JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA
KAKINADA – 533 003, Andhra Pradesh, India

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

COURSE STRUCTURE AND SYLLABUS

For UG – R20

B. TECH - ELECTRONICS AND COMMUNICATION ENGINEERING

(Applicable for batches admitted from 2020-2021)

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA

KAKINADA - 533 003, ANDHRA PRADESH, INDIA

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY:: KAKINADA
DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

III Year –II Semester

S. No	Category	Name of the subject	L	T	P	Credits
1	PC	Microprocessor and Microcontrollers	3	1	0	3
2	PC	VLSI Design	3	0	0	3
3	PC	Digital Signal Processing	3	0	0	3
4	PE2	Professional Elective courses - 2	3	0	0	3
5	OE 2	Open Elective Course/Job oriented elective -2	2	0	2	3
6	LC	Microprocessor and Microcontrollers - Lab	0	0	3	1.5
7	LC	VLSI Design Lab	0	0	3	1.5
8	LC	Digital Signal Processing Lab	0	0	3	1.5
9	SC	ARM based/ Aurdino based Programming	1	0	2	2
10	MC	Research Methodology	2	0	0	0
					Total credits	**21.5**
	Honors/Minor courses (The hours distribution can be 3-0-2 or 3-1-0 also)					**4**

Industrial/Research Internship (Mandatory) 2 Months during summer vacation

PE2:	**OE2:**
1. Microwave Engineering 2. Mobile & Cellular Communication 3. Embedded Systems 4. CMOS Analog IC Design	Candidate should select the subject from list of subjects offered by other departments

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IV Year –I Semester

S. No	Category	Name of the subject	L	T	P	Credits
1	PE	Professional Elective courses -3	3	0	0	3
2	PE	Professional Elective courses -4	3	0	0	3
3	PE	Professional Elective courses -5	3	0	0	3
4	OE	Open Elective Courses/ Job oriented elective -3	2	0	2	3
5	OE	Open Elective Courses/ Job oriented elective -4	2	0	2	3
6	HS	***Humanities and Social Science Elective**	3	0	0	3
7	SC	**Designer tools (HFSS,** Microwave Studio CST. Cadence Virtuoso. Synopsys, Mentor Graphics, Xilinx.)	1	0	2	2
Industrial/Research Internship 2 Months (Mandatory) afterthird year (to be evaluated during VII semester			0	0	0	3
					Total credits	**23**
	Honors/Minor courses (The hours distribution can be 3-0-2 or 3-1-0 also)					**4**

PE 3:	PE5:
1. Optical Communication 2. Digital Image Processing 3. Low Power VLSI Design	1. Radar engineering 2.Pattern recognition & Machine Learning 3.Internet of Things
PE4:	
1.Satellite Communications 2.Soft Computing Techniques 3.Digital IC Design using CMOS	

IV Year – II Semester

S. No.	Category	Code	Course Title	Hours per week			Credits
1	Major Project	PROJ	Project work, seminar and internship inindustry	-	-	-	12
INTERNSHIP (6 MONTHS)							
						Total credits	**12**

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SUBJECTS FOR HONORS

POOL-1

Instrumentation and Control Systems: (any four of the following subjects which are not chosen as professional electives are to be considered for Honors Degree)

S. No.	Subject	L-T-P	Credits
1	Data Acquisition systems	3-1-0	4
2	Adaptive Control Systems	3-1-0	4
3	Bio-Medical Instrumentation	3-1-0	4
4	Digital Control Systems	3-1-0	4
5	Process Control Instrumentation	3-1-0	4
6	Transducers & sensors	3-1-0	4
7	MEMS	3-1-0	4
8	Intelligent & Smart Instrumentation	3-1-0	4
In addition to any of the four subjects, MOOC/NPTEL Courses for 04 credits (02 courses@ 2 credits each) are compulsory in the domain of Electronics and Communication Engineering			

POOL-2

Integrated circuits and Systems: (any four of the following subjects which are not chosen asprofessional electives are to be considered for Honors Degree)

S. No	Subject	L-T-P	Credits
1	VLSI Technology and Design	3-1-0	4
2	CMOS Analog IC Design	3-1-0	4
3	CMOS Digital IC design	3-1-0	4
4	Design for Testability	3-1-0	4
5	System on Chip	3-1-0	4
6	Programmable Logic Devices and ASIC	3-1-0	4
7	Scripting Language	3-1-0	4
8	Low Power VLSI Design	3-1-0	4
In addition to any of the four subjects, MOOC/NPTEL Courses for 04 credits (02 courses@ 2 credits each) are compulsory in the domain of Electronics and Communication Engineering			

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POOL-3

Communication Engineering: (any four of the following subjects which are not chosen as a professional electives are to be considered for Honors Degree)

S. No	Subject	L-T-P	Credits
1	Wireless Sensor Networks	3-1-0	4
2	Software defined radio	3-1-0	4
3	Data Communications & Computer Networks	3-1-0	4
4	Cognitive radio	3-1-0	4
5	5G Communications	3-1-0	4
6	Satellite communication	3-1-0	4
7	Optical Communication	3-1-0	4
8	Global navigational satellite systems	3-1-0	4
In addition to any of the four subjects, MOOC/NPTEL Courses for 04 credits (02 courses@ 2 credits each) are compulsory in the domain of Electronics and Communication Engineering			

POOL-4

Digital Signal processing (any four of the following subjects which are not chosen as professional electives are to be considered for Honors Degree)

S. No	Subject	L-T-P	Credits
1	Speech Signal Processing	3-1-0	4
2	Video Signal Processing	3-1-0	4
3	Adaptive Signal Processing	3-1-0	4
4	Bio- Medical Signal Processing	3-1-0	4
5	DSP Processors and Architectures	3-1-0	4
6	Wavelet Theory	3-1-0	4
7	Multirate Systems And Filter Banks	3-1-0	4
8	Mathematical methods for signal processing	3-1-0	4
In addition to any of the four subjects Compulsory MOOC/NPTEL Courses for 04 credits (02 courses@ 2 credits each)			

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GENERAL MINOR TRACKS

S. No.	Subject	L-T-P	Credits
1	Electronics Devices and Basic Circuits	3-1-0	4
2	Digital Electronics	3-1-0	4
3	Principles of Communication	3-1-0	4
4	Signal Analysis	3-1-0	4
In addition to any of the four subjects, MOOC/NPTEL Courses for 04 credits (02 courses@ 2 credits each) are compulsory in the domain of Electronics and Communication Engineering			

List of the **OPEN ELECTIVES** offered by **ECE** Department to **other Branches**:

1. Basics of Signals and Systems
2. Electronic Measurements and Instrumentation
3. Principles of Signal Processing
4. Industrial Electronics
5. Consumer Electronics
6. Fundamentals of Microprocessors and Microcontrollers
7. Transducers and Sensors
8. IOT and Applications
9. Soft Computing Techniques
10. IC Applications
11. Principles of Communications
12. Basic Electronics
13. Data Communications
14. Digital Logic design
15. Remote Sensing and GIS
16. Bio Medical Instrumentation

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III Year – II Semester		L	T	P	C
		3	1	0	3
MICROPROCESSOR AND MICROCONTROLLERS					

UNIT–I

Introduction: Basic Microprocessor architecture, Harvard and Von Neumann architectures with examples, Microprocessor Unit versus Microcontroller Unit, CISC and RISC architectures.

8086 Architecture: Main features, pin diagram/description, 8086 microprocessor family, internal architecture, bus interfacing unit, execution unit, interrupts and interrupt response, 8086 system timing, minimum mode and maximum mode configuration.

UNIT–II

8086 Programming: Program development steps, instructions, addressing modes, assembler directives, writing simple programs with an assembler, assembly language program development tools.

UNIT-III

8086 Interfacing: Semiconductor memories interfacing (RAM, ROM), Intel 8255 programmable peripheral interface, Interfacing switches and LEDS, Interfacing seven segment displays, software and hardware interrupt applications, Intel 8251 USART architecture and interfacing, Intel 8237a DMA controller, stepper motor, A/D and D/A converters, Need for 8259 programmable interrupt controllers.

UNIT-IV

Intel 8051 MICROCONTROLLER

Architecture, Hardware concepts, Input/output ports and circuits, external memory, counters/timers, serial data input/output, interrupts. Assembly language programming: Instructions, addressing modes, simple programs. Interfacing to 8051: A/D and D/A Convertors, Stepper motor interface, keyboard, LCD Interfacing, Traffic light controls.

UNIT–V

ARM Architectures and Processors: ARM Architecture, ARM Processors Families, ARM Cortex-M Series Family, ARM Cortex-M3 Processor Functional Description, functions and interfaces, Programmers Models, ARM Cortext-M3 programming – Software delay, Programming techniques, Loops, Stack and Stack pointer, subroutines and parameter passing, parallel I/O, Nested Vectored Interrupt Controller – functional description and NVIC programmers' model.

TEXTBOOKS:

1. A.K Ray, K.M.Bhurchandhi, Advanced Microprocessor and Peripherals", Tata McGraw Hill Publications, 2000.
2. The 8051 Microcontrollers and Embedded systems Using Assembly and C, Muhammad Ali Mazidi and Janice Gillespie Mazidi and Rollin D. McKinlay; Pearson 2-Edition, 2011.
3. The Definitive Guide to ARM Cortex-M3 and Cortex-M4 Processors by JosephYou.

REFERENCE BOOKS:

1. Embedded Systems Fundamentals with Arm Cortex-M based Microcontrollers: A Practical Approach in English, by Dr. Alexander G. Dean, Published by Arm Education Media, 2017.
2. Microprocessors and Interfacing – Programming and Hardware by Douglas V Hall, SSSP Rao, Tata McGraw Hill Education Private Limited, 3rd Edition, 1994.
3. Cortex -M3 Technical Reference Manual.

Course Outcomes:

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

1. Understand the architecture of microprocessor/ microcontroller and their operation.
2. Demonstrate programming skills in assembly language for processors and Controllers.
3. Analyze various interfacing techniques and apply them for the design ofprocessor / Controller based systems.

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III Year – II Semester		L	T	P	C
		3	0	0	3
VLSI DESIGN					

UNIT-I:
INTRODUCTIONANDBASICELECTRICALPROPERTIESOFMOSCIRCUITS:
VLSI Design Flow, Introduction to IC technology, Fabrication process: nMOS, pMOS and CMOS. Ids versus Vds Relationships, Aspects of MOS transistor Threshold Voltage, MOS transistor Trans, Output Conductance and Figure of Merit. nMOS Inverter, Pull-up to Pull-down Ratio for nMOS inverter driven by another nMOS inverter, and through one or more pass transistors. Alternative forms of pull-up, The CMOS Inverter, Latch-up in CMOS circuits, Bi-CMOS Inverter, Comparison between CMOS and BiCMOS technology, MOS Layers, Stick Diagrams, Design Rules and Layout, Layout Diagrams for MOS circuits

UNIT-II:
BASIC CIRCUIT CONCEPTS: Sheet Resistance, Sheet Resistance concept applied to MOS transistors and Inverters, Area Capacitance of Layers, Standard unit of capacitance, some area Capacitance Calculations, The Delay Unit, Inverter Delays, driving large capacitive loads, Propagation Delays, Wiring Capacitances, Choice of layers.
SCALING OF MOS CIRCUITS: Scaling models and scaling factors, Scaling factors for device parameters, Limitations of scaling, Limits due to sub threshold currents, Limits on logic levels and supply voltage due to noise and current density. Switch logic, Gate logic.

UNIT-III:
BASIC BUILDING BLOCKS OF ANALOG IC DESIGN: Regions of operation of MOSFET, Modelling of transistor, body bias effect, biasing styles, single stage amplifier with resistive load, single stage amplifier with diode connected load, Common Source amplifier, Common Drain amplifier, Common Gate amplifier, current sources and sinks.

UNIT-IV:
CMOS COMBINATIONAL AND SEQUENTIAL LOGIC CIRCUIT DESIGN:
Static CMOS Design: Complementary CMOS, Rationed Logic, Pass-Transistor Logic.
Dynamic CMOS Design: Dynamic Logic-Basic Principles, Speed and Power Dissipation of Dynamic Logic, Issues in Dynamic Design, Cascading Dynamic Gates, Choosing a Logic Style, Gate Design in the Ultra Deep-Submicron Era, Latch Versus Register, Latch based design, timing decimation, positive feedback, in stability, Meta stability, multiplexer based latches, Master-Slave Based Edge Triggered Register, clock to q delay, setup time, hold time, reduced clock load master slave registers, Clocked CMOS register. Cross coupled NAND and NOR, SR Master Slave register, Storage mechanism, pipelining.

UNIT-V:
FPGA DESIGN: FPGA design flow, Basic FPGA architecture, FPGA Technologies, Introduction to FPGA Families.
INTRODUCTIONTOADVANCEDTECHNOLOGIES: Giga-scale dilemma, Short channel effects, High–k, Metal Gate Technology, Fin-FET, TFET.

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TEXTBOOKS:

1. Essentials of VLSI Circuits and Systems – Kamran Eshraghian, Douglas and A.Pucknell and Sholeh Eshraghian, Prentice-Hall of India Private Limited, 2005 Edition.
2. Design of Analog CMOS Integrated Circuits by Behzad Razavi, McGraw Hill, 2003
3. Digital Integrated Circuits, Jan M.Rabaey, Anantha Chandrakasan and Borivoje Nikolic, 2nd edition, 2016.

REFERENCES:

1. "Introduction to VLSI Circuits and Systems", John P.Uyemura, John Wiley&Sons, reprint 2009.
2. Integrated Nano electronics: Nano scale CMOS, Post-CMOS and Allied Nano technologies Vinod Kumar Khanna, Springer India, 1stedition, 2016.
3. Fin-FETs and other multi-gate transistors, Colinge JP, Editor NewYork, Springer, 2008.

Course Outcomes:

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

1. Demonstrate a clear understanding of CMOS fabrication flow and technology scaling.
2. Apply the design Rules and draw layout of a given logic circuit.
3. Design basic building blocks in Analog IC design.
4. Analyze the behavior of amplifier circuits with various loads.
5. Design various CMOS logic circuits for design of Combinational logic circuits.
6. Design MOSFET based logic circuits using various logic styles like static and dynamic CMOS.
7. Design various applications using FPGA.

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III Year – II Semester		L	T	P	C
		3	0	0	3
DIGITAL SIGNAL PROCESSING					

UNIT I
INTRODUCTION: Introduction to Digital Signal Processing: Discrete time signals & sequences, Classification of Discrete time systems , stability of LTI systems, Invertability, Response of LTI systems to arbitrary inputs. Solution of Linear constant coefficient difference equations, Frequency domain representation of discrete time signals and systems, Review of Z-transforms, solution of difference equations using Z-transforms, System function.

UNIT II
DISCRETE FOURIER SERIES &FOURIER TRANSFORMS: Properties of discrete Fourier series, DFS representation of periodic sequences, Discrete Fourier transforms: Properties of DFT, linear filtering methods based on DFT, Fast Fourier transforms (FFT) - Radix-2 decimation in time and decimation in frequency FFT Algorithms, Inverse FFT.

UNIT III
DESIGN OF IIR DIGITAL FILTERS& REALIZATIONS: Analog filter approximations – Butter worth and Chebyshev, Design of IIR Digital filters from analog filters, Design Examples, Analog and Digital frequency transformations. Basic structures of IIR systems, Transposed forms.

UNIT IV
DESIGN OF FIR DIGITAL FILTERS & REALIZATIONS:
Characteristics of FIR Digital Filters, frequency response. Design of FIR Digital Filters using Window Techniques and Frequency Sampling technique, Comparison of IIR & FIR filters, Basic structures of FIR systems, *Lattice structures, Lattice-ladder structures*

UNIT V
INTRODUCTION TO DSP PROCESSORS: Introduction to programmable DSPs: Multiplier and Multiplier Accumulator, Modified bus structures and memory access schemes in P-DSPs ,Multiple Access Memory, Multi ported memory, VLIW architecture, Pipelining, Special addressing modes, On-Chip Peripherals.
Architecture of TMS320C5X: Introduction, Bus Structure, Central Arithmetic Logic Unit, Auxiliary Register ALU, Index Register, Block Move Address Register, Parallel Logic Unit, Memory mapped registers, program controller, some flags in the status registers, On- chip memory, On-chip peripherals

TEXT BOOKS:

1. Digital Signal Processing, Principles, Algorithms, and Applications: John G. Proakis, Dimitris G.Manolakis, Pearson Education / PHI, 2007.
2. Discrete Time Signal Processing – A.V.Oppenheim and R.W. Schaffer, PHI

Reference Books:

1. Digital Signal Processing: Andreas Antoniou, TATA McGraw Hill , 2006
2. DSP Primer - C. Britton Rorabaugh, Tata McGraw Hill, 2005.
3. Digital Signal Processors – Architecture, Programming and Applications, B.Venkataramani, M.Bhaskar, TATA McGraw Hill, 2002

Course Outcomes:

After going through this course the student will be able to

1. Apply the difference equations concept in the analysis of Discrete time systems
2. Use the FFT algorithm for solving the DFT of a given signal
3. Design a Digital filter (FIR&IIR) from the given specifications
4. Realize the FIR and IIR structures from the designed digital filter.
5. Use the Multirate Processing concepts in various applications (eg: Design of phase shifters, Interfacing of digital systems
6. Apply the signal processing concepts on DSP Processor.

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III Year – II Semester		L	T	P	C
		3	0	0	3
MICROWAVE ENGINEERING (PE2)					

UNIT I

MICROWAVE TRANSMISSION LINES: Introduction, Microwave Spectrum and Bands, Applications of Microwaves. Rectangular Waveguides – TE/TM mode analysis, Expressions for Fields, Characteristic Equation and Cut-off Frequencies, Filter Characteristics, Dominant and Degenerate Modes, Sketches of TE and TM mode fields in the cross-section, Mode Characteristics – Phase and Group Velocities, Wavelengths and Impedance Relations, Impossibility of TEM mode. Related Problems

MICROSTRIP LINES– Introduction, Z_o Relations, Effective Dielectric Constant, Losses, Q factor

UNIT II

MICROWAVE TUBES: Limitations and Losses of conventional tubes at microwave frequencies, Re-entrant Cavities, Microwave tubes – O type and M type classifications, O-type tubes :2 Cavity Klystrons – Structure, Velocity Modulation Process and Applegate Diagram, Bunching Process and Small Signal Theory –, Applications, Reflex Klystrons – Structure, Applegate Diagram and Principle of working, Electronic Admittance; Oscillating Modes and output Characteristics, Electronic and Mechanical Tuning, Applications,

UNIT - III

HELIX TWTS: Significance, Types and Characteristics of Slow Wave Structures; Structure of TWT and Suppression of Oscillations,

M-type Tubes

Introduction, Cross-field effects, Magnetrons – Different Types, 8-Cavity Cylindrical Travelling Wave Magnetron – Hull Cut-off Condition, Modes of Resonance and PI-Mode Operation, Separation of PI-Mode, o/p characteristics

UNIT IV

WAVEGUIDE COMPONENTS AND APPLICATIONS - I: Coupling Mechanisms – Probe, Loop, Aperture types. Waveguide Discontinuities – Waveguide irises, Tuning Screws and Posts, Matched Loads. Waveguide Attenuators – Resistive Card, Rotary Vane types; Waveguide Phase Shifters – Dielectric, Rotary Vane types, Scattering Matrix– Significance, Formulation and Properties, S-Matrix Calculations for – 2 port Junction, E-plane and H-plane Tees, Magic Tee, Hybrid Ring; Directional Couplers – 2Hole, Bethe Hole types, Ferrite Components– Faraday Rotation, S-Matrix Calculations for Gyrator, Isolator, Circulator, Related Problems.

UNIT V

MICROWAVE SOLID STATE DEVICES: Introduction, Classification, Applications. TEDs – Introduction, Gunn Diode – Principle, RWH Theory, Characteristics, Basic Modes of Operation, Oscillation Modes

MICROWAVE MEASUREMENTS: Description of Microwave Bench – Different Blocks and their Features, Precautions; Microwave Power Measurement – Bolometer Method. Measurement of Attenuation, Frequency, Q- factor, Phase shift, VSWR, Impedance Measurement

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TEXT BOOKS:

1. Foundations for Microwave Engineering – R.E. Collin, IEEE Press, John Wiley, 2nd Edition, 2002.
2. Microwave Engineering- Annapurna Das and Sisir K.Das, Mc Graw Hill Education, 3rd Edition.

REFERENCES:

1. Microwave Devices and Circuits – Samuel Y. Liao, PHI, 3rd Edition,1994.
2. Microwave Engineering – G S N Raju , I K International
3. Microwave and Radar Engineering-M.Kulkarni, Umesh Publications, 3rd Edition

Course Outcomes: After going through this course the student will be able to

1. Design different modes in waveguide structures
2. Calculate S-matrix for various waveguide components and splitting the microwave energy in a desired direction
3. Distinguish between Microwave tubes and Solid State Devices, calculation of efficiency of devices.
4. Measure various microwave parameters using a Microwave test bench

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III Year – II Semester		L	T	P	C
		3	0	0	3

MOBILE & CELLULAR COMMUNICATION
(PE2)

UNIT I
CELLULAR MOBILE RADIO SYSTEMS: Introduction to Cellular Mobile System, uniqueness of mobile radio environment, operation of cellular systems, consideration of the components of Cellular system, Hexagonal shaped cells, Analog and Digital Cellular systems.
CELLULAR CONCEPTS: Evolution of Cellular systems, Concept of frequency reuse, frequency reuse ratio, Number of channels in a cellular system, Cellular traffic: trunking and blocking, Grade of Service; Cellular structures: macro, micro, pico and femto cells; Cell splitting, Cell sectoring.

UNIT II
INTERFERENCE: Types of interferences, Introduction to Co-Channel Interference, real time Co-Channel interference, Co-Channel measurement, Co-channel Interference Reduction Factor, desired C/I from a normal case in a omni-directional Antenna system, design of Antenna system, antenna parameters and their effects, diversity receiver, non-co-channel interference-different types.

