Edge Triggered Operation.

FPGA: Programmable logic FPGA, Configuration logic blocks, Function Generator, ROM implementation, RAM implementation, Time skew buffers, FPGA Design tools, Network-on-chip, Adaptive System-on-chip.

System Design Examples using FPGA Board: Design Applications using FPGA Board - Traffic Light Controller and Real Time CLO sck, XSV FPGA Board Features, Testing of FPGA Board, Setting the XSV Board CLO sck Oscillator Frequency, Downloading Configuration Bit Streams.

Logic Synthesis: Fundamentals, Logic synthesis with synopsis, Physical design compilation, Simulation, implementation. Floor planning and placement, Commercial EDA tools for synthesis.

Course learning outcome (CLOs):
The students will be able to:

1. To utilize the top-down design methodology in the design of complex digital devices such as FPGAs/ ASICs.
2. To learn modern hardware/software design tools to develop modern digital Systems

3. Ability to design and verification of integrated circuits chips
4. To design and implement different Field Programmable Gate Array (FPGA)
5. architectures and their applications to real life

Text Books:

1. *Smith, Michael.,Application-Specific Integrated Circuits, Addison-Wesley Professional, (2008) Ist ed.*
2. *Wolf, W., FPGA-based System Design, PH/Pearson, (2004) Cheap ed.*

Reference Books:

1. *Steve Kilts, Advanced FPGA Design, Wiley Inter-Science, Jhon weilly & sons, (2007) 4th ed.*

Evaluation Scheme:

S.No.	Evaluation Elements	Weightage (%)
1.	MST	30
2.	EST	45
3.	Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	25

UEC851: VLSI DIGITAL SIGNAL PROCESSING

L	T	P	Cr
3	1	0	3.5

Course Objective: To introduce techniques for designing efficient DSP architectures, to realize architectures that will process high throughput data and/or require less power and/or less chip area, techniques for altering the existing DSP structures to suit VLSI implementations, to introduce efficient design of DSP architectures suitable for VLSI.

Introduction to DSP Systems: Pipelining and Parallel Processing for FIR Filters:Introduction to DSP systems – Typical DSP algorithms, Data flow and Dependence graphs – critical path, Loop bound, Iteration bound, Longest path matrix algorithm, Pipelining and Parallel processing of FIR filters, Pipelining and Parallel processing for low power.

Retiming, Algorithmic Strength Reduction: Retiming – definitions and properties, Unfolding – an algorithmfor unfolding, properties of unfolding, sample period reduction and parallel processing application, Algorithmic strength reduction in filters and transforms – 2-parallel FIR filter, 2-parallel fast FIR filter, DCT architecture, rank-order filters, Odd-Even merge-sort architecture, parallel rank-order filters.

Fast Convolution, Pipelining and Parallel Processing of IIR Filters: Fast convolution – Cook-Toom algorithm, modified Cook-Toom algorithm, Pipelined and parallel recursive filters – Look-Ahead pipelining in first-order IIR filters, Look-Ahead pipelining with power-of-2 decomposition, Clustered look-ahead pipelining, Parallel processing of IIR filters, combined pipelining and parallel processing of IIR filters.

Bit-Level Arithmetic Architectures: Bit-level arithmetic architectures – parallel multipliers with sign extension, parallel carry-ripple and carry-save multipliers, Design of Lyon's bit-serial multipliers using Horner's rule, bit-serial FIR filer, CSD representation, CSD multiplication using Horner's rule for precisionimprovements Distributed Arithmeticfundamentals and FIR filters.

Numerical Strength Reduction, Synchronous, Wave and Asynchronous Pipelining: Numerical strength reduction – subexpressionelimination, multiple constant, iterative matching, synchronous pipelining and clocking styles, Clock skew in edge-triggered single phase Clocking, two-phase Clocking, wave pipelining.

Course Learning Outcomes (CLO S): The student will be able to:

1. Acquired knowledge about VLSI design methodology for signal processing systems.
2. Ability to acquire knowledge about VLSI algorithms and DSP architectures,retiming techniques, folding and register minimization path problems.
3. Ability to understand the concepts of systolic architecture and its methodology.
4. Ability to have knowledge about algorithmic strength reduction techniques and parallel processing of FIR and IIR digital filters.
5. To understand asynchronous and wave pipelines.
6. To understand scaling and round-off noise issues and their impact on performance.
7. To modify the existing or new DSP architectures suitable for VLSI.

Text Books:

1. *Parhi, K. K., VLSI Digital Signal Processing: Design and Implementation, John Wiley (2007) 2nd ed.*
2. *Wanhammar, L., DSP for Integrated Circuits, Academic Press (1999) 4th ed.*

Reference Books:

1. *U. Meye–Baese, Digital Signal Processing with Field Programmable Gate Arrays,Springer, 2nd Edition, 2004.*
2. *W. Wolf, High-performance embedded computing architectures, applications, and methodologies, Morgan Kaufman Publishers (2007).*
3. *S. Y. Kung, H. J. White House, T. Kailath, VLSI and Modern Signal Processing, Prentice-Hall, 1985.*
4. *IEEE Journal papers on Signal processing, VLSI and Embedded Systems.*

Evaluation Scheme:

S.No.	Evaluation Elements	Weightage (%)
1	MST	30
2	EST	45
3	Sessional (May include Assignments/Quizzes)	25

UEC862: IC FABRICATION TECHNOLOGY

L	T	P	Cr
3	1	0	3.5

Course Objective: To gain knowledge about crystal growth and wafer preparation techniques. Subsequently, the thoroughly understanding of different integral steps needed for IC components fabrication mainly bipolar and field effect transistors. To acquire knowledge of various linear and nonlinear ICs and the various packaging techniques.

