NRI INSTITUTE OF TECHNOLOGY

(An Autonomous Institution Permanently Affiliated to JNTUK, Kakinada)
(Accredited by NAAC with "A" Grade and ISO 9001:2015 Certified Institution)
POTHAVARAPPADU (V), (VIA) NUNNA, AGIRIPALLI (M), PIN – 521 212

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

COURSE STRUCTURE FOR THIRD YEAR B.TECH PROGRAMME

III YEAR I SEMESTER

Sl. No	Course Code	Title of the Course	Scheme of Instruction (Periods Per Week)				Scheme of Examination (Maximum Marks)			No. of Credits
			L	T	P	Total	CIA	SEA	Total	
1	18A3104401	Linear and digital Integrated circuits	3	1	-	4	40	60	100	4
2	18A3104402	Digital Communications	3	1	-	4	40	60	100	4
3	18A3104403	Antennas and Wave Propagation	3	1	-	4	40	60	100	4
4	18A3104511 18A3104512 18A3104513	**Professional Elective I** i) Telecommunication Switching systems and networks ii) Computer Organisation and Architecture iii) Electronic Measurements and Instrumentation	3	-	-	3	40	60	100	3
5	OE	**Open Elective III**	3	-	-	3	40	60	100	3
6	18A3104802	IPR and Patents	2	-	-	2	40	60	100	0
7	18A3104491	Linear and Digital Integrated Circuit laboratory	-	-	2	2	40	60	100	1
8	18A3104492	Digital Communication Laboratory	-	-	2	2	40	60	100	1
9	18A3104493	VHDL Programming Lab	-	-	2	2	40	60	100	1
Total			**17**	**3**	**6**	**26**	**360**	**540**	**900**	**21**

III YEAR II SEMESTER

Sl. No	Course Code	Title of the Course	Scheme of Instruction (Periods Per Week)				Scheme of Examination (Maximum Marks)			No. of Credits
			L	T	P	Total	CIA	SEA	Total	
1	18A3204401	VLSI Design	3	1	-	4	40	60	100	4
2	18A3204402	Digital Signal Processing	3	1	-	4	40	60	100	4
3	18A3204403	Microprocessors and Microcontrollers	3	1	-	4	40	60	100	4
4	18A3204511 18A3204512 18A3204513	**Professional Elective II** Cellular & Mobile Communications Digital System Design Electromagnetic Interference & Electromagnetic Compatibility	3	-	-	3	40	60	100	3
5	OE	**Open Elective IV**	3	-	-	3	40	60	100	3
6	18A3204491	Microprocessors and Microcontrollers Laboratory	-	-	2	2	40	60	100	1
7	18A3204492	Digital Signal Processing Laboratory	-	-	2	2	40	60	100	1
8	18A3204493	VLSI Laboratory	-	-	2	2	40	60	100	1
Total			**15**	**3**	**6**	**24**	**320**	**480**	**800**	**21**

III Year - I Semester **L T P C**
4 0 0 3

Linear and Digital Integrated Circuits

Per-Requisites: - Electronic Devices & Circuits, Digital Electronics & Logic Design, and Pulse & Digital Circuits

OBJECTIVES:

- To understand the basic operation &performance parameters of differential amplifiers.
- To understand & learn the measuring techniques & performance parameters of OP-AMP
- To learn the linear and non-linear applications of operational amplifiers.
- To understand the analysis & design of different types of active filters using OP-AMP
- To learn the internal structure, operation and applications of different ICs
- To Design and implementation of combinational and sequential digital logic circuits.

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

- Design Differential amplifier circuits and gains knowledge in OP-AMPs.
- Understand and gains knowledge in various applications of O-PAMPS
- Analyze and design amplifiers and active filters using Op-amp.
- Understand thoroughly the operational amplifiers with linear integrated circuits.
- Analyze and design basic digital circuits with combinatorial and sequential logic circuits
- Understand the structure of commercially available Analog & Digital integrated circuit families.

CO-PO Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	3	2	-	-	-	-	-	-	-	-	-	-
CO2	-	3	2	-	-	2	-	-	-	-	-	-
CO3	2	-	-	3	-	-	-	-	-	-	-	2
CO4	-	2	-	2	-	-	-	-	-	-	-	-
CO5	2	-	3	-	-	-	-	-	-	-	-	2
CO6	-	3	2	-	-	-	-	-	-	-	-	-

UNIT - I

DIFFERENTIAL AMPLIFIERS: Introduction, DC and AC analysis of Dual input Balanced output Configuration, Properties of other differential amplifier configurations, Integrated circuits-Types, Classification, Package Types and Temperature ranges, Power supplies.

OP-AMPS: Introduction to OP-amp, Characteristics of OP-Amps, Op-amp Block Diagram, ideal and practical Op-amp Specifications, DC and AC characteristics, 741 op-amp & its features, Op-Amp parameters & Measurement, Input & Output Off set voltages & currents, Slew rate, CMRR, PSRR, drift.

UNIT II

OP-AMP APPLICATIONS: Inverting and Non-Inverting amplifiers, Difference Amplifier, Instrumentation Amplifier, AC Amplifier, Differentiator and Integrator; Comparator, Triangular, Saw-tooth and Square Wave generators, Schmitt Trigger, Log and Anti log Amplifiers.

OP-AMP FILTERS: Introduction to Active Filters, Characteristics of Low pass, high pass, band pass, band reject and all pass filters. Design and analysis of Butterworth active filters-- 1^{st} - 2^{nd} order LPF, HPF,BPF,BRF and All pass filters.

UNIT - III

TIMERS & PHASE LOCKED LOOPS: Introduction to 555 timer, functional diagram, Monostable and Astable operations and applications, Schmitt Trigger; PLL - introduction, block schematic, principles and description of individual blocks, 565 PLL, Applications of PLL – frequency multiplication, frequency translation and Amplitude Modulation.

D/A and A/D CONVERTERS: Introduction, Basic DAC techniques, Different types of DACs-Weighted resistor DAC, R-2R ladder DAC, Inverted R-2R DAC, Different Types of ADCs - Parallel Comparator Type ADC, Counter Type ADC, Successive Approximation ADC and Dual Slope ADC, DAC and ADC Specifications.

UNIT – IV

COMBINATIONAL LOGIC DESIGN ICs: Decoders-74x138, 74x139, Encoders-74x148 Priority Encoder, Multiplexers-74x151 MUX, Demultiplexers -74X155, Barrel shifter.

SEQUENTIAL LOGIC DESIGN ICs: 8-Bit Latch 74x373, Flip Flops-D Flip Flop74X74, JK Flip Flop74X109, Counters- 74x163 4-Bit Binary Counter, 74X163 as Modulus-N Counter, Universal Shift Register 74x194.

TEXT BOOKS:

1. Linear Integrated Circuits – D. Roy Choudhury, New Age International (p) Ltd, 2nd Edition,2003.
2. Op-Amps & Linear ICs - Ramakanth A. Gayakwad, PHI,1987.
3. Operational Amplifiers–C.G. Clayton, Butterworth & Company Publ. Ltd./Elsevier, 1971
4. Digital Design Principles & Practices – John F. Wakerly, PHI/ Pearson Education Asia, 3rd Ed., 2005.

