ECE - (4 Year B.Tech Programme) - COURSE CURRICULUM R-20

III Year Course structure

Semester - I

Course Code	Title of the course	CAT	L	T	P	E	O	Total	Sessionals Marks	Semester end Exam marks	Total Marks	Credits
ECE311	Open Elective- I	OE	3	0	0	1	2	6	40	60	100	3
ECE312	Professional Elective-1	PE	3	0	0	1	2	6	40	60	100	3
ECE313	Digital communications	PC	3	0	0	1	5	9	40	60	100	3
ECE314	Embedded systems and IOT	PC	3	0	0	1	5	9	40	60	100	3
ECE315	Integrated circuits and Applications	PC	3	0	0	1	5	9	40	60	100	3
ECE316	Antennas and Propagation	PC	3	0	0	1	5	9	40	60	100	3
ECE317	Quantitative Aptitude & Verbal Aptitude-I	HS	0	0	3	1	3	7	100	0	100	1.5
ECE318	Embedded systems and IOT lab	PC	0	0	3	0	1	4	50	50	100	1.5
ECE319	AC& DC Laboratory	PC	0	0	3	0	1	4	50	50	100	1.5
ECE320	INTERNSHIP-I	PR							100		100	2
Total			18	0	9	7	29	63	540	460	1000	24.5

Semester – II

Course Code	Title of the course	Category	L	T	P	E	O	Total	Sessionals Marks	Semester end Exam marks	Total Marks	Credits
ECE321	Open Elective- II	OE	3	0	0	1	2	6	40	60	100	3
ECE322	Professional Elective-2	PE	3	0	0	1	4	8	40	60	100	3
ECE323	Professional Elective-3	PE	3	0	0	1	4	8	40	60	100	3
ECE324	Data structures	ES	3	0	0	1	5	9	40	60	100	3
ECE325	Digital signal processing	PC	3	0	0	1	5	9	40	60	100	3
ECE326	VLSI Design	PC	3	0	0	1	5	9	40	60	100	3
ECE327	Quantitative Aptitude-II & Soft skills	HS	0	0	2	2	3	7	100	0	100	1.5
ECE328	ICA Laboratory	PC	0	0	3	0	1	4	50	50	100	1.5
ECE329	DS lab	ES	0	0	3	0	1	4	50	50	100	1.5
Total			18	0	8	8	30	64	440	460	900	22.5

ELECTRONIC MEASUREMENTS AND INSTRUMENTATION	
ECE 312(a)	CREDITS: 3
Instruction: 3 Periods & 1 E/Week	Sessional Marks: 40
End Exam: 3 Hours	End Exam Marks: 60

Pre -requisites: Nil

Course Outcomes:

	By the end of the course, the student will be able to:
1.	Illustrate the operation of PMMC & EMMC along with their applications and measure various parameters with accuracy, precision and resolution.
2.	Illustrate the principle of operation and working of different electronic instruments.
3.	Apply the knowledge of cathode ray oscilloscopes and understand the functioning, specification, applications of signal analyzing instruments.
4.	Apply principles of measurement associated with different bridges.
5.	Select appropriate passive or active transducers for measurement of physical phenomenon

SYLLABUS

UNIT – I   [10 Periods]
BASIC MEASUREMENT CONCEPTS

Objectives of engineering measurement, performance characteristics-static and dynamic. Errors in measurement, sources of error, types of errors, statistical analysis, classification of standards, permanent magnet moving coil (PMMC) meter, DC ammeter, DC voltmeter, voltmeter sensitivity, series ohmmeter, shunt ohmmeter, Electrodynamometer, problems

UNIT – II   [15 Periods]
BASIC ELECTRONIC INSTRUMENTS

Instruments for measuring basic parameters-Amplified DC meter, AC voltmeter using rectifier, true RMS responding voltmeter, electronic multimeter, Q-meter, vector-impedance meter, vector voltmeter, rf and power measurement
DIGITAL INSTRUMENTS

Digital voltmeters and its different types-ramp, stair case ramp, integrating, continuous balance, successive approximation, resolution and sensitivity of digital meters, Digital multimeter, digital frequency meter, digital measurement of time, phase meter

UNIT – III   [15 Periods]
OSCILLOSCOPES AND SIGNAL ANALYSIS

Introduction, oscilloscope block diagram cathode ray tube, crt circuits, vertical deflection system, delay line, horizontal deflection system, oscilloscope probes and transducers, Measurement of amplitude, time, frequency and phase (Lissajous method). Principle of sampling oscilloscope, digital storage oscilloscope
SIGNAL ANALYSIS

Basic wave analyzer, heterodyne wave analyzer, harmonic distortion analyzer, spectrum analyzer

UNIT – IV   [10 Periods]
BRIDGE MEASUREMENTS

Wheatstone bridge, Kelvin bridge, digital read-out bridges, microprocessor controlled bridge AC bridges: Measurement of inductance-Maxwell's bridge, hay bridge, Anderson Bridge. Measurement of capacitance- Schering Bridge, measurement of frequency-Wien bridge, wagners earth connection

UNIT – V   **[10 Periods]**
TRANSDUCERS
Active and passive transducers: Measurement of displacement (Resistance, capacitance, inductance; LVDT) Force (strain gauges) Pressure (piezoelectric transducers) Temperature (resistance thermometers, thermocouples, and Thermistors), Velocity, Acceleration, vibration, pH measurement signal conditioning circuits, data acquisition systems, telemetry systems, IEEE 488 standard bus

TEXT BOOKS:
1. A.D.Helfrick and W.D.Cooper, "modern Electronic Instrumentation and Measurement Techniques", PHI, 5th edition, 2002
2. A.K.Sawhney, Electrical and Electronic Measurements and Instrumentation, 2002 edition

REFERENCE BOOKS:
1. H.S.Kalsi,"Electronic instrumentation", second edition, TMH, 2004.
2. Oliver and Cage,"electronic measurements and instrumentation, TMH

ELECTROMAGNETIC INTERFERENCE / COMPATABILITY

ECE 312(b)	Credits : 3
Instruction : 3 periods & 1 E/Week	Sectional Marks : 40
End Exam : 3 Hours	End Exam Marks: 60

Pre -requisites: Nil

Course Outcomes:

By the end of the course, the student will be able to:	
1.	Understand the concept of EMI / EMC, related to product design & development.
2.	Analyze the different EM coupling principles and its impact on performance of electronic system.
3.	Ensure that a designed system conforms itself to certain standard through a thorough understanding of various standards in different countries.
4.	Have broad knowledge of various EM radiation measurement techniques.
5.	Model a given electromagnetic environment/system so as to comply with the standards.

SYLLABUS

UNIT – I   [12 Periods]
INTRODUCTION TO OVERVIEW OF EMI/EMC/ESD/EMP

EM environment, Historical Notes, Problems of EMI, Frequency Conservation, Assignment & spectrum, practical experiences, Occurrence of EMI, Concepts of EMI/EMC-definitions, Sources of noise, Natural and Nuclear Sources of EMI, Conducted and Radiated Emissions and Susceptibility. Introduction - EMI Testing and Compliance Tests, ESD, EMP.

UNIT – II   [12 Periods]
ELIMINATION/REDUCTION METHODOLOGIES

Grounding Techniques, Shielding Techniques, Electrical Bonding Techniques, Cabling Techniques, Power Supply Filters, Power Supplies, Connectors and Components/ Accessories.

UNIT – III   [12 Periods]
EMC REGULATION/ STANDARDS

Introduction to different commercial and defense Standards like FCC, CISPR/IEC, VDE, IEEE/ ANSI, MIL-STD

UNIT – IV   [12 Periods]
EMI/EMC MEASUREMENT TECHNOLOGIES

Introduction to various instruments used in the measurements and their characteristics, Radiated Interference Measurements, Conducted Interference Measurements, Pitfalls in EMI Measurements, Measurements of pulsed EMI, Introduction of Measurement Environment – OATS, Anechoic Chamber, TEM, GTEM cell. Software in EMI/EMC Measurements, Different EMI Test Instruments and their comparisons.

UNIT – V   [12 Periods]
EMI/EMC MODELING

Modeling of filter for suppression of EMI in the design, choice of various electronic components, Pulse Interference Immunity, EMC computer modeling and Simulation, Signal Integrity EMC design, Guidelines, Probabilistic

TEXT BOOKS:

1. IMPACT, EMI/EMC for Engineering Colleges, RSTE ,1997.
2. Kodali, V.P., "Engineering EMC- Principles, Measurements, Technologies and Computer Models", 2nd Ed., IEEE Press, NY, 2000.

REFERENCE BOOKS:

1. Paul, R.C, "Introduction to EMC", 2nd Ed., John Wiley & Sons Inc., 2006

MICROELECTRONICS	
ECE 312(c)	**Credits : 3**
Instruction : 3 periods & 1 E /Week	Sectional Marks : 40
End Exam : 3 Hours	End Exam Marks: 60

Pre -requisites: Electronic circuits and analysis- I & Electronic circuits and analysis- II

Course Outcomes:

By the end of the course, the student will be able to:	
1.	Illustrate the process of IC fabrication techniques.
2.	Perform DC and AC analysis of the MOSFETs amplifiers.
3.	Illustrate the operation of current mirror circuits in IC amplifiers
4.	Analyze the MOS differential amplifiers.
5.	Design and analyze the CMOS logic circuits.