Integrated Circuits: Introduction,Impact of ICs on Industry, Advantages over discrete components, Monolithic and Hybrid ICs, Scales of integration and related issues.

Growth of Single Crystals wafers: Crystal growth using Czochralski's method, Float Zone method and Bridgeman technique, Zone refining, characteristics and crystal evaluation, Wafer Shaping operations, Slicing, polishing and etching.

Epitaxy Film Formation: Importance of epitaxial layer growth, Types of epitaxy: VPE, MBE, MOCVDDefects in epitaxial layers and their removal.

Diffusion: Impurity diffusion in a semiconductor crystal. Fick's Laws, Gaussian and Complementary Error Function Distribution of Impurities.Properties of diffusion.

Subsequent Processes: Oxidation, Ion-implantation, Photolithography, Electron beam and X-Ray lithography, Different printing techniques, +ve& -ve Photo resist, dry and wet Etching, Metallization, and Clean room: Standards, Exposure Tools.

MOSFET Technology: Design of junction diode, Transistor, FET and MOSFETsPolysilicon gates and Well Structures.

Passive Components for IC's: Analog, Linear and Non-linear I.C's. Digital I.C's. Digital I.C's like TTL, ECL, HTL, Video I.C's, Tuners like 555 and 556: internal circuits and their operation.

Packaging of I.C's: Mountings in packages using Dual-in-line (DIP) or TO packages. Packages using surface-mount-technology (SMT).

Course Learning Outcomes (CLOs):
Upon completion of this course, the student will be able to:

1. Acquire knowledge about crystal growth and wafer preparation techniques.
2. Learn about different fabrication process used in ICs industry.
3. Understand various linear and non-linear ICs.
4. To understand the various packaging techniques.

Text Books:

1. Sze, S. M., VLSI Technology, Wiley Eastern, USA (1999) 2nd ed.
2. Sze, S. M., Semiconductor Devices, Physics & Technology, (2001) 3rd ed.

Reference Books:

1. Pucknell and Eshraghian, Basic VLSI Design, (2000) 2nd edition
2. Nagchoudhri, D., Principles of Microelectronics Technology (2002) 4th edition.

Evaluation Scheme:

S.No.	Evaluation Elements	Weightage (%)
1.	MST	30
2.	EST	50
3.	Sessional (May include Assignments/Projects/Tutorials/ Quizes)	20

UEC863: VLSI INTERCONNECTS

L	T	P	Cr
3	1	0	3.5

Course Objectives: In this course the students will learn interconnect models, device models, interconnect analysis and interconnect materials.

Introduction: Technology trends, Device and interconnect scaling ,Interconnect Models: RC model and RLC model, Effect of capacitive coupling, Effect of inductive coupling, Transmission line model, Power dissipation, Interconnect reliability.

Device Models: Introduction, device I-V characteristics, General format of device Models, device models in explicit expression, device model using a table-Lookup model and effective capacitive model.

Interconnect Analysis: Time domain analysis: RLC network analysis, RC network analysis and responses in time domain, S domain analysis, circuit reduction via matrix approximation, Analysis using moment matching, transmission lines: step input response.

Crosstalk Analysis: Introduction, Capacitive coupled and inductive coupled interconnect model and analysis, Transmission line based model.

Advanced Interconnect Materials: Basic materials: Copper and aluminium. Problem with existing material in deep submicron: Electro-migration effect, surface and grain boundary effect. CNT as an interconnect, impedance parameters of CNT, types of CNT,GNR and Optical interconnects.

Course Learning Outcomes(CLOs):
Upon the completion of this course, the students are able to:

1. understand the advanced interconnect materials
2. acquire knowledge about Technology trends, Device and interconnect scaling.
3. identify basic device and Interconnect Models.
4. perform RLC based Interconnect analysis.
5. analyse the problem with existing material in deep submicron.

TextBooks:

1. *Chung-Kang Cheng,John Lillis,Shen Lin and Norman H.Chang, "Interconnect Analysis and Synthesis",A wiley Interscience Publication(2000).*
2. *Sung-Mo (Steve) Kang, Yusuf Leblebigi, "CMOS Digital integrated circuits analysis and design", by Tata Mcgraw-Hill, (2007).*

Reference Books:

1. *L.O.Chua,C.A.Desoer,and E.S.Kuh, "Linear and Non linear circuits",McGraw-Hill,1987.*
2. *R.E.Matrick, "Transmission lines for digital and communication networks", IEEE press,1995.*
3. *Mauricio Marulanda, "Electronic properties of Carbon Nanotubes",InTech publisher 2011.*

Evaluation Scheme:

S.No.	Evaluation Elements	Weightage (%)
1.	MST	30
2.	EST	50
3.	Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	20

UEC864: RADAR AND REMOTE SENSING

L	T	P	Cr
3	1	0	3.5

Course Objectives: To introduce the basic functioning of a radar system and to make the students understand this by taking a specific example of MTI and PULSE Doppler radar. Implement the usage of these systems with the help of specific sensors for gaining knowledge about inaccessible areas (remote sensing).