REFERENCES:

1. Operational Amplifiers & Linear Integrated Circuits –Sanjay Sharma ;SK Kataria Sons;2nd Edition,2010
2. Design with Operational Amplifiers & Analog Integrated Circuits – Sergio Franco, McGraw Hill, 1988.
3. Operational Amplifiers & Linear ICs – David A Bell, Oxford Uni. Press, 3rd Edition
4. Fundamentals of Digital Logic Design- Stephen Brown, ZvonkoVranesic, McGrawHill

E-Resources

1. https://www.tutorialspoint.com/linear_integrated_circuits_applications/index.htm
2. https://www.electronics-tutorials.ws/opamp
3. https://www.elprocus.com/operational-amplifiers/
4. http://www.ee.surrey.ac.uk/Projects/CAL/seq-switching/General_seq_circ.htm
5. https://www.electronics-tutorials.ws/combination/comb_1.html

III- I Semester **DIGITAL COMMUNICATIONS** **L T P C**
3 1 0 4

Prerequisites:	
Basics of Communications, Signals and Systems and Probability and Random processes.	
Course Objectives:	
1. To acquire basic knowledge of digital communication systems and its advantages. 2. To analyze various pulse digital and digital modulation techniques and their error performance. 3. To understand and analyze various source coding and channel coding techniques.	
Course Outcomes:	
Upon successful completion of the course, the student will be able to:	
CO1	Apply the knowledge of statistical theory of communication and understand the basics of digital communication Systems.
CO2	Analyze the performance of digital modulation techniques for generation, detection and digital representation of the signal.
CO3	Analyze the probability of error for various digital modulation techniques with the help of random variables and filters.
CO4	Understand and apply the basics of information theory to the communication and compute entropy, information rate of the source.
CO5	Understand and analyze the source coding techniques and channel capacity.
CO6	Compute and analyze different error control coding schemes for reliable transmission of digital information over the channel.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2- Medium, 3 – High)

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**
CO1	3	2	-	-	-	-	-	-	-	-	-	-
CO2	-	3	2	-	-	2	-	-	-	-	-	-
CO3	2	-	-	3	-	-	-	-	-	-	-	2
CO4	-	2	-	2	-	-	-	-	-	-	-	-
CO5	2	-	3	-	-	-	-	-	-	-	-	2
CO6	-	3	2	-	-	-	-	-	-	-	-	-

UNIT WISE SYLLABUS

UNIT I

INTRODUCTION TO DIGITAL COMMUNICATION:

Elements of digital communication systems, advantages of digital communication systems, Elements of PCM: Sampling, Quantization & Coding, Quantization error, Companding in PCM systems.

Differential PCM systems (DPCM). Delta modulation, its draw backs, adaptive delta modulation, comparison of PCM and DM systems.

UNIT II

DIGITAL MODULATION TECHNIQUES:

Introduction, Line Codes, ASK, FSK, PSK, DPSK, DEPSK, QPSK, coherent reception, non-coherent detection, M-ary PSK, ASK, FSK.

Probability of error, the optimum filter, matched filter, probability of error using matched filter, calculation of error probability of ASK, BPSK, BFSK, QPSK.

UNIT III

INFORMATION THEORY:

Discrete messages, concept of amount of information and its properties. Average information, Entropy and its properties. Information rate, Mutual information and its properties.

SOURCE CODING:

Introductions, Advantages, Shannon's theorem, Shanon-Fano coding, Huffman coding, efficiency calculations, channel capacity of discrete and analog Channels, capacity of a Gaussian channel, bandwidth –S/N trade off.

UNIT IV

LINEAR BLOCK CODES:

Introduction, Matrix description of Linear Block codes, Error detection and error correction capabilities of Linear block codes, Hamming codes, Binary cyclic codes, Algebraic structure, encoding, syndrome calculation.

CONVOLUTION CODES:

Introduction, encoding of convolution codes, Graphical approach: state, tree and trellis diagram, decoding using Viterbi algorithm.

TEXT BOOKS:

1. Digital communications - Simon Haykin, John Wiley, 2005
2. Principles of Communication Systems – H. Taub and D. Schilling, TMH, 2003

REFERENCES:

1. Digital and Analog Communication Systems - Sam Shanmugam, John Wiley, 2005.
2. Digital Communications – John Proakis, TMH, 1983. Communication Systems- Analog & Digital – Singh & Sapre, TMH, 2004.
3. Modern Analog and Digital Communication – B.P.Lathi, Oxford reprint, 3rd edition, 2004.

ANTENNAS AND WAVE PROPAGATION LTPC
3104

Prerequisites: EM Waves and Transmission Lines

Course Objectives:

1. To introduce the fundamental principles of antenna theory and to apply them for the analysis, design.
2. To introduce to the design principles of different antenna arrays.
3. To understand the radiation mechanism of various types of antennas and also to learn about the basic parameters of antennas and their measurement.
4. To understand the wave propagation over ground and through different layers of atmosphere

Course Outcomes:

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

CO1	Understand the basic antenna radiation parameters and radiation mechanism of single wire & two wire antennas with current distribution analysis.
CO2	Quantify the radiation fields and power radiated by dipole antennas also analyze their radiation characteristics using mathematical approach.
CO3	Illustrate the different types of arrays and their radiation patterns with both mathematical and geometrical analysis.
CO4	Understand the geometry and working principle of operation of non resonant radiators and microstrip antennas with qualitative analysis.5.
CO5	Design Microwave antennas also Analyze antenna measurements to assess antenna's performance.
CO6	Identify and distinguish the characteristics of different modes of radio wave propagation in the atmosphere with both qualitative and quantitative treatment.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2- Medium, 3 – High)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	2	-	-	-	-	-	-	-	-	-
CO2	-	3	3	2	-	-	2	2	-	-	-	-
CO3	2	3	-	3	-	-	-	-	-	-	-	-
CO4	2	-	3	3	-	-	-	-	-	-	2	-
CO5	2	3	-	-	-	2	-	2	-	-	-	-
CO6	-	3	2	-	-	-	-	-	-	-	-	-

Course Content (Syllabus)

UNIT-I

Part-A (Antenna Fundamentals): Introduction, Radiation Mechanism – single wire, 2 wire. Antenna Parameters - Radiation Patterns, Patterns in Principal Planes, Main Lobe and Side Lobes,Beamwidths, Beam Area, Radiation Intensity, Beam Efficiency, Directivity and Gain ,Antenna Apertures, Aperture Efficiency, Effective Height, illustrated Problems.

Part-B(Thin Linear Wire Antennas): Retarded Potentials, Dipoles, Current Distribution on a thin wire antenna ,Radiation from Small Electric Dipole, Quarter wave Monopole and Half wave Dipole – Directivity, Effective Area . Natural current distributions, and patterns of Thin Linear Center-fed Antennas of different lengths.

UNIT-II

Part-A(Antenna Arrays-I):2 element arrays – different cases, Principle of Pattern Multiplication, N element Uniform Linear Arrays – Broadside, End-fire Arrays, EFA with Increased Directivity, Directivity Relations (no derivations). Related Problems.

Part-B(Antenna Arrays-II): Concept of Scanning Arrays. Binomial Arrays, Effects of Uniform and Non-uniform Amplitude Distributions, Design Relations. Arrays with Parasitic Elements, Yagi-Uda Arrays.