SYLLABUS

UNIT – I [09 Periods]

INTEGRATED- CIRCUIT FABRICATION

Monolithic Integrated - Circuit (microelectronics) technology- The planar processes - Bipolar Trasister Fabrication - Fabrication of FETs - CMOS Technology - Monolithic Diodes - The Metal – Semiconductor Contact - IC Resistor - IC Capacitors - IC Packaging- Characteristics of IC Components - Microelectronic circuit layout.

UNIT – II [09 Periods]

MOSFETs

Device Structure and Physical Operation, V-I Characteristics, MOSFET Circuits at DC, MOSFET as an amplifier and as a switch, Biasing in MOS amplifier Circuits, Small Signal Operation and Models, Basic MOSFET amplifier, MOSFET internal capacitances, frequency response of CS amplifier

UNIT – III [09 Periods]

INTEGRATED-CIRCUIT AMPLIFIERS

Cascade Amplifier: double cascading- folded cascode- BiCMOS cascodes- IC biasing: Current Sources-Current Mirrors. and Current-Steering Circuits-Cascode MOS mirrors-wilson and wildar current mirror

UNIT – IV [09 Periods]

DIFFERENTIAL AMPLIFIERS

The MOS differential pair, small signal operation of MOS differential pair, Differential amplifier with active loads, and frequency response of the differential amplifiers.

UNIT – V [09 Periods]

DIGITAL INTEGRATED CIRCUITS

Digital Logic Inverters: function of the inverter- Voltage Transfer function- Noise Margin-power dissipation- propagation delay- power-delay product-design abstraction and computer aids-CMOS Inverter- Dynamic operation of the CMOS inverter-inverter sizing-dynamic power dissipation

TEXT BOOKS:

1.Adel S.Sedra, Kenneth C.Smith Microelectronic circuits, Oxford University press, USA, sixth edition, 2009

2. Jacob Millman, Christos C. Halkias. Integated Electronics Analog and Digital Circuits ans Systems, Mcgraw-Hill, first Edition, 1972.

REFERENCE BOOKS:

1. Warner and Fordemwalt, Part 2 of Integrated Circuits, Design Principles and Fabrications by editors, 1965, Motorola Series, McGraw Hill.

2. Dr. William N. Carr and Dr. Jack P. Mize, MOS LSI Design and Applications, McGraw Hill, 1972.

DIGITAL COMMUNICATIONS

ECE 313	CREDITS: 3
Instruction: 3 Periods & 1 E /Week	Sessional Marks: 40
End Exam : 3 Hours	End Exam Marks: 60

Pre -requisites: Digital Electronics & Logic Design, Analog Communication, Electronic Circuit Analysis.

Course Outcomes:

By the end of the course, the student will be able to:	
1.	Compare and analyze baseband digital modulation techniques like PCM,DPCM and DM.
2.	Compare and analyze band pass digital modulation techniques like ASK,FSK and PSK.
3.	Calculate probability of error for various digital modulation techniques to analyze the performance of DCS in the presence of noise.
4.	Analyze the performance of spread spectrum code acquisition and tracking circuits.
5.	Illustrate the concepts of OFDM and PAPR.

SYLLABUS

UNIT – I   **[10 Periods]**
WAVEFORM CODING TECHNIQUES:
Analog to digital conversion- Pulse Code Modulation, Differential Pulse Code Modulation, Delta Modulation, Adaptive Delta Modulation, Noise in Pulse-Code and Delta-Modulation Systems.

UNIT – II   **[10 Periods]**
DIGITAL MODULATION TECHNIQUES
Binary Amplitude-Shift Keying, Binary Phase-Shift Keying, Differential Phase-Shift Keying, Quadrature Phase-Shift Keying (QPSK), M-ary PSK, MSK Generation Methods, Quadrature Amplitude Shift Keying (QASK), Binary Frequency Shift-Keying, M-ary FSK, Digital Multiplexing.

UNIT – III   **[10 Periods]**
DATA RECEPTION
A Base-band Signal Receiver, Probability of Error, The Optimum Filter, White Noise: The Matched Filter, Probability of Error of the Matched Filter, Coherent Reception: Correlation, Phase-Shift Keying, Frequency-Shift Keying, Non-coherent Detection of FSK, Differential PSK, QPSK, Error Probability for QPSK, MSK, Inter Symbol Interference,Comparison of Modulation Systems.

UNIT – IV   **[10 Periods]**
SPREAD SPECTRUM MODULATION:
Direct Sequence (DS) Spread Spectrum, Use of Spread Spectrum with Code Division Multiple Access (CDMA), Ranging using DS Spread Spectrum, Frequency Hopping (FH) Spread Spectrum, Generation and Characteristics of PN Sequence.

UNIT – V   **[10 Periods]**
INTRODUCTION TO OFDM:
Multi-carrier transmission; OFDM modulation & demodulation, BER; coded-OFDM; Orthogonal frequency-division multiple-access (OFDMA).OFDM Synchronization: Effect/estimation of symbol-time offset (STO); Effect/estimation of carrier-frequency offset (CFO).Peak-to-Average Power Ratio (PAPR) Concepts: Distribution of OFDM-signal amplitude; PAPR & oversampling, OFDM Applications.

TEXT BOOKS:

1 H.Taub and D.Schilling, "Principles of Communication Systems"- TMH, 2003.**[UNIT-I,II]**

2. P.Ramakrishna rao, "Digital Communications" – Mc,Graw Hill editon, 2011. **[UNIT-III,IV]**

3. Yong Soo Cho, Jaekwon Kim, Won Young Yang, Chung-Gu Kang , "MIMO-OFDM
   Wireless Communications with MATLAB" Wiley, 2010, ISBN: 978-0-470-82561-7   **[UNIT-V]**

REFERENCE BOOKS:

1. Simon Haykin, "Digital communications"- John Wiley, 2005.

2. B. P. Lathi, "Modern Digital and Analog Communication Systems," (2nd Edition).

EMBEDDED SYSTEMS AND IOT	
ECE314	**Credits:3**
Instruction: 3 Periods & 1 E/week	Sessional Marks:40
End Exam: 3 Hours	End Exam Marks:60

Pre -requisites: Microprocessors & Microcontrollers

Course Outcomes:

By the end of the course, the student will be able to:	
1.	Evaluate the Embedded system design flow from the requirements to the deployment level and analyze the hardware/software tradeoffs involved in the design of embedded systems.
2.	Acquire knowledge of the architecture of Raspberry Pi microcontroller and Install & Configure Raspberry Pi
3.	Explore the IoT conceptual frame work, IoT Architectural view and Understand the Technology behind IOT & Sources of IoT along with M2M communication
4.	Evaluate Design Principles for Connected Devices and analyze Data Enrichment, Data consolidation and device management at gateway
5.	Analyze various protocols of Web communication & Message communication for connected devices and Web connectivity for connected-devices

SYLLABUS

UNIT – I [10 Periods]
INTRODUCTION TO EMBEDDED SYSTEMS
Embedded systems overview, Design challenge – optimizing design metrics, Embedded processor technology: General-purpose processors – software, Single-purpose processors – hardware, Application-specific processors; IC technology: Full-custom/VLSI, Semicustom ASIC (gate array and standard cell), PLD; Design Technology: Compilation/Synthesis, Libraries/IP, Test/Verification, Other productivity improvers;

UNIT – II [12 Periods]
INTRODUCTION TO THE RASPBERRY PI'S ARCHITECTURE AND SETUP
History and background of the Raspberry Pi, Basic hardware needed, The microSD card – the main storage and boot device of the Raspberry Pi 2, Installing Screen and Vim, Running tests on the OS and configuration changes

UNIT – III [10 Periods]
INTERNET OF THINGS: AN OVERVIEW
Internet of things: IoT Definition, IoT Vision, Smart and Hyper connected Devices; IoT conceptual frame work, IoT Architectural view, Technology behind IOT: Server-end Technology, Major Components of IoT System, Development Tools and Open-source Framework for IoT Implementation, APIs and Device Interfacing Components, Platforms and Integration Tools; Sources of IoT: Popular IoT Development Boards, Role of RFID and IoT Applications, Wireless Sensor Networks (WSNs); M2M communication: M2M to IoT, M2M Architecture, Software and Development Tools; Examples of IoT: Wearable Smart Watch, Smart Home, Smart Cities

UNIT – IV [10 Periods]
DESIGN PRINCIPLES FOR CONNECTED DEVICES
Introduction, IoT and M2M Systems layers, and design standardization, Communication technologies, Data Enrichment, Data consolidation and device management at gateway, Ease of designing and affordability

UNIT – V   **[12 Periods]**
DESIGN PRINCIPLES FOR WEB CONNECTIVITY
Introduction, Web communication protocols for connected devices, Message communication protocols for connected devices, Web connectivity for connected-devices network using Gateway, SOAP, REST, HTTP RESTful, and Web sockets

TEXT BOOKS:
1. Frank Vahid, Tony Givargis, Embedded System Design, 2nd Edition, John Wiley.
2. Andrew K. Dennis , Raspberry Pi Computer Architecture Essentials, 1st edition, Packt Publishing,2016
3. Raj Kamal, INTERNET OF THINGS Architecture and Design Principles, 1st edition, McGraw Hill Education (India) Private Limited, 2017

REFERENCE BOOKS:
1. David E. Simon, An Embedded Software Primer, Pearson Education
2. Wayne Wolf, Computers as Components-principles of Embedded computer system design, Elsevier

INTEGRATED CIRCUITS AND APPLICATIONS	
ECE 315	**Credits:3**
Instruction: 3 Periods & 1 E/week	Sessional Marks:40
End Exam: 3 Hours	End Exam Marks:60

Pre -requisites: ECA-I, ECA-II

Course Outcomes:

By the end of the course, the student will be able to:	
1.	Familiarization of op-amp DC and AC characteristics
2.	Design linear and nonlinear applications of Op-amp
3.	Analyze the applications of Timer IC 555 and PLL
4.	Design ADC and DAC using Op-amps
5.	Synthesize waveforms using Op-amp Circuits and design a regulator circuits using Voltage Regulator ICs

SYLLABUS

UNIT – I   **[09 Periods]**
INTRODUCTION TO OPERATIONAL AMPLIFIERS
Basic block diagram of op-amp, internal stages of op-amp, ideal and practical specifications of op-amp, DC and AC characteristics, Open and closed loop configurations.