Introduction to Radar: Basic Radar –The simple form of the Radar Equation – Radar Block Diagram – Radar Frequencies –Applications of Radar – The Origins of Radar

The Radar Equation: Introduction – Detection of Signals in Noise – Receiver Noise and the Signal-to-Noise Ratio –Probability Density Functions – Probabilities of Detection and False Alarm – Integration of Radar Pulses – Radar Cross Section of Targets – Radar cross Section Fluctuations – Transmitter Power – Pulse Repetition Frequency – Antenna Parameters – System losses – Other Radar Equation Considerations

MTI and Pulse Doppler Radar: Introduction to Doppler and MTI Radar – Delay – Line Cancelers – Staggered Pulse Repetition Frequencies – Doppler Filter Banks – Digital MTI Processing – Moving Target Detector – Limitations to MTI Performance – MTI from a Moving Platform (MTI) – Pulse Doppler Radar – Other Doppler Radar Topics – Tracking with Radar – Monopulse Tracking – Conical Scan and Sequential Lobing – Limitations to Tracking Accuracy - Low-Angle Tracking – Tracking in Range – Other Tracking Radar Topics – Comparison of Trackers – Automatic Tracking with Surveillance Radars.

Fundamentals of Remote Sensing: Definition of terms, Concepts and types of remote sensing; evolution of remote sensing Technology, stages in remote sensing technology, spatial data acquisition, interdisciplinary nature and relation with other disciplines, applications of remote sensing, advantages of RS over conventional methods of survey and inventorying.

Basic Principles of Remote Sensing: Types of remote sensing with respect to wavelength regions; Definition of radiometry; Black body radiation; Spectral characteristics of solar radiation; EMR Interaction with Earth materials; Spectral signature concepts spectral reflectance and emittance specular reflection and nonspecular reflectance Albedo of materials EMR interaction with rocks, minerals, vegetation and water -Factors affecting spectral reflectance of materials. Instruments used to study the spectral reflectance spectrophotometer spectro-radiometer.

Sensors - Types of sensors- passive sensors and active sensors; imaging systems, photographic sensors; Sensor resolution- spectral, spatial, radiometric and temporal; Imaging sensors and non-imaging radiometers; photograph v/s image, Panchromatic, Multispectral, hyperspectral, stereo images, Optical mechanical line scanner; Pushbroom scanner; Imaging spectrometer; spaceborne imaging sensors, active and passive microwave sensors; Thermal sensors; Atmospheric sensors; Sonar; Laser, Radar, hyperspectral sensors.

Platforms - Principles of satellite Missions; Types of platforms- airborne remote sensing, space borne remote sensing; Orbital elements of satellite; satellites for Land, Ocean, and atmospheric studies IRS, Landsat, SPOT, Radarsat, quick bird, Ikonos and ESA satellite series.

Image Interpretation and Analysis - Fundamentals of satellite image interpretation; Types of imaging, elements of interpretation; Techniques of visual interpretation; Generation of Thematic maps.

Introduction to advanced Remote Sensing Technologies: Synthetic Aperture Radar; Side Looking Airborne Radar; Hyper spectral Imaging Spectrometer; Lidar; Thermal Imaging System; Advanced Laser Terrain Mapping

Course Learning Outcomes(CLOs):

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

1. Understand the basic working of a RADAR.
2. Understand the working of a Moving target Indicator (MTI) on the basis of Doppler shift.
3. Recognize the advantages of RS over conventional methods of survey and inventorying.
4. Distinguish among various sensors for specific Remote sensing applications.
5. Understand the types of sensing and interpret the results obtained.

Text Books:

1. *Skolnik, Merrill I., Introduction to Radar Systems, Tata McGraw-Hill (2003) 3rd ed.*
2. *Peebles, Peyton Z., Radar Principles, John Wiley, (2004) 2nd ed.*
3. *Microwave Radar and Radiometric Remote Sensing by F.T. Ulaby, D.G. Long University of Michigan Press, 2013, ISBN0472119354.*

Reference Books:

1. *Toomay, J.C., Principles of Radar, PHI, (2004) 2nd ed.*
2. *Microwave Remote Sensing: Active and Passive, Volume I: Microwave remote sensing fundamentals and radiometry by F. Ulaby, R. Moore, A. FungArtech House, 1981, ISBN 0890061904.*

Evaluation Scheme:

S.No.	Evaluation Elements	Weightage (%)
1.	MST	30
2.	EST	50
3.	Sessional (May include Assignments/Projects/Tutorials/ Quizes)	20