UNIT-III

Part-A(Non-Resonant Radiators) : Introduction, Traveling wave radiators – basic concepts, Long wire antennas –field strength calculations and patterns, Helical Antennas – Significance, Geometry, basic properties; Design considerations of helical antennas in Axial Mode and Normal Modes (Qualitative Treatment).

Part-B(Microstrip Antennas): Introduction, Definition, Basic geometry , Features, Advantages and Limitations, Different Shapes of patch elements, Rectangular Patch Antennas –Geometry and Parameters, Radiation Mechanism of Microstrip antenna. Characteristics of Microstrip antennas, Impact of different parameters on characteristics.

UNIT-IV

Part-A(Microwave Antennas): Paraboloidal Reflectors – Geometry, characteristics, types of feeds, Cassegrain Feeds. Horn Antennas – Types, Optimum Horns, Design Characteristics of Pyramidal Horns; Antenna Measurements – Directivity and Gain Measurements.

Part-B(Wave Propagation): Concepts of Propagation – frequency ranges and types of propagations. Ground Wave Propagation–Characteristics, Parameters, Wave Tilt.Sky Wave Propagation – Formation of Ionospheric Layers and their Characteristics, Mechanism of Reflection and Refraction, Critical Frequency, MUF and Skip Distance ,Virtual Height,. Fundamental Equation for Free-Space Propagation, Space Wave Propagation– Mechanism, LOS and Radio Horizon. Effective Earth's Radius, Duct Propagation, Tropospheric Scattering.

Text Books:

1. Antennas and Wave Propagation– John D. Kraus and Ronald J. Marhefka, 4th Edition, TMH, 2010.

2. Electromagnetic Waves and Radiating Systems – E.C. Jordan and K.G. Balmain, PHI, 2nd Edition,

REFERENCES:

1. Antenna Theory - C.A. Balanis, John Wiley and Sons, 2nd Edition, 2001.
2. Antennas and Wave Propagation – K.D. Prasad, Satya Prakashan, Tech India Publications, New Delhi, 2001.
3. Micro strip Antenna Design Hand Book – Ramesh Garg, Prakash Bhartia,Inder Bahl, Apisak Ittipiboon, Artech House, second edition 2001
4. Transmission and Propagation – E.V.D. Glazier and H.R.L. Lamont, The Services Text Book of Radio, vol. 5,Standard Publishers Distributors, Delhi.
5. Electronic and Radio Engineering – F.E. Terman, McGraw-Hill, 4th Edition, 1955.
6. Antennas – John D. Kraus, McGraw-Hill, 2nd Edition, 1988

III Year - I Semester **L T P C**

3 0 0 3

TELECOMMUNICATION SWTICHING SYSTEMS AND NETWORKS

Pre-Requisites:

Fundamental knowledge of Analog and Digital circuits, Basic knowledge of Analog and Digital Communication, Analytical skills for communication systems and mathematical knowledge

OBJECTIVES:

1. To understand various switching systems
2. To learn in detail about stored program control
3. To know about time division switching concepts
4. To study the basic telephone network structures
5. To understand various internet concepts like LAN,WAN and MAN
6. To gain knowledge on telecommunication traffic and ISDN

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

CO1: To explain the need for switching systems and their evolution from analogue to digital
CO2: To discuss the types of stored program control
CO3: To explain the concepts of space switching, time switching and combination switching
CO4: To differentiate between signaling methods used in telecommunication networks
CO5: To exhibit good knowledge on data communication networks and be able to differentiate LAN, WAN and MAN
CO6: To demonstrate and work on telecommunication traffic and ISDN services

Contribution of Course Outcomes towards achievement of Program Outcomes
(1 – Low, 2- Medium, 3 – High)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	3											
CO2	2	3			2							
CO3			3		2							
CO4	3		3									
CO5	3		3									
CO6			3									

UNIT I:

INTRODUCTION:

Evolution of telecommunications, Basics of switching system – general principle and elements, Classification of switching system

CROSSBAR SWITCHING:

Principles of crossbar switching, Crossbar switch configurations, Cross point technology, Crossbar exchange organization

UNIT II

ELECTRONIC SPACE DIVISION SWITCHING:

Stored program control, Centralized SPC, Distributed SPC, Enhanced services, Two stage networks, Three stage networks, n stage networks

TIME DIVISION SWITCHING:

Time multiplexed space switching, Time multiplexed time switching, Combination switching, Three stage Combination switching, n stage Combination switching

UNIT III

TELEPHONE NETWORKS:

Subscriber loop systems, Switching hierarchy and routing, Transmission plan, Transmission systems, Numbering plan, Charging plans, In channel signaling, Common channel signaling

PUBLIC SWITCHED DATA NETWORKS:

Connection oriented and Connection less service, Circuit switching, Packet switching, Virtual switching concepts, LAN, WAN, MAN, Internetworking

UNIT IV

TELECOMMUNICATION TRAFFIC:

The unit of traffic, Congestion, Traffic measurement, A mathematical model, Lost call systems, Queuing systems

INTEGRATED SERIVES DIGITAL NETWORK:

Introduction, Motivation, New services, Network and protocol architecture, Transmission channels, User network interfaces, Signaling, Numbering &Addressing, Service characterization, Internetworking, ISDN standards, Broadband ISDN

TEXT BOOKS:

1. Telecommunication switching system and networks – Thyagarajan Viswanath, PHI, 2000
2. J. E Flood, "Telecommunications Switching and Traffic Networks," Pearson Education, 2006

REFERENCE BOOKS:

1. Data Communication & Networking - B.A. Forouzan, TMH, 4 Edition, 2004.
2. Digital telephony - J. Bellamy, John Wiley, 2nd edition, 2001.
3. Data Communications & Networks - Achyut. S. Godbole, TMH, 2004.
4. Principles of Communication Systems – H. Taub & D. Schilling, TMH, 2nd Edition, 2003.
5. An Engineering approach to computer networking -S.Keshav, Addison W

E-RESOURCES:

1. **www.modernelectronics.org**
2. **www.npteliitm.ac.in**

III Year – I Semester

L	T	P	C
3	1	0	4

COMPUTER ORGANIZATION AND ARCHITECTURE

PER-REQUISITES

Computer Fundamentals, Programming Concepts

OBJECTIVES

1. Understand the architecture of a modern computer with its various processing units.
2. Understand the Performance measurement of the computer system.
3. Understand the memory management system of computer.

COURSE OUTCOMES

At the end of the course student can able to

CO1: Gain the knowledge of the computer architecture of modern computers.
CO2: Analyse the performance of a computer using performance equations.
CO3: Identify the fundamentals of different instruction set architectures and their relationship to the CPU design.
CO4: Gain the knowledge on the memory system and multi programmed concepts.
CO5: Identify the operation of modern CPUs including interfacing, pipelining, memory systems and busses.
CO6: Gain the knowledge on the principles of operation of multiprocessor systems.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	**3**				**2**							
CO 2	**3**	**3**			**2**							
CO 3	**2**		**3**									
CO 4	**3**	**2**	**3**									
CO 5	**2**	**2**	**3**		**2**							
CO 6	**2**		**3**									

SYLLABUS

UNIT-I

Basic Structure Of Computers: Functional unit, Basic Operational concepts, Bus structures, System Software, Performance, The history of computer development.