UNIT – II   **[09 Periods]**
APPLICATIONS OF OPERATIONAL AMPLIFIERS
Adder, Subtractor, V-to-I and I-to-V converters, Instrumentation amplifier, Integrator, Differentiator, Log and Antilog amplifier, Comparators, Schmitt trigger, Precision rectifier, peak detector, clipper and clamper.

UNIT – III   **[09 Periods]**
TIMER IC 555 AND PLL
Timer IC 555 operating modes and its applications, Operation of PLL, Voltage controlled oscillator, Monolithic PLL IC 565, application of PLL for AM and FM detection, FSK.

UNIT – IV   **[09 Periods]**
ANALOG-TO-DIGITAL AND DIGITAL-TO-ANALOG CONVERTERS
A/D Converter, Flash type, Successive Approximation type, Single Slope type and Dual Slope type, D/A converter, weighted resistor type, R-2R Ladder type: Voltage Mode and Current-Mode
ACTIVE FILTERS
First and second order filters: Low-pass, high-pass, band-pass, band-reject and All pass filter.

UNIT – V   **[09 Periods]**
WAVEFORM GENERATORS AND VOLTAGE REGULATOR ICs
Sine wave generators: wein bridge, quadrature; Multivibrators and Triangular wave generator, IC Voltage regulators – fixed and adjustable voltage regulators, Monolithic switching regulator, Switched capacitor filter, Frequency-to-Voltage and Voltage-to-Frequency converters

TEXT BOOKS:
1. Ramakant A. Gayakwad, OP-AMP and Linear ICs, Prentice Hall, Fourth Edition, 2001.
2. Sergio Franco, Design with Operational Amplifiers and Analog Integrated Circuits, Tata Mc Graw-Hill, Third Edition, 2007.

REFERENCE BOOKS:

1. Roy Choudhry D, Shail Jain, Linear Integrated Circuits, New Age International, Fourth Edition, 2012.
2. Sonde B.S., System design using Integrated Circuits, New Age International, Second Edition, 2001

ANTENNAS AND PROPAGATIONS	
ECE 316	**Credits : 3**
Instruction : 3 periods & 1 E/Week	Sessional Marks : 40
End Exam : 3 Hours	End Exam Marks: 60

Pre -requisites: EMFT

Course Outcomes:

	By the end of the course, the student will be able to:
1.	Analyze the basic antenna parameters by applying the concepts and properties of electromagnetism.
2.	Determine the fundamental parameters of practical antennas operating at various frequencies from LF to Microwave applications.
3.	Analyze & design the linear antenna arrays.
4.	Assess antenna performance y using suitable measurement technique.
5.	Identify & Analyze the characteristics of radio wave propagation.

SYLLABUS

UNIT – I [12 Periods]
RADIATION MECHANISM AND ANTENNAS BASICS
Antenna definition, Functions of antennas, Network theorems, Properties of antennas, Antenna parameters. Radiation mechanism, Radiation fields of alternating current element, Radiated power and radiation resistance; Radiation, induction and electrostatic fields. Different current distributions in linear antennas, Radiation from half-wave dipole, quarter wave mono pole and their characteristics. Radiation patterns of alternating current element, dipoles and monopoles.

UNIT – II [12 Periods]
TYPES OF ANTENNAS & APPLICATIONS
Introduction, Isotropic radiators, Directional antennas, omnidirectional antennas, Resonant antennas, Non-resonant antennas, LF, HF, VHF and UHF antennas. Folded dipole, V-Antennas, Inverted V-antennas, Rhombic antenna, Yagi-Uda antenna, Log-periodic antennas, Loop antenna, Helical antennas. Microwave Antennas: Rod reflector, Plane reflector, Corner reflector, Parabolic reflector, Types of parabolic reflectors, Feed systems for parabolic reflectors, Horn antennas, Corrugated horns, Slot antennas, Babinet's principle, Lens antennas, Microstrip patch antenna and feeding techniques & IOT antennas.

UNIT – III [12 Periods]
ANALYSIS & SYNTHESIS OF LINEAR ARRAYS
Two-element uniform array, Uniform linear arrays, Field strength of a uniform linear array, First side-lobe ratio (SLR), Broadside and End-fire arrays, Patterns of array of non-isotropic radiators, Multiplication of patterns, Generalized expression for principle of pattern multiplication, Radiation pattern characteristics, Binomial arrays. Transmission loss between transmitting and receiving antennas - FRIIS formula, Antenna temperature and signal-to-noise ratio. Schelkunoff Synthesis methods, Linear array design by Woodward-Lawson method, Dolph-Chebychev method (Tschebyscheff distribution), Standard amplitude distributions. Introduction to phased arrays.

UNIT – IV [12 Periods]
ANTENNA MEASUREMENTS
Introduction, Drawbacks of measurements of antenna parameters, Methods to overcome drawbacks in measurements, Methods for accurate measurements, TEM cell, GTEM cell, Anechoic chamber,

Measurement ranges, Indoor and outdoor ranges, Antenna impedance measurements, Measurement of radiation resistance, Gain measurements, Measurement of antenna bandwidth, Directivity measurement, Measurement of side-lobe ratio, Measurement of radiation efficiency, Measurement of antenna aperture efficiency, Measurement of polarization of antenna, Phase measurement.

UNIT – V   **[12 Periods]**
PROPAGATION
Propagation characteristics of EM Waves, Factors involved in the propagation of radio waves, Ground wave propagation, Ground wave field strength by Maxwell's equations, Reflection of radio waves by the surface of the earth, Roughness of earth, Reflection factors of earth, Wave tilt of the ground wave, Tropospheric wave propagation, Atmospheric effects in space wave propagation, Duct propagation, Radio horizon, Troposcatter, Fading of EM waves in Troposphere, Line of sight (LOS), Ionospheric propagation, Characteristics of ionosphere, Refractive index of ionosphere, Phase and group velocities, Mechanism of Ionospheric propagation, reflection and refraction, Characteristic parameters of Ionospheric propagation, Sky wave field strength, Fading and diversity techniques, Faraday's rotation, Effect of earth's magnetic field.

TEXT BOOKS:
1. C.A. Balanis, Antenna Theory, John Wiley & Sons, NY, 3rd edn., 2005.
2. G.S.N. Raju, Antennas and Wave Propagation, Pearson Education (Singapore) Pvt., Ltd., New Delhi, 2007.

REFERENCE BOOKS:
1. E. C. Jordan and K. G. Balmain, EM Waves and Radiation Systems, PHI – N. Delhi,2nd Edn., 2000.
2. J.D. Kraus, Antennas, McGraw Hill, NY,2nd Edn., 1988.

EMBEDDED SYSTEMS AND INTERNET OF THINGS (IOT) LABORATORY

ECE 318	Credits:1.5
Instruction: 3 Practical & 1 O/Week	Sessional Marks:50
End Exam: 3 Hours	End Exam Marks:50

Pre -requisites: Embedded systems & IoT

Course Outcomes:

By the end of the course, the student will be able to:	
1.	Interface various input and output devices with Raspberry pi.
2.	Design the minimum system for sensor-based application.
3.	Solve the problems related to the primitive needs using IoT.
4.	Develop full-fledged IoT application for distributed environment.

SYLLABUS (List of Experiments)	
S.No	Name of the Experiment
1.	Familiarization of Raspberry pi 4 and its installation.
2.	Interface and control LED/Buzzer with Raspberry pi 4.
3.	Interface push button/digital sensors with Raspberry pi 4.
4.	Read the humidity using Raspberry pi 4.
5.	Operate the motor through relay using Raspberry pi 4.
6.	Send the sensor data through Bluetooth using Raspberry pi 4.
7.	Control LED/Buzzer with Raspberry pi 4 using Bluetooth.
8.	Upload and retrieve humidity and temperature data to thingspeak cloud using Raspberry pi 4.
9.	Control the lights in a room using Raspberry pi 4 (based on user requirements).
10.	Control 230 V devices for a threshold temperature using Raspberry pi 4.
11.	Control 230 V devices using Raspberry pi 4 from a remote location.
12.	IoT based Project

Note: Students have to perform minimum of eight experiments (from Exp.1 to 11) and IoT based project.