UNIT III
FREQUENCY MANAGEMENT AND CHANNEL ASSIGNMENT: Numbering and grouping, setup access and paging channels, channel assignments to cell sites and mobile units: fixed channel and non-fixed channel assignment, channel sharing and borrowing, overlaid cells. **CELL COVERAGE FOR SIGNAL AND TRAFFIC:** Signal reflections in flat and hilly terrain, effect of human made structures, phase difference between direct and reflected paths, straight line path loss slope, general formula for mobile propagation over water and flat open
area, near and long distance propagation, antenna height gain, form of a point to point model.

UNIT IV
HANDOFF STRATEGIES:
Concept of Handoff, types of handoff, handoff initiation, delaying handoff, forced handoff, mobile assigned handoff, intersystem handoff, soft and hard hand offs, vehicle locating methods, dropped call rates and their evaluation.

UNIT V
DIGITAL CELLULAR NETWORKS: GSM architecture, GSM channels, multiple access schemes; TDMA, CDMA, OFDMA.3G and 4G Wireless Standards GSM , GPRS , WCDMA , LTE , Wi-MAX, Introduction to 5G standards.

TEXT BOOKS:

1. Mobile Cellular Telecommunications – W.C.Y. Lee, Tata McGraw Hill, 2nd Edn., 2006.
2. Principles of Mobile Communications – Gordon L. Stuber, Springer International 2nd Edition, 2007.
3. Advanced Wireless Communications-4G By. Savo G Glisic, John Wiley & Sons Publication 2nd Edition

REFERENCES:

1. Wireless Communications – Theodore. S. Rapport, Pearson education, 2nd Edn.,2002.
2. Fundamentals of Wireless Communication By. David Tse and Pramod Viswanath, Cambridge University Press

Course Outcomes:

At the end of this course the student can able to:

1. Identify the limitations of conventional mobile telephone systems; understand the concepts of cellular systems.
2. Understand the frequency management, channel assignment strategies and antennas in cellular systems.
3. Understand the concepts of handoff and architectures of various cellular systems.

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III Year – II Semester		L	T	P	C
		3	0	0	3
EMBEDDED SYSTEMS (PE2)					

UNIT-I
INTRODUCTION: Embedded system-Definition, history of embedded systems, classification of embedded systems, major application areas of embedded systems, purpose of embedded systems, the typical embedded system-core of the embedded system, Memory, Sensors and Actuators, Communication Interface, Embedded firmware, Characteristics of an embedded system, Quality attributes of embedded systems, Application-specific and Domain-Specific examples of an embedded system.

UNIT-II
EMBEDDED HARDWARE DESIGN: Analog and digital electronic components, I/O types and examples, Serial communication devices, Parallel device ports, Wireless devices, Timer and counting devices, Watchdog timer, Real time clock.

UNIT-III
EMBEDDED FIRMWARE DESIGN: Embedded Firmware design approaches, Embedded Firmware development languages, ISR concept, Interrupt sources, Interrupt servicing mechanism, Multiple interrupts, DMA, Device driver programming, Concepts of C versus Embedded C and Compiler versus Cross-compiler.

UNIT-IV
REAL TIME OPERATING SYSTEM: Operating system basics, Types of operating systems, Tasks, Process and Threads, Multiprocessing and Multitasking, Task Scheduling, Threads, Processes and Scheduling, Task communication, Task synchronization. **HARDWARE SOFTWARE CO-DESIGN:** Fundamental Issues in Hardware Software Co-Design, Computational models in embedded design, Hardware software Trade-offs, Integration of Hardware and Firmware.

UNIT-V:
EMBEDDED SYSTEM DEVELOPMENT, IMPLEMENTATION AND TESTING: The integrated development environment, Types of files generated on cross-compilation, De-assembler/ De-compiler, Simulators, Emulators and Debugging, Target hardware debugging, Embedded Software development process and tools, Interpreters, Compilers and Linkers, debugging tools, Quality assurance and testing of the design, Testing on host machine, Simulators, Laboratory Tools.

Case Study: digital camera hardware and software architecture, embedded systems in automobile, embedded system for a smart card, mobile phone software for key inputs.

Text Books:
1. Embedded Systems Architecture- By Tammy Noergaard, Elsevier Publications, 2013.
2. Embedded Systems-By Shibu. K.V-Tata McGraw Hill Education Private Limited, 2013.

References:

1. Embedded System Design, Frank Vahid, Tony Givargis, John Wiley Publications, 2013.
2. Embedded Systems-Lyla B.Das-Pearson Publications,2013.

Course Outcomes:

At the end of this course the student can able to:

1. Understand the basic concepts of an embedded system and able to know an embedded system design approach to perform a specific function.
2. The hardware components required for an embedded system and the design approach of an embedded hardware.
3. The various embedded firmware design approaches on embedded environment.
4. Understand how to integrate hardware and firmware of an embedded system using real time operating system.

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III Year – II Semester		L	T	P	C
		3	0	0	3
CMOS ANALOG IC DESIGN (PE2)					

UNIT -I
Basic MOS Device Physics – General Considerations, MOS I/V Characteristics, Second Order effects, MOS Device models. Short Channel Effects and Device Models, Single Stage Amplifiers –Basic Concepts, Common Source Stage, Source Follower, Common Gate Stage, Cascode Stage

UNIT -II:
Differential Amplifiers – Single Ended and Differential Operation, Basic Differential Pair, Common Mode Response, Differential Pair with MOS loads, Gilbert Cell. Passive and Active Current Mirrors– Basic Current Mirrors, Cascode Current Mirrors, Active Current Mirrors

UNIT -III:
Frequency Response of Amplifiers – General Considerations, Common Source Stage, Source Followers, Common Gate Stage, Cascode Stage, Differential Pair, Noise – Types of Noise, Representation of Noise in circuits, Noise in single stage amplifiers, Noise in Differential Pairs

UNIT -IV:
Feedback Amplifiers – General Considerations, Feedback Topologies, Effect of Loading, Operational Amplifiers – General Considerations, One Stage Op Amps, Two Stage Op Amps, Gain Boosting, Common – Mode Feedback, Input Range limitations, Slew Rate, Power Supply Rejection, Noise in Op Amps. Stability and Frequency Compensation

UNIT -V:
Characterization of Comparator, Two-Stage, Open-Loop Comparators, Other Open-Loop Comparators, Improving the Performance of Open-Loop Comparators, Discrete-Time Comparators

Text Books:
1. B.Razavi, “Design of Analog CMOS Integrated Circuits”, 2nd Edition, McGraw Hill Edition2016.
2. Paul. R.Gray&Robert G. Meyer, “Analysis and Design of Analog Integrated Circuits”, Wiley, 5th Edition, 2009.

Reference Books:
1. T. C. Carusone, D. A. Johns & K. Martin, “Analog Integrated Circuit Design”, 2nd Edition, Wiley, 2012.
2. P.E.Allen&D.R. Holberg, “CMOS Analog Circuit Design”, 3rd Edition, Oxford University
Press, 2011.
3. R. Jacob Baker, “CMOS Circuit Design, Layout, and Simulation”, 3rd Edition, Wiley, 2010.

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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

Course Outcomes:

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

1. Design MOSFET based analog integrated circuits.
2. Analyze analog circuits at least to the first order.
3. Appreciate the trade-offs involved in analog integrated circuit design.
4. Understand and appreciate the importance of noise and distortion in analog circuits.
5. Analyze complex engineering problems critically in the domain of analog IC design for conducting research.

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III Year – II Semester		L	T	P	C
		0	0	3	1.5
MICROPROCESSOR AND MICROCONTROLLERS LAB					

List of Experiments:

PART- A: (Minimum of 5 Experiments has to be performed) 8086 Assembly Language Programming and Interfacing

1. Programs for 16 -bit arithmetic operations (using Various Addressing Modes).
   a. Addition of n-BCD numbers.
   b. Multiplication and Division operations.
2. Program for sorting an array.
3. Program for Factorial of given n-numbers.
4. Interfacing ADC to8086
5. Interfacing DAC to8086.
6. Interfacing stepper motor to8086.

PART-B: (Minimum of 5 Experiments has to be performed) 8051 Assembly Language Programming and Interfacing

1. Finding number of 1's and number of 0's in a given 8-bit number
2. Average of n-numbers.
3. Program and verify Timer/ Counter in8051.
4. Interfacing Traffic Light Controller to8051.
5. UART operation in8051
6. Interfacing LCD to8051.

PART-C (Minimum of 2 Experiments has to be performed) Conduct the following experiments using ARM CORTEX M3 PROCESSOR USING KEIL MDK ARM

1. Write an assembly program to multiply of 2 16-bit binary numbers.
2. Write an assembly program to find the sum of first 10 integers numbers.
3. Write a program to toggle LED every second using timer interrupt.

Equipment Required:

1. Regulated Power supplies
2. Analog/Digital Storage Oscilloscopes
3. 8086 Microprocessor kits
4. 8051 microcontroller kits
5. ADC module, DAC module
6. Stepper motor module
7. Key board module
8. LED, 7-SegemtUnits
9. Digital Multi-meters
10. ROM/RAM Interface module
11. Bread Board etc.
12. ARM CORTEX M3
13. KEIL MDKARM, Digital Multi-meters

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III Year – II Semester		L	T	P	C
		0	0	3	1.5
VLSI DESIGN LAB					

List of Experiments

PART (A): FPGA Level Implementation (Any Seven Experiments)
Note 1: The students need to develop Verilog /VHDL Source code, perform simulation usingrelevant simulator and analyze the obtained simulation results using necessary Synthesizer
Note 2: All the experiments need to be implemented on the latest FPGA/CPLD Hardware in theLaboratory

1. Realization of Logic gates

   Design and Implementation of the following:

2. 4-bit ripple carry and carry look ahead adder using behavioral, dataflow and structural modeling
3. a) 16:1 mux through 4:1 mux
   b) 3:8 decoder realization through 2:4 decoder
4. 8:3 encoder
5. 8-bit parity generator and checker
6. Flip-Flops
7. 8-bit synchronous up-down counter
8. 4-bit sequence detector through Mealy and Moore state machines.

EDA Tools/Hardware Required:

1. EDA Tool that supports FPGA programming including Xilinx Vivado/Altera(Intel)/Cypress/Equivalent Industry standard tool along with corresponding FPGA hardware.
2. Desktop computer with appropriate Operating System that supports the EDA tools.

PART (B): Back-end Level Design and Implementation (Any Five Experiments)
Note: The students need to design the following experiments at schematic level using CMOSlogic and verify the functionality. Further students need to draw the corresponding layout and verify the functionality including parasites. Available state of the art technology libraries can be used while simulating the designs using Industry standardEDA Tools.

Design and Implementation of the following

1a. Universal Gates
1b. An Inverter
2. Full Adder
3. Full Subtractor
4. Decoder
5. D-Flip-flop

EDA Tools/Hardware Required:

- Mentor Graphics Software / Cadence/Synopsys/Tanner or Equivalent Industry Standard/CAD Tool.
- Desktop computer with appropriate Operating System that supports the EDA tools.

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III Year – II Semester		L	T	P	C
		0	0	3	1.5
DIGITAL SIGNAL PROCESSING LAB					

(Note: Students have to perform at least FOUR experiments from each part.)

PART-A

List of the Experiments

1. Generation of DT signals.
2. Verify the Linear Convolution of two DT signals
   a) Using MATLAB
   b) Using Code Composer Studio(CCS)
3. Verify the Circular Convolution of two DT signals
   a) Using MATLAB
   b) Using Code Composer Studio(CCS)
4. Find the sum of DT sinusoidal signals.
5. Computation of Discrete Fourier Transform(DFT) and Inverse Discrete Fourier Transform (IDFT)
   a) Using MATLAB
   b) Using Code Composer Studio(CCS)
6. Transfer Function Stability Analysis: using pole-zero plot, bode Plot and Nyquist plot.

PART-B

Following Experiments are to be done using a TIDSP Starter Kit**.**

7. Generation of a sinusoidal signal.
8. Linear and circular convolution of DT sequences.
9. Compute N-point DFT of a given DT sequence.
10. Design and implementation of FIR filters.
11. Design and implementation of IIR filters.

PART-C

FollowingExperimentsaretobedoneusing**CypressFM4StarterKit.**

12. Verification of sampling theorem.
13. Implementation of FFT algorithm.
14. Implementation of FIR filters.
15. Implementation of IIR filters.

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III Year – II Semester		L	T	P	C
		1	0	2	2
ARM BASED/ AURDINO BASED PROGRAMMING					

LIST OF EXPERIMENTS:

1. Measure Analog signal from Temperature Sensor
2. Generate PWM output
3. Drive single character generation on Hyper Terminal
4. Drive a given string on Hyper Terminal
5. Full duplex Link establishment using Hyper terminal
6. Drive a given value on a 8 bit DAC consisting of SPI
7. Drive Stepper motor using Analog GPIOs
8. Drive Accelerometer and Display the readings on Hyper Terminal

COMPONENTS/ BOARDS :

1. Arduino Duemilanove Board
2. Arduino Software IDE

Course Outcomes:

At the end of the Course, the Student will be able to:

1. Comprehend Microcontroller-Transducers Interface techniques
2. Establish Serial Communication link with Arduino
3. Analyze basics of SPI interface.
4. Interface Stepper Motor with Arduino
5. Analyze Accelerometer interface techniques

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		L	T	P	C
		3	0	0	3
BASICS OF SIGNALS AND SYSTEMS (OE)					

Unit I:
Introduction: Definitions of a signal and a system, classification of signals, basic Operations on signals, elementary signals, Systems viewed as Interconnections of operations, properties of systems.

Unit II:
Time-domain representations for LTI systems: Convolution, impulse response representation, Convolution Sum and Convolution Integral. Properties of impulse response representation, Differential and difference equation Representations, Block diagram representations.

UNIT III:
Frequency-domain representation for signals: Introduction, Discrete-time and continuous-time Fourier series (derivation of series excluded) and their properties. Discrete-time and continuous-time Fourier transforms (derivations of transforms are excluded) and their properties.

Unit IV:
Applications of Fourier representations: Introduction, Frequency response of LTI systems, Fourier transform representation of periodic signals, Fourier transform representation of discrete time signals.

Unit V:
LAPLACE & Z-TRANSFORMS: Introduction**,** Concept of region of convergence (ROC) for Laplace transforms, constraints on ROC for various classes of signals, Properties of L.T's, Inverse Laplace transform, Relation between L.T's, and F.T. of a signal.
Z-Transforms: Introduction, Z-transform, properties of ROC, properties of Z – transforms, inversion Z-transforms. Z-Transform analysis of LTI Systems, unilateral Z-Transform and its application to solve difference equations

TEXT BOOKS:

1. A.V. Oppenheim, A.S. Willsky and S.H. Nawab, "Signals and Systems", Pearson, 2nd Edn.
2. B. P. Lathi, "Linear Systems and Signals", Second Edition, Oxford University Press,
3. Simon Haykin and Van Veen, "Signals & Systems", Wiley, 2nd Edition.

Reference Books:

1. Michel J. Robert, "Fundamentals of Signals and Systems", MGH International Edition, 2008.
2. Ramakrishna Rao,"Signals and Systems", 2008, TMH

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Course Outcomes:

1. Understand linear time invariant systems.
2. Apply the concepts of Fourier series representations to analyze continuous and discrete time periodic signals.
3. Understand and apply the continuous time Fourier transform, discrete time Fourier transform,
4. Apply the concepts of Laplace transform, and z-Transform to the analysis and description of LTI continuous and discrete-time systems

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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

		L	T	P	C
		3	0	0	3
ELECTRONIC MEASUREMENTS AND INSTRUMENTATION (OE)					

UNIT I

Performance characteristics of instruments, Static characteristics; Accuracy, Resolution, Precision, Expected value, Error, Sensitivity, Dynamic Characteristics, speed of response, Fidelity, Lag and Dynamic error. Types of errors in measurements and their analysis, Design of multi-range AC , DC meters (voltmeter &ammeter) and ohmmeter(series &shunt type) using D'arsonval movement. True rms meter.

UNIT II

Specifications and designing aspects of Signal Generators – AF sine and square wave signal generators, Function Generators, Random noise generators, Arbitrary waveform generators. Wave Analyzers, Harmonic Distortion Analyzers, Spectrum Analyzers, Digital Fourier Analyzers.

UNIT III

Oscilloscopes- general purpose CROs; block diagram , functions and implementation of various blocks, specifications, various controls and their functions , types of probes used in CROs. Measurement of frequency and phase difference using Lissajous patterns, Special purpose CROs; sampling oscilloscope, analog storage oscilloscope, digital storage oscilloscope

UNIT IV

Bridge circuits- Wheat stone bridge, measurement of very low resistance, Measurement of inductance- Maxwell's bridge, Anderson bridge, Measurement of capacitance-Schearing Bridge. Wien Bridge, Errors and precautions in using bridges, Q-meter; principle of operation, measurement methods and sources of errors, Counters: principle of operation -modes of operation- totalizing mode, frequency mode and time period mode- sources of errors.

UNIT V

Transducers- active & passive transducers: Resistance, Capacitance, inductance; Strain gauges, LVDT, Piezo Electric transducers. Measurement of physical parameters temperature, force, pressure, velocity, acceleration and displacement

TEXT BOOKS:

1. Electronic instrumentation, second edition - H.S. Kalsi, Tata McGrawHill, 2004.
2. Modern Electronic Instrumentation and Measurement Techniques – A.D. HelfrickandW.D. Cooper, PHI, 5th Edition, 2002.

REFERENCES:

1. Electronic Instrumentation & Measurements - David A. Bell, PHI, 3rd Edition,2013.
2. Electrical and Electronic Measurement and Instrumentation A.K. Sawhney. Dhanpat Rai & Co, 12thEdition,2002.

Course Outcomes:

The student will be able to

1. Select the instrument to be used based on the requirements.
2. Understand and analyze different signal generators and analyzers.
3. Understand the design of oscilloscopes for different applications.
4. Design different transducers for measurement of different parameters.

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PRINCIPLES OF SIGNAL PROCESSING (OE)					

Unit I:
Discrete Signals and Systems- A Review – Introduction to DFT – Properties of DFT – Circular Convolution – Filtering methods based on DFT – FFT Algorithms –Decimation in time Algorithms, Decimation in frequency Algorithms – Use of FFT in Linear Filtering.

Unit II:
Structures of IIR filters – Analog filter design – Discrete time IIR filter from analog filter – IIR filter design by Impulse Invariance, Bilinear transformation.

Unit III:
Structures of FIR filters – Linear phase FIR filter – Filter design using windowing techniques (Rectangular Window, Hamming Window, Hanning Window), Frequency sampling techniques

Unit IV:
Multirate signal processing: Basic building blocks of multirate DSP, Decimation, Interpolation, Sampling rate conversion by a rational factor, Multistage Sampling Rate Converters.

Unit V:
Adaptive Filters: Introduction, LMS and RLS Adaptation Algorithms, Applications of adaptive filtering to equalization, noise cancellation.

TEXT BOOKS:

1. Digital Signal Processing, Principles, Algorithms, and Applications: John G. Proakis, Dimitris G.Manolakis, Pearson Education / PHI, 2007.
2. Discrete Time Signal Processing – A.V.Oppenheim and R.W. Schaffer, PHI

Reference Books:

1. Fundamentals of Digital Signal Processing using Matlab – Robert J. Schilling, Sandra L. Harris,Thomson, 2007.
2. Understanding Digital Signal Processing 2nd Edition by Richard G.Lyons

Course Outcomes:

1. Use the FFT algorithm for solving the DFT of a given signal
2. Design a Digital filter (FIR&IIR) from the given specifications
3. Realize the FIR and IIR structures from the designed digital filter.
4. Use the Multirate Processing concepts in various applications
5. Apply the Adaptive signal processing concepts to various signal processing applications

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		3	0	0	3
INDUSTRIAL ELECTRONICS (OE)					

UNIT - I
DC Amplifiers: Need for DC amplifiers, DC amplifiers - Drift, Causes, Darlington Emitter Follower, Cascode amplifier, Stabilization, Differential amplifiers - Chopper stabilization, Operational Amplifiers, Ideal specifications of Operational Amplifiers, Instrumentation Amplifiers.

UNIT - II
Regulated Power Supplies: Block diagram, Principle of voltage regulation, Series and Shunt type Linear Voltage Regulators, Protection Techniques - Short Circuit, Over voltage and Thermal Protection. Switched Mode & IC Regulators: Switched Mode voltage regulator, Comparison of Linear and Switched Mode Voltage Regulators, Servo Voltage Stabilizer, monolithic voltage regulators Fixed and Adjustable IC Voltage regulators, 3-terminal Voltage regulators - Current boosting .

UNIT - III SCR and Thyristor: Principles of operation and characteristics of SCR, Triggering of Thyristors, Commutation Techniques of Thyristors - Classes A, B, C, D, E and F, Ratings of SCR.

UNIT - IV Applications of SCR in Power Control: Static circuit breaker, Protection of SCR, Inverters - Classification, Single Phase inverters, Converters –single phase Half wave and Full wave. DIAC, TRIAC and Thyristor Applications: Chopper circuits – Principle, methods and Configurations, DIAC AND TRIAC, TRIACS – Triggering modes, Firing Circuits, Commutation.

UNIT – V Industrial Applications –
I: Industrial timers -Classification, types, Electronic Timers – Classification, RC and Digital timers, Time base Generators. Electric Welding Classification, types and methods of Resistance and ARC wielding, Electronic DC Motor Control. Industrial Applications –
II: High Frequency heating – principle, merits, applications, High frequency Source for Induction heating. Dielectric Heating – principle, material properties, Electrodes and their Coupling to RF generator, Thermal losses and Applications. Ultrasonics – Generation and Applications.