Central Arithmetic: Data representation, Addition and Subtraction Algorithms, Multiplication Algorithms, Division Algorithms, Floating Point Arithmetic Operations.

UNIT – II

Machine Instruction Sequencing: Register Transfer Notation, Assembly Language Notation, The role of Stacks and Queues in computer programming equation, Addressing Modes.

Type of Instructions: Basic Instruction Types, Data transfer Instructions, Arithmetic Instructions, Logical Instructions, shift and Rotate Instructions, Branch Instructions.

UNIT-III

Micro Programmed Control: Control Memory, Address Sequencing, Micro Program Example, Hard Wired Control, Micro Programmed Control.

The Memory System: Memory Hierarchy, Main Memory, Auxiliary Memory, Associative Memory, Cache Memory, Virtual Memory, Memory Management Hardware.

UNIT-IV

Input-Output Organization: Peripheral Devices, Input-Output Interface, Asynchronous Data Transfer Modes, Priority Interrupt, Direct Memory Access, Serial Communication.

Pipeline and Multiprocessors: Parallel Processing, Pipelining, Arithmetic Pipeline, Instruction Pipeline, RISC Pipeline, Vector Processing, Array Processing, Interconnection Structures, Cache Coherence.

TEXT BOOKS

1. Computer System Architecture – M.Moris Mano, IIIrd Edition, PHI / Pearson, 2006.
2. Computer Organization – Car Hamacher, ZvonksVranesic, SafwatZaky, V Edition, McGraw Hill, 2002.

REFERENCES

1. Computer Organization and Architecture – William Stallings Seventh Edition, PHI/Pearson, 2006.
2. Computer Architecture and Organization – John P. Hayes, McGraw Hill International editions, 1998.
3. Structured Computer Organization – Andrew S. Tanenbaum, 4th Edition PHI/Pearson.
4. Fundamentals or Computer Organization and Design, - Sivaraama Dandamudi Springer Int. Edition.
5. “Computer Organization and Design: The Hardware/Software Interface” by David A. Patterson and John L. Hennessy.

III Year - I Semester **L T P C**

3 0 0 3

Electronic Measurements and Instrumentation

(Professional Elective I)

Pre-Requisites:

Electrical Circuits, Electronic Devices and Circuits Laboratory.

OBJECTIVES:

1. Introduce the basic concepts related to the operation of electronic measuring instruments.
2. Acquire a sound understanding theory and performance characteristics of instruments and errors in measurement and apply to DC voltmeters, ammeters, ohmmeters.
3. Provide concepts and operation of different signal generators and wave form analyzers.
4. Compare and contrast different types of oscilloscopes.
5. Select different types of D.C and A.C bridges for the measurement of passive components.
6. Study the principles behind various transducers and their applications in the measurement of various parameters.

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

CO1	Understand the fundamental concepts instrumentation, basic concepts of measuring systems, and characteristics of measuring systems.
CO2	Describe different types of meters and understanding the operation of meters.
CO3	Understand the Different types of signal generators and signal analyzers and their working principles.
CO4	Understand the different types of Oscilloscopes and their working principles.
CO5	Explore the different types of A.C. and DC Bridges and their operations.
CO6	Demonstrate the different types of transducers and their principles and operations.

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**
CO1	3	2	-	-	3	-	-	-	-	-	-	-
CO2	3	2	-	-	3	-	-	-	-	-	-	-
CO3	2	-	-	-	-	-	-	-	-	-	-	-
CO4	2	-	-	2	-	-	-	-	-	-	-	-
CO5	3	3	-	2	-	-	-	-	-	-	-	-
CO6	3	-	3	-	-	-	-	-	-	-	-	-

UNIT Wise Syllabus

UNIT-I

Performance Characteristics of Instruments: Block Schematic of Measuring Systems, Static characteristics, Accuracy, Resolution, Precision, Expected value, Error, Sensitivity. Dynamic Characteristics-speed of response, Fidelity, Lag and Dynamic error, Types of Errors.

DC & AC Meters: Basic DC Voltmeter, Multi-range Voltmeters, Range extension/Solid state and differential voltmeters, AC voltmeters, Digital Voltmeters: Ramp Type, Staircase, Dual slope integrating type, Successive Approximation type, Ohmmeters series type, shunt type, Multi-meter for Voltage, Current and resistance measurements.

UNIT-II

Signal Generators: Fixed and variable AF oscillators, Standard AF sine and square wave signal generators, Function Generator, Square pulse, Random noise, sweep, Arbitrary waveform generator.

Wave Analyzers: Harmonic Distortion Analyzer, Spectrum Analyzer, Digital Spectrum Analyzer, Digital Fourier Analyzer, Power analyzer.

UNIT-III

Oscilloscopes: CRT, Block Schematic of CRO, vertical amplifiers, horizontal deflection system, sweep, trigger pulse, delay line, sync selector circuits.

Special Oscilloscopes: Dual beam CRO, Dual trace oscilloscope, sampling oscilloscope, digital readout oscilloscope, digital storage oscilloscope, Lissajous method of frequency measurement, standard specifications of CRO, probes for CRO- Active & Passive, attenuator type.

UNIT-IV

Bridges: Measurement of Resistance – Wheatstone, Kelvin Bridge, Measurement of inductance-Maxwell's bridge, Anderson Bridge. Measurement of capacitance - Shearing Bridge. Wheat stone bridge. Wien Bridge.

Transducers: active & passive transducers : Resistance, Capacitance, inductance; Strain gauges, LVDT, Piezo Electric transducers, Resistance Thermometers, Thermocouples, Thermistors, Sensistors. Measurement of physical parameters force, pressure, velocity, humidity, moisture, speed. Basic block diagram of Data acquisition systems, single channel and multi-channel DAS.

TEXT BOOKS:

1. Electronic Instrumentation, second edition-H.S.Kalsi, Tata McGraw Hill, 2004.
2. Modern Electronic Instrumentation and Measurement Techniques- A.D.Helfrick and W.D.Cooper, PHI, 5th Edition, 2002.

REFERENCES:

1. Electronic Instrumentation & Measuements- David A. Bell, PHI, 2nd Edition, 2003.
2. Electronic Measurements and Instrumentation by K.Lal Kishore, Pearson Education-2005.

III Year - I Semester **L T P C**
0 0 3 2

Linear and Digital Integrated Circuits lab

Minimum 10 experiments should be conducted.
{8 experiments from part A and 2 experiments from part B}

Pre-Requisites: EDC LAB, DELD LAB & APC LAB,

Course Outcomes: The Students will

- Have a thorough understanding of operational amplifier (741).
- Be able to design circuits using operational amplifiers for various applications.
- Design various active filters using Opamps
- Understand various applications of 555 565 and 566 ICs
- Demonstrate their knowledge by digital circuits.
- Be able to design various combinational circuits using various Digital Integrated IC's.