TEXT BOOKS:

1. Vijay Madisetti, Arshdeep Bahga," Internet of Things A Hands-On- Approach",2014, ISBN:978 0996025515.

REFERENCE BOOKS:

1. Adrian McEwen, "Designing the Internet of Things", Wiley Publishers, 2013, ISBN: 978-1-118-43062-0
2. Daniel Kellmereit, "The Silent Intelligence: The Internet of Things". 2013, ISBN 0989973700.

COMMUNICATIONS LABORATORY

ECE 319	Credits:1.5
Instruction: 3 Practical & 1 O/Week	Sessional Marks:50
End Exam: 3 Hours	End Exam Marks:50

Pre -requisites: Analog Communications, Digital Communications

Course Outcomes:

By the end of the course, the student will be able to:	
1.	Evaluate the performance of analog and digital modulation - demodulation techniques.
2.	Implement analog and digital pulse modulation and demodulation methods.
3.	Analyze the performance of Super Heterodyne Radio Receiver.
4.	Analyze source/channel encoding & decoding methods.
5.	Simulate functional blocks of analog and digital communication system using MATLAB.

SYLLABUS (List of Experiments)	
S.No	NAME OF THE EXPERIMENT
	(Trainer Kit Based Experiments)
1.	Amplitude Modulation & Demodulation
2.	Frequency Modulation & Demodulation
3.	Balanced Modulator &synchronous Detector
4.	Generation and Detection of FSK.
5.	Generation and Detection of DPSK.
6.	Pulse Amplitude - Pulse Position Modulation & Demodulation
7.	Generation and Detection of Pulse Code Modulation for both A.C and D.C signals
8.	Generation and Detection of Delta Modulation
9.	Super Heterodyne Radio Receiver
10.	Linear Block code-Encoder and Decoder
11.	Convolution code-Encoder and Decoder
	Simulation based experiments(open source/MATLAB/MULTISIM)
12.	Amplitude Modulation & Demodulation
13.	Frequency Modulation & Demodulation
14.	Amplitude Shift Keying
15.	Phase Shift keying

DIGITAL IC DESIGN USING HDL

ECE 322(a)	**Credits:3**
Instruction : 3 periods & 1 E/Week	Sessional Marks:40
End Exam : 3 Hours	End Exam Marks:60

Pre -requisites: Digital Electronics, Computer Architecture & Organization, Integrated Circuits and Applications

Course Outcomes:

By the end of the course, the student will be able to:	
1.	Interpret the importance of EDA tools and its flow for VLSI designs
2.	Model logic gates ,half adder, full adder ,various digital blocks by using modern tools with HDL
3.	Construct verilog HDL models for combinational and sequential circuits using gate level, behavioral level and dataflow level
4.	Build CMOS circuits using Verilog switch level programming
5.	Apply design rule checks and timing parameters to digital circuits and model the state machines

SYLLABUS

UNIT – I   **[10 Periods]**

INTRODUCTION TO ELECTRONIC DESIGN AUTOMATION

Introduction, FPGA Design flow, ASIC Design flow, architectural design, logic design, Physical design of IC. Simulation, verification and testing. EDA Tools: FPGA Design, ASIC Design.
FPGA Based Front End Design-Implementation, FPGA configuration.

UNIT – II   **[10 Periods]**

VERILOG LANGUAGE CONSTRUCTS

Verilog as HDL, Levels of Design Description, Concurrency, Simulation and Synthesis, Functional Verification, System Tasks, Programming Language Interface (PLI), Module, Simulation and Synthesis Tools, Test Benches. Keywords, Identifiers, White Space Characters, Comments, Numbers, Strings, Logic Values, Strengths, Data Types, Scalars and Vectors, Parameters, Memory, Operators, System Tasks, Exercises

UNIT – III   **[10 Periods]**

GATE LEVEL MODELING AND DATAFLOW MODELING

AND Gate Primitive, Module Structure, Other Gate Primitives, Tri-State Gates, Array of Instances of Primitives, Additional Examples, Design of Flip-flops with Gate Primitives, Delays, Strengths and Contention Resolution, Net Types, Design of Basic Circuits, Exercises. Continuous Assignment Structures, Delays and Continuous Assignments, Assignment to Vectors, Operators.

UNIT – IV   **[10 Periods]**

BEHAVIORALAND SWITCH LEVEL MODELING

Introduction, Operations and Assignments, Functional Bifurcation, Initial Construct, Always Construct, Examples, Assignments with Delays, Wait construct, Multiple Always Blocks, Designs at Behavioral Level, Blocking and Non blocking Assignments, The case statement, Simulation Flow. If and if-else constructs, repeat construct, for loop, , while loop, forever loop, parallel blocks, force-release construct, Event. Basic Transistor Switches, CMOS Switch, Bi-directional Gates, Time Delays with Switch Primitives, Instantiations with Strengths and Delays, Strength Contention with Tri-reg Nets, Exercises

UNIT – V   **[10 Periods]**
SYSTEM TASKS, FUNCTIONS, UDP AND SM CHARTS
Introduction, Parameters, Path Delays, Module Parameters, System Tasks and Functions. Compiler Directives, Hierarchical Access, General observations, Exercises. User-Defined Functions, Tasks and Primitives-Introduction, Function, Tasks, User- Defined Primitives (UDP), FSM Design (Moore and Mealy Machines), State Machine Charts, Derivation of SM Charts, Realization of SM Charts, Examples based on SM charts

TEXT BOOKS:
1. T.R. Padmanabhan and B. Bala Tripura Sundari," Design through Verilog HDL" WSE, IEEE Press, 2004**(UNIT-I,II,III,IV &V)**
2. J. Bhaskar" A Verilog Primier" ,First edition ,BSP, 2003**(UNIT-I,II,III,IV &V)**

REFERENCE BOOKS:
1. Brown and ZvonkoVranesic Stephen" Fundamentals of Logic Design with Verilog "TMH, 2005.
2. Michael D. Ciletti "Advanced Digital Design with Verilog HDL ",Second edition, PHI, 2005.

BIOMEDICAL INSTRUMENTATION

ECE 322(b)	Credits:3
Instruction: 3 Periods & 1 E/week	Sessional Marks:40
End Exam: 3 Hours	End Exam Marks:60

Pre -requisites: Nil

Course Outcomes:

By the end of the course, the student will be able to:	
1.	Infer the physical foundations of biological systems and bioelectric potentials in medical field
2.	Analyze electrical and non-electrical parameter in the human body
3.	Illustrate the concepts of medical assisting and therapy equipment
4.	Outline various clinical instruments and image modalities applicable in medical field
5.	Illustrate on electrical safety, hazards, protection against shock and testing of medical equipment

SYLLABUS

UNIT – I [10 Periods]

Introduction: Introduction to biomedical engineering field, Components of man instrument system, Problems encountered in measuring a living system.

Physiological Systems of the Body: Basic features of cardiovascular system, Nervous system, Muscular system, Respiratory system.

Resting Potential & Action Potential Concepts: Resting potential concept, Characteristics of resting potential, Action potential concept, Propagation of action potential.

Bio-electric Potentials: Bio-electric potential, Electro physiology of nerve and nerve to muscle function, Transmission of impulse from nerve to muscle, Evoked potentials.

UNIT – II [10 Periods]

Electrical and Non-Electrical Parameter Acquisition and Measurement: Electrodes, ECG, EEG, EMG Lead systems and recording methods, Typical waveforms, Measurement of blood pressure, Cardiac output, Heart sounds

UNIT – III [10 Periods]

Assisting and Therapeutic Instruments: Pacemakers, Defibrillators, Ventilator, Anesthesia machine, Nerve and muscle stimulator, Heart lung machine, Dialyzers, Diathermy, Audiometers

UNIT – IV [10 Periods]

Instruments in Clinical Laboratory: Blood gas analyzers: Measurement of blood pH, pCO2, pO2, Finger-tip oximeter, Blood cell counters

Imaging Modalities in Bio-Medical Field:

Use of X-Rays in medicine, X-ray machine, CT scan, MRI scan, PET, SPECT, Ultrasonography

UNIT – V [10 Periods]

Electrical safety: Physiological effects of electricity, Important susceptibility parameters, Macro shock hazards, Micro shock hazards, Electrical safety codes and standards, Basic approaches to protection against shock, Protection: Power distribution and Equipment design, Electrical safety analysers, Tests of the grounding system in patient-care areas, Tests of electric appliances

TEXT BOOKS:
1. Leslie Cromwell, Fred J Weibell and Erich A Pfeiffer, "Biomedical Instrumentation and Measurements", 2nd Edition, Pearson, 2003**(UNIT-I,II,&III)**
2. Khandpur R.S, "Hand Book of Biomedical Instrumentation", Tata McGraw Hill publication, New Delhi 2nd edition 2003.(**UNITS - IV &V)**

REFERENCE BOOKS:
1.John G. Webster, "Medical Instrumentation-Application and Design", 3rd Ed., John Wiley & Sons, Inc., 1998.
2. Dr M. Arumugam, "Biomedical Instrumentation", 2nd Ed., Anuradha publications, 2009

OPTICAL COMMUNICATION	
ECE 322(c)	**Credits:3**
Instruction: 3 Periods & 1 E/week	Sessional Marks:40
End Exam: 3 Hours	End Exam Marks:60

Prerequisites: Basic of Optics, Electromagnetic Theory, Communication systems, and Computer networks

Course Outcomes:

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

1.	Illustrate the structure and fabrication methods of Optical fibers
2.	Analyze the channel impairments: losses and dispersion
3.	Analyze the Optical sources (LED and LASER) and detectors (PIN and Avalanche Photo diode).
4.	Apply design considerations to analog and digital fiber optic systems
5.	Analyze the components of fiber optic networks: Couplers, multiplexers, switches and filters.