TEXTBOOKS:
1. Industrial and Power Electronics – G. K. Mithal and Maneesha Gupta, Khanna Publishers, 19th Ed., 2003.
2. Integrated Electronics – J. Millman and C.C Halkias, McGraw Hill, 1972

REFERENCE BOOKS:
1. Electronic Devices and circuits – Theodore. H. Bogart, Pearson Education, 6th Edn., 2003.
2. Thyristors and applications – M. Rammurthy, East-West Press, 1977.
3. Integrated Circuits and Semiconductor Devices – Deboo and Burroughs, ISE

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Course Outcomes:

1. Understand the concept of DC amplifiers.
2. Analyze and design different voltage regulators for real time applications
3. Describe the basis of SCR and Thyristor
4. Determine the performance of DIAC and TRIAC
5. Develop real time application using electronics

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		L	T	P	C
		3	0	0	3
CONSUMER ELECTRONICS (OE)					

Unit I:
Audio Systems: Microphones and Loudspeakers: Carbon, moving coil, cordless microphone, Direct radiating and horn loudspeaker, Multi-speaker system, Hi-Fi stereo and dolby system. Concept to fidelity, Noise and different types of distortion in audio system

Unit II:
Digital Audio Fundamentals:
Audio as Data and Signal, Digital Audio Processes Outlined, Time Compression and Expansion.

Unit III:
Television: Basics of Television: Elements of TV communication system, Scanning and its need, Need of synchronizing and blanking pulses, VSB, Composite Video Signal, Colour Television: Primary, secondary colours, Concept of Mixing, Colour Triangle, Camera tube, PAL TV Receiver, NTSC, PAL, SECAM

Unit IV:
Digital Transmission and Reception: Digital satellite television, Direct-To-Home(DTH) satellite television, Introduction to :Video on demand, CCTV, High Definition(HD)-TV. Introduction to Liquid Crystal and LED Screen Televisions Basic block diagram of LCD and LED Television and their comparison

Unit V:
Introduction to different type of domestic/commercial appliances: Operation of Micro-wave oven, Food Processors, Digital Electronic Lock, Vacuum cleaner, Xerox Machine, Scanner

Test Books:
1. Modern Television Practice by R. R. Gulai; New Age International Publishers.
2. Audio Video Systems by R. G. Gupta; McGraw Hill Education System.
3. Audio Video Systems Principles Practices and Troubleshooting by Bali & Bali; Khanna Publishing Company
4. Consumer Electronics by S. P. Bali; Pearson Education, New Delhi

Course Outcomes:
1. Understand the various type of microphones and loud speakers.
2. To identify the various digital and analog signal.
3. Describe the basis of television and composite video signal.
4. Describe the various kind of colour TV standards and system.
5. Compare the various types of digital TV system.
6. Understand the various type of consumer goods.

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		3	0	0	3
FUNDAMENTALS OF MICROPROCESSORS AND MICROCONTROLLERS (OE)					

UNIT I
8085 PROCESSOR
Hardware Architecture, pinouts — Functional Building Blocks of Processor — Memory organization — I/O ports and data transfer concepts,Interrupts.
8086 Architecture: Main features, pin diagram/description, 8086 microprocessor family, internal architecture, interrupts and interrupt response, 8086 system timing, minimum mode and maximum mode configuration

UNIT II
8086 Programming: Program development steps, instructions, addressing modes, assembler directives, writing simple programs with an assembler, assembly language program development tools.

UNIT-III
8086 Interfacing: Semiconductor memories interfacing (RAM, ROM), Intel 8255 programmable peripheral interface, Interfacing switches and LEDS, Interfacing seven segment displays, software and hardware interrupt applications, Intel 8251 USART architecture and interfacing, Intel 8237a DMA controller, stepper motor, A/D and D/A converters, Need for 8259 programmable interrupt controllers.

UNIT IV
8051 MICRO CONTROLLER
Hardware Architecture, pinouts — Functional Building Blocks of Processor — Memory organization — I/O ports and data transfer concepts– Timing Diagram — Interrupts- Data Transfer, Manipulation, Control Algorithms& I/O instructions, Comparison to Programming concepts with 8085.

UNIT V
MICRO CONTROLLER PROGRAMMING & APPLICATIONS
Simple programming exercises- key board and display interface –Control of servo motor stepper motor control- Application to automation systems.

TEXTBOOKS:

1. R.S. Gaonkar, Microprocessor Architecture Programming and Application, with 8085, Wiley Eastern Ltd., New Delhi, 2013.
2. A.K Ray, K.M.Bhurchandhi," Advanced Microprocessor and Peripherals", Tata McGraw Hill Publications, 2000.
3. The 8051 Microcontrollers and Embedded systems Using Assembly and C, Muhammad Ali Mazidi and Janice Gillespie Mazidi and Rollin D.McKinlay; Pearson 2-Edition, 2011.

REFERENCEBOOKS:

1. Microprocessors and Interfacing – Programming and Hardware by Douglas V Hall, SSSP Rao, Tata Mc Graw Hill Education Private Limited,3rdEdition,1994

Course Outcomes:

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

1. Understand the architecture of microprocessor/microcontroller and their operation.
2. Demonstrate programming skills in assembly language for processors and controllers.
3. Analyze various interfacing techniques and apply them for the design of processor/Controller based systems.

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		L	T	P	C
		3	0	0	3
TRANSDUCERS AND SENSORS (OE)					

UNIT – I

Measurements and Instrumentation of Transducers: Measurements – Basic method of measurement – Generalized scheme for measurement systems – Units and standards – Errors – Classification of errors, error analysis – Statistical methods – Sensor – Transducer – Classification of transducers – Basic requirement of transducers.

UNIT – II

Characteristics of Transducers: Static characteristics – Dynamic characteristics – Mathematical model of transducer – Zero, first order and second order transducers – Response to impulse, step, ramp and sinusoidal inputs

UNIT – III

Resistive Transducers: Potentiometer –Loading effect – Strain gauge – Theory, types, temperature compensation – Applications – Torque measurement – Proving Ring – Load Cell – Resistance thermometer – Thermistors materials – Constructions, Characteristics – Hot wire anemometer

UNIT – IV

Inductive and Capacitive Transducer: Self inductive transducer – Mutual inductive transducers – Linear Variable Differential Transformer – LVDT Accelerometer – RVDT – Synchros – Microsyn – Capacitive transducer – Variable Area Type – Variable Air Gap type – Variable Permittivity type – Capacitor microphone.

UNIT- V Miscellaneous Transducers: Piezoelectric transducer – Hall Effect transducers – Smart sensors – Fiber optic sensors – Film sensors – MEMS – Nano sensors, Digital transducers

TEXT BOOKS:

1. Sawhney. A.K, "A Course in Electrical and Electronics Measurements and Instrumentation", 18th Edition, Dhanpat Rai & Company Private Limited, 2007.
2. Patranabis. D, "Sensors and Transducers", Prentice Hall of India, 2003.

REFERENCE BOOKS:

1. Renganathan. S, "Transducer Engineering", Allied Publishers, Chennai, 2003.
2. Doebelin. E.A, "Measurement Systems – Applications and Design", Tata McGraw Hill, New York, 2000
3. John. P, Bentley, "Principles of Measurement Systems", III Edition, Pearson Education, 2000. 4. Murthy. D. V. S, "Transducers and Instrumentation", Prentice Hall of India, 2001.
4. Sensor Technology Hand Book – Jon Wilson, Newne 2004.
5. Instrument Transducers – An Introduction to their Performance and design – by Herman K. P. Neubrat, Oxford University Press



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Course Outcomes:

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

1. Use concepts in common methods for converting a physical parameter into an electrical quantity
2. Classify and explain with examples of transducers, including those for measurement of temperature, strain, motion, position and light
3. Choose proper sensor comparing different standards and guidelines to make sensitive measurements of physical parameters like pressure, flow, acceleration, etc
4. Predict correctly the expected performance of various sensors
5. Locate different type of sensors used in real life applications and paraphrase their importance
6. Set up testing strategies to evaluate performance characteristics of different types of sensors and transducers
7. develop professional skills in acquiring and applying the knowledge outside the classroom through design of a real-life instrumentation system.

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		L	T	P	C
		3	0	0	3
IOT AND APPLICATIONS (OE)					

UNIT I:

Introduction to IoT: Introduction to IoT, Architectural Overview, Design principles and needed capabilities, Basics of Networking, M2M and IoT Technology Fundamentals- Devices and gateways, Data management, Business processes in IoT, Everything as a Service (XaaS), Role of Cloud in IoT, Security aspects in IoT.

UNIT II:

Elements of IoT: Hardware Components- Computing- Arduino, Raspberry Pi, ARM Cortex-A class processor, Embedded Devices – ARM Cortex-M class processor, Arm Cortex-M0 Processor Architecture, Block Diagram, Cortex-M0 Processor Instruction Set, ARM and Thumb Instruction Set.

UNIT III:

IoT Application Development: Communication, IoT Applications, Sensing, Actuation, I/O interfaces.

Software Components- Programming API's (using Python/Node.js/Arduino) for Communication Protocols-MQTT, ZigBee, CoAP, UDP, TCP, Bluetooth.

Bluetooth Smart Connectivity Bluetooth overview, Bluetooth Key Versions, Bluetooth Low Energy (BLE) Protocol, Bluetooth, Low Energy Architecture, PSoC4 BLE architecture and Component Overview.

UNIT IV:

Solution framework for IoT applications: Implementation of Device integration, Data acquisition and integration, Device data storage- Unstructured data storage on cloud/local server, Authentication, authorization of devices.

UNIT V:

IoT Case Studies: IoT case studies and mini projects based on Industrial automation, Transportation, Agriculture, Healthcare, Home Automation. Cloud Analytics for IoT Application :Introduction to cloud computing, Difference between Cloud Computing and Fog Computing: The Next Evolution of Cloud Computing, Role of Cloud Computing in IoT, Connecting IoT to cloud, Cloud Storage for IoT Challenge in integration of IoT with Cloud.

Text Books:

1. Raj Kamal, "Internet of Things: Architecture and Design Principles", 1st Edition, McGraw Hill Education,2017.
2. The Definitive Guide to the ARM Cortex-M0 by JosephYiu,2011
3. Vijay Madisetti, Arshdeep Bahga, Internet of Things, "A Hands on Approach", UniversityPress,2015

References:

1. CypressSemiconductor/PSoC4BLE(BluetoothLowEnergy)ProductTrainingModules.
2. PethuruRajandAnupamaC.Raman,"TheInternetofThings:EnablingTechnologies,Platforms,andUse Cases",CRCPress,2017.

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Course Outcomes:

The student will be able to:

1. Understand internet of Things and its hardware and software components.
2. Interface I/O devices, sensors & communication modules.
3. Remotely monitor data and control devices.
4. Design real time IoT based applications

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		3	0	0	3
SOFT COMPUTING TECHNIQUES (OE)					

UNIT –I:
Introduction to soft computing: Introduction, Artificial Intelligence, Artificial Neural Networks, Fuzzy systems, Genetic Algorithm and Evolutionary programming, Swarm Intelligent systems, Expert systems, Comparison among Intelligent systems.

UNIT –II:
Artificial Neural Networks: Introduction to Artificial Neural Networks, Classification of ANNS, First generation neural networks, Perceptron network, Adaline, Madaline, Second generation neural networks, Back propagation neural networks, Hopfield Neural Network, Kohonen neural network, Hamming neural network, Radial basis function neural networks, spike neuron models.

UNIT –III:
Fuzzy Logic System: Introduction to fuzzy logic, classical sets and fuzzy sets, fuzzy set operations, fuzzy relations, fuzzy composition, natural language and fuzzy interpretations, fuzzy inference system, fuzzy controllers

UNIT –IV:
Genetic Algorithm: Introduction to Genetic algorithms, Genetic algorithms, procedures of Gas, working of Gas, Travelling sales man problem, Evolutionary programming, working principle of GA Machine learning classifier system

UNIT –V:
Swarm Intelligent system: Introduction to swarm intelligence, back ground, Ant colony system, working of ant colony optimization, Particle swarm intelligent systems, Artificial bee colony system, cuckoo search algorithm..

TEXT BOOKS:

1. Soft computing with MATLAB programming—N.P.Padhy, S.P.Simon, Oxford university press, 2015
2. Neural Networks and Fuzzy Systems - Kosko, B., Prentice-Hall of India Pvt. Ltd., 1994.
3. Introduction to Artificial Neural Systems-Jacek.M.Zurada, Jaico Publishing House,1999

REFERENCE BOOKS:

1. Fuzzy Sets, Uncertainty and Information - Klir G.J. &Folger T.A., Prentice-Hall of IndiaPvt. Ltd., 1993.
2. Fuzzy Set Theory and Its Applications - Zimmerman H.J. Kluwer Academic Publishers, 1994.
3. Introduction to Fuzzy Control - Driankov, Hellendroon, Narosa Publishers.
4. Artificial Neural Networks - Dr. B. Yagananarayana, 1999, PHI, New Delhi.
5. Elements of Artificial Neural Networks - KishanMehrotra, Chelkuri K. Mohan, Sanjay Ranka, Penram International.

6. Artificial Neural Network –Simon Haykin, 2nd Ed., Pearson Education.
7. Introduction Neural Networks Using MATLAB 6.0 - S.N. Shivanandam, S. Sumati, S. N. Deepa,1/e, TMH, New Delhi.

Course Outcomes:

1. Develop intelligent systems leveraging the paradigm of soft computing techniques.
2. Implement, evaluate and compare solutions by various soft computing approaches for finding the optimal solutions.
3. Recognize the feasibility of applying a soft computing methodology for a particular problem
4. Design the methodology to solve optimization problems using fuzzy logic, genetic algorithms and neural networks.
5. Design hybrid system to revise the principles of soft computing in various application

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IC APPLICATIONS (OE)					

Unit I:
Ideal and Practical Op-Amp, Op-amp characteristics-DC and AC Characteristics, General Linear Applications of Op-Amp: Adder, Subtractor, Differentiators and Integrators, Active Filters and Oscillators, Non linear Applications of OPAMP: Comparators, Schmitt Trigger, Multivibrators

Unit II:
Introduction to 555 Timer, Functional Diagram, Monostable and Astable Operations and Applications, Schmitt Trigger, PLL- Introduction, Block Schematic, Principles and Description of individual Blocks of 565, VCO.

Unit III:
Introduction, Basic DAC Techniques - Weighted Resistor Type. R-2R Ladder Type, inverted R-2R Type. Different types of ADCs - Parallel Comparator Type. Counter Type. Successive Approximation Register Type and Dual Slope Type DAC and ADC Specifications.

Unit IV:
Use of TTL-74XX Series & CMOS 40XX Series ICs, TTL ICs - Code Converters, Decoders, Demultiplexers, Encoders, Priority Encoders, multiplexers & their applications. Priority Generators, Arithmetic Circuit ICs-Parallel Binary Adder/Subtractor Using 2's Complement System, Magnitude Comparator Circuits.

Unit V:
Commonly Available 74XX & CMOS 40XX Series ICs - RS, JK.JK Master-Slave. D and T Type Flip-Flops & their Conversions, Synchronous and asynchronous counters. Decade counters. Shift Registers & applications.

TEXT BOOKS:
1. Linear Integrated Circuits -D. Roy Chowdhury, New Age International (p)Ltd, 3" Ed., 2008.
2. Digital Fundamentals - Floyd and Jain, Pearson Education,8th Edition, 2005.

REFERENCE BOOKS:
1. Modern Digital Electronics - RP Jain - 4/e - TMH, 2010.
2. Op-Amps & Linear ICs - Ramakanth A. Gayakwad, PHI, 1987.

Course Outcomes:
1. Analyse the Differential Amplifier with Discrete components
2. Describe the Op-Amp and internal Circuitry: 555 Timer, PLL
3. Discuss the Applications of Operational amplifier: 555 Timer, PLL
4. Design the digital application using digital ICs
5. Use the Op-Amp in A to D & D to A Converters

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PRINCIPLES OF COMMUNICATIONS (OE)					

UNIT-1

Amplitude modulation: Introduction, Amplitude Modulation: Time & Frequency – Domain description, switching modulator, Envelop detector.

Double side band-suppressed carrier modulation: Time and Frequency – Domain description, Ring modulator, Coherent detection, Costas Receiver, Quadrature Carrier Multiplexing.

Single side–band and vestigial sideband methods of modulation: SSB Modulation, VSB Modulation, Frequency Translation, Frequency- Division Multiplexing, Theme Example: VSB Transmission of Analog and Digital Television

UNIT-II

Angle modulation: Basic definitions, Frequency Modulation: Narrow Band FM, Wide Band FM, Transmission bandwidth of FM Signals, Generation of FM Signals, Demodulation of FM Signals, FM Stereo Multiplexing,

UNITIII

Signal Sampling and Analog Pulse Communication: Ideal Sampling, Pulse Amplitude Modulation, Pulse Width Modulation, Pulse Position Modulation. Digital Communication Techniques: Quantization, Digital Transmission of Data, Parallel and Serial Transmission, Data Conversion, Pulse Code Modulation, Delta Modulation.

UNIT-IV

Noise in analog modulation: Introduction, Receiver Model, Noise in DSB-SC receivers, Noise in AM receivers, Threshold effect, Noise in FM receivers, Capture effect, FM threshold effect, FM threshold reduction, Pre-emphasis and De-emphasise in FM.

UNIT-V

Transmission of Binary Data in Communication Systems: Digital Codes, Principles of Digital Transmission, Transmission Efficiency, Modem Concepts and Methods – FSK, BPSK, Error Detection and Correction

Text Books:

1. Principles of Communication Systems – H Taub& D. Schilling, GautamSahe, TMH, 2007, 3rdEdition.
2. Communication Systems – B.P. Lathi, BS Publication,2006.

References:

1. Principles of Communication Systems - Simon Haykin, John Wiley,2ndEdition.
2. Electronics & Communication System – George Kennedy and Bernard Davis, TMH 2004.
3. Communication Systems– R.P. Singh, SP Sapre, Second Edition TMH,2007.

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Course Outcomes:

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

1. Analyze the performance of analog modulation schemes in time and frequency domains.
2. Analyze the performance of angle modulated signals.
3. Characterize analog signals in time domain as random processes and noise
4. Characterize the influence of channel on analog modulated signals
5. Determine the performance of analog communication systems in terms of SNR
6. Analyze pulse amplitude modulation, pulse position modulation, pulse code modulation and TDM systems.

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BASIC ELECTRONICS (OE)					

Unit I: Semiconductor Basics: Atomic Structure, Semiconductors, Conductors, and Insulators, Covalent Bonds, Conduction in Semiconductors, N-Type and P-Type Semiconductors, Diode, Biasing a Diode, Voltage-Current Characteristic of a Diode, Diode Models.
Diode Applications: Half- Wave Rectifiers, Full-Wave Rectifiers, Power Supply Filters and Regulators.

Unit II: Special-Purpose Diodes: Zener Diodes, Zener Diode Applications, Varactor Diodes, Optical Diodes

Unit III: Bipolar junction Transistors: Transistor Structure, Basic Transistor Operation, Transistor Characteristics and Parameters, Transistor as an Amplifier and Switch

Unit IV: Field-Effect Transistors (FETs): JFET, Characteristics and Parameters, JFET Biasing, MOSFET Characteristics and Parameters

Unit V: Thyristors and Other Devices: Basic 4-Layer Device, The Silicon-Controlled Rectifier, SCR Applications, Unijunction Transistor , IGBT, Phototransistor, Light-Activated SCR, Optical Couplers

Text Books:

1. Electronic Devices conventional current version By Floyd, Seventh Edition, Pearson publications

References:

1. Electronics devices & circuit theory- Robert L.Boylestad and Loui Nashelsky, Pearson/Prentice hall, tenth edition, 2009
2. Electronic Devices and Circuits- J. Millman, C. Halkias, Tata Mc-Graw Hill, SecondEdition,2007

Course Outcomes:

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

1. Understand the formation of p-n junction and how it can be used as a p-n junction as diode in different modes of operation.
2. Know the construction, working principle of rectifiers with and without filters with relevant expressions and necessary comparisons.
3. Understand the construction, principle of operation of transistors,

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DATA COMMUNICATIONS (OE)					

UNIT I:
Introduction to Data Communications: Components, Data Representation, Data Flow, Networks-Distributed Processing, Network Criteria, Physical Structures, Network Models, Categories of Networks Interconnection of Networks, The Internet - A Brief History, The Internet Today, Protocol and Standards - Protocols, Standards, Standards Organizations, Internet Standards. Network Models, Layered Tasks, OSI model, Layers in OSI model, TCP/IP Protocol Suite, Addressing Introduction, Wireless Links and Network Characteristics, WiFi: 802.11 Wireless LANs -The 802.11 Architecture,

UNIT II:
Data Link Layer: Links, Access Networks, and LANs- Introduction to the Link Layer, The Services Provided by the Link Layer, Types of errors, Redundancy, Detection vs Correction, Forward error correction Versus Retransmission Error-Detection and Correction Techniques, Parity Checks, Check summing Methods, Cyclic Redundancy Check (CRC) , Framing, Flow Control and Error Control protocols , Noisy less Channels and Noisy Channels, HDLC, Multiple Access Protocols, Random Access ,ALOHA, Controlled access, Channelization Protocols. 802.11 MAC Protocol, IEEE 802.11 Frame.

UNIT III:
The Network Layer: Introduction, Forwarding and Routing, Network Service Models, Virtual Circuit and Datagram Networks-Virtual-Circuit Networks, Datagram Networks, Origins of VC and Datagram Networks, Inside a Router-Input Processing, Switching, Output Processing, Queuing, The Routing Control Plane, The Internet Protocol(IP):Forwarding and Addressing in the Internet-Datagram format, Ipv4 Addressing, Internet Control Message Protocol(ICMP), IPv6

UNIT IV:
Transport Layer: Introduction and Transport Layer Services : Relationship Between Transport and Network Layers, Overview of the Transport Layer in the Internet, Multiplexing and Demultiplexing, Connectionless Transport: UDP -UDP Segment Structure, UDP Checksum, Principles of Reliable Data Transfer-Building a Reliable Data Transfer Protocol, Pipelined Reliable Data Transfer Protocols, Go-Back-N(GBN), Selective Repeat(SR), Connection Oriented Transport: TCP - The TCP Connection, TCP Segment Structure, Round-Trip Time Estimation and Timeout, Reliable Data Transfer, Flow Control, TCP Connection Management, Principles of Congestion Control - The Cause and the Costs of Congestion, Approaches to Congestion Control

UNIT V:
Application Layer: Principles of Networking Applications – Network Application Architectures, Processes Communicating, Transport Services Available to Applications, Transport Services Provided by the File Transfer: FTP,- FTP Commands and Replies, Electronic Mail in the Internet- STMP, Comparison with HTTP, DNS-The Internet's Directory Service – Service Provided by DNS, Overview of How DNS Works, DNS Records and messages.