PART- A

1. Study of ICs 741, IC 555, IC 565, IC 566, IC 1496 – functioning, parameters and Specifications.
2. OP AMP Applications – Adder, Subtractor, Comparator Circuits.
3. Integrator and Differentiator Circuits using IC 741.
4. Active Filter Applications – LPF, HPF (first order)
5. Active Filter Applications – BPF, Band Reject (Wideband).
6. Schmitt Trigger Circuits – using IC 741 and IC 555
7. Function Generator using OP AMPs.
8. IC 555 Timer – Monostable Operation Circuit.
9. IC 555 Timer – Astable Operation Circuit.
10. 4 bit DAC using OP AMP

PART -B

11. 8X1 MULTIPLEXER-74151.
12. 1X8 Demultiplexer-74155.
13. Decade counter using 74LS90

Equipment required for Laboratories:

1. RPS.
2. CRO.
3. Function Generator.
4. Multimeter.

5. IC Trainer Kits (Optional).
6. Bread Boards.
7. Components:- IC741, IC555, IC74151, IC74155, IC74LS90, IC Tester.

Experiments to be conducted beyond the syllabus:

1. IC 741 Oscillator Circuit - Wien Bridge Oscillator
2. IC 741 Oscillator Circuit – Phase Shift Oscillator.

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III –I Semester **DIGITAL COMMUNICATIONS LAB** **L T P C**

- - 2 1

Prerequisites:

Basics of Communications, Signals & Systems and Probability & Random Processes.

Course Objectives:

- To acquire practical knowledge of digital communication systems.
- To implement different modulation and demodulation techniques.
- To analyze the outputs of various digital modulation techniques.
- To perform and interpret various source coding and error control coding techniques.

Course Outcomes:

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

CO1	Understand the Time-Division Multiplexing systems, and verify the output of pulse code modulation and demodulation.
CO2	Analyze the output of differential pulse code modulation and demodulation and verify the delta modulation.
CO3	Analyze the outputs of different digital modulation techniques-FSK, PSK.
CO4	Interpret the outputs of DPSK modulation and demodulation.
CO5	Analyze the outputs of source encoder and decoder, linear block codes, convolution codes and binary cyclic codes.
CO6	Perform and analyze the output of companding circuit.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2- Medium, 3 – High)

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**
CO1	2	3	-	-	2	-	-	-	1	-	-	-
CO2	-	3	2	-	-	-	-	-	-	-	-	-
CO3	2	2	2	-	2	-	-	-	-	-	-	-
CO4	2	2	2	-	2	-	-	-	2	-	-	-
CO5	-	-	-	-	-	-	-	-	-	-	-	2
CO6	3	2	2	-	3	-	-	-	-	-	-	-

List of Experiments:

1. Time division multiplexing.
2. Pulse code modulation.
3. Differential pulse code modulation.
4. Delta modulation.
5. Frequency shift keying.
6. Phase shift keying.
7. Differential phase shift keying.
8. Companding
9. Source Encoder and Decoder
10. Linear Block Code-Encoder and Decoder
11. Binary Cyclic Code – Encoder and Decoder
12. Convolution Code – Encoder and Decoder

Equipment Required:

1. RPS – 0 – 30 V
2. CRO – 0 – 20 M Hz.
3. Function Generators – 0 – 1 M Hz
4. RF Generators – 0 – 1000 M Hz. /0 – 100 M Hz.
5. Multimeters
6. Lab Experimental kits for Digital Communication
7. Components

III Year - I Semester **L T P C**

0 0 2 1

VHDL PROGRAMMING LABORATORY

Pre-Requisites: -

Switching Theory and Logic Design, C Language, Pulse & Digital Circuits Laboratory

OBJECTIVES:-

1. Introduce the basic HDL languages and their importance in digital design.
2. VHDL fundamentals were discussed to modelling the digital system design blocks.
3. Model digital systems at several levels of abstractions, dataflow, behavioural, structural & mixed signalling modelling.
4. Analyse and design basic digital circuits with combinatorial and sequential logic circuits using VHDL.
5. VHDL compilers, simulators and synthesis tools are described, which are used to verify digital systems in a technology-independent fashion.

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

CO1	Understand the internal structure of digital circuits.
CO2	Design the internal structure of digital circuits.
CO3	Develop a VHDL source code.
CO4	Perform simulation using relevant simulators.
CO5	Analysis of the obtained simulation results using necessary synthesizers.
CO6	Verify the logic with the necessary hardware.

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**
CO1	3	2	3	2	3	-	-	-	-	-	-	3
CO2	3	2	3	-	2	-	-	-	-	-	-	2
CO3	3	2	3	3	3	-	-	-	2	-	-	2
CO4	3	2	2	2	3	-	-	-	-	-	1	2
CO5	3	2	3	2	-	-	-	-	2	-	-	2
CO6	3	3	3	2	2	-	-	-	-	-	-	2

Syllabus

List of Experiments :(Minimum of ten experiments has to be performed)

Note: The students are required to develop VHDL source code, perform simulation using a relevant simulator, and analyze the obtained simulation results using a necessary synthesizer.

All the experiments are required to verify and implement the logical operations on the latest FPGA Hardware in the Laboratory.

1. Realization of logic gates using three models.
2. Design of full adder and develop VHDL code using three models.
3. Design 3 to 8 decoders and develop VHDL code.
4. Design 8 to 3 encoder and develop VHDL code.
5. Design 8 x 1 multiplexer and develop VHDL code.
6. Design 4- bit magnitude comparator and develop VHDL code.
7. Design 4-bit binary to grey code converter and develop VHDL code.
8. Design D-flip-flop and develop VHDL code.
9. Design decade counter and develop VHDL code.
10. Design universal shift registers and develop VHDL code.
11. Design an 8-bit serial in-parallel out and parallel in-serial out shift register and develop VHDL code.
12. Design ALU and develop VHDL code.

Equipment/Software required:

1. Xilinx Vivado software / Equivalent Industry Standard Software.
2. Xilinx Hardware / Equivalent hardware.
3. Personal computer system with necessary software to run the programs and implement.

III Year – II Semester **L T P C**

3 1 - 4

VLSI DESIGN

PRE-REQUISITES FOR THE COURSE:

Students are expected to have knowledge on the following topics:

S.No	Topic
1	Basic electrical properties of MOSFET.
2	CMOS technology.
3	Digital electronics circuits.

COURSE OBJECTIVES:

Students will be able to:

1. Use mathematical methods and circuit analysis models in analysis of CMOS digital electronics circuits, including logic components and their interconnects.
2. Learn the various fabrication steps of IC and come across basic electrical properties of MOSFET.
3. Apply CMOS technology-specific layout rules in the placement and routing of transistors and interconnect and to verify the functionality, timing, power and parasitic effects.
4. Understand the design for testability
5. Know the FPGA architecture and design flow ,CPLD and system on chip
6. Highlight the circuit design issues in the context of VLSI technology, power calculations and clock mechanism.

COURSE OUTCOMES:

At the end of the course, the students will develop ability to:

1. Understand the CMOS fabrication flow and also the electrical properties of MOS and Bi-CMOS circuit.
2. Know three sets of design rules with which NMOS and CMOS designs may be fabricated.
3. Understand the scaling factors determining the characteristics and performance of MOS circuits in silicon.
4. Understand the FPGA architecture, design flow and technologies.
5. Analyze the VLSI design issues along with the design process and technology option.
6. Classify the power calculations, package selection and clock mechanism and understand the design for testability techniques.