SYLLABUS

UNIT I **[10 Periods]**

Introduction To Optical Communications: Evolution of fiber optic communications - Basic elements of an optical fiber communication link – Structure of optical fiber waveguide – Total internal reflection -single mode & multimode fibers- Step-index and graded index fibers – fiber fabrication – optical fiber cables.

UNIT II **[10 Periods]**

Signal Degradation In Optical Fibers: Signal attenuation in optical fibers- Modal analysis - single mode and multi-mode fibers - Dispersion effects: intermodal & chromatic dispersion – Bit rate & bandwidth.

UNIT III **[10 Periods]**

Optical Sources & Optical Detectors: LED & its types - Semiconductor Laser diode, types of LD- Source to Fiber Power launching and coupling – PIN and Avalanche photodiodes (APD) - Noise sources in photodetectors

UNIT IV **[8 Periods]**

Design Considerations of Fiber Optic Systems: System Design Considerations-Optical Tx/Rx Circuits -
Link Power Budget & Rise time Budget of point-to-point digital links

UNIT V **[12 Periods]**

WDM, Components, Networks: WDM operation principles, passive optical Couplers – Isolators and circulators, Fiber gratings – optical network -SONET/SDH - FTTH – Optical switching – Wideband & Narrowband WDM Networks.

TEXT BOOKS:

1. Gerd Keiser, Optical Fiber Communications, 5th Ed., Tata McGraw Hill, 2017
2. Rajiv Ramaswami, Kumar Sivarajan and Galen Sasaki, Optical Networks: A Practical Perspective, Morgan Kaufmann, 3rd ed., 2009

REFERENCE BOOKS:

1. John Senior, Optical Fiber Communications – Principles and practice, 3rd Ed. Pearson, 2008
2. DjafarMynbaev and Lowell Scheiner, Fiber-Optic Communications Technology, Pearson education, 2001

INFORMATION THEORY AND CODING	
ECE 323(a)	**Credits:3**
Instruction: 3 Periods & 1 E/week	Sessional Marks:40
End Exam: 3 Hours	End Exam Marks:60

Prerequisites: Digital Electronics, Digital Communications.
Course Outcomes:
At the end of the course, students will be able to

1.	Evaluate the parameters of Digital data over discrete channels / Calculate information entropy and mutual information for discrete channel.
2.	Compare efficiency of Source coding techniques / Decide an efficient source coding for a given information source.
3.	Implement linear block coding-decoding and comprehend error detection and correction.
4.	Implement Cyclic coding-decoding and comprehend error detection and correction.
5.	Design convolution encoder and perform Convolution coding-decoding.

SYLLABUS

UNIT I   **[10 Periods]**
INFORMATION THEORY
Measure of Information and its Properties,Entropy and its Properties, Joint Entropy, Marginal Entropy, Conditional Entropy, Information rate, Mutual Information and its Properties, Discrete Memoryless Channels,Rate of Information over Discrete Channels, Capacity of Binary Symmetric Channel

UNIT II   **[10Periods]**
SOURCE CODING
Shannon Fano Algorithm, Huffman Binary Coding, Huffman Ternary Coding, Huffman Quaternary Coding, Shannan Hartley Theorem, Trade-off Between S/N Ratio and Bandwidth, Ideal Communication system.

UNIT III   **[10 Periods]**
LINEAR BLOCK CODES
Introduction to Linear Block Codes, Matrix Description of Generator Matrix & Parity Check Matrix, Linear Block codes Generation, Minimum Distance of a Block code, Error-Detecting and Error-correcting Capabilities of a Block code, Syndrome Decoding, Standard array and Hamming Codes.

UNIT IV   **[10Periods]**
CYCLIC CODES
Encoders and Decoders for Cyclic Codes, Generator matrix Systematic and Non systematic form, Binary Cyclic code generation in systematic and Non systematic form, Syndrome decoding for cyclic codes.

UNIT V   **[10 Periods]**
CONVOLUTION CODES
Convolution Encoder, Generation in Time Domain and Frequency domain ,Code Tree, Code Trellis, State Diagram, Viterbi Decoding and Sequential Decoding.

TEXT BOOKS:

1. Communication Systems, by A.B. Carlson, Mc. Graw Hill Publishers
2. Digital Communications by Simon Haykin , John Wiley & Sons

REFERENCE BOOKS:

1.Digital Communications- John G. Proakis, 5th ed., , TMH.
2.Information Theory, Coding and Cryptography, Ranjan Bose.

WIRELESS SENSOR NETWORKS	
ECE 323(b)	**Credits:3**
Instruction: 3 Periods & 1 E/week	Sessional Marks:40
End Exam: 3 Hours	End Exam Marks:60

Prerequisites: Telecommunication Switching & Networks, Computer Network Engineering, Communication Systems Engineering.

Course Outcomes:

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

1.	Adapt the basic concepts of wireless sensor networks, sensing, computing and communication tasks
2.	Explain the architectures, features, and performance for wireless sensor network systems and platforms
3.	Describe and explain radio standards and communication protocols adopted in wireless sensor networks
4.	Illustrate allocation of addresses and management of names in wireless sensor networks
5.	Able to apply appropriate algorithms to improve existing or to develop new wireless sensor network applications

SYLLABUS

UNIT I   **[12 Periods]**

Introduction to Wireless Sensor Networks: Ambient Intelligence, Types of Applications, Challenges for WSNs, Differences between mobile ad hoc networks and wireless sensor networks, Enabling Technologies for Wireless Sensor Networks.

Single-Node Architecture: Hardware Components, Operating Systems and Execution Environments: Embedded operating systems, Programming paradigms and application programming interfaces

UNIT II   **[8 Periods]**

Network Architecture: Sensor Network Scenarios, Optimization goals and figures of merit, Design principles for WSNs - Distributed organization, In-network processing, Adaptive fidelity and accuracy.

Physical Layer and Transceiver Design Considerations - Energy usage profile, Choice of modulation scheme

UNIT III   **[12 Periods]**

MAC Protocols for Wireless Sensor Networks: Fundamentals of (wireless) MAC protocols: Requirements and design constraints for wireless MAC protocols, Important classes of MAC protocols, MAC protocols for wireless sensor networks, Low duty cycle protocols – STEM, Contention-based protocols: CSMA protocols, Schedule-based protocols: LEACH.

UNIT IV   **[8 Periods]**

Naming and addressing: Fundamentals, Use of addresses and names in sensor networks, Address management tasks, Uniqueness of addresses, Address allocation and assignment, Addressing overhead, Address and name management in wireless sensor networks

UNIT V   **[10 Periods]**

Localization and positioning: Properties of localization and positioning procedures, Possible approaches, Proximity, Trilateration and triangulation, Mathematical basics for the lateration problem, Single-hop localization: Active Badge, Active office, RADAR.

TEXT BOOKS:
1. Holger Karl & Andreas Willig, "Protocols And Architectures for Wireless Sensor Networks", John Wiley, 2005 **[UNIT- I-V]**
2. KazemSohraby, Daniel Minoli, &TaiebZnati, "Wireless Sensor Networks- Technology, Protocols, and Applications", John Wiley, 2007. **[UNIT- V]**

REFERENCE BOOKS:
1. C. S. Raghavendra, Krishna M. Sivalingam, Wireless Sensor Networks, Springer, 2004.
2. S Anandamurugan, Wireless Sensor Networks, Lakshmi Publications

ANALOG IC DESIGN

ECE 323(c)	Credits : 3
Instruction : 3 Periods & 1 Tut/Week	Sessional Marks : 40
End Exam : 3 Hours	End Exam Marks : 60

Prerequisites:

Network Analysis and Synthesis, Electronic Circuits Analysis-I, Electronic Circuits Analysis-II

Course Outcomes:

By the end of the course, the student will be able to:
1. Understand the basic MOS device physics and models
2. Analyze and design single stage amplifiers
3. Analyze and design differential amplifiers
4. Analyze and design current sources/sinks/mirrors
5. Analyze and design basic operational amplifiers circuits

Mapping of Course Outcomes with Program Outcomes & Program Specific Outcomes:

		PO												PSO		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C O	1	2	2	1	-	-	-	-	-	-	-	-	2	1	1	1
	2	2	2	1	-	1	-	-	-	-	-	-	2	1	1	1
	3	2	2	2	2	2	-	-	-	-	-	-	2	1	1	1
	4	2	2	1	-	-	-	-	-	-	-	-	1	1	1	1
	5	2	2	1	-	-	-	-	-	-	-	-	2	1	1	1

SYLLABUS

UNIT-I: **12 Periods**

Basic MOS Device Physics:

MOSFET as a switch, MOSFET structure and symbols, Threshold voltage, Derivation of I-V characteristics, second order effects.