TEXT BOOKS:

1. Computer Networking A Top-Down Approach – Kurose James F, Keith W, 6thEdition , Pearson,2017.
2. Data Communications and Networking Behrouz A.Forouzan4th Edition McGraw Hill Education,2017.

REFERENCES:

1. Data communication and Networks - Bhusan Trivedi, Oxford university press, 2016
2. Computer Networks -- Andrew S Tanenbaum, 4th Edition, Pearson Education, 2003.
3. Understanding Communications and Networks, 3rd Edition, W.A.Shay, Cengage Learning, 2003.

Course Outcomes:

Upon completing this course, the student will be able to

1. Know the Categories and functions of various Data communication Networks
2. Design and analyze various error detection techniques.
3. Demonstrate the mechanism of routing the data in network layer
4. Know the significance of various Flow control and Congestion control Mechanisms

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DIGITAL LOGIC DESIGN (OE)					

UNIT – I
REVIEW OF NUMBER SYSTEMS & CODES:
Representation of numbers of different radix, conversation from one radix to another radix, r-1's compliments and r's compliments of signed members, Gray code ,4 bit codes; BCD, Excess-3, 2421, 84-2-1 code etc. Error detection & correction codes: parity checking, even parity, odd parity, Hamming code.
BOOLEAN THEOREMS AND LOGIC OPERATIONS:
Boolean theorems, principle of complementation & duality, De-morgan theorems, Logic operations ; Basic logic operations -NOT, OR, AND, Universal Logic operations, EX-OR, EX- NOR operations. Standard SOP and POS Forms, NAND-NAND and NOR-NOR realizations, Realization of three level logic circuits. Study the pin diagram and obtain truth table for the following relevant ICs 7400,7402,7404,7408,7432,7486.

UNIT – II
MINIMIZATION TECHNIQUES:
Minimization and realization of switching functions using Boolean theorems, K-Map (up to 6 variables)and tabular method(Quine-mccluskey method) with only four variables and single function.
COMBINATIONAL LOGIC CIRCUITS DESIGN:
Design of Half adder, full adder, half subtractor, full subtractor, applications of full adders; 4-bit adder-subtractor circuit, BCD adder circuit, Excess 3 adder circuit and carry look-a-head adder circuit, Design code converts using Karnaugh method and draw the complete circuit diagrams.

UNIT – III
COMBINATIONAL LOGIC CIRCUITS DESIGN USING MSI &LSI :
Design of encoder ,decoder, multiplexer and de-multiplexers, Implementation of higher order circuits using lower order circuits . Realization of Boolean functions using decoders and multiplexers, Design of Priority encoder, 4-bit digital comparator and seven segment decoder. . Study the relevant ICs pin diagrams and their functions 7442,7447,7485,74154.
INTRODUCTION OF PLD's :
PLDs: PROM, PAL, PLA -Basics structures, realization of Boolean functions, Programming table.

UNIT – IV
SEQUENTIAL CIRCUITS I:
Classification of sequential circuits (synchronous and asynchronous) , operation of NAND & NOR Latches and flip-flops; truth tables and excitation tables of RS flip-flop, JK flip-flop, T flip-flop, D flip-flop with reset and clear terminals. Conversion from one flip-flop to another flip- flop, Design of 5ripple counters, design of synchronous counters, Johnson counter, ring counter. Design of registers - Buffer register, control buffer register, shift register, bi-directional shift register, universal shift, register, Study the following relevant ICs and their relevant functions 7474,7475,7476,7490,7493,74121.

UNIT – V
SEQUENTIAL CIRCUITS II :
Finite state machine; state diagrams, state tables, reduction of state tables. Analysis of clocked sequential circuits Mealy to Moore conversion and vice-versa, Realization of sequence generator, Design of Clocked Sequential Circuit to detect the given sequence (with overlapping or without overlapping)

TEXT BOOKS:

1. Switching and finite automata theory Zvi.KOHAVI, Niraj.K. Jha 3rdEdition,Cambridge UniversityPress,2009
2. Digital Design by M.Morris Mano, Michael D Ciletti,4th edition PHIpublication,2008
3. Switching theory and logic design by Hill and Peterson**,** Mc-Graw Hill TMH edition, 2012.

REFERENCES:

1. FundamentalsofLogicDesignbyCharlesH.RothJr,JaicoPublishers,2006
2. DigitalelectronicsbyRSSedha.S.Chand&companylimited,2010
3. SwitchingTheoryandLogicDesignbyA.AnandKumar,PHILearningpvtltd,2016.
4. DigitallogicapplicationsanddesignbyJohnMYarbough,Cengagelearning,2006.
5. TTL74-Seriesdatabook.

Course Outcomes:

1. Classify different number systems and apply togenerate various codes.
2. Use the concept of Boolean algebra in minimization of switching functions
3. Design different types of combination allogic circuits.
4. Apply knowledge offlip-flops in designing of Registers and counters
5. The operation and design methodology for synchronous sequential circuits and algorithmic state machines
6. Produce innovative designs by modifying the traditional design techniques

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REMOTE SENSING AND GIS (OE)					

UNIT – I
Introduction to Photogrammetry: Principles& types of aerial photograph, geometry of vertical aerial photograph, Scale & Height measurement on single vertical aerial photograph, Height measurement based on relief displacement, Fundamentals of stereoscopy, fiducial points, parallax measurement using fiducial line.

UNIT – II
Remote Sensing: Basic concept of remote sensing, Data and Information, Remote sensing data Collection, Remote sensing advantages & Limitations, Remote Sensing process. Electro-magnetic Spectrum, Energy interactions with atmosphere and with earth surface features (soil, water, vegetation), Indian Satellites and Sensors characteristics, Resolution, Map and Image and False color composite, introduction to digital data, elements of visual interpretation techniques.

UNIT – III
Geographic Information Systems: Introduction to GIS; Components of a GIS; Geospatial Data: Spatial Data-Attribute data – Joining Spatial and Attribute data; GIS Operations: Spatial Data Input- Attribute data Management –Data display- Data Exploration- Data Analysis. COORDINATE SYSTEMS: Geographic Coordinate System: Approximation of the Earth, Datum; Map Projections: Types of Map Projections-Map projection parameters

UNIT – IV
Vector Data Model: Representation of simple features- Topology and its importance; coverage and its data structure, Shape file; Data models for composite features Object Based Vector Data Model; Classes and their Relationship; The geobase data model; Geometric representation of Spatial Feature and data structure, Topology rules

UNIT – V
Raster Data Model: Elements of the Raster data model, Types of Raster Data, Raster Data Structure, Data Conversion, Integration of Raster and Vector data. Data Input: Metadata, Conversion of Existing data, creating new data; Remote Sensing data, Field data, Text data, Digitizing, Scanning, on screen digitizing, importance of source map, Data Editing

TEXT BOOKS:
1. Remote Sensing and GIS Lillesand and Kiefer, John Willey 2008.
2. Remote Sensing and GIS B. Bhatta by Oxford Publishers 2015.
3. Introduction to Geographic Information System – Kang-Tsung Chang, McGraw-Hill 2015

REFERENCES:

1. Concepts & Techniques of GIS by C. P. Lo Albert, K.W. Yonng, Prentice Hall (India) Publications.
2. Principals of Geo physical Information Systems – Peter A Burragh and Rachael A. Mc Donnell, Oxford Publishers 2004.
3. Basics of Remote sensing & GIS by S. Kumar, Laxmi Publications

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

1. Retrieve the information content of remotely sensed data
2. Analyze the energy interactions in the atmosphere and earth surface features
3. Interpret the images for preparation of thematic maps
4. Apply problem specific remote sensing data for engineering applications
5. Analyze spatial and attribute data for solving spatial problems
6. Create GIS and cartographic outputs for presentation

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BIO MEDICAL INSTRUMENTATION (OE)					

UNIT-I

Sources of Bioelectric potentials and Electrodes: Resisting and Action Potentials, Propagation of Action Potentials, The Bioelectric Potentials. Electrodes: Electrode theory, Bio Potential Electrodes, Biochemical Transducers, introduction to bio-medical signals

UNIT-II

The Cardiovascular System: The Heart and Cardiovascular System, The Heart, Blood Pressure, Characteristics of Blood Flow, Heart Sounds, Cardio Vascular Measurements, Electrocardiography, Measurement of Blood Pressure, Measurement of Blood Flow and Cardiac output, Plethysmography, Measurement of Heart Sounds, Event detection, PQRS & T-Waves in ECG, the first & second Heart beats, ECG rhythm analysis, the di-crotic notch in the carotid pulse detection of events and waves, analysis of exercise ECG, analysis of event related potentials, correlation analysis of EEG channels, correlation of muscular contraction.

UNIT- III

Patient Care & Monitory and Measurements in Respiratory System: The elements of Intensive Care Monitory, Diagnosis, Calibration and reparability of Patient Monitoring equipment, other instrumentation for monitoring patients, pace makers, defibrillators, the physiology of respiratory system, tests and instrumentation for mechanics of breathing, respiratory theory equipment, analysis of respiration.

UNIT-IV

Bio telemetry and Instrumentation for the clinical laboratory Introduction to bio telemetry, Physiological parameters adaptable to bio telemetry, the components of bio telemetry system, implantable units, applications of telemetry in patient care – The blood, tests on blood cells, chemical test, automation of chemical tests.

UNIT-V

X-ray and radioisotope instrumentation and electrical safety of medical equipment:
Generation of Ionizing radiation, instrumentation for diagnostic X-rays, special techniques, instrumentation for the medical use of radioisotopes, radiation therapy - Physiological effects of electrical current, shock Hazards from electrical equipment, Methods of accident prevention, Modern Imaging Systems: Tomography, Magnetic resonance Imaging System, Ultrasonic Imaging System, Medical Thermography

TEXT BOOK:

1. Biomedical Instrumentation and Measurements – C. Cromwell, F.J. Weibell, E.A.Pfeiffer – Pearson education.
2. Biomedical signal analysis – Rangaraj, M. Rangayya – Wiley Inter science – John willey & Sons Inc.

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Reference:

1. Hand Book of Bio-Medical Instrumentation – R.S. Khandpur, (TMH)
2. Introduction to Bio-Medical Engineering – Domach, (Pearson)
3. Introduction to Bio-Medical Equipment Technology – Cart, (Pearson)

Course outcomes:

1. Apply principles and concepts of electronics to analyze input and output signals in medical electronics
2. Apply principles and concepts of electronics to design filters for de-noising of medical measurements
3. Recognize different types of transducers, ongoing progress in improving their design, and their application in medical measurements
4. Apply principles and concepts of engineering to quantify and model measurements of biopotentials
5. Apply principles and concepts of sensing and engineering to (i) design diagnostic devices for detection of markers in biofluids, and (ii) be able to evaluate quality of diagnostic devices
6. Apply engineering tools to evaluate parameters needed for point-of-care health screening and mobile-health, and design of appropriate point-of-care diagnostic devices

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POOL-1 (HONOR)		L	T	P	C
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Data Acquisition Systems

UNIT-1
INTRODUCTION: Objective of a DAS, single channel DAS, Multi-channel DAS, Components used in DAS– Converter Characteristics-Resolution-Non-linearity, settling time, Monotonicity.

UNIT-2
ANALOG TO DIGITAL CONVERTERS (ADCS): Classification of A/D Converters, Parallel feed back – Successive approximation – Ramp comparison – Dual slope integration – Voltage to frequency – Voltage to Time – Logarithmic types of ADCS.
NON-LINEAR DATA CONVERTERS (NDC): Basic NDC configurations – Some common NDACS and NADCS – Programmable non-linear ADCS – NADC using optimal sized ROM – High speed hybrid NADC – PLS based NADC – Switched capacitor NDCS.
ADC APPLICATIONS: Data Acquisition systems – Digital signal processing systems – PCM voice communication systems – Test and measurement instruments – Electronic weighing machines.

UNIT-3
DIGITAL TO ANALOG CONVERTERS (DACS): Principles and design of – Parallel R– 2R, Weighted resistor, inverted ladder, D/A decoding – Codes other than ordinary binary.
DATA CONVERTER APPLICATIONS: DAC applications – Digitally programmable V/I sources – Arbitrary waveform generators – Digitally programmable gain amplifiers – Analog multipliers/ dividers – Analog delay lines.

UNIT-4
Monolithic data converters: typical study of monolithic DACS and ADCS. Interfacing of DACS and ADCS to a μP

UNIT-5
Error budget of DACS and ADCS: Error sources, error reduction and noise reduction Techniques in DAS, Error budget analysis of DAS, case study of a DAC and an ADC

TEXT BOOKS:
1. Electronic data converters fundamentals and applications – Dinesh K. Anvekar, B.S. Sonde – Tata McGraw Hill

REFERENCES:
1. Electronic Analog/ Digital conversions – Hermann Schmid – Tata McGraw Hill.
2. E.R. Hanateck, User's Handbook of D/A and A/D converters – Wiley
3. Electronic instrumentation by HS Kalsi- TMH 2 ndEdition, 2004.
4. Data converters by G.B. Clayton

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Course Outcomes:

1. Be able to identity a data acquisition system.
2. Be able to prescribe a sensor type to measure a specific environmental change.
3. Be able to determine what type of amplifier is needed for a specific sensor output.
4. Be familiar with different forms of signal conditioning.
5. Be familiar with different methods of Analog-to-Digital conversion.
6. Be able to identify the type of interface used to get a digital signal into a microprocessor.

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POOL-1 (HONOR)		L	T	P	C
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ADAPTIVE CONTROL SYSTEMS					

Unit-1:
Introduction: Definitions, History of adaptive Control, Essential aspects of adaptive control, Classification of adaptive control system: Feedback adaptive controllers, Feed forward adaptive controllers, Why adaptive control?

Unit-2:
Model Reference Adaptive System: Different configuration of model reference adaptive Systems, classification of MRAS, Mathematical description, and Equivalent representation as a nonlinear time-varying system, direct and indirect MRAS.

Unit-3:
Analysis and Design of Model Reference Adaptive Systems: Model reference control with local parametric optimization (Gradient method), MIT rule, MRAS for a first order system, MRAS based on Lyapunov stability theory, Design of a first order MRAS based on stability theory, Hyperstability approach, Monopoli's augmented error approach.

Unit-4:
Self Tuning Regulators: Introduction: The basic idea; process models, disturbance models, General linear difference equation models, model simplification, Different approaches to self-tuning, Recursive Parameter Estimation Methods: The RLS method, extended Least squares, Recursive instrumental variable method; U-D factorization, Covariance resulting, variable data forgetting, Estimation accuracy, Direct and Indirect Self-tuning regulators, Clarke and Gawthrop's Self tuning Controller, Pole Placement approach to self tuning control; Connection between MRAS and STR.

Unit 5:
Gain Scheduling: Introduction, The Principal, Design of Gain Scheduling Regulators, Nonlinear transformations, Applications of gain scheduling Alternatives to Adaptive Control: Why not Adaptive Control? Robust High gain feedback control, Variable Structure schemes, Practical aspects, application and Perspectives on adaptive control.

References Books:

1. B Landau, Adaptive Control - The Model Reference Approach, New York; Marcel Dekker, 1979.
2. K. J. Astrom and B. Wittenmark, Adaptive Control, Addison Wesley Publication Company, 1989.
3. B. Roffel, P. J. Vermeer, P. A. Chin, Simulation and Implementation of self Tuning Controllers, Prentice-Hall, Englewood cliffs, NJ, 1989.
4. R. Isermann, K. Lashmann and D. Marko, Adaptive Control Systems, Printice-Hall International (UK) Ltd. 1992.
5. K. S. Narendra and A. M. Annaswamy, Stable Adaptive Systems

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Course Outcomes:

CO1: Design identifiers and adaptive controllers for linear systems
CO2: Design Adaptive feedback linearizing control systems for nonlinear systems
CO3: Apply the concept of different types of optimal control for solving problems
CO 4 Apply the concept of calculus of variation and principal of optimality for solving problems
CO 5 Apply the concept of Linear Quadratic method for solving problems
CO 6 Apply the concept of adaptive control technique for solving problems

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BIO-MEDICAL INSTRUMENTATION					

UNIT-I

Sources of Bioelectric potentials and Electrodes: Resisting and Action Potentials, Propagation of Action Potentials, The Bioelectric Potentials. Electrodes: Electrode theory, Bio Potential Electrodes, Biochemical Transducers, introduction to bio-medical signals

UNIT-II

The Cardiovascular System: The Heart and Cardiovascular System, The Heart, Blood Pressure, Characteristics of Blood Flow, Heart Sounds, Cardio Vascular Measurements, Electrocardiography, Measurement of Blood Pressure, Measurement of Blood Flow and Cardiac output, Plethysmography, Measurement of Heart Sounds, Event detection, PQRS & T-Waves in ECG, the first & second Heart beats, ECG rhythm analysis, the di-crotic notch in the carotid pulse detection of events and waves, analysis of exercise ECG, analysis of event related Potentials, correlation analysis of EEG channels, correlation of muscular contraction.

UNIT- III

Patient Care & Monitory and Measurements in Respiratory System: The elements of Intensive Care Monitory, Diagnosis, Calibration and reparability of Patient Monitoring equipment, other instrumentation for monitoring patients, pace makers, defibrillators, the physiology of respiratory system, tests and instrumentation for mechanics of breathing, respiratory theory equipment, analysis of respiration.

UNIT-IV

Bio telemetry and Instrumentation for the clinical laboratory Introduction to bio telemetry, Physiological parameters adaptable to bio telemetry, the components of bio telemetry system, implantable units, applications of telemetry in patient care – The blood, tests on blood cells, chemical test, automation of chemical tests.

UNIT-V

X-ray and radioisotope instrumentation and electrical safety of medical equipment: Generation of Ionizing radiation, instrumentation for diagnostic X-rays, special techniques, instrumentation for the medical use of radioisotopes, radiation therapy - Physiological effects of electrical current, shock Hazards from electrical equipment, Methods of accident prevention, Modern Imaging Systems: Tomography, Magnetic resonance Imaging System, Ultrasonic Imaging System, Medical Thermography

TEXT BOOK:

1. Biomedical Instrumentation and Measurements – C. Cromwell, F.J. Weibell, E.A.Pfeiffer – Pearson education.
2. Biomedical signal analysis – Rangaraj, M. Rangayya – Wiley Inter science – John Willey & Sons Inc.

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Reference:

1. Hand Book of Bio-Medical Instrumentation – R.S. Khandpur, (TMH)
2. Introduction to Bio-Medical Engineering – Domach, (Pearson)
3. Introduction to Bio-Medical Equipment Technology – Cart, (Pearson)

Course outcomes:

1. Apply principles and concepts of electronics to analyze input and output signals in medical electronics
2. Apply principles and concepts of electronics to design filters for de-noising of medical measurements
3. Recognize different types of transducers, ongoing progress in improving their design, and their application in medical measurements
4. Apply principles and concepts of engineering to quantify and model measurements of bio potentials
5. Apply principles and concepts of sensing and engineering to (i) design diagnostic devices for detection of markers in bio fluids, and (ii) be able to evaluate quality of diagnostic devices
6. Apply engineering tools to evaluate parameters needed for point-of-care health screening and mobile-health, and design of appropriate point-of-care diagnostic devices

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POOL-1 (HONOR)		L	T	P	C
		3	1	0	4
DIGITAL CONTROL SYSTEMS					

UNIT –I:
Sampling and Reconstruction: Introduction, sample and hold operations, Sampling theorem, Reconstruction of original sampled signal to continuous-time signal.
The Z – Transforms: Introduction, Linear difference equations, pulse response, Z – transforms, Theorems of Z –Transforms, the inverse Z – transforms, Modified Z- Transforms.
Z-Plane Analysis of Discrete-Time Control System: Z-Transform method for solving difference equations; Pulse transforms function, block diagram analysis of sampled – data systems, mapping between s-plane and z-plane: Primary strips and Complementary Strips.

UNIT –II:
State Space Analysis: State Space Representation of discrete time systems, Pulse Transfer Function Matrix solving discrete time state space equations, State transition matrix and its Properties, Methods for Computation of State Transition Matrix, Discretization of continuous time state – space equations

UNIT –III:
Controllability and Observability: Concepts of Controllability and Observability, Tests for controllability and Observability, Duality between Controllability and Observability, Controllability and Observability conditions for Pulse Transfer Function.
Stability Analysis: Stability Analysis of closed loop systems in the Z-Plane, Jury stablility test – Stability Analysis by use of the Bilinear Transformation and Routh Stability criterion, Stability analysis using Liapunov theorems.

UNIT –IV:
Design of Discrete Time Control System by Conventional Methods: Design of digital control based on the frequency response method – Bilinear Transformation and Design procedure in the W-plane, Lead, Lag and Lead-Lag compensators and digital PID controllers. Design digital control through deadbeat response method.

UNIT –V:
State Feedback Controllers and Observers: Design of state feedback controller through pole placement – Necessary and sufficient conditions, Ackerman's formula, State Observers – Full order and Reduced order observers. Introduction to Kalman filters, State estimation through Kalman filters, introduction to adaptive controls.

TEXT BOOKS:
1. K. Ogata - "Discrete-Time Control systems" - Pearson Education/PHI, 2nd Edition.
2. M.Gopal - "Digital Control and State Variable Methods"- TMH

REFERENCE BOOKS:
1. Kuo - "Digital Control Systems"- Oxford University Press, 2nd Edition, 2003.
2. M. Gopal - "Digital Control Engineering".