COURSE OUTCOMES vs. PROGRAM OUTCOMES (CO-PO) MAPPING:

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2- Medium, 3 – High)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	-	-	-	-	2
CO2	-	-	3	2	-	-	-	-	-	-	-	2
CO3	3	3	2	-	-	-	-	2	-	-	-	-
CO4		3	3	-	-	-	-	2	-	-	-	-
CO5	2	3	3	-	-	-	-	-	-	-	-	2
CO6	-	2	-	-	-	-	-	3	-	-	-	2
AVG	2.66	2.75	2.75	2	-	-	-	2.33	-	-	-	2

SYLLABUS

Unit-I:

Introduction : Introduction to IC Technology, MOS and related VLSI Technology, Basic MOS Transistors, Enhancement and Depletion modes of transistor action, IC production process, MOS and CMOS Fabrication processes

Basic Electrical Properties Of MOS and Bi-CMOS Circuits: I_{ds} versus V_{ds} Relationships, Aspects of MOS transistor Threshold Voltage, MOS transistor Trans, Output Conductance and Figure of Merit, Alternative forms of pull-up, The CMOS Inverter ,Comparison between CMOS and Bipolar technologies, BiCMOS Technology

Unit-II:

MOS and Bi-CMOS Circuit Design Processes: The NMOS Inverter , Pull-up to Pull-down Ratio for NMOS inverter driven by another NMOS inverter. Pass transistor, Pull-up to Pull-down Ratio for NMOS inverter driven by another NMOS inverter through one or more pass transistors.

MOS and Bi-CMOS Circuit Design Rules: MOS Layers, Realization of gates using NMOS, PMOS and CMOS technologies, Stick Diagrams, Design Rules and Layout, General observations on the lambda based Design rules, 2µm Double Metal, Double Poly, CMOS/BiCMOS rules, 1.2µm Double Metal, Double Poly CMOS rules, Layout Diagrams of NAND and NOR gates and CMOS inverter.

Unit-III:

Basic Circuit Concepts: Sheet Resistance, Sheet Resistance concept applied to MOS transistors and Inverters, Area Capacitance of Layers, Standard unit of capacitance, The Delay

Unit, Inverter Delays, Propagation Delays, Wiring Capacitances, Fan-in and fan-out characteristics, Choice of layers, Switch logic, Gate logic.

Scaling Of MOS Circuits: Scaling models, Scaling factors for device parameters, Limits due to sub threshold currents, current density limits on logic levels and supply voltage due to noise.

Unit-IV:

FPGA Design: ASIC design flow, FPGA design flow, Basic FPGA architecture, FPGA Technologies, CPLD, Introduction to SoC design.

VlSI Design Issues: VLSI Design issues and design trends, design process, design for testability, technology options, power calculations, package selection, clock mechanisms, mixed signal design.

Text Books:

1. Essentials of VLSI Circuits and Systems By Kamran Eshraghian, Douglas and A. Pucknell and Sholeh Eshraghian, Prentice-Hall of India Private Limited,2005 Edition.
2. VLSI Design-Black Book By Dr. K.V.K.K. Prasad, Kattula Shyamala, Kogent Learning Solutions Inc.2012 Edition.

References:

1. VLSI Design By A.Albert Raj & T.Latha,PHI Learning Private Limited,2010.
2. VLSI Design-A.Shanthi and A.Kavita, New Age International Private Limited, 2006 First Edition.

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DIGITAL SIGNAL PROCESSING

Lecture – Tutorial:	3+1 Hours	**Internal Marks:**	40
Credits:	4	**External Marks:**	60

Prerequisites:

Mathematics-I, Mathematics-II and Signals & Systems.

Course Objectives:

- To analyze the Discrete Time Signals and Systems.
- To know the importance of FFT algorithm for computation of Discrete Fourier Transform.
- To understand the various implementations of digital filter structures.
- To learn the FIR and IIR Filter design procedures.
- To know the need of Multirate Signal Processing.
- To learn the concepts of DSP Processors.

Course Outcomes:

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

CO1	Understand the representation of different Discrete time signals and apply the difference equations concept in the analysis of Discrete Time Systems.
CO2	Interpret and explore the concepts of Discrete Fourier Transforms and Fast Fourier Transforms for various Discrete Time Signals and Sequences.
CO3	Construct the basic structures of Digital FIR and IIR systems.
CO4	Design the Digital IIR Filters from the analog filters using frequency transformations and FIR filters using windowing techniques.
CO5	Illustrate the sampling rate conversion by Decimation and Interpolation processes and extend the concepts to Digital Filter Banks and sub band coding of speech signals.
CO6	Interpret the architectural and functional concepts of commercial programmable Digital Signal Processors.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2- Medium, 3 – High)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	3	3	1	1							2	1
CO2	3	2		2	1						1	2
CO3	3	2	1	1					1			
CO4	3	2	3	1	3				1			
CO5	3	2	2							1	2	1
CO6	2			1	2	1					1	2

UNIT I

INTRODUCTION TO DIGITAL SIGNAL PROCESSING: Discrete time signals & sequences, Classification of Discrete time systems, stability of LTI systems, Response of LTI systems to arbitrary inputs. Solution of Linear constant coefficient difference equations. Frequency domain representation of discrete time signals and systems.

DISCRETE FOURIER SERIES AND DISCRETE FOURIER TRANSFORMS: Properties of Discrete Fourier series, DFS representation of periodic sequences. Discrete Fourier Transforms**,** Properties of DFT, linear filtering methods based on DFT.

UNIT II

FAST FOURIER TRANSFORMS: Fast Fourier Transforms (FFT) - Radix-2 decimation in time and decimation in frequency FFT Algorithms, Inverse FFT.

REALIZATION OF DIGITAL SYSTEMS: Review of Z-Transforms: Solution of difference equations using Z-transforms, System function. Building blocks of a block diagram, Basic structures of IIR systems, Transposed forms. Basic structures of FIR systems.

UNIT III

DESIGN OF IIR DIGITAL FILTERS:
Analog filter approximations – Butterworth and Chebyshev, Design of IIR Digital filters from analog filters, Design Examples, Analog and Digital frequency transformations.

DESIGN OF FIR DIGITAL FILTERS:
Characteristics of FIR Digital Filters, frequency response. Design of FIR Digital Filters using Window Techniques and Frequency Sampling technique, Comparison of IIR & FIR filters.

UNIT IV

MULTIRATE DIGITAL SIGNAL PROCESSING: Introduction, Decimation , Interpolation Sampling rate conversion ,Implementation of sampling rate converters**,** Applications – Sub-band Coding of Speech Signals ,Implementation of Digital Filter Banks, Trans-multiplexers.

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, Multiported 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.
3. Digital Signal Processors – Architecture, Programming and Applications,, B.Venkataramani,M.Bhaskar, TATA McGraw Hill, 2002.
4. Digital Signal Processing – K Raja Rajeswari, I.K. International Publishing House.

REFERENCE BOOKS:

1. Digital Signal Processing: Andreas Antoniou, TATA McGraw Hill , 2006.
2. Digital Signal Processing: MH Hayes, Schaum's Outlines, TATA Mc-Graw Hill, 2007.