UNIT-II: **12 Periods**

Device Modeling:

DC Models, Small signal models, use of device models in circuit analysis, DC MOSFET model, and small signal MOSFET model, High frequency MOSFET Model, Measurement of MOSFET Model parameters.

UN IT-III: **12 Periods**

Single stage amplifiers:

Basic concepts, CS stage with resistive load, CS stage with diode connected load, CS stage with Current-Source load, CS stage with Triode load, CS stage with Source degeneration, Source follower, Common gate stage, Cascode stage

UNIT-IV: **12 Periods**

Differential amplifiers:

Single ended and differential operation, qualitative and quantitative analysis of Basic differential pair, common mode response, differential pair with MOS Loads

Passive and Active current mirrors: Basic current mirrors, Cascode current mirrors, Active current mirrors.

UNIT-V: **12 Periods**

Operational amplifiers:

Performance parameters, one stage op-amps, two stage op-amps, gain boosting, common mode feedback, input

range limitations, slew rate, power supply rejection.

Text books:
1. Behzad Razavi , *Design of Analog CMOS Integrated Circuits,* Tata McGraw-Hill, 1st edition, 2002.
2. Randall Geiger, Phillip Allen, Noel Strader, *VLSI Design Techniques for Analog and Digital Circuits,* Tata McGraw-Hill, 1st edition, 2010.

References:
1.   Douglas R. Holberg, P. E. Allen Phillip E. Allen, *CMOS Analog Circuit Design,* 2nd edition, 2002

DATA STRUCTURES

ECE 324		**Credits:3**
Instruction: 3 Periods & 1 E/week		Sessional Marks:40
End Exam: 3 Hours		End Exam Marks:60

Pre -requisites: Mathematics, Signals and Systems

Course Outcomes:

By the end of the course, the student will be able to:	
1.	Analyze and apply linear data structures -arrays and their applications.
2.	Interpret linear data structures -stacks and queues and their applications.
3.	Implement linear data structures -Linked List and their operations.
4.	Implement tree traversal techniques and operations on binary search tree.
5.	Apply Non-linear data structures-graph algorithms to implement graph applications and graph traversals.

SYLLABUS

UNIT – I   [12 Periods]
ARRAYS AND STACKS
Introduction: Basic Terminology, Elementary Data Organization, Data Structure operations, Algorithm Complexity and Time-Space trade-off.
Arrays: Array Definition, Representation and Analysis, Single and Multidimensional Arrays, address calculation, application of arrays, Array as Parameters, Sparse Matrices.
Searching: Sequential search, binary search, Interpolation Search, comparison and analysis, Hash Table, Hash Functions, collision resolution techniques-linear probing, quadratic probing, separate chaining, Double hashing.
Sorting: Insertion Sort, Bubble Sort, Selection sort, Merge Sort, Quick Sort.

UNIT – II   [15 Periods]
STACKS
Array Representation and Implementation of stack, Operations on Stacks: Push & Pop, Application of stack: Conversion of Infix to Prefix and Postfix Expressions, Evaluation of Postfix expressions using stack, Recursion, Towers of Hanoi Problem.
QUEUES AND LINKED LIST
Queues: Array representation and implementation of queues, Operations on Queue: Insert, Delete, Display, Full and Empty. Operations on-Circular queue, De-queue, and Priority Queue, Applications of Queues.

UNIT – III   [12 Periods]
LINKED LIST
Representation and Implementation of Singly Linked Lists, Traversing and Searching of Linked List, Insertion and deletion to/from Linked Lists, operations on-Doubly linked list, Circular Doubly linked list, implementing priority queue using Linked List, Polynomial representation using Linked list & addition of polynomials.

UNIT – IV   **[12 Periods]**
TREES
Basic terminology, Binary Trees, Binary tree representation- Array and Linked list Representation of Binary trees, Full Binary Tree, Complete Binary Tree, Traversing Binary trees- in-order, pre-order, post-order, introduction to Threaded Binary trees
BINARY SEARCH TREES
Binary Search Tree (BST), Insertion and Deletion in BST, Complexity of Search Algorithm, AVL Trees-Rotations, Balance factor, operations-insert, delete, display

UNIT – V   **[12 Periods]**
GRAPHS
Terminology & Representations- Graphs, Directed Graphs, Adjacency Matrices, Adjacency List, Path OR Transitive Closure of a Graph, Warshall‟s Algorithm, Shortest path Algorithm- Dijkstra‟s Algorithm, Connected Component and Spanning Trees, Minimum Cost Spanning Trees- Kruskal's, prims algorithms, Graph Traversals.

TEXT BOOKS:
1. Y. Langsam, M. Augenstin and A. Tannenbaum, "Data Structures using C and C++",Pearson Education, 2nd Edition, 1995.
2. Mark Allen Weiss, "Data Structures and Algorithm Analysis in C", Second Edition,Pearson Education.

REFERENCE BOOKS:
1. E.Horowitz and Sahani, "Fundamentals of Data Structures"
2. P. Padmanabham, C Programming and Data structures, 3rd Edition, BS publications..
3. S. Lipschutz, "Data Structures", McGraw Hill, 1986.
4. P. Dey & M. Ghosh, Programming in C, Oxford Univ. Press.
5. ISRD Group, "Data Structures through C++", McGraw Hill, 2011.

DIGITAL SIGNAL PROCESSING	
ECE 325	**Credits:3**
Instruction: 3 Periods & 1 E/week	Sessional Marks:40
End Exam: 3 Hours	End Exam Marks:60

Pre -requisites: Mathematics, Signals and Systems

Course Outcomes:

	By the end of the course, the student will be able to:
1.	Transform a DTS into frequency domain using DFT and FFT and compare these two methods with respect to their computation complexity.
2.	Design IIR digital filters for a arbitrary frequencies and attenuation values .
3.	Design FIR digital filters for a arbitrary frequencies and attenuation values
4.	Realize the IIR and FIR digital filters in different structure forms and understand the application of sampling rate conversion
5.	Understand the architecture of DSP processors which can be used for practical applications.

SYLLABUS

UNIT – I [10 Periods]
FOURIER TRANSFORMS AND FFTS
Discrete Fourier transforms, Properties of DFT, Circular Convolution, linear convolution of sequences using DFT, Filtering Long duration sequences-Overlap Add and Overlap Save Method, Fast Fourier transforms (FFT) - Radix-2 decimation in time and decimation in frequency FFT Algorithms, Inverse FFT.

UNIT – II [10 Periods]
IIR DIGITAL FILTER DESIGN TECHNIQUES
Introduction, Analog low pass Filter design: Butterworth and Chebyshev approximations, Frequency transformations, Design of HPF, Design of IIR Digital filters from analog filters: Bilinear Transformations method, Impulse invariance method.

UNIT – III [10 Periods]
FIR DIGITAL FILTER DESIGN TECHNIQUES
Introduction, Fourier Series method to design digital FIR filter, Design of FIR Digital Filters using Window Techniques- Rectangular, Triangular, Hanning, Hamming and Kaiser windows, Comparison of IIR & FIR filters.

UNIT – IV [8 Periods]
REALIZATION OF DIGITAL FILTERS
Direct form –I &II , cascade form and parallel form structures of IIR and FIR digital filters.
MULTIRATE DIGITAL SIGNAL PROCESSING
Decimation, Interpolation, sampling rate conversion

UNIT – V [8 Periods]
INTRODUCTION TO DSP PROCESSORS
Introduction to programmable DSPs - Multiplier and Multiplier Accumulator (MAC), Modified Bus Structures and Memory Access schemes in DSPs, Special addressing modes , Architecture of TMS 320C5X - Introduction, Bus Structure - Central Arithmetic Logic Unit - Auxiliary Register - 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, Applications of DSP in Speech Processing and Bio-Medical Engineering.

TEXT BOOKS:
1. John G. Proakis, Dimitris G.Manolakis, Digital Signal Processing, Principles, Algorithms, and Applications: Pearson Education / PHI, 2007.
2. B.Venkataramani, M.Bhaskar, Digital Signal Processors – Architecture, Programming and Applications,TATA McGraw Hill, 2002.

REFERENCE BOOKS:
1. Alan V. Oppenheim and Ronald W. Schafer, Digital Signal Processing, PHI.
2. Sanjit K. Mitra, Digital Signal Processing, Tata Mc Graw Hill Third edition,.

VLSI DESIGN	
ECE 326	**Credits:3**
Instruction: 3 Periods & 1 E/week	Sessional Marks:40
End Exam: 3 Hours	End Exam Marks:60

Pre -requisites: Digital Electronics and Logic Design, ECA-I, ECA-II, IC analysis.

Course Outcomes:

By the end of the course, the student will be able to:	
1.	Delineate IC Production process, fabrication processes for NMOS, PMOS, Bi-CMOS Technologies.
2.	Analyze CMOS electrical properties with circuit concepts.
3.	Draw stick diagrams, layouts for CMOS circuits and compute delays of CMOS circuits using modern tools.
4.	Design and test the CMOS digital Circuits at different levels of abstraction using modern tools.
5.	Apply testing methods on the digital designs for DFT.