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Course outcomes:

1. Design a pure, two-pole system that satisfies specified performance specifications like percent overshoot, peak time, settling time, and DC gain.
2. Calculate the z-plane location of a pair of dominant poles given time-domain performance information like percent overshoot, settling time, and peak time.
3. Create discrete equivalents from given continuous-time systems,
4. Able to Construct a discrete-time difference equation containing input variables and output variables at particular time instances from a system's discrete-time transfer function.
5. Numerically compute the value of any system variable (e.g., state variable or output variable) at any discrete, time instant given initial conditions and input waveforms.

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POOL-1 (HONOR)		L	T	P	C
		3	1	0	4
PROCESS CONTROL INSTRUMENTATION					

UNIT-1
P & ID symbols. Process characteristics: Process load, Process lag, self-regulation. Control system parameters: control lag, dead time, cycling. Discontinuous controller modes: two position, multi position, floating control modes. Continuous controller modes: Mathematical representation and description of P, I, D controller modes. Composite control modes: Mathematical representation and description of PI, PD, PID control modes. Response of control modes to linear, step and square wave error signals.

UNIT-2
Electronic Controller mode implementation: Designing of P, PI, PD, PID using OP amplifiers.

UNIT-3
Pneumatic controller mode implementation: Implementation of P, PI, PD, PID using flapper – nozzle system.

UNIT-4
Final control: Actuators – Electrical & Pneumatic. Control Valves – Quick opening, linear and equal percentage control valves, valve sizing. I to P, P to I converters

UNIT-5
Programmable controllers & Digital Controllers:
Programmable controllers: Ladder Diagram, Programmable controller program from the ladder diagram of simple applications. Digital Controllers**:** Data logging, supervisory control, computer based controller.

Text Book:
1. Process control Instrumentation Technology by Curtis Johnson, 4 th Edition – PHI, Dec, 2000.

Reference Books:
1. Principles of Process control by D. Patranabis- TMH 2 nd Edition, 1996
2. P. Harriott, process control, Tata MoGraw – Hill publishing Co., Ltd., New Delhi, 1984.

Course Outcomes:
- Understand the popular process automation technologies.
- Design and development of different PLC programming for simple process applications.
- Understand the different security design approaches, Engineering and operator interface issues for designing Distributed control system.
- Know the latest communication technologies like HART and Field bus protocol. Mapping of Course Outcome with Programme Outcomes:

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POOL-1 (HONOR)		L	T	P	C
		3	1	0	4
TRANSDUCERS AND SENSORS					

Unit – 1
Introduction: functional elements of an instrument, generalized performance characteristics of instruments – static characteristics, dynamic characteristics.
Zero order, first order, second order instruments – step response, ramp response and impulse response. Response of general form of instruments to periodic input and to transient input Experimental determination of measurement system parameters, loading effects under dynamic conditions

Unit – 2
Transducers for motion and dimensional measurements: Relative displacement, translation and rotational resistive potentiometers, resistance strain guages, LVDT, synchros, capacitance ickups, Piezo-electric transducers, electro-optical devices, nozzle – flapper transducers, digital displacement transducers, ultrasonic transducers.
Magnetic and photoelectric pulse counting methods, relative acceleration measurements, seismic acceleration pickups, calibration of vibration pickups. Gyroscopic sensors

Unit – 3
TRANSDUCERS FOR FORCE MEASUREMENT: Bonded strain guage transducers, Photo-electric transducers, variable reluctance pickup, torque measurement dynamometers.
TRANSDUCERS FOR FLOW MEASUREMENT: Hot wire and hot-film anemometers, Electro-magnetic flow meters, laser Doppler velocimeter
TRANSDUCERS FOR PRESSURE MEASUREMENT: Manometers, elastic transducers, liquid systems, gas systems, very high pressure transducers. Thermal conductivity guages, ionization guages, microphone.

Unit – 4
TRANSDUCERS FOR TEMPERATURE MEASUREMENT: Thermal expansion methods, Thermometers (liquid in glass), pressure thermometers, Thermocouples, Materials configuration and techniques. Resistance thermometers, Thermistors, junction semiconductors, Sensors, Radiation methods, Optical pyrometers, Dynamic response of temperature sensors heat flux Sensors, Transducers for liquid level measurement, humidity, silicon and quartz sensors, fiber optic sensors.

Unit –5
Smart sensors: Introduction, primary sensors, converters, compensation. Recent trends in sensor technology – film sensors, semi conductor IC technology, MEMS, Nano-sensors.

Text Book:
1. Doebelin, E.O., “Measurement systems – Application and Design”, McGraw Hill.
2. D. Patranabis, “Sensors and Transducers”, PHI, 2nd Edition.

Reference:
1. Instrumentation Measurement & Analysis, by B.C. Nakra, K.K. Choudry, (TMH)
2. Transducers and Instrumentation, by D.V.S. Murthy (PHI)

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Course Outcomes:

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

1. Use concepts in common methods for converting a physical parameter into an electrical quantity
2. Classify and explain with examples of transducers, including those for measurement of temperature, strain, motion, position and light
3. Choose proper sensor comparing different standards and guidelines to make sensitive measurements of physical parameters like pressure, flow, acceleration, etc
4. Predict correctly the expected performance of various sensors
5. Locate different type of sensors used in real life applications and paraphrase their importance
6. Set up testing strategies to evaluate performance characteristics of different types of sensors and transducers
7. develop professional skills in acquiring and applying the knowledge outside the classroom through design of a real-life instrumentation system.

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POOL-1 (HONOR)		L	T	P	C
		3	1	0	4
MEMS					

UNIT I: Overview of MEMS and Microsystems: MEMS and Microsystems, Typical MEMS and Micro-system products, Evolution of Micro-fabrication, Micro-system and Microelectronics, The Multidisciplinary nature of micro-system design and manufacture, Micro-system and Miniaturization. Application of Microsystems in the automotive industry, Application of Microsystems in other industries: Health care industry, Aerospace industry, Industrial products, Consumer products, Telecommunications. Markets for Microsystems

UNIT II: Working Principles of Microsystems: Introduction, Micro-sensors: Acoustic Wave Sensors, Biomedical sensors and Biosensors, Chemical sensors, Pressure sensors, Thermal sensors. Micro actuation: Actuation using thermal forces, shaped memory alloys, Piezoelectric crystals, Electrostatic forces. MEMS with Micro actuators: Micro-grippers, Micro-motors, Micro-valves, Micro-pumps, Micro accelerators, Micro-fluidics.

UNIT III: Scaling Laws in Miniaturization: Introduction to scaling, Scaling in Geometry, Scaling in Rigid-Body Dynamics, Scaling in Electrostatic Forces, Scaling in Electromagnetic Forces, Scaling in Electricity, Scaling in Fluid Mechanics, Scaling in Heat Transfer.
Materials for MEMS and Microsystems: Introduction, Substrates and wafers, Active substrate materials, Silicon as a substrate material. Silicon compounds, Silicon piezo resistors, Gallium Arsenide, Quartz, Piezoelectric crystals, Polymers, Packing materials.
UNIT IV: Micro system Fabrication Process: Photolithography, Ion Implantation, Diffusion, Oxidation, Chemical Vapour Deposition, Physical Vapour Deposition, Deposition by Epitaxy, Etching. Overview of Micro manufacturing and Applications: Bulk Micro manufacturing- any one example of application, Surface Micromachining- any one example of application. LIGA Process- any one example of application

UNIT V: Applications of MEMS-Switching: Introduction, Switch parameters, Basics of switching, Mechanical switches, Electronic switches for RF and microwave applications, Mechanical RF switches, PIN diode RF switches.

Text Books:

1. Tai-Ran Hsu, “MEMS and Microsystems: Design and Manufacture”, Tata McGraw Hill, (2002).
2. Gabriel M. Rebeiz, “RF MEMS Theory, Design and Technology”, Wiley India Pvt Ltd.

Reference Books:

1. Stephen D. Senturia, “Microsystem Design”, Springer International Edition, (2010).
2. Mohamed Gad-el-Hak, “The MEMS Handbook”, CRC Press,(2002).
3. Chang Liu, “Foundations of MEMS”, Second Edition, Pearson Publication.

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Course Outcomes:

1. Understand the basic overview of MEMS and Microsystems with broad category of MEMS& Micro system applications.
2. Understanding the working principles of Microsystems
3. Understand the Scaling Laws in Miniaturization and Materials for MEMS and Microsystems
4. Understand the Micro system Fabrication Process and Analyze the different Micro manufacturing process and Applications.
5. Study and Analyze the different types of RF switches, Various Switching Mechanism and their applications.

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POOL-1 (HONOR)		L	T	P	C
		3	1	0	4

Intelligent and Smart Instrumentation

UNIT I:
Introduction: Definition of intelligent instrumentation, types of instruments, Static Characteristics: Accuracy and Precision, Error, Correction, and Uncertainty, Repeatability, Reproducibility, and Hysteresis,
Sensitivity, Offset, and Dead Band, Resolution and Linearity, Statistical Characteristics, Error Modeling, Dynamic Characteristics, Dynamic Error and Dynamic Sensitivity, Input-Output Impedances, Historical Perspective, Current status, software based instruments.

UNIT II:
Intelligent Sensors: Classification, Smart sensors , Cogent Sensors, Soft or Virtual sensors, Self-Adaptive Sensors, Self-Validating Sensors, VLSI Sensors, Temperature Compensating Intelligent Sensors, Pressure Sensor,Indirect Sensing

UNIT III:
Linearization, Calibration, and Compensation:
Analog Linearization of Positive and Negative Coefficient Resistive Sensors, Higher-Order Linearization, Nonlinear ADC- and Amplifier-Based Linearization, Interpolation, Piecewise Linearization, Microcontroller-Based Linearization, Artificial Neural Network–Based Linearization, Nonlinear
Adaptive Filter–Based Linearization, Sensor Calibration, Conventional Calibration Circuits, Offset Compensation, Error and Drift Compensation, Lead Wire Compensation

UNIT IV:
Sensors with Artificial Intelligence:
Artificial Intelligence, Sensors with Artificial Intelligence, Multidimensional Intelligent Sensors, AI for Prognostic Instrumentation, ANN-Based Intelligent Sensors, Fuzzy Logic–Based Intelligent Sensors
UNIT V:
Intelligent Sensor Standards and Protocols:
IEEE 1451 Standard, STIM, TEDS, NCAP, Network Technologies, LonTalk, CEBUS, J1850 Bus, 1 Signal Logic and Format, MI Bus, Plug-n-Play Smart Sensor Protocol
Text Books:
1. Manabendra Bhuyan, ―Intelligent Instrumentation: Principles and Applications‖ CRC Press,2011.
2. G. C. Barney, ―Intelligent Instrumentation‖, Prentice Hall, 1995.
3. J.B DIXIT, A. yadav Laxmi Publications, Ltd., 01-Sep-2011

Course Outcomes:
1. To develop the design methodologies for measurement and instrumentation of real world problems.
2. To be study the concepts of intelligent sensor devices, their performance characteristics and signal and system dynamics.
3. To address the issues in dealing signal conditioning operations such as calibration, linearization and compensation
4. To use artificial intelligence in sensor signal processing to solve real world problems
5. To deal with interfacing protocols in wireless networking platform.

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POOL-2 (HONOR)		L	T	P	C
		3	1	0	4
VLSI TECHNOLOGY AND DESIGN					

UNIT 1: MOS Transistors
Introduction, The Structure of MOS Transistors, The Fluid Model, The MOS Capacitor, The MOS Transistor, Modes of Operation of MOS Transistors, Electrical Characteristics of MOS Transistors, Threshold Voltage, Transistor Transconductance g_m, Figure of Merit, Body Effect, Channel-Length Modulation, MOS Transistors as a Switch, Transmission Gate

UNIT 2: MOS Fabrication Technology
Introduction, Basic Fabrication Processes, Wafer Fabrication, Oxidation, Mask Generation, Photolithography, Diffusion, Deposition. N-MOS Fabrication Steps, CMOS Fabrication Steps, n-Well Process, p-Well Process, Twin-Tub Process, Latch-Up Problem and Its Prevention, Use of Guard Rings, Use of Trenches, Short-Channel Effects-Channel Length Modulation Effect. Drain-Induced Barrier Lowering, Channel Punch Through, Hot carrier effect, Velocity Saturation Effect

UNIT 3: Layout Design Rules
Scaling Theory, Scalable CMOS Design Rules, CMOS Process Enhancements, Transistors, Interconnects, Circuit Elements, Efficient layout Design techniques

UNIT 4: Combinational Logic Networks
Layouts for logic networks. Delay through networks. Power optimization.Switch logic networks. Combinational logic testing

UNIT 5: Sequential Systems
Memory cells and Arrays, clocking disciplines, sequential circuit Design, Performance Analysis,Power optimization, Design validation and testing.

Text Books:
1. Principals of CMOS VLSI Design-N.H.EWeste, K. Eshraghian, 2nd Edition, Addison Wesley.
2. CMOS Digital Integrated Circuits Analysis and Design – Sung-Mo Kang, Yusuf Leblebici, TMH, 3rd Ed., 2011.
3. Low-Power VLSI Circuits and Systems, Ajit Pal, SPRINGER PUBLISHERS
4. Modern VLSI Design – Wayne Wolf, 3rd Ed., 1997, Pearson Education.

Reference Books:
1. Digital Integrated Circuit Design – Ken Martin, Oxford University Press, 2011.
2. Digital Integrated Circuits – A Design Perspective, Jan M. Rabaey, Anantha Chandrakasan, BorivojeNikolic, 2nd Ed., PHI.

Course outcomes
At the end of the course the student able to
1. Understand the basics of MOS transistors and also the characteristics of MOS transistors.
2. Learn about the MOS fabrication process and short channel effects.
3. Learn about the basic rules in layout designing.
4. Analyse various combinational logic networks and sequential systems.

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POOL-2 (HONOR)		L	T	P	C
		3	1	0	4
CMOS ANALOG IC DESIGN					

UNIT -I
Basic MOS Device Physics – General Considerations, MOS I/V Characteristics, Second Order effects, MOS Device models. Short Channel Effects and Device Models. Single Stage Amplifiers –Basic Concepts, Common Source Stage, Source Follower, Common Gate Stage, Cascode Stage

UNIT -II:
Differential Amplifiers – Single Ended and Differential Operation, Basic Differential Pair, Common Mode Response, Differential Pair with MOS loads, Gilbert Cell. Passive and Active Current Mirrors– Basic Current Mirrors, Cascode Current Mirrors, Active Current Mirrors.

UNIT -III:
Frequency Response of Amplifiers – General Considerations, Common Source Stage, Source Followers, Common Gate Stage, Cascode Stage, Differential Pair. Noise – Types of Noise, Representation of Noise in circuits, Noise in single stage amplifiers, Noise in Differential Pairs.

UNIT -IV:
Feedback Amplifiers – General Considerations, Feedback Topologies, Effect of Loading. Operational Amplifiers – General Considerations, One Stage Op Amps, Two Stage Op Amps, Gain Boosting, Common – Mode Feedback, Input Range limitations, Slew Rate, Power Supply Rejection, Noise in Op Amps. Stability and Frequency Compensation.

UNIT -V:
Characterization of Comparator, Two-Stage, Open-Loop Comparators, Other Open-Loop Comparators, Improving the Performance of Open-Loop Comparators, Discrete-Time Comparators.

Text Books:

1. B.Razavi, “Design of Analog CMOS Integrated Circuits”, 2nd Edition, McGraw Hill Edition2016.
2. Paul. R.Gray&Robert G. Meyer, “Analysis and Design of Analog Integrated Circuits”, Wiley, 5th Edition, 2009.

Reference Books:

1. T. C. Carusone, D. A. Johns & K. Martin, “Analog Integrated Circuit Design”, 2nd Edition, Wiley, 2012.
2. P.E.Allen &D.R. Holberg, “CMOS Analog Circuit Design”, 3rd Edition, Oxford University Press, 2011.
3. R. Jacob Baker, “CMOS Circuit Design, Layout, and Simulation”, 3rd Edition, Wiley, 2010.
4. Recent literature in Analog IC Design.

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Course Outcomes:

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

1. Design MOSFET based analog integrated circuits.
2. Analyze analog circuits at least to the first order.
3. Appreciate the trade-offs involved in analog integrated circuit design.
4. Understand and appreciate the importance of noise and distortion in analog circuits.

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POOL-2 (HONOR)		L	T	P	C
		3	1	0	4
CMOS DIGITAL IC DESIGN					

UNIT-I: MOS Design
Pseudo NMOS Logic – Inverter, Inverter threshold voltage, Output high voltage, Output Low voltage, Gain at gate threshold voltage, Transient response, Rise time, Fall time, Pseudo NMOS logic gates, Transistor equivalency, CMOS Inverter logic.

UNIT-II: Combinational MOS Logic Circuits:
MOS logic circuits with NMOS loads, Primitive CMOS logic gates – NOR & NAND gate, Complex Logic circuits design – Realizing Boolean expressions using NMOS gates and CMOS gates, AOI and OAI gates, CMOS full adder, CMOS transmission gates, Designing with Transmission gates.

UNIT-III: Sequential MOS Logic Circuits
Behaviour of bistable elements, SR Latch, Clocked latch and flip flop circuits, CMOS D latch and edge triggered flip-flop.

UNIT-IV: Dynamic Logic Circuits
Basic principle, Voltage Bootstrapping, Synchronous dynamic pass transistor circuits, Dynamic CMOS transmission gate logic, High performance Dynamic CMOS circuits.

UNIT-V: Semiconductor Memories
Types, RAM array organization, DRAM – Types, Operation, Leakage currents in DRAM cell and refresh operation, SRAM operation Leakage currents in SRAM cells, Flash Memory-NOR flash and NAND flash.

Text Books:
1. Digital Integrated Circuit Design – Ken Martin, Oxford University Press, 2011.
2. CMOS Digital Integrated Circuits Analysis and Design – Sung-Mo Kang, Yusuf Leblebici, TMH, 3rd Ed., 2011.

Reference Books:
1. Introduction to VLSI Systems: A Logic, Circuit and System Perspective – Ming-BO Lin, CRC Press, 2011
2. Digital Integrated Circuits – A Design Perspective, Jan M. Rabaey, Anantha Chandrakasan Borivoje Nikolic, 2nd Ed., PHI.

Course Outcomes:
At the end of the course, students will be able to:
1. Demonstrate advanced knowledge in Static and dynamic characteristics of CMOS, Alternative CMOS Logics, Estimation of Delay and Power, Adders Design.
2. Classify different semiconductor memories.
3. Analyze, design and implement combinational and sequential MOS logic circuits.
4. Analyze complex engineering problems critically in the domain of digital IC design for conducting research.
5. Solve engineering problems for feasible and optimal solutions in the core area of digital ICs.

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POOL-2 (HONOR)		L	T	P	C
		3	1	0	4
DESIGN OF TESTABILITY					

UNIT-I: Introduction to Testing
Testing Philosophy, Role of Testing, Digital and Analog VLSI Testing, VLSI Technology Trends affecting Testing, Types of Testing, Fault Modeling: Defects, Errors and Faults, Functional Versus Structural Testing, Levels of Fault Models, Single Stuck-at Fault.

UNIT-II: Logic and Fault Simulation
Simulation for Design Verification and Test Evaluation, Modeling Circuits for Simulation, Algorithms for True-value Simulation, Algorithms for Fault Simulation

UNIT -III: Testability Measures
SCOAP Controllability and Observability, High Level Testability Measures, Digital DFT and Scan Design: Ad-Hoc DFT Methods, Scan Design, Partial-Scan Design, Variations of Scan.

UNIT-IV: Built-In Self-Test
The Economic Case for BIST, Random Logic BIST: Definitions, BIST Process, Pattern Generation, Response Compaction, Built-In Logic Block Observers, Test-Per-Clock, Test-Per- Scan BIST Systems, Circular Self Test Path System, Memory BIST, Delay Fault BIST.

UNIT-V: Boundary Scan Standard
Motivation, System Configuration with Boundary Scan: TAP Controller and Port, Boundary Scan Test Instructions, Pin Constraints of the Standard, Boundary Scan Description Language: BDSL Description Components, Pin Descriptions.

TEXT BOOKS:
1. Essentials of Electronic Testing for Digital, Memory and Mixed Signal VLSI Circuits - M.L. Bushnell, V. D. Agrawal, Kluwer Academic Publishers.

REFERENCE BOOKS:
1. Digital Systems and Testable Design - M. Abramovici, M.A.Breuer and A.D Friedman, Jaico Publishing House.
2. Digital Circuits Testing and Testability - P.K. Lala, Academic Press.

Course Outcome:
Students are able to
1. apply the concepts in testing which can help them design a better yield in IC design.
2. tackle the problems associated with testing of semiconductor circuits at earlier design levels so as to significantly reduce the testing costs.
3. analyse the various test generation methods for static & dynamic CMOS circuits.
4. identify the design for testability methods for combinational & sequential CMOS circuits.
5. recognize the BIST techniques for improving testability.

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POOL-2 (HONOR)		L	T	P	C
		3	1	0	4
SYSTEM ON CHIP					

Unit 1:
ASIC: Overview of ASIC types, design strategies, CISC, RISC and NISC approaches for SOC architectural issues and its impact on SoC design methodologies, Application Specific Instruction Processor (ASIP) concepts.

Unit 2:
NISC:NISC Control Words methodology, NISC Applications and Advantages, Architecture Description Languages (ADL) for design and verification of Application Specific Instruction set Processors (ASIP), No-Instruction-Set-computer (NISC)- design flow, modeling NISC architectures and systems, use of Generic Netlist Representation - A formal language for specification, compilation and synthesis of embedded processors.

Unit 3:
Simulation: Different simulation modes, behavioral, functional, static timing, gate level, switch level, transistor/circuit simulation, design of verification vectors, Low power FPGA, Reconfigurable systems, SoC related modeling of data path design and control logic, Minimization of interconnects impact, clock tree design issues.