3. DSP Primer - C. Britton Rorabaugh, Tata McGraw Hill, 2005.
4. Fundamentals of Digital Signal Processing using Matlab – Robert J. Schilling, Sandra L. Harris,Thomson, 2007.
5. Digital Signal Processing – Alan V. Oppenheim, Ronald W. Schafer, PHI Ed., 2006.
6. Digital Signal Processing – P.Ramesh babu, Sci Tech publications.

E-RESOURCES:

1. https://nptel.ac.in/courses/117/102/117102060/
2. https://freevideolectures.com/course/2339/digital-signal-processing-iitkharagpur
3. http://www.nptelvideos.in/2012/12/digital-signal-processing.html
4. https://ocw.mit.edu/resources/res-6-008-digital-signal-processing-spring-2011/study-materials/

III Year – II Semester

L	T	P	C
3	1	0	4

MICROPROCESSOR & MICROCONTROLLERS

PER-REQUISITES

Switching Theory Logic Design, Computer Organization and Architecture

OBJECTIVES

1. To familiarize with architecture of 8086 microprocessor.
2. To introduce the assembly language programming concepts of 8086 processor.
3. To expose with various interfacing devices with 8086.
4. To familiarize with architecture of 8051 microcontroller.
5. To introduce the assembly language programming concepts of 8051 microcontroller.
6. To expose with various interfacing devices with 8051 microcontroller.

COURSE OUTCOMES

At the end of the course student can able to

CO 1: Gain the knowledge of the architecture of 8086 Microprocessor and instruction set.
CO 2: Gain the knowledge of the architecture of 8051 Microcontroller and instruction set.
CO 3: Identify a detailed s/w & h/w structure of the microprocessor and microcontroller.
CO 4: Illustrate how the different peripherals are interfaced with 8086.
CO 5: Interface various I/O devices to the 8051 microcontroller.
CO 6: Develop 8086 and 8051 based different kinds of applications.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	**3**				**2**							
CO 2	**3**	**3**			**2**							
CO 3	**2**		**3**									
CO 4	**3**	**2**	**3**									
CO 5	**2**	**2**	**3**		**2**							
CO 6	**2**		**3**									

SYLLABUS

UNIT - I

8086 Microprocessor

Introduction to Microprocessor, Features of 8086 Processor, Register Organization of 8086, Architecture, Memory Segmentation, Signal Descriptions of 8086.

Modes of 8086 System

Physical Memory Organization, General Bus Operation, I/O Addressing Capability, Minimum and Maximum Mode 8086 Systems and Timing Diagrams.

Unit - II

Instruction Set and Assembly Language Programming of 8086

Addressing Modes, Instruction Sets, Assembler Directives and Operators, Simple Programs Involving Logical, Branch and Call Instructions, Sorting, String Manipulations.

Stack and Interrupts

Introduction to Stack, Stack Structure of 8086, Interrupts and Interrupt Service Routines, Interrupt Cycle of 8086, Non Maskable Interrupts, Maskable Interrupts, Interrupt Programming.

Unit - III

Basic Peripherals and Interfacing

Semiconductor Memory Interfacing, PIO 8255, Modes of Operations of 8255, Interfacing Analog to Digital Data Converters, Interfacing Digital to Analog Converters, Stepper Motor Interfacing.

Programmable Peripheral Devices

Programmable Interrupt Controller 8259A, Programmable Communication Interface 8251 USART, DMA Controller 8257.

Unit - IV

8051 Microcontrollers

Introduction to Microcontrollers, Features of 8051 Controller, Architecture of 8051, Signal Description of 8051, Register Set 0f 8051, Memory Organization, Addressing Modes of 8051, Instruction Set of 8051.

Interfacing with Keyboard/Display Devices

Input/Output Ports and Circuits, Timers and Counters Serial Ports, Interrupt Structure, Interrupt Priority in 8051, LED's, 7 Segment Display, LCD, A/D, D/A and Keyboard Interfacing.

Text Books

1. A. K. Ray and K.M. Bhurchandani, "Advanced Microprocessors and Peripherals", TMH, 2nd edition, 2006
2. Kenneth. J. Ayala, "The 8051 Microcontroller", 3rd Edition, Cengage Learning, 2010.

Reference Books

1. D. V. Hall' "Microprocessors and Interfacing", TMH, 2nd edition 2006. .
2. Muhammad Ali Mazidi, Janice Gillispie Mazidi and Rolin D. McKinlay, "The 8051 Microcontrollers and Embedded Systems", Pearson, 2nd Edition.
3. Barry B.Brey, "The Intel Microprocessors", PHI, 7th Edition, 2006.

III Year – II Semester **L T P C**

3 - - 3

Cellular & Mobile Communications

PRE-REQUISITES FOR THE COURSE:

Students are expected to have knowledge on the following topics:

S. No	Topic
1.	Wireless Communication Engineering
2.	Analog Communications
3.	Digital Communications

COURSE OBJECTIVES:

Students will be able to:

1. An understanding on cellular communication system, architecture, functioning, various standards and gains knowledge of the various cellular mobile standards.
2. Understanding of the Cellular concept, Frequency reuse, Hand-off strategies, cell splitting, cell sectoring, Cellular structures.
3. Understand different co-channel interference non co-channel interference. Understand the concept of frequency management, Channel assignment with fixed and non-fixed channels.
4. To understand cell coverage in traffic and signal reflections in different terrains and also interpret the Lee Model. Interpret the Omni-directional and directional antennas used at cell sites and their synthesis methods and also understand different types of antennas.
5. Understand the fundamental techniques to assign a handoff without termination of call, different handoffs, how a dropped call can be overcome.
6. To understand the multiple access techniques CDMA technology, GSM architectures, concepts of LTE along with 5G challenges.

COURSE OUTCOMES:

At the end of the course, the students will develop ability to:

1. Demonstrate an understanding on cellular communication system, architecture, functioning, various standards and different evolution of cellular communication systems up to 5G.
2. Interpret the cellular system operation and design concepts, cell splitting.
3. Measure Co-Channel and Non Co-Channel interferences for various mobile radio propagation models and interpret the C/I measurements for different antenna systems. Estimate the frequency management, channel assignment, channel sharing and channel borrowing techniques.
4. Understand impairments due to multipath fading channel, and designing of different antennas. Design the Omni-directional and directional antennas used at cell sites and their synthesis methods.
5. Demonstrates the fundamental techniques to assign a handoff without termination of call, different handoffs, how a dropped call can be overcome.
6. To choose proper multiple accessing methods, CDMA technology, GSM architectures and GSM channels and familiar with 5G challenges.

COURSE OUTCOMES vs. PROGRAM OUTCOMES (CO-PO) MAPPING:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	1	-	-	2	-	-
CO2	3	2	2	-	-	-	-	-	-	1	-	-
CO3	3	2	3	1	-	-	-	-	-	2	-	2
CO4	-	2	3	-	2	-	1	-	-	2	1	2
CO5	-	-	1	-	1	-	1	-	-	2	1	1
CO6	-	2	-	1	2	-	2	-	-	2	2	2
Total	9	8	9	2	5	-	5	-	-	11	4	7
Avg.	**3.0**	**2.0**	**2.25**	**1.0**	**1.66**	**0.00**	**1.25**	**0.00**	**0.00**	**1.83**	**1.33**	**1.75**

COURSE CONTENT (Syllabus):

Cellular & Mobile Communications

UNIT I

Introduction to Cellular Mobile Systems: A basic cellular system, Performance criteria, Uniqueness of mobile radio environment: Modal of transmission medium, Mobile fading characteristics, Delay spread and Coherence bandwidth, Operation of Cellular Systems, Hexagonal shaped cells. Evolution of mobile cellular communication: different generations of mobile cellular communication (1G, 2G, 3G, 4G and beyond), 5G vision.