SYLLABUS

UNIT – I [10 Periods]

MOS TECHNOLOGY

Introduction to Integrated Circuit Technology & IC Era, Integrated circuits fabrication process, MOS Technology Basic MOS Transistors Enhancement Mode Transistor- Depletion Mode Transistor-nMOS, CMOS Fabrication: p-well, n-well Twin-Tub Process, BiCMOS technologies, Thermal Aspects of Processing, Comparison of MOS technologies.

UNIT – II [10 Periods]

CMOS ELECTRICAL PROPERTIES

Basic Electrical Properties of MOS Circuits: Ids-Vds relationships, threshold Voltage, gm, gds, figure of merit, NMOS Inverter, Pull-up to Pull-down Ratio, Various pull ups, CMOS Inverter analysis and design; Basic Circuit Concepts- Sheet Resistance R_S and its concept to MOS, Area Capacitance Units, Calculations – Delays.

UNIT – III [10 Periods]

MOS CIRCUIT DESIGN PROCESSES

VLSI Design Flow, MOS Layers, Stick Diagrams, Design Rules and Layout, 2-micron CMOS Design rules, Contacts and Transistors Layout Diagrams for NMOS and CMOS Inverters and Gates, Scaling of MOS circuits, Limitations of Scaling.

UNIT – IV [10 Periods]

GATE LEVEL DESIGN

Switch logic and realization of complex gates, Different CMOS logic Circuits-Pseudo, Dynamic, Domino, C^2MOS; Subsystem Design- Subsystem Design, Barrel Shifter, Adders- carry look ahead, carry select, Multipliers- Braun array, Parity generators, Comparator.

UNIT – V [10 Periods]

VLSI TESTING

CMOS Testing, need for testing, Test Principles, Test and Testability- System Partitioning Layout and Testability Reset/Initialization Design for Testability Testing Combinational Logic Testing Sequential Logic Practical Design for Test (OFT) Guidelines Scan Design Techniques Built-In-Self-Test (BIST).

TEXT BOOKS:
1. Douglas A, Pucknell, Kamran Eshraghian,"Basic VLSI Design",3rd Edition,Prentice Hall, l996.**(UNITS I, II, III, IV & V)**
2. Weste and Eshraghian, "Principles of CMOS VLSI Design", Pearson Education, 1999

REFERENCE BOOKS:

1. John .P. Uyemura,"Introduction to VLSI Circuits and Systems",JohnWiley, 2003.
2. Wayne Wolf, "Modern VLSI Design", 3rd Edition, Pearson Education, 1997

1. John .P. Uyemura,"Introduction to VLSI Circuits and Systems",JohnWiley, 2003.
2. Wayne Wolf, "Modern VLSI Design", 3rd Edition, Pearson Education, 1997

INTEGRATED CIRCUITS LABORATORY

ECE 328	Credits:1.5
Instruction: 3 Practical's & 1 O/week	Sessional Marks:50
End Exam: 3 Hours	End Exam Marks:50

Pre -requisites: Digital Electronics, Integrated Circuits and Applications, VHDL/Verilog Language

Course Outcomes:

	By the end of the course, the student will be able to:
1.	Design the circuits using op-amps for various applications like Schmitt Trigger, Precision Rectifier, Comparators and three terminal IC 78XX regulator.
2.	Design active filters for the given specifications and obtain their frequency response characteristics.
3.	Design and analyze multivibrator circuits using Op-amp and 555Timer
4.	Design and Verify various combinational circuits like multiplexers, and de-multiplexers, encoder, decoder, ALU, code converters etc using FPGA
5.	Design and Verify various sequential circuits like flip-flops, counters using FPGA

LIST OF EXPERIMENTS

CYCLE-I: Analog Circuits

1. Frequency response of Op-amp in Inverting and Non-inverting modes.

2. Design an amplifier using Op-amp for the given specifications

3. Measurement of Op-amp parameters

4. Design and verification of Op-amp adder, subtractor, Integrator, Differentiator.

5. Design of Schmitt Trigger using op-amp

6. Design and verification of Active LPF & HPF using op-amp

7. Comparison of functionality of Astable multivibrator using a) Op-amp b) IC 555

8. Verification of functionality of R-2R ladder DAC

CYCLE-II: Experiments Using FPGA

1. Verify the functionality of parallel adder using FPGA

2. Verify the functionality of 4x1 Multiplexer using FPGA

3. Verify the functionality of 1x4 Demultiplexer using FPGA

4. Verify the functionality of 4:2 encoder using FPGA.

5. Verify the functionality of 3:8 decoder using FPGA.

6. Design and verify the functionality of Binary to Gray Code converter

7. Verify the functionality of 2-bit Comparator using FPGA

8. Verify the functionality of ALU using FPGA

9. Verify the functionality of Mod-4 Counter using FPGA

10. Verify the functionality of Delay Flip flop using FPGA

Note: A minimum of any five experiments have to be done from each cycle.

DATA STRUCTURES LABORATORY

ECE 329	**Credits:1.5**
Instruction: 3 Practical's & 1 O/week	Sessional Marks:50
End Exam: 3 Hours	End Exam Marks:50

Pre -requisites: Digital Electronics, Integrated Circuits and Applications, VHDL/Verilog Language

Course Outcomes:

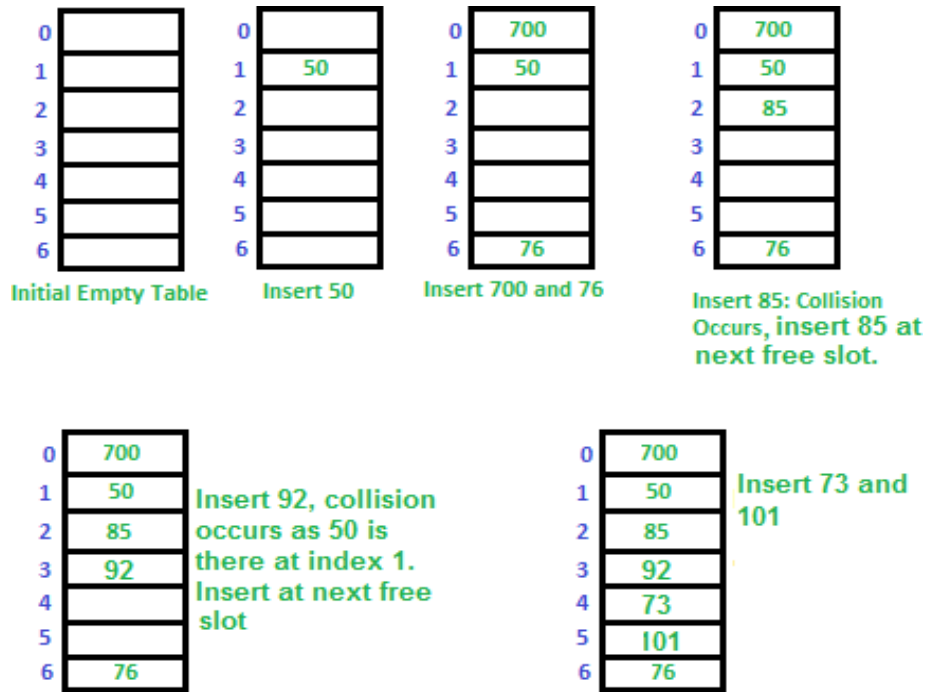| By the end of the course, the student will be able to:	
1.	Implement the techniques for searching and sorting and hashing techniques.
2.	Implement of stack and queue and Linked list data structures and their applications.
3.	Implement operations like insertion, deletion, search and traversing mechanism on binary search tree
4.	Apply BFS and DFS algorithms to implement graph traversal.
5.	Implement the techniques for searching and sorting and hashing techniques.

LIST OF EXPERIMENTS

Experiments:

1. Write a C Program to search whether an item K present in an array of N elements (Using Linear and binary Search algorithms)   CO1
Constraints: 1<K<1000
          1<N<1000
Sample Input array: 45, 78,123, 48, 34, 89, 67, 54, and 74,543
Search Item: 34   Search Item: 343
Output: Key Found   Output: Key Not Found

2. Write a program to sort the given array of N elements using divide and conquer method (merge sort and quick sort algorithms)   CO1
Constraints: 1<N<1000
Sample Input array: 87, 36, 9, 12, 24, 5, 78, 567, 456, 34, 96, 45, 39, and 89,123
Sample Output array: 5, 9, 12, 24, 34, 36, 39, 45, 78, 87, 89, 96, 123, 456, and 567

3. Write a C program to store k keys into an array of size n at the location computed using a hash function, loc = key % n, where k<=n and k takes values from [1 to m], m>n. CO1
Design, Develop and Implement a C program to handle the collisions using the following collision resolution Technique   CO1
 a) **Linear probing**: In linear probing, we linearly probe for next slot, let store k keys into an array of size S at the location computed using a hash function, hash(x) where k<=n and k takes values from [1 to m], m>n.
 Constraints: If slot hash(x) % S is full, then we try (hash(x) + 1) % S
If (hash(x) + 1) % S is also full, then we try (hash(x) + 2) % S If
(hash(x) + 2) % S is also full, then we try (hash(x) + 3) % S

....
....