Unit 4:
Low power SoC design / Digital system: Design synergy, Low power system perspective-power gating, clock gating, adaptive voltage scaling (AVS), Static voltage scaling, Dynamic clock frequency and voltage scaling (DCFS),building block optimization, building block memory, power down techniques, power consumption verification.

Unit 5:
Synthesis: Role and Concept of graph theory and its relevance to synthesizable constructs, Walks, trails paths, connectivity, components, mapping/visualization, nodal and admittance graph. Technology independent and technology dependent approaches for synthesis, optimization constraints, Synthesis report analysis Single core and Multi core systems, dark silicon issues, HDL coding techniques for minimization of power consumption, Fault tolerant designs

Text Books:

1. Hubert Kaeslin, “Digital Integrated Circuit Design: From VLSI Architectures to CMOS
2. Fabrication”, Cambridge University Press, 2008.
3. B. Al Hashimi, “System on chip-Next generation electronics”, The IET, 2006

Reference Books:

1. Rochit Rajsuman, “System-on- a-chip: Design and test”, Advantest America R & D Center,2000
2. P Mishra and N Dutt, “Processor Description Languages”, Morgan Kaufmann, 2008
3. Michael J. Flynn and Wayne Luk, “Computer System Design: System-on-Chip”.

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Course Outcomes: At the end of the course, students will be able to:

1. Identify and formulate a given problem in the framework of SoC based design approaches Design SoC based system for engineering applications
2. Realize impact of SoC on electronic design philosophy and Macro-electronics thereby incline towards entrepreneurship & skill development.

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POOL-2 (HONOR)		L	T	P	C
		3	1	0	4
PROGRAMMABLE LOGIC DEVICES AND ASIC					

Unit I:
INTRODUCTION TO ASICS, CMOS LOGIC, ASIC LIBRARY DESIGN: Types of ASICs - Design flow – CMOS transistors- CMOS Design rules –Combinational logic Cell Sequential logic cell - Transistor as Resistors - Transistor parasitic capacitance – Logical effort - Library cell design – Library architecture.

Unit II:
PROGRAMMABLE ASICS, PROGRAMMABLE ASIC LOGIC CELLS AND PROGRAMMABLE ASIC I/O CELLS: Anti fuse - Static RAM - EPROM and EEPROM technology - PREP benchmarks - Actel ACT - Xilinx LCA – Altera FLEX - Altera MAX DC & AC inputs and outputs - Xilinx I/O blocks.

Unit III:
PROGRAMMABLE ASIC INTERCONNECT, PROGRAMMABLE ASIC 09 DESIGN SOFTWARE AND LOW LEVEL DESIGN: Entry: Actel ACT -Xilinx LCA - Xilinx EPLD - Altera MAX 5000 and 7000 - Altera MAX 9000 - Altera FLEX – Design systems - Logic Synthesis - Half gate ASIC -Low level design language - PLA tools EDIF- CFI design representation.

Unit IV:
SILICON ON CHIP DESIGN: Voice over IP SOC - Intellectual Property – SOC Design challenges- Methodology and design-FPGA to ASIC conversion – Design for integration-SOC verification-Set top box SOC.

Unit V:
PHYSICAL AND LOW POWER DESIGN: Over view of physical design flow- tips and guideline for physical design- modern physical design techniques- power dissipation-low power design techniques and methodologies-low power design tools- tips and guideline for low power design.

Text book:

1. M.J.S. Smith, ―Application Specific Integrated Circuits‖, Pearson Education, 2008
2. Wayne Wolf, ―FPGA-Based System Design‖, Prentice Hall PTR, 2009.
3. Farzad Nekoogar and Faranak Nekoogar, ―From ASICs to SOCs: A Practical Approach‖, Prentice Hall PTR, 2003.

Course Outcomes: At the end of the course, students will be able to
1. Recognize need for programmable devices
2. Describe architecture of programmable devices.
3. Explain programmable methodologies.
4. Recall IC fabrication techniques vis-à-vis CMOS switch
5. Relate design and implementation flow for PLDs
6. low power design techniques and methodologies

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POOL-2 (HONOR)		L	T	P	C
		3	1	0	4

SCRIPTING LANGUAGE

UNIT-I:
Introduction to Scripts and Scripting: Basics of Linux, Origin of Scripting languages, scripting today, Characteristics and uses of scripting languages.
PERL: Introduction to PERL, Names and values, Variables and assignment, Scalar expressions, Control structures, Built-in functions, Collections of Data, working with arrays, Lists and hashes,
Simple input and output, Strings, Patterns and regular expressions, Subroutines, Scripts with arguments

UNIT-II:
Advanced PERL: Finer points of Looping, Subroutines, Using Pack and Unpack, working with files, Type globs, Eval, References, Data structures, Packages, Libraries and modules, Objects, Objects and modules in action, tied variables, interfacing to the operating systems, Security issues

UNIT-III:
TCL: The TCL phenomena, Philosophy, Structure, Syntax, Parser, Variables and data in TCL, Control flow, Data structures, Simple input/output, Procedures, Working with Strings, Patterns, Files and Pipes, Example code.

UNIT-IV:
Advanced TCL: The eval, source, exec and up-level commands, Libraries and packages, Namespaces, trapping errors, Event-driven programs, Making applications 'Internet-aware',' Nuts-and-bolts' internet programming, Security issues, TCL and TK integration.

UNIT-V:
PYTHON: Introduction to PYTHON language, PYTHON-syntax, statements, functions, Built-in functions and Methods, Modules in PYTHON, Exception Handling.

Text Books:
1. The World of Scripting Languages- David Barron, Wiley Student Edition, 2010.
2. PYTHON Web Programming, Steve Holden and David Beazley, New Riders Publications

References:
1. TCL/TK: A Developer's Guide- ClifFlynt, 2003, Morgan Kaufmann Series.
2. Core PYTHON Programming, Chun, Pearson Education, 2006.
3. Learning Perl, Randal L. Schwartz, O' Reilly publications 6th edition 2011.
4. Linux: The Complete Reference", Richard Peterson McGraw Hill Publications, 6th Edition, 2008.

Course Outcomes:
At the end of this course, the student will be able to:
1. Gain fluency in programming with scripting languages
2. Create and run scripts using PERL/TCL/PYTHON in CAD Tools
3. Demonstrate the use of PERL/PYTHON/ TCL in developing system and web applications

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POOL-2 (HONOR)		L	T	P	C
		3	1	0	4
LOW POWER VLSI DESIGN					

UNIT-I: Sources of Power Dissipation
Introduction, Short-Circuit Power Dissipation, Switching Power Dissipation, Dynamic Power for a Complex Gate, Reduced Voltage Swing, Switching Activity, Leakage Power Dissipation, p–n Junction Reverse-Biased Current, Band-to-Band Tunneling Current, Subthreshold Leakage Current, Short-Channel Effects

UNIT 2: Supply Voltage Scaling for Low Power
Device Feature Size Scaling, Constant-Field Scaling, Constant-Voltage Scaling, Architectural-Level Approaches: Parallelism for Low Power, Pipelining for Low Power, Combining Parallelism with Pipelining, Voltage Scaling Using High-Level Transformations: Multilevel Voltage Scaling Challenges in MVS Voltage Scaling Interfaces, Static Timing Analysis Dynamic Voltage and Frequency Scaling

UNIT-3: Switched Capacitance Minimization
Probabilistic Power Analysis: Random logic signals, probability and frequency, probabilistic power analysis techniques, signal entropy, Bus Encoding: Gray Coding, One-Hot Coding, Bus-Inversion, T0 Coding, Clock Gating, Gated-Clock FSMs FSM State Encoding, FSM Partitioning, Precomputation, Glitching Power Minimization

UNIT 4: Leakage Power Minimization
Fabrication of Multiple Threshold Voltages, Multiple Channel Doping, Multiple Oxide CMOS, Multiple Channel Length, Multiple Body Bias, VTCMOS Approach, MTCMOS Approach, Power Gating, Clock Gating Versus Power Gating, Power-Gating Issues, Isolation Strategy, State Retention Strategy, Power-Gating Controller, Power Management, Combining DVFS and Power Management

UNIT 5: Low power clock distribution & Simulation Power Analysis
Low power clock distribution: Power dissipation in clock distribution, single driver versus distributed buffers, Zero skew versus tolerable skew, chip and package co design for clock network.
Simulation Power Analysis: SPICE circuit simulators, gate level logic simulation, capacitive power estimation, architecture level analysis, data correlation analysis of DSP systems, Monte Carlo Simulation

Text Books:
1. Low-Power VLSI Circuits and Systems, Ajit Pal, SPRINGER PUBLISHERS
2. Practical Low Power Digital Vlsi Design , Gary Yeap Motorola, Springer Science Business Media, LLC.

Reference Books:
1. Low Power CMOS Design – Anantha Chandrakasan, IEEE Press/Wiley International, 1998. 2
2. Massoud Pedram, Jan M. Rabaey , “Low power design methodologies “, Kluwer Academic Publishers.

3. Low Power CMOS VLSI Circuit Design – A. Bellamour, M. I. Elamasri, Kluwer Academic Press, 1995.

Course Outcomes:

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

1. Identify the sources of power dissipation in digital IC systems & understand the impact of power on system performance and reliability.
2. Characterize and model power consumption & understand the basic analysis methods.
3. Understand leakage sources and reduction techniques.

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POOL-3 (HONOR)		L	T	P	C
		3	1	0	4
WIRELESS SENSOR NETWORKS					

Unit I
Introduction and overview of sensor network architecture and its applications, sensor network comparison with Ad Hoc Networks, Sensor node architecture with hardware and software details.

Unit II
Hardware: Examples like mica2, micaZ, telosB, cricket, Imote2, tmote, btnode, and Sun SPOT, Software (Operating Systems): tiny OS, MANTIS, Contiki, and RetOS.

Unit III
Programming tools: C, nesC. Performance comparison of wireless sensor networks simulation and experimental platforms like open source (ns-2) and commercial (QualNet, Opnet)

Unit IV
Overview of sensor network protocols (details of atleast 2 important protocol per layer): Physical, MAC and routing/ Network layer protocols, node discovery protocols, multi-hop and cluster based protocols, Fundamentals of 802.15.4, Bluetooth, BLE (Bluetooth low energy), UWB.

Unit V
Data dissemination and processing; differences compared with other database management systems, data storage; query processing. Specialized features: Energy preservation and efficiency; security challenges; fault- tolerance, Issues related to Localization, connectivity and topology, Sensor deployment mechanisms; coverage issues; sensor Web; sensor Grid, Open issues for future research, and Enabling technologies in wireless sensor network.

TEXT BOOKS:
1. H. Karl and A. Willig, “Protocols and Architectures for Wireless Sensor Networks”, John Wiley & Sons, India,2012.
2. C. S. Raghavendra, K. M. Sivalingam, and T. Znati, Editors, “Wireless Sensor Networks”, Springer Verlag, 1st Indian reprint,2010.

REFERENCES:
1. F. Zhao and L. Guibas, “Wireless Sensor Networks: An Information Processing Approach”, Morgan Kaufmann, 1st Indian reprint,2013.
2. YingshuLi, MyT. Thai, Weili Wu, “Wireless sensor Network and Applications”, Springer series on signals and communication technology,2008.

Course Outcomes:
At the end of this course, students will be able to
1. Design wireless sensor network system for different applications under consideration.
2. Understand the hardware details of different types of sensors and select right type of sensor for various applications.
3. Understand radio standards and communication protocols to be used for wireless sensor network based systems and application.
4. Use operating systems and programming languages for wireless sensor nodes, performance of wireless sensor networks systems and platforms.
5. Handle special issues related to sensors like energy conservation and security challenges

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POOL-3 (HONOR)		L	T	P	C
		3	1	0	4
SOFTWARE DEFINED RADIO					

UNIT -I:
Introduction: The Need for Software Radios, What is Software Radio, Characteristics and benefits of software radio- Design Principles of Software Radio, RF Implementation issues- The Purpose of RF Front – End, Dynamic Range- The Principal Challenge of Receiver Design – RF Receiver Front- End Topologies- Enhanced Flexibility of the RF Chain with Software Radios- Importance of the Components to Overall Performance- Transmitter Architectures and Their Issues- Noise and Distortion in the RF Chain, ADC and DAC Distortion.

UNIT -II:
Multi Rate Signal Processing: Introduction- Sample Rate Conversion Principles- Polyphase Filters Digital Filter Banks- Timing Recovery in Digital Receivers Using Multirate Digital Filters.
Digital Generation of Signals: Introduction- Comparison of Direct Digital Synthesis with Analog Signal Synthesis- Approaches to Direct Digital Synthesis- Analysis of Spurious Signals- Spurious Components due to Periodic jitter- Band Pass Signal Generation- Performance of Direct Digital Synthesis Systems- Hybrid DDS-PLL Systems- Applications of direct Digital Synthesis- Generation of Random Sequences- ROM Compression Techniques.

UNIT -III:
Analog to Digital and Digital to Analog Conversion: Parameters of ideal data converters- Parameters of Practical data converters- Analog to Digital and Digital to Analog Conversion- Techniques to improve data converter performance- Common ADC and DAC architectures.

UNIT -IV:
Digital Hardware Choices: Introduction- Key Hardware Elements- DSP Processors- Field Programmable Gate Arrays- Trade-Offs in Using DSPs, FPGAs, and ASICs- Power Management Issues Using a Combination of DSPs, FPGAs, and ASICs.
UNIT -V:
Object – Oriented Representation of Radios and Network Resources: Networks- Object Oriented Programming- Object Brokers- Mobile Application Environments- Joint Tactical Radio System. Case Studies in Software Radio Design: Introduction and Historical Perspective, SPEAK easy- JTRS, Wireless Information Transfer System, SDR-3000 Digital Transceiver Subsystem, Spectrum Ware, CHARIOT

TEXT BOOKS:
1. Software Radio: A Modern Approach to Radio Engineering - Jeffrey H. Reed, 2002, PEA Publication.
2. Software Defined Radio: Enabling Technologies- Walter Tuttle Bee, 2002, Wiley Publications.

REFERENCE BOOKS:
1. Software Defined Radio for 3G - Paul Burns, 2002, Artech House.
2. Software Defined Radio: Architectures, Systems and Functions - Markus Dillinger, KambizMadani, Nancy Alonistioti, 2003, Wiley.
3. Software Radio Architecture: Object Oriented Approaches to wireless System Engineering – Joseph Mitola, III, 2000, John Wiley & Sons.
4. R.F Microelectronics – B. Razavi, 1998, PHI. 5. DSP – A Computer Based Approach – S. K. Mithra, 1998, McGraw-Hill

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COURSE OUTCOMES:

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

1. Demonstrate advanced knowledge in the evolving paradigm of Software defined radio and technologies for its implementation.
2. Analyze complex problems critically in the domains of Radio frequency implementation issues, Multirate signal processing in SDR, as well as a Smart antenna techniques for better spectrum exploitation for conducting research.
3. Apply appropriate techniques for the development of scientific and technological knowledge in designing software defined radios and their usage for cognitive radio.

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POOL-3 (HONOR)		L	T	P	C
		3	1	0	4
DATA COMMUNICATION &COMPUTER NETWORKS					

UNIT I

Introduction to Data Communications: Components, Data Representation, Data Flow, Networks- Distributed Processing, Network Criteria, Physical Structures, Network Models, Categories of Networks Interconnection of Networks, The Internet - A Brief History, The Internet Today, Protocol and Standards - Protocols, Standards, Standards Organizations, Internet Standards. Network Models, Layered Tasks, OSI model, Layers in OSI model, TCP/IP Protocol Suite, Addressing Introduction, Wireless Links and Network Characteristics, WiFi: 802.11 Wireless LANs -The 802.11 Architecture

UNIT II

Data Link Layer: Links, Access Networks, and LANs- Introduction to the Link Layer, The Services Provided by the Link Layer, Types of errors, Redundancy, Detection vs Correction, Forward error correction Versus Retransmission Error-Detection and Correction Techniques, Parity Checks, Check summing Methods, Cyclic Redundancy Check (CRC) , Framing, Flow Control, and Error Control protocols , Noisy less Channels and Noisy Channels, HDLC, Multiple Access Protocols, Random Access ,ALOHA, Controlled access, Channelization Protocols. 802.11 MAC Protocol, IEEE 802.11 Frame

Unit-III

The Network Layer: Introduction, Forwarding and Routing, Network Service Models, Virtual Circuit and Datagram Networks-Virtual-Circuit Networks, Datagram Networks, Origins of VC and Datagram Networks, Inside a Router-Input Processing, Switching, Output Processing, Queuing, The Routing Control Plane, The Internet Protocol(IP):Forwarding and Addressing in the Internet- Datagram format, Ipv4 Addressing, Internet Control Message Protocol(ICMP), IPv6

Unit-IV

Transport Layer: Introduction and Transport Layer Services : Relationship Between Transport and Network Layers, Overview of the Transport Layer in the Internet, Multiplexing and Demultiplexing, Connectionless Transport: UDP -UDP Segment Structure, UDP Checksum, Principles of Reliable Data Transfer-Building a Reliable Data Transfer Protocol, Pipelined Reliable Data Transfer Protocols, Go- Back-N(GBN), Selective Repeat(SR), Connection Oriented Transport: TCP - The TCP Connection, TCP Segment Structure, Round-Trip Time Estimation and Timeout, Reliable Data Transfer, Flow Control, TCP Connection Management, Principles of Congestion Control - The Cause and the Costs of Congestion, Approaches to Congestion Control-The Cause and the Costs of Congestion, Approaches to Congestion Control

Unit-V

Application Layer: Principles of Networking Applications – Network Application Architectures, Processes Communicating, Transport Services Available to Applications, Transport Services Provided by the File Transfer: FTP,- FTP Commands and Replies, Electronic Mail in the Internet- STMP, Comparison with HTTP, DNS-The Internet's Directory Service – Service Provided by DNS, Overview of How DNS Works, DNS Records and messages.

TEXTBOOKS:

1. Computer Networking A Top-Down Approach – Kurose James F, Keith W, 6th Edition, Pearson.
2. Data Communications and Networking Behrouz A. Forouzan 4th Edition McGraw-Hill Education

REFERENCES:

1. Data communication and Networks - Bhusan Trivedi, Oxford university press, 2016
2. Computer Networks -- Andrew S Tanenbaum, 4th Edition, Pearson Education
3. Understanding Communications and Networks, 3rd Edition, W. A. Shay, Cengage Learning.

Course Outcomes:

Upon completing this course, the student will be able to

1. Know the Categories and functions of various Data communication Networks
2. Design and analyze various error detection techniques.
3. Demonstrate the mechanism of routing the data in network layer
4. Know the significance of various Flow control and Congestion control Mechanisms
5. Know the Functioning of various Application layer Protocols.

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POOL-3 (HONOR)		L	T	P	C
		3	1	0	4
COGNITIVE RADIO					

Unit I: Introduction to Cognitive Radios: Digital dividend, cognitive radio (CR) architecture, functions of cognitive radio, dynamic spectrum access (DSA), components of cognitive radio, spectrum sensing, spectrum analysis and decision, potential applications of cognitive radio.

Unit II: Sensing: Spectrum sensing, detection of spectrum holes (TVWS), collaborative sensing, geo-location database and spectrum sharing business models (spectrum of commons, real time secondary spectrum market).

Unit III: Optimization Techniques of Dynamic Spectrum Allocation: Linear programming, convex programming, non-linear programming, integer programming, dynamic programming, stochastic programming.

Unit IV: Dynamic Spectrum Access and Management: Spectrum broker, cognitive radio architectures, centralized dynamic spectrum access, distributed dynamic spectrum access, learning algorithms and protocols.

Unit V: Spectrum Trading: Introduction to spectrum trading, classification to spectrum trading, radio resource pricing, brief discussion on economics theories in DSA (utility, auction theory), classification of auctions (single auctions, double auctions, concurrent, sequential).Research Challenges in Cognitive Radio: Network layer and transport layer issues, cross- layer design for cognitive radio networks

TEXT BOOKS:

1. Ekram Hossain, DusitNiyato, Zhu Han, “Dynamic Spectrum Access and Management in Cognitive Radio Networks”, Cambridge University Press,2009.
2. Kwang-Cheng Chen, Ramjee Prasad, “Cognitive radio networks”, John Wiley & Sons Ltd.,2009.

REFERENCE BOOKS

1. Bruce Fette, “Cognitive radio technology”, Elsevier, 2nd edition,2009.
2. HuseyinArslan, “Cognitive Radio, Software Defined Radio, and Adaptive Wireless Systems”, Springer,2007.
3. Francisco Rodrigo Porto Cavalcanti, Soren Andersson, “Optimizing Wireless Communication Systems” Springer,2009.
4. Linda Doyle, “Essentials of Cognitive Radio”, Cambridge University Press,2009

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

1. Understand the fundamental concepts of cognitive radio networks.
2. Develop the cognitive radio, as well as techniques for spectrum holes detection that cognitive radio takes advantages in order to exploit it.
3. Understand technologies to allow an efficient use of TVWS for radio communications based on two spectrum sharing business models/policies.
4. Understand fundamental issues regarding dynamic spectrum access, the radio-resource management and trading, as well as a number of optimization techniques for better Spectrum exploitation

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POOL-3 (HONOR)		L	T	P	C
		3	1	0	4
5G COMMUNICATION					

UNIT I:
Overview of 5G Broadband Wireless Communications: Evaluation of mobile technologies 1G to 4G (LTE, LTEA, LTEA Pro) , An Overview of 5G requirements, Regulations for 5G, Spectrum Analysis and Sharing for 5G.

UNIT II:
The 5G wireless Propagation Channels: Channel modeling requirements, propagation scenarios and challenges in the 5G modeling, Channel Models for mm Wave MIMO Systems.