Sample Test Case:

Let us consider a simple hash function as ―key mod 7‖ and sequence of keys as 50, 700, 76, 85, 92, 73, 101.

0 | | 0 | | 0 | 700 | 0 | 700
1 | | 1 | 50 | 1 | 50 | 1 | 50
2 | | 2 | | 2 | | 2 | 85
3 | | 3 | | 3 | | 3 |
4 | | 4 | | 4 | | 4 |
5 | | 5 | | 5 | | 5 |
6 | | 6 | | 6 | 76 | 6 | 76

Initial Empty Table   **Insert 50**   **Insert 700 and 76**

Insert 85: Collision Occurs, insert 85 at next free slot.

0 | 700
1 | 50
2 | 85
3 | 92
4 |
5 |
6 | 76

Insert 92, collision occurs as 50 is there at index 1. Insert at next free slot

0 | 700
1 | 50
2 | 85
3 | 92
4 | 73
5 | 101
6 | 76

Insert 73 and 101

b) **Quadratic probing:** Quadratic Probing we look for i2„th slot in i"th iteration, let store k keys into an array of size S at the location computed using a hash function, hash(x) where k<=n and k takes values from [1 to m], m>n.

Constraints: let hash(x) be the slot index computed using hash function.

If slot hash(x) % S is full, then we try (hash(x) + 1*1) % S

If (hash(x) + 1*1) % S is also full, then we try (hash(x) + 2*2) % S If (hash(x) + 2*2) % S is also full, then we try (hash(x) + 3*3) % S

....

Sample Test Case:

Insert 18, 89, 21   Insert 58   Insert 68

0 | | 0 | | | 0 |
1 | 21 | 1 | 21 | | 1 | 21
2 | | 2 | 58 | | 2 | 58
3 | | 3 | | | 3 |
4 | | 4 | | | 4 |
5 | | 5 | | | 5 |
6 | | 6 | | | 6 |
7 | | 7 | | | 7 | 68
8 | 18 | 8 | 18 | | 8 | 18
9 | 89 | 9 | 89 | | 9 | 89

For **58**:
- H = hash(58, 10) = 8
- Probe sequence:
  i = 0, (8+0)% 10 = 8
  i = 1, (8+1) % 10 = 9
  i = 2, (8+4) % 10 = 2

For **68**:
- H = hash(68, 10) = 8
- Probe sequence:
  i = 0, (8+0)% 10 = 8
  i = 1, (8+1) % 10 = 9
  i = 2, (8+4) % 10 = 2
  i = 3, (8+9) % 10 = 7
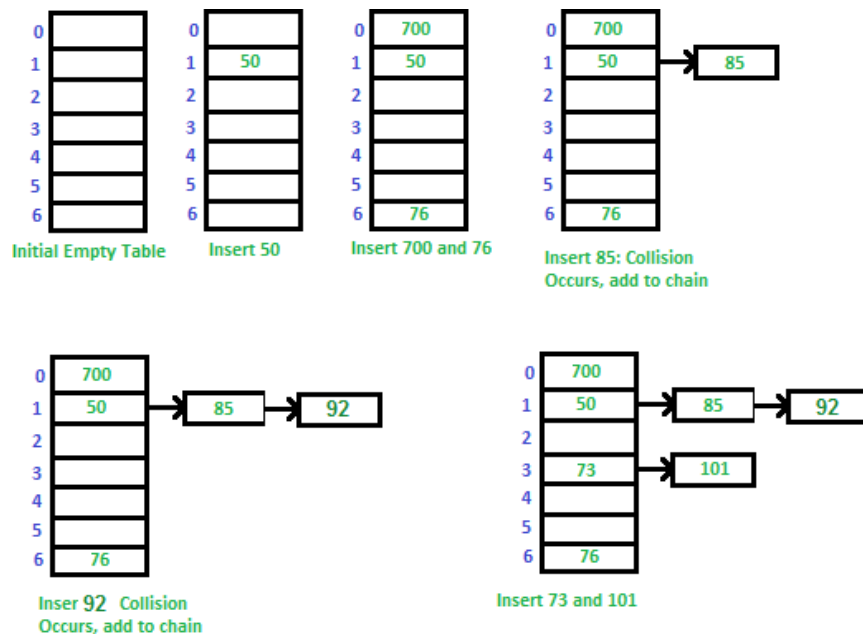
c) **Separate Chaining**: The idea is to make each cell of hash table points to a linked list of records that have same hash function value.

Let us store K keys into hash table of size S, where k<=n and k takes values from [1 to m], m>n.

Sample Test Case:

Let us consider a simple hash function as –**key mod 7** and sequence of keys as 50, 700, 76, 85, 92, 73, 101.

0	
1	
2	
3	
4	
5	
6	

Initial Empty Table

0	
1	50
2	
3	
4	
5	
6	

Insert 50

0	700
1	50
2	
3	
4	
5	
6	76

Insert 700 and 76

0	700
1	50 → 85
2	
3	
4	
5	
6	76

Insert 85: Collision Occurs, add to chain

0	700
1	50 → 85 → 92
2	
3	
4	
5	
6	76

Inser 92 Collision Occurs, add to chain

0	700
1	50 → 85 → 92
2	
3	73 → 101
4	
5	
6	76

Insert 73 and 101

4. Design, Develop and Implement a menu driven Program in C for the following. CO2
Operations on **STACK** of Integers (Array Implementation of Stack with maximum size **MAX**)

1. ***Push*** an Element on to Stack
2. ***Pop*** an Element from Stack
3. Demonstrate ***Overflow*** and ***Underflow*** situations on Stack
4. Display the status of Stack
5. Exit

5. Design, Develop and Implement a Program in C for the following   CO2
   a) Converting an Infix Expression to Postfix Expression. Program should support for both parenthesized and free parenthesized expressions with the operators: +, -, *, /, % (Remainder), ^(Power) and alphanumeric operands.

   b) Evaluation of postfix expression with single digit operands and operators: +,-, *, /, %, ^

6. Operations on **QUEUE** of Characters (Array Implementation of Queue with maximum size **MAX**) CO2

1. Insert an Element on to QUEUE
2. Delete an Element from QUEUE
3. Demonstrate ***Overflow*** and ***Underflow*** situations on QUEUE
4. Display the status of QUEUE
5. Exit

  Note: Support the program with appropriate functions for each of the above operations

7. Design, Develop and Implement a menu driven Program in C for the following : CO2
   a) **Circular Queue**
   - Insert an Element on to Circular QUEUE
   - Delete an Element from Circular QUEUE
   - Demonstrate ***Overflow*** and ***Underflow*** situations on Circular QUEUE
   - Display the status of Circular QUEUE
   - Exit
   b) **Priority Queue**

- Insert an Element on to Priority QUEUE
- Delete an Element with highest priority from Priority QUEUE
- Demonstrate *Overflow* and *Underflow* situations on Priority QUEUE
- Display the status of Priority QUEUE
- Exit

Support the program with appropriate functions for each of the above operations

8. Design, Develop and Implement a menu driven C program to Perform Operations on dequeue (double ended queue) using circular array.   CO2
     a) insertFront(): Adds an item at the front of Deque.
     b) insertRear(): Adds an item at the rear of Deque.
     c) deleteFront(): Deletes an item from front of Deque
     d) deleteRear(): Deletes an item from rear of Deque
     e) getFront(): Gets the front item from queue
     f) getRear(): Gets the last item from queue
     g) isEmpty(): Checks whether Deque is empty or not
     h) isFull(): Checks whether Deque is full or not

Support the program with appropriate functions for each of the above operations

9. Design, Develop and Implement a C program to do the following using a singly linked list. CO2

a) Stack- In single linked list store the information in the form of nodes .Create nodes using dynamic memory allocation method. All the single <u>linked list</u> operations perform based on Stack operations LIFO (last in first out).
A stack contains a top pointer. Which is ―head‖ of the stack where pushing and popping items happens at the head of the list. first node have null in link field and second node link have first node address in link field and so on and last node address in ―top‖ pointer.

Stack Operations:
  1. <u>push()</u> : Insert the element into linked list nothing but which is the top node of Stack.
  2. <u>pop()</u> : Return top element from the Stack and move the top pointer to the second node of linked list or Stack.
  3. <u>peek()</u>: Return the top element.
  4. display(): Print all element of Stack.

b) Queue- All the single <u>linked list</u> operations perform based on queue operations FIFO (First in first out).

In a Queue data structure, we maintain two pointers, *front* and *rear*. The *front* points the first item of queue and *rear* points to last item.

1. **enQueue()** This operation adds a new node after *rear* and moves *rear* to the next node.
2. **deQueue()** This operation removes the front node and moves *front* to the next node.
3. Display() Display all elements of the queue.

Note: Sample node information: Student Data with the fields: USN, Name, Branch, Sem, PhNo.

10. Design, Develop and Implement a menu driven Program in C for the following operations on Binary Search Tree (BST) of Integers
    CO3
    a. Create a BST of N Integers: 6, 9, 5, 2, 8, 15, 24, 14, 7
    b. Delete 2,8 and 6 and display tree
    c. Traverse the BST in Inorder, Preorder and Post Order
    d. exit

11. Implement graph traversal techniques   CO4
    a. BFS
    b. DFS