UNIT III:
Transmission and Design Techniques for 5G: Basic requirements of transmission over 5G, Modulation Techniques – Orthogonal frequency division multiplexing (OFDM), generalized frequency division multiplexing (GFDM), filter bank multi-carriers (FBMC) and universal filtered multi-carrier (UFMC), Multiple Accesses Techniques – orthogonal frequency division multiple accesses (OFDMA), generalized frequency division multiple accesses (GFDMA), non-orthogonal multiple accesses (NOMA).

UNIT IV:
Device-to-device (D2D) and machine-to-machine (M2M) type communications – Extension of 4G D2D standardization to 5G, radio resource management for mobile broadband D2D, multi-hop and multi-operator D2D communications

UNIT V:
Millimeter-wave Communications – spectrum regulations, deployment scenarios, beam forming, physical layer techniques, interference and mobility management, Massive MIMO propagation channel models, Channel Estimation in Massive MIMO, Massive MIMO with Imperfect CSI, Multi-Cell Massive MIMO, Pilot Contamination, Spatial Modulation (SM)

Textbooks:

1. Martin Sauter “From GSM From GSM to LTE–Advanced Pro and 5G: An Introduction to Mobile Networks and Mobile Broadband”, Wiley-Blackwell.
2. Afif Osseiran, Jose.F.Monserrat, Patrick Marsch, “Fundamentals of 5G Mobile Networks” , Cambridge University Press.
3. Athanasios G.Kanatos, Konstantina S.Nikita, Panagiotis Mathiopoulos, “New Directions in Wireless Communication Systems from Mobile to 5G”, CRC Press.
4. Theodore S.Rappaport, Robert W.Heath, Robert C.Danials, James N.Murdock “Millimeter Wave Wireless Communications”, Prentice Hall Communications.

References

1. Jonathan Rodriguez, “Fundamentals of 5G Mobile Networks”, John Wiley & Sons.
2. Amitabha Ghosh and Rapeepat Ratasuk “Essentials of LTE and LTE-A”, Cambridge University Press

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

1. Learn 5G Technology advances and their benefits
2. Learn the key RF, PHY, MAC and air interface changes required to support 5G
3. Learn Device to device communication and millimeter wave communication
4. Implementation options for 5G

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POOL-3 (HONOR)		L	T	P	C
		3	1	0	4
SATELLITE COMMUNICATION					

UNIT I

INTRODUCTION Origin of Satellite Communications, Historical Back-ground, Basic Concepts of Satellite Communications, Frequency allocations for Satellite Services, Applications, Future Trends of Satellite Communications.

ORBITAL MECHANICS AND LAUNCHERS : Orbital Mechanics, Look Angle determination, Orbital perturbations, Orbit determination, launches and launch vehicles, Orbital effects in communication systems performance.

UNIT II

SATELLITE SUB SYSTEMS : Attitude and orbit control system, telemetry, tracking, Command and monitoring, power systems, communication subsystems, Satellite antenna Equipment reliability and Space qualification.

UNIT III

SATELLITE LINK DESIGN : Basic transmission theory, system noise temperature and G/T ratio, Design of down links, up link design, Design of satellite links for specified C/N, System design example.

UNIT IV

MULTIPLE ACCESS: Frequency division multiple access (FDMA) Intermodulation, Calculation of C/N. Time division Multiple Access (TDMA) Frame structure, link design using TDMA, Examples. Satellite Switched TDMA Onboard processing, DAMA, Code Division Multiple access (CDMA), Spread spectrum transmission and reception.
EARTH STATION TECHNOLOGY: Introduction, Transmitters, Receivers, Antennas, Tracking systems,Terrestrial interface, Primary power test methods.

UNIT V

LOW EARTH ORBIT AND GEO-STATIONARY SATELLITE SYSTEMS: Orbit consideration, coverage and frequency considerations, Delay & Throughput considerations, System considerations, Operational NGSO constellation Designs

SATELLITE NAVIGATION & THE GLOBAL POSITIONING SYSTEM: Radio and Satellite
Navigation, GPS Position Location principles, GPS Receivers and codes, Satellite signal acquisition, GPSNavigation Message, GPS signal levels, GPS receiver operation, GPS C/A code accuracy, Differential GPS

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TEXT BOOKS:

1. Satellite Communications – Timothy Pratt, Charles Bostian and Jeremy Allnutt, WSE, Wiley Publications, 2ndEdition, 2003.
2. Satellite Communications Engineering – Wilbur L. Pritchard, Robert A Nelson and Henri G. Suyderhoud, 2ndEdition, Pearson Publications, 2003.
3. Digital satellite communication by TRI T HA …..TMH

REFERENCES:

1. Satellite Communications : Design Principles – M. Richharia, BS Publications, 2nd Edition, 2003.
2. Satellite Communication - D.C Agarwal, Khanna Publications, 5th Ed.
3. Fundamentals of Satellite Communications – K.N. Raja Rao, PHI, 2004
4. Satellite Communications – Dennis Roddy, McGraw Hill, 2nd Edition, 1996.

Outcomes:
At the end of this course the student can able to:

1. Understand the concepts, applications and subsystems of Satellite communications.
2. Derive the expression for G/T ratio and to solve some analytical problems on satellite link design.
3. Understand the various types of multiple access techniques and architecture of earth station design.
4. Understand the concepts of GPS and its architecture.

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POOL-3 (HONOR)		L	T	P	C
		3	1	0	4
OPTICAL COMMUNICATION					

UNIT I

Overview of optical fiber communication - Historical development, The general system, advantages of optical fiber communications. Optical fiber wave guides- Introduction, Ray theory transmission, Total Internal Reflection, Acceptance angle, Numerical Aperture, Skew rays, Cylindrical fibers- Modes, V-number, Mode coupling, Step Index fibers, Graded Index fibers, Single mode fibers- Cut off wavelength, Mode Field Diameter, Effective Refractive Index, Related problems.

UNIT II

Fiber materials:- Glass, Halide, Active glass, Chalgenide glass, Plastic optical fibers. Signal distortion in optical fibers-Attenuation, Absorption, Scattering and Bending losses, Core and Cladding losses, Information capacity determination, Group delay, Types of Dispersion:- Material dispersion, Wave-guide dispersion, Polarization-Mode dispersion, Intermodal dispersion, Pulse broadening in Graded index fiber, Related problems.

UNIT III

. Optical fiber Connectors-Connector types, Single mode fiber connectors, Connector return loss, Fiber Splicing- Splicing techniques, Splicing single mode fibers, Fiber alignment and joint loss- Multimode fiber joints, single mode fiber joints.

UNIT IV

Optical sources- LEDs, Structures, Materials, Quantum efficiency, Power, Modulation, Power bandwidth product. Injection Laser Diodes- Modes, Threshold conditions, External quantum efficiency, Laser diode rate equations, Resonant frequencies, Reliability of LED&ILD, Optical detectors- Physical principles of PIN and APD, Detector response time, Temperature effect on Avalanche gain, Comparison of Photo detectors, Related problems.

UNIT V

Source to fiber power launching - Output patterns, Power coupling, Power launching, Equilibrium Numerical Aperture, Laser diode to fiber coupling, Optical receiver operation- Fundamental receiver operation, Digital signal transmission, error sources, Receiver configuration, Digital receiver performance, Probability of Error, Quantum limit, Analog receivers.

Optical system design - Point-to- point links- Component choice and considerations, Link power budget, Rise time budget with examples, Line coding in Optical links, WDM, Necessity, Principles, Measurement of Attenuation and Dispersion, Eye pattern.

TEXT BOOKS:

1. Optical Fiber Communications – Gerd Keiser, Mc Graw-Hill International edition, 3rd Edition, 2000.
2. Optical Fiber Communications – John M. Senior, PHI, 2nd Edition, 2002.

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RERFERENCES:

1. Fiber Optic Communications – D.K. Mynbaev , S.C. Gupta and Lowell L. Scheiner, Pearson Education,2005.
2. Text Book on Optical Fiber Communication and its Applications – S.C.Gupta, PHI, 2005.
3. Fiber Optic Communication Systems – Govind P. Agarwal , John Wiley, 3rd Edition, 2004.
4. Fiber Optic Communications – Joseph C. Palais, 4th Edition, Pearson Education, 2004.

OUTCOMES:

After going through this course the student will be able to

1. Choose necessary components required in modern optical communications systems .
2. Design and build optical fiber experiments in the laboratory, and learn how to calculate electromagnetic modes in waveguides, the amount of light lost going through an optical system, dispersion of optical fibers.
3. Use different types of photo detectors and optical test equipment to analyze optical fiber and light wave systems.
4. Choose the optical cables for better communication with minimum losses
5. Design, build, and demonstrate optical fiber experiments in the laboratory

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POOL-3 (HONOR)		L	T	P	C
		3	1	0	4
GLOBAL NAVIGATIONAL SATELLITE SYSTEMS					

UNIT I:
Introduction, GNSS overview, Global Positioning System, Russian GLONASS system, Galileo satellite system, Chinese BeiDou system, Regional system: Quasi-Zenith Satellite System (QZSS), Navigation with Indian Constellation (NavIC), Augmentations, Markets and Applications.
Fundamentals of satellite Navigation: Concept of Ranging using Time of arrival Measurements: Two-Dimensional Position Determination, Principle of Position Determination via Satellite-Generated Ranging Codes, Fundamentals of satellite orbits: Orbital Mechanics, Constellation Design, Positioning determination using Ranging codes: Determining Satellite-to-User Range,

UNIT II:
Global positioning system: overview: Space Segment Overview, Control Segment Overview, User Segment Overview, Space segment description: GPS Satellite Constellation Description, Space Segment Phased Development, Control segment description: OCS Current Configuration, OCS Transition, OCS Planned Upgrades, User segment: GNSS Receiver Characteristics

UNIT III:
Navigation with Indian Constellation (NavIC): overview, space segment, NavIC control segment, Geodesy and time system, Navigation services, signals, applications and NavIC user equipment.

UNIT – IV:

GNSS Receiver: Acquisition: Single Trial Detector, Tong Search Detector, M of N Search Detector, Combined Tong and M of N Search Detectors, FFT-Based Techniques, Direct Acquisition of GPS Military Signals, Vernier Doppler and Peak Code Search, carrier tracking, code tracking: Carrier Loop Discriminator, sequence of initial receiver operation.

UNIT – V:
GNSS errors: Introduction, Measurement errors: satellite clock error, ephemeris error, relative effects, atmospheric effects, receiver noise and resolution, multipath and shadowing effects, hardware bias errors, Psedorange error budgets.

Text Books:
1. Elliott D. Kaplan, Christopher J. Hegarty, **Understanding GPS/GNSS** principles and applications, third edition, artech house publishers, Boston, 2017

Reference Books:
1. G S Rao, Global Navigational satellite system, Tata McGraw-Hill education private Ltd, New Delhi, 2010
2. ISRO-IRNSS-ICD-SPS-1.1, Bangalore, 2017
3. Bhatta, B., 2010. Global Navigation Satellite Systems: Insights Into GPS, Glonass, Galileo, Compass, and Others, BS Publications, New Delhi.

4. Grewal, M. S., Weill, L. R., Andrews, A. P., 2006. Global Positioning Systems, Inertial Navigation, and Integration, John Wiley & Sons, New York.
5. Hofmann-Wellenhof, B., Lichtenegger, H., Wasle, E., 2008. GNSS – Global Navigation Satellite Systems, Springer, Verlag Wien.

Course Outcomes:

1. Understand global navigational satellite systems
2. Understand Indian regional Navigational Satellite System
3. Develop GNSS Receiver

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POOL-4 (HONOR)		L	T	P	C
		3	1	0	4
SPEECH SIGNAL PROCESSING					

Unit I

Mechanics of speech: Speech production: Mechanism of speech production, Acoustic phonetics, The Acoustic Theory of Speech Production: Uniform lossless tube, Effects of losses in the vocal tract, Digital models for speech signals: Vocal tract, Radiation, Excitation, Auditory perception: psycho acoustics. Representations of speech waveform: Sampling of speech signals, Quantization.

Unit II

Time and frequency domain methods for speech processing: Time domain parameters of Speech signal: Short-Time Energy, Average Magnitude, Average Zero crossing Rate, Silence Discrimination using ZCR and energy, Short Time Auto Correlation Function, Pitch period estimation using Auto Correlation Function.

Short Time Fourier analysis: Fourier transform and linear filtering interpretations, Sampling rates in time and frequency, Pitch detection, Analysis by Synthesis, Analysis synthesis systems: Phase vocoder, Channel Vocoder, Median Smoothing, Spectrographic displays

Unit III

Linear predictive analysis of speech: Basic Principles of linear predictive analysis: Auto correlation method, Covariance method, Solution of LPC equations: Cholesky method, Durbin's Recursive algorithm, Application of LPC parameters: Pitch detection using LPC parameters, Formant analysis using LPC parameters, VELP. Relations Between the Various Speech Parameters, CELP.

Unit IV

Application of speech processing: Voice response systems: General considerations in the design of voice response systems, A multiple output digital voice response system, Speaker recognition systems: Speaker verification system, Speaker identification system.

Unit V

Speech recognition systems: Isolated digit recognition system, Continuous digit recognition system. Typical applications of computer voice response systems: Wiring communication equipment, Information retrieval systems

Textbooks:

1. L.R.Rabinerand, R.W.Schaffer, Digital Processing of Speech signals, Prentice Hall, 2004
2. Ben Gold and Nelson Morgan, Speech and Audio Signal Processing, John Wiley and Sons Inc., Singapore, 2004

References:

1. Quatieri, Discrete-time Speech Signal Processing, PrenticeHall,2001
2. L.R. Rabiner and B. H. Juang, Fundamentals of speech recognition, Prentice Hall, 1999.

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Course Outcomes:
At the end of this course the student will be able to:

1. Summarize the mechanism of human speech production and articulation
2. Identify the time domain speech signal parameters
3. Differentiate time and frequency domain methods of speech processing
4. Attribute linear predictive analysis for speech signals
5. Explain the solutions for LPC equations
6. Implementthedifferentalgorithmsandmodelsinvolvedforspeakerandspeechrecognition systems

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VIDEO SIGNAL PROCESSING					

Unit – I
Video formation, perception and representation – color perception and specification – video capture and display – Analog video raster – Analog color television systems, Digital video and Frequency Domain characterization of Video Signals.

Unit – II
Video sampling – Basics of the Lattice theory, Sampling of Video Signals, Conversion of Signals Sampled on Different Lattices, Sampling Rate Conversion of Video Signals

Unit -III
Video modeling-Camera model, Illumination model, Object model and Scene model, Two dimensional models, Two Dimensional motion estimation-Types, Optical Flow, Pixel Based Motion, Block matching Algorithm.

Unit -IV
Waveform Based Video Coding-Predictive coding, Video coding using Temporal prediction and transform coding, Content Dependent Video Coding – Two dimensional shape coding, Texture coding for Arbitrarily shaped Regions

Unit-V
Video Compression standards-Standardization- Video Telephony with H.261 and H.263-Multimedia content description with MPEG7

Text Books
1. Video Processing and Communication – 1st edition - Yao Wang, J.Ostermann, Ya Zhang, Prentice Hall, 2001.

Reference Books:
1. Image processing, analysis, and machine vision, 2nd Edition,-Sonka M, Hlavac V, Boyle R. Brooks Cole publishing, 1999.
2. Multidimensional, signal, image and video processing and coding, -Woods, Elsevier, Academic press, 2006.

Course Outcomes:
1. Understand the formation of video, its perception and representation and characterization of video in frequency domain
2. Understand the concept of Lattice theory and sampling of video signals
3. Modeling of the video signal in different methods and understand the different motion estimation algorithms
4. Coding of video in different approaches / algorithms
5. Knowledge in Video compression standards

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ADAPTIVE SIGNAL PROCESSING					

Unit -I
Introduction to Adaptive Systems: Adaptive Systems: Definitions, Characteristics, Applications, Example of an Adaptive System. The Adaptive Linear Combiner - Description, Weight Vectors, Desired Response, Performance function - Gradient & Mean Square Error.

Unit-II
Development of Adaptive Filter Theory & Searching the Performance surface: Introduction to Filtering - Smoothing and Prediction – Linear Optimum Filtering, Problem statement, Principle of Orthogonality - Minimum Mean Square Error, Wiener- Hopf equations, Error Performance surface Searching the performance surface – Methods & Ideas of Gradient Search methods, Gradient Searching Algorithm & its Solution, Stability& Rate of convergence , Learning Curve.

Unit-III
Steepest Descent Algorithms: Gradient Search by Newton's Method, Method of Steepest Descent, Comparison of Learning Curves.

Unit-IV
LMS Algorithm & Applications: Overview - LMS Adaptation algorithms, Stability & Performance analysis of LMS Algorithms - LMS Gradient & Stochastic algorithms - Convergence of LMS algorithm. Applications: Noise cancellation – Cancellation of Echoes in long distance telephone circuits, Adaptive Beam forming.

Unit-V
RLS &Kalman Filtering: Introduction to RLS Algorithm, Statement of Kalman filtering problem, The Innovation Process, Estimation of State using the Innovation Process- Expression of Kalman Gain, Filtering Examples using Kalman filtering.

Text Books
1. Adaptive Signal Processing - Bernard Widrow, Samuel D. Strearns, 2005, PE.
2. Adaptive Filter Theory - Simon Haykin-, 4th Ed., 2002, PE Asia.

Reference Books
1. Optimum signal processing: An introduction – Sophocles .J. Orfamadis, 2nd Ed., 1988, McGraw-Hill, New York
2. Adaptive signal processing-Theory and Applications - S.Thomas Alexander, 1986, Springer –Verlag.
3. Signal analysis – Candy, McGraw Hill Int. Student Edition
4. James V. Candy - Signal Processing: A Modern Approach, McGraw-Hill, International Edition, 1988



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Course outcomes

1. Review the Adaptive Systems and Understand the various measures to be opted for developing adaptive system
2. Study of different algorithms to develop the adaptive filter theory
3. Application of adaptive filter theory for different problems
4. Study of RLS &Kalman Filtering

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		3	1	0	4
BIO- MEDICAL SIGNAL PROCESSING					

Unit I
Acquisition, Generation of Bio-signals, Origin of bio-signals, Types of bio-signals, Study of diagnostically significant bio-signal parameters

Unit II
Electrodes for bio-physiological sensing and conditioning, Electrode-electrolyte interface, polarization, electrode skin interface and motion artefact, biomaterial used for electrode, Types of electrodes (body surface, internal, array of electrodes, microelectrodes), Practical aspects of using electrodes, Acquisition of bio-signals (signal conditioning) and Signal conversion (ADC's DAC's) Processing, Digital filtering

Unit III
Biomedical signal processing by Fourier analysis, Biomedical signal processing by wavelet (time-frequency) analysis, Analysis (Computation of signal parameters that are diagnostically significant)

Unit IV
Classification of signals and noise, Spectral analysis of deterministic, stationary random signals and non-stationary signals, Coherent treatment of various biomedical signal processing methods and applications

Unit V
Principal component analysis, Correlation and regression, Analysis of chaotic signals Application areas of Bio–Signals analysis Multi resolution analysis (MRA) and wavelets, Principal component analysis(PCA), Independent component analysis(ICA). Pattern classification– supervised and unsupervised classification, Neural networks, Support vector Machines, Hidden Markov models. Examples of biomedical signal classification examples.

Text Books:
1. W. J. Tompkins, "Biomedical Digital Signal Processing", Prentice Hall,1993.
2. Eugene N Bruce, "Biomedical Signal Processing and Signal Modeling", John Wiley & Son's publication,2001.

References:
1. Myer Kutz, "Biomedical Engineering and Design Handbook, Volume I", McGraw Hill, 2009.
2. D C Reddy, "Biomedical Signal Processing", McGraw Hill,2005.
3. Katarzyn J. Blinowska, Jaroslaw Zygierewicz, "Practical Biomedical Signal Analysis Using MATLAB", 1st Edition, CRC Press,2011

Course Outcomes:
1. Understand different types of biomedical signal.
2. Identify and analyze different biomedical signals.
3. Find applications related to biomedical signal processing

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DSP PROCESSORS AND ARCHITECTURES					

Unit – I:
Introduction to Digital Signal Processing: Introduction, A Digital signal-processing system, The sampling process, Discrete time sequences, Discrete Fourier Transform (DFT) and Fast Fourier Transform (FFT), Linear time-invariant systems, Digital filters, Decimation and interpolation. Computational Accuracy in DSP Implementations: Number formats for signals and coefficients in DSP systems, Dynamic Range and Precision, Sources of error in DSP implementations, A/D Conversion errors, DSP Computational errors, D/A Conversion Errors, Compensating filter.

Unit – II:
Architectures for Programmable DSP Devices: Basic Architectural features, DSP Computational Building Blocks, Bus Architecture and Memory, Data Addressing Capabilities, Address Generation Unit, Programmability and Program Execution, Speed Issues, Features for External interfacing.

Unit-III:
Programmable Digital Signal Processors: Commercial digital signal processing devices, Data Addressing modes of TMS320C54XX DSPs, data Addressing modes of TMS320C54XX Processors, Memory space of TMS320C54XX processors, program control, TMS320C54XX instructions and programming, On-Chip Peripherals, Interrupts of TMS320C54XX processors, pipeline Operation of TMS320C54XX Processors.

Unit – IV:
Analog Devices Family of DSP Devices: Analog Devices Family of DSP Devices ALU and MAC block diagram, Shifter Instruction, Base Architecture of ADSP 2100, ADSP2181 high performance processor. Introduction to Blackfin Processor- The Blackfin Processor, Introduction to Micro signal Architecture, Overview of Hardware Processing Units and Register files, Address Arithmetic Unit, Control Unit, Bus Architecture and Memory, Basic Peripherals.

Unit – V:
Interfacing Memory and I/O Peripherals to Programmable DSP Devices: Memory space organization, External bus interfacing signals, Memory interface, Parallel I/O interface, Programmed I/O, Interrupts and I/O, Direct memory access (DMA).

Text Books:
1. Digital Signal Processing – Avtar Singh and S. Srinivasan, Thomson Publications, 2004.
2. A Practical Approach To Digital Signal Processing - K Padmanabhan, R. Vijayarajeswaran, Ananthi. S, New Age International, 2006/2009
3. Embedded Signal Processing with the Micro Signal Architecture Publisher: Woon-Seng Gan, Sen M. Kuo, Wiley-IEEE Press, 2007

Reference Books:

1. Digital Signal Processors, Architecture, Programming and Applications–B. Venkata ramani and M. Bhaskar, 2002, TMH.
2. DSP Processor Fundamentals, Architectures & Features – Lapsley et al., S. Chand & Co
3. Digital Signal Processing Applications Using the ADSP-2100 Family, Amy Mar, PHI
4. The Scientist and Engineer's Guide to Digital Signal Processing by Steven W. Smith, California Technical Publishing
5. Embedded Media Processing, David J. Katz and Rick Gentile of Analog Devices, Newnes

Course Outcomes:

1. Understand the basics of Digital Signal Processing and transforms.
2. Able to distinguish between the architectural features of general purpose processors and DSP processors.
3. Understand the architectures of TMS320C54xx devices and ADSP 2100 DSP devices.
4. Able to write simple assembly language programs using instruction set of TMS320C54xx.
5. Can interface various devices to DSP Processors.

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		3	1	0	4
WAVELET THEORY					

Unit – I
The Age of Wavelets –Introduction-The Origins of Wavelets-Are They Fundamentally New-Wavelets and Other Reality Transforms, Managing Heisenberg's Uncertainty Ghost. History of Wavelet from Morlet to Daubechies Via Mallat , Different Communities of Wavelets, Different Families of Wavelets within Wavelet Communities, Interesting Recent Developments, Wavelets in the Future

Unit – II
Introduction-Vector spaces – bases, orthonormality, projection, functions and function spaces, orthogonal functions, orthonormal functions, function spaces, orthogonal basis functions, orthonormality and the method of finding the coefficients, complex fourier series, orthogonality of complex exponential bases

Unit – III
Continuous Wavelet and Short time Fourier Transform-Wavelet Transform, mathematical preliminaries, continuous time frequency representation of signals, the windowed fourier transform(Short Time Fourier Transform), The uncertainty principle and time frequency tiling, properties of wavelets used in Continuous Wavelet Transform, Continuous Versus Discrete Wavelet Transform

Unit – IV
Discrete Wavelet Transform-Haar scaling functions and function spaces, Nested Spaces, Haar Wavelet Function, Normalization of Haarbases at different scales, Standardizing the Notations, Refinement Relation with Respect to Normalized Bases, Support of a wavelet system, Daubechies Wavelets

Unit – V
Biorthogonal Wavelets-Biorthogonality in vector space, Biorthogonal Wavelet Systems, Signal Representation using Biorthogonal Wavelet System, Biorthogonal Analysis, Biorthogonal Synthesis, Construction of Biorthogonal Wavelet Systems.

Text Book:
1. Insight into Wavelets: From theory to practice by K.P.Soman, Ramachandran, Resmi, PHI Learning PVT Ltd,2010
2. L.Prasad & S.S.Iyengar, Wavelet Analysis with Applications to Image Processing, CRC Press, 1997.

References:
1. Wavelet Transforms - Introduction to Theory and Applications, Raghuveer M.Rao, Ajit Bopardikar, Pearson Education, Asia
2. Fundaments of Wavelets - Theory, Algorithms and Applications, Jaideva C.Goswami, Andrew K. Chan, John Wiley & Sons.

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Course Outcomes:

1. Understand windowed Fourier transform and difference between windowed Fourier Transform and wavelet transform.
2. Understand wavelet basis and characterize continuous and discrete wavelet transforms
3. Understand multire solution analysis and identify various wavelets and evaluate their Time- frequency resolution properties
4. Implement discrete wavelet transforms with multirate digital filters and can under stand Wavelet packets
5. Design certain classes of wavelets to specification and justify the basis of the application of wavelet transforms to different fields

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POOL-4 (HONOR)		L	T	P	C
		3	1	0	4
MULTIRATE SYSTEMS AND FILTER BANKS					

Unit – I: Fundamentals of Multirate Systems: Basic Multirate Operations, Interconnection of Building Blocks, The Polyphase representation, Multistage Implementations, Some Applications of Multirate Systems, Special Filters and Filter Banks

Unit – II
Maximally Decimated Filter Banks: Errors created in the QMF Bank, A Simple Alias Free QMF System, Power Symmetric QMF Banks, M-Channel Filter Banks, Polyphase representation, Perfect Reconstruction Systems, Alias Free Filter Banks, Tree Structured Filter Banks, Trans-Multiplexers

Unit – III
Para unitary Perfect Reconstruction (PR) Filter Banks: Lossless Transfer Matrices, Filter Bank Properties Induced by Para unitariness, Two channel FIR Para unitary QMF Banks, The Two channel Para unitary QMF Lattice, Transform Coding and the LOT.

Unit – IV
Cosine Modulated Filter Banks: The Pseudo QMF Bank, Design of Pseudo QMF Bank, Efficient Polyphase Structures, Deeper Properties of Cosine Matrices, Cosine Modulated Perfect Reconstruction Systems.

Unit – V
Quantization effects, Types of Quantization effects, Review of standard techniques, Noise transmission in multirate systems, Noise in filter banks, Filter bank output noise, Limit Cycles, Coefficient Quantization

Text Book:
1. Multirate Systems and Filter Banks, P.P.Vaidyanathan, Pearson Education, Low Priced Edition, 2006.

Reference Books:
1. Multirate Signal Processing for Communication Systems by F.J.Harris, Pearson Education, Low Priced Edition.
2. Digital Signal Processing, A computer Based Approach by Sanjit K Mitra, Tata McGraw Hill Publishing.

Course Outcomes:
1. Understand the concepts multi-rate systems
2. Describe the applications of multi-rate systems
3. Study of various filter banks
4. Analyze the efforts of quantization
5. Explain the overall multi-rate systems and filter banks

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POOL-4 (HONOR)		L	T	P	C
		3	1	0	4

MATHEMATICAL METHODS FOR SIGNAL PROCESSING

Unit – I
Vectors: Representation and Dot products, Matrices: Matrix Multiplication, Transposes, Inverses, Gaussian Elimination, factorization, rank of a matrix, Vector spaces: Column and row spaces, Solving Ax=0 and Ax=b, Independence, basis, dimension, linear transformations, Orthogonality: Orthogonal vectors and subspaces, projection and least squares, Gram-Schmidt orthogonalization.

Unit – II
Determinants: Determinant formula, cofactors, inverses and volume, Eigenvalues and Eigenvectors: characteristic polynomial, Diagonalization, Hermitian and Unitary matrices, Spectral theorem, Change of basis, Positive definite matrices and singular value decomposition, Linear transformations.

Unit – III
Review of Probability: Basic set theory and set algebra, basic axioms of probability, Conditional Probability, Bayes theorem/Law of total probability.

Unit – IV
Random variables PDF/PMF/CDF Properties, random vectors marginal/joint/conditional density functions, transformation of Random Variables, characteristic/moment generating functions, Random sums of Random variables, Law of Large numbers (strong and Weak), Limit theorems convergence types, Inequalities Chebyshev/Markov/Chernoff bounds.

Unit – V
Random processes: classification of random processes, wide sense stationary processes, autocorrelation function and power spectral density and their properties. Examples of random process models - Gaussian/Markov Random process, Random processes through LTI systems.

Textbooks:
1. Introduction to linear algebra - Gilbert Strang, SIAM, 2016.
2. Introduction to probability - Bertsekas and Tsitsiklis, Athena, 2008

References Books:
1. Probability and Random processes for Electrical Engineers, Leon Garcia Addison Wesley, 2nd edition, 1994
2. Probability and Random Processes, Geoffrey Grimmett, David Stirzaker, 3rd Edition, Oxford University Press, 2001.
3. Probability and Stochastic Process, Roy D Yates, David J Goodman, 2nd edition Wiley, 2010

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Course Outcomes:

1. Understand and solve the problems associated with Vectors
2. Solve the problem associated with linear algebra
3. Understand probability theory and conditional probability
4. Summarize the concepts associated with multiple random variables and to solve the problems associated with power spectral density of the output of the system.
5. Recognize the usage of random process in signal processing and to solve the corresponding problems.

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MINOR Course		L	T	P	C
		3	0	0	4
ELECTRONICS DEVICES AND BASIC CIRCUITS					

UNIT-I :Review of Semi Conductor Physics: Hall effect, continuity equation, law of junction, Fermi Dirac function, Fermi level in intrinsic and extrinsic Semiconductors
Junction Diode Characteristics : energy band diagram of PN junction Diode, Open circuited p-n junction, Biased p-n junction, p-n junction diode, current components in PN junction Diode, diode equation, V-I Characteristics, temperature dependence on V-I characteristics, Diode resistance, Diode capacitance.

UNIT-II:
Special Semiconductor Devices: Zener Diode, Breakdown mechanisms, Zener diode applications, LED, Varactor Diode, Photodiode, Tunnel Diode, UJT, PNPN Diode, SCR. Construction, operation and V-I characteristics.
Rectifiers and Filters: Basic Rectifier setup**,** half wave rectifier, full wave rectifier, bridge rectifier, derivations of characteristics of rectifiers, rectifier circuits-operation, input and output waveforms, Filters, Inductor filter(Series inductor), Capacitor filter(Stunt inductor), π-Filter, comparison of various filter circuits in terms of ripple factors.

UNIT- III: Transistor Characteristics:
BJT: Junction transistor, transistor current components, transistor equation, transistor configurations, transistor as an amplifier, characteristics of transistor in Common Base, Common Emitter and Common Collector configurations, Ebers-Moll model of a transistor, punch through/ reach through, Photo transistor, typical transistor junction voltage values.
FET: FET types, construction, operation, characteristicsμ, g_m, r_d parameters, MOSFET-types, construction, operation, characteristics, comparison between JFET and MOSFET.

UNIT- IV: Transistor Biasing and Thermal Stabilization : Need for biasing, operating point, load line analysis, BJT biasing- methods, basic stability, fixed bias, collector to base bias, self bias, Stabilization against variations in V_{BE}, Ic, and β, Stability factors, (S,S',S''), Bias compensation, Thermal runaway, Thermal stability.
FET Biasing- methods and stabilization.

UNIT- V: Small Signal Low Frequency Transistor Amplifier Models:
BJT: Two port network, Transistor hybrid model, determination of h-parameters, conversion of h-parameters, generalized analysis of transistor amplifier model using h-parameters, Analysis of CB, CE and CC amplifiers using exact and approximate analysis, Comparison of transistor amplifiers.
FET: Generalized analysis of small signal model, Analysis of CG, CS and CD amplifiers, comparison of FET amplifiers.

Text Books:

1. Electronic Devices and Circuits- J. Millman, C. Halkias, Tata Mc-Graw Hill, SecondEdition,2007
2. Electronic Devices and Circuits by David A. Bell, Oxford University Press
3. Electronics devices & circuit theory- Robert L.Boylestad and Loui Nashelsky, Pearson/Prentice hall, tenth edition,2009

References:

1. Integrated Electronics-J. Millman, C. Halkias,Tata Mc-Graw Hill, Second Edition, 2009
2. Electronic Devices and Circuits-K. Lal Kishore, BS Publications, Fourth Edition, 2016.
3. Electronic Devices and Circuits-Salivahanan, Kumar, Vallavaraj, Tata Mc-Graw Hill, 4th Edition, 2008.
4. Electronic Devices and Integrated Circuits – B.P. Singh, Rekha , Pearson publications, 2006.

OUTCOMES:

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

1. Apply the basic concepts of semiconductor physics.
2. Understand the formation of p-n junction and how it can be used as a p-n junction as diode in different modes of operation.
3. Know the construction, working principle of rectifiers with and without filters with relevant expressions and necessary comparisons.
4. Understand the construction, principle of operation of transistors, BJT and FET with their V-I characteristics in different configurations.
5. Know the need of transistor biasing, various biasing techniques for BJT and FET and stabilization concepts with necessary expressions.
6. Perform the analysis of small signal low frequency transistor amplifier circuits using BJT and FET in different configurations.

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DIGITAL ELECTRONICS					

UNIT – I

REVIEW OF NUMBER SYSTEMS & CODES:

Representation of numbers of different radix, conversation from one radix to another radix, r-1's compliments and r's compliments of signed members. Gray code ,4 bit codes; BCD, Excess-3, 2421, 84-2-1 code etc. Error detection & correction codes: parity checking, even parity, odd parity, Hamming code.

BOOLEAN THEOREMS AND LOGIC OPERATIONS:

Boolean theorems, principle of complementation & duality, De-morgan theorems. Logic operations ; Basic logic operations -NOT, OR, AND, Universal Logic operations, EX-OR, EX-NOR operations. Standard SOP and POS Forms, NAND-NAND and NOR-NOR realizations, Realization of three level logic circuits. Study the pin diagram and obtain truth table for the following relevant ICs 7400,7402,7404,7408,7432,7486.

UNIT – II

MINIMIZATION TECHNIQUES:

Minimization and realization of switching functions using Boolean theorems, K-Map (up to 6 variables)and tabular method(Quine-mcCluskey method) with only four variables and single function.

COMBINATIONAL LOGIC CIRCUITS DESIGN:

Design of Half adder, full adder, half subtractor, full subtractor, applications of full adders; 4-bit adder-subtractor circuit, BCD adder circuit, Excess 3 adder circuit and carry look-a-head adder circuit, Design code converts using Karnaugh method and draw the complete circuit diagrams.

UNIT – III

COMBINATIONAL LOGIC CIRCUITS DESIGN USING MSI &LSI :

Design of encoder ,decoder, multiplexer and de-multiplexers, Implementation of higher order circuits using lower order circuits .Realization of Boolean functions using decoders and multiplexers. Design of Priority encoder, 4-bit digital comparator and seven segment decoder. . Study the relevant ICs pin diagrams and their functions 7442,7447,7485,74154.

INTRODUCTION OF PLD's :

PLDs: PROM, PAL, PLA -Basics structures, realization of Boolean functions, Programming table.

UNIT – IV

SEQUENTIAL CIRCUITS I:

Classification of sequential circuits (synchronous and asynchronous) , operation of NAND & NOR Latches and flip-flops; truth tables and excitation tables of RS flip-flop, JK flip-flop, T flip-flop, D flip-flop with reset and clear terminals. Conversion from one flip-flop to another

flip-flop. Design of 5ripple counters, design of synchronous counters, Johnson counter, ring counter. Design of registers - Buffer register, control buffer register, shift register, bi-directional shift register, universal shift, register.

Study the following relevant ICs and their relevant functions 7474,7475,7476,7490,7493,74121.

UNIT – V

SEQUENTIAL CIRCUITS II :

Finite state machine; state diagrams, state tables, reduction of state tables. Analysis of clocked sequential circuits Mealy to Moore conversion and vice-versa.Realization of sequence generator, Design of Clocked Sequential Circuit to detect the given sequence (with overlapping or without overlapping).

TEXT BOOKS:

1. Switching and finite automata theory Zvi.KOHAVI, Niraj.K.Jha 3rd Edition, Cambridge University Press,2009
2. Digital Design by M.Morris Mano, Michael D Ciletti,4th edition PHI publication,2008
3. Switching theory and logic design by Hill and Peterson**,** Mc-Graw Hill TMH edition, 2012.

REFERENCES:

1. Fundamentals of Logic Design by Charles H. Roth Jr, Jaico Publishers,2006
2. Digital electronics by R S Sedha.S.Chand& company limited,2010
3. Switching Theory and Logic Design by A. Anand Kumar, PHI Learning pvt ltd,2016.
4. Digital logic applications and design by John M Yarbough, Cengage learning, 2006.
5. TTL 74-Series data book.

Course Outcomes:

1. Classify different number systems and apply to generate various codes.
2. Use the concept of Boolean algebra in minimization of switching functions
3. Design different types of combinational logic circuits.
4. Apply knowledge of flip-flops in designing of Registers and counters
5. The operation and design methodology for synchronous sequential circuits and algorithmic state machines.
6. Produce innovative designs by modifying the traditional design techniques.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA
KAKINADA – 533 003, Andhra Pradesh, India
DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

MINOR Course		L	T	P	C
		3	0	0	4
PRINCIPLES OF COMMUNICATIONS					

UNIT-I

Amplitude modulation: Introduction, Amplitude Modulation: Time & Frequency – Domain description, switching modulator, Envelop detector.

Double side band-suppressed carrier modulation: Time and Frequency – Domain description,Ringmodulator,Coherentdetection,CostasReceiver,QuadratureCarrier Multiplexing.

Singleside–andvestigialsidebandmethodsofmodulation:SSBModulation,VSBModulation,FrequencyTranslation,Frequency-Division Multiplexing, Theme Example: VSB Transmission of Analog and Digital Television

UNIT-II

Angle modulation: Basic definitions, Frequency Modulation: Narrow Band FM, Wide Band FM, Transmission bandwidth of FM Signals, Generation of FM Signals, Demodulation of FM Signals, FM Stereo Multiplexing,

Phase–Locked Loop: Nonlinear model of PLL, Linear model of PLL, Nonlinear Effects in FM Systems. The Super-heterodyne Receiver

UNIT-III

Randomvariables&process:Introduction,Probability,ConditionalProbability,Randomvariables,SeveralRandomVariables.StatisticalAverages:Functionofarandomvariable,Moments,RandomProcesses,Mean,CorrelationandCovariancefunction:Propertiesofautocorrelationfunction,Cross–correlationfunctions.

Noise:ShotNoise,Thermalnoise,WhiteNoise,NoiseEquivalentBandwidth,NoiseFigure.

UNIT-IV

Noise in analog modulation: Introduction, Receiver Model, Noise in DSB-SC receivers, Noise in AM receivers, Threshold effect, Noise in FM receivers, Capture effect, FM threshold effect, FM threshold reduction, Pre-emphasis and De-emphasis in FM.

UNIT-V

Digitalrepresentationofanalogsignals: Introduction,WhyDigitizeAnalogSources?,TheSampling process, Pulse Amplitude Modulation, Time Division Multiplexing, Pulse-Position Modulation, Generation of PPM Waves, Detection of PPM Waves, The Quantization Process, Quantization Noise,

Pulse Code Modulation: Sampling, Quantization, Encoding, Regeneration, Decoding, Filtering, Multiplexing

Textbooks:

1. Principles of Communication Systems – H Taub& D. Schilling, Gautam Sahe, TMH, 2007, 3rd Edition.
2. Communication Systems–B.P.Lathi,BSPublication,2006.

References:

1. Principles of Communication Systems – Simon Haykin, John Wiley, 2nd Edition.
2. Electronics & Communication System – George Kennedy and Bernard Davis, TMH 2004.
3. Communication Systems–R.P. Singh,SPSapre,SecondEditionTMH,2007.

Course Outcomes:

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

1. Analyze the performance of analog modulation schemes in time and frequency domains.
2. Analyze the performance of angle modulated signals.
3. Characterize analog signals in time domain as random processes and noise
4. Characterize the influence of channel on analog modulated signals
5. Determine the performance of analog communication systems interms of SNR
6. Analyzepulseamplitudemodulation,pulsepositionmodulation,pulseco demodulationandTDMsystems

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MINOR Course		L	T	P	C
		3	0	0	4
SIGNAL ANALYSIS					

UNIT- I: INTRODUCTION: Definition of Signals and Systems, Classification of Signals, Classification of Systems, Operations on signals: time-shifting, time-scaling, amplitude-shifting, amplitude-scaling. Problems on classification and characteristics of Signals and Systems. Complex exponential and sinusoidal signals, Singularity functions and related functions: impulse function, step function signum function and ramp function. Analogy between vectors and signals, orthogonal signal space, Signal approximation using orthogonal functions, Mean square error, closed or complete set of orthogonal functions, Orthogonality in complex functions. Related Problems.

UNIT–II: FOURIER Analysis of Periodic Signals:
Fourier series representation of continuous time periodic signals, properties of Fourier series, Dirichlet's conditions, Trigonometric Fourier series and Exponential Fourier series, Relation between Trigonometric and Exponential Fourier series, Complex Fourier spectrum.

UNIT-III: FOURIER Analysis of Aperiodic Signals:
Deriving Fourier transform from Fourier series, Fourier transform of arbitrary signal, Fourier transform of standard signals, Fourier transform of periodic signals, properties of Fourier transforms, Fourier transforms involving impulse function and Signum function. Introduction to Hilbert Transform. Related Problems.

UNIT –IV:
CORRELATION: Auto-correlation and cross-correlation of functions, properties of correlation function, Energy density spectrum, Parseval's theorem, Power density spectrum, Relation between Convolution and correlation
SAMPLING THEOREM : Graphical and analytical proof for Band Limited Signals, impulse sampling, Natural and Flat top Sampling, Reconstruction of signal from its samples, effect of under sampling – Aliasing, Introduction to Band Pass sampling, Related problems.

UNIT –V:
LAPLACE TRANSFORMS: Introduction**,** Concept of region of convergence (ROC) for Laplace transforms, constraints on ROC for various classes of signals, Properties of L.T's, Inverse Laplace transform, Relation between L.T's, and F.T. of a signal.

Z–TRANSFORMS: Concept of Z- Transform of a discrete sequence. Region of convergence in Z-Transform, constraints on ROC for various classes of signals, Inverse Z-transform, properties of Z-transforms. Distinction between Laplace, Fourier and Z transforms.

TEXT BOOKS:

1. Signals, Systems & Communications - B.P. Lathi, BS Publications, 2003.
2. Signals and Systems - A.V. Oppenheim, A.S. Willsky and S.H. Nawab, PHI, 2ndEdn,1997

REFERENCE BOOKS:

1. Signals & Systems - Simon Haykin and Van Veen, Wiley, 2ndEdition,2007

Course Outcomes: At the end of this course the student will able to:

1. Differentiate the various classifications of signals and systems
2. Analyze the frequency domain representation of signals using Fourier concepts
3. Know the sampling process and various types of sampling techniques.
4. Apply Laplace and z-transforms to analyze signals and Systems (continuous & discrete).