Elements of Cellular Mobile Radio System Design: Concept of frequency reuse channels: Frequency reuse schemes, Frequency reuse distance, Number of customers in the system, Permanent and Dynamic cell splitting, cell sectoring, Cellular structures: macro, micro, pico and femto cells.

UNIT II

Interference: Co-channel Interference at the mobile unit and cell site, Design of an Omni-directional and Directional antenna systems. Non-cochannel Interference: Adjacent channel interference: Next channel interference, Neighboring channel interference, Near-End-Far-End Interference.

Frequency Management: Numbering the channels and grouping into subsets, Frequency spectrum utilization, Setup, access and paging channels, Self-location scheme at the mobile unit.

Channel Assignment: Channel assignments to cell sites and travelling mobile units, Fixed channel assignment: Adjacent-channel assignment, Channel sharing, Channel borrowing and Underlay-overlay cells, Non-fixed channel assignment algorithms.

UNIT III

Cell Coverage for Signal and Traffic: Signal reflections in flat and hilly terrain, obtaining the mobile point-to-point model (Lee Model), Phase difference between direct and ground reflected paths, General formula for mobile radio propagation between two fixed stations over water or flat open area, Land to mobile transmission over water, Foliage loss.

Cell Site and Mobile Antennas: Sum and difference patterns and their synthesis, Antennas at cell site: Omni directional and Directional antennas: Start-up and Abnormal antenna configurations, Space diversity antennas, Umbrella pattern antennas, unique situations of cell site antennas, Mobile antennas: Roof-mounted and Glass-mounted antennas, Mobile high gain antennas, Horizontally oriented and vertically oriented space-diversity antennas.

UNTI IV

Handoff and Dropped calls: Concept of Handoff, Types of handoff: Based on signal strength and based on carrier to interference Ratio, Handoff initiation, Delaying handoff, Forced handoff, Power- difference handoff, mobile assigned handoff , soft and hard handoff, cell site handoff only, Intersystem handoff, Dropped call rates introduction and formula for Dropped call rate.

Digital Cellular Systems: Global system for mobile (GSM): GSM architecture, OSI model of GSM, GSM channels, Multiple Access schemes FDMA, TDMA CDMA, OFDMA, concepts of LTE and LTE-advanced standards, 5G features and challenges.

TEXTBOOKS:

1. Mobile Cellular Telecommunications – W.C.Y. Lee, Tata McGraw Hill, 2rd Edn., 2006.
2. Principles of Mobile Communications–Gordon L.Stuber,Springer International 2nd Edt. 2007.

REFERENCES:

1. Wireless Communications - Theodore. S. Rapport, Pearson education, 2nd Edn., 2002.
2. Wireless and Mobile Communications – Lee McGraw Hills, 3rd Edition, 2006.
3. Mobile cellular communication- G.Sasibhushan rao, Pearson Education.
4. Wireless Communication and Networking – Jon W. Mark and Weihua Zhqung, PHI, 2005.
5. Wireless Communication Technology – R. Blake, Thompson Asia Pvt. Ltd., 2004.

DIGITAL SYSTEM DESIGN

Lecture – Tutorial:	3-0 Hours	**Internal Marks:**	40
Credits:	3	**External Marks:**	60

Prerequisites: Digital Logic Design, Digital IC Applications

Course Objectives:

1. To learn advanced digital design concepts.
2. To design digital sub-systems using Verilog HDL.
3. To learn Memory, CPLDs, FPGAs and ASICs.
4. To Design and implementation of combinational and sequential digital logic circuits

Course Outcomes:

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

CO1	Model complex digital systems at several levels of abstractions, behavioral, structural, simulation, synthesis and rapid system prototyping.
CO2	Have basic understanding of Memory, CPLDs, FPGAs and ASICs.
CO3	Design digital circuits and subsystems using Verilog HDL
CO4	Analyze and design basic digital circuits with combinatorial and sequential logic circuits using Verilog VHDL
CO5	Investigate suitable Verilog VHDL program constructs in Digital System Designs
CO6	Apply various Digital ICs in performance evaluation for the synthesis process.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2- Medium, 3 – High)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**3**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO2	**-**	**3**	**3**	**2**	**-**	**-**	**2**	**2**	**-**	**-**	**-**	**-**
CO3	**2**	**3**	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO4	**2**	**-**	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**-**
CO5	**2**	**3**	**-**	**-**	**-**	**2**	**-**	**2**	**-**	**-**	**-**	**-**
CO6	**-**	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**

Course Content (Syllabus)

UNIT-I

Part-A (Verilog HDL-Basics) : Introduction, Overview of Digital Design with Verilog HDL,Hierarchical Modeling Concepts, Basic Concepts, Modules and Ports, Gate Level Modeling, Dataflow Modeling

Part-B (Verilog HDL-Programming): Behavioral Modeling, Tasks and Functions, Useful Modeling Techniques, Timing and Delays, User Defined Primitives, Logic Synthesis with Verilog HDL, Testbenches for verification of HDL models.

UNIT-II

Part-A (Combinational Logic Design-I): Introduction, Combinational-Circuit Analysis, Combinational-Circuit Synthesis, Programmed Minimization Methods, Timing Hazards, Circuit Timing, Decoders, Encoders, Three-State Devices.

Part-B (Combinational Logic Design-II): Multiplexers, Exclusive-OR Gates and Parity Circuits, Comparators, Adders, Subtractors, ALUs, Combinational Multipliers. Design considerations of the above combinational logic circuits.

UNIT-III

Part-A (Sequential Logic Design-I): Bistable Elements, Latches and Flip-Flops, Counters, Shift Registers, Clocked Synchronous State-Machine Analysis and Design, Designing State Machines Using State Diagrams.

Part-B (Sequential Logic Design-II): State-Machine Synthesis Using Transition Lists, State-Machine Design Example, Decomposing State Machines, Feedback Sequential Circuits, Feedback Sequential-Circuit Design.

UNIT-IV

Part-A(Memory and CPLDs): Read-Only Memory, Read/Write Memory, Static RAM, Dynamic RAM, Complex Programmable Logic Devices.

Part-B(FPGAs and ASICs): Field-Programmable Gate Arrays, Types of ASICs, ASIC Design flow, Economics of ASICs.

Text Books:

1. John F. Wakerly, *"Digital Design: Principles and Practices"*, 4th edition, Pearson, 2008
2. Samir Palnitkar, *"Verilog HDL: A Guide to Digital Design and Synthesis"*, 2nd edition, Pearson, 2003
3. Enoch O. Hwang, *"Digital Logic and Microprocessor Design with VHDL"*, 1st edition, Nelson Engineering, 2007.

REFERENCES:

1. Michael John Sebastian Smith, *"Application-Specific Integrated Circuits"*, 1st edition, Pearson, 2002
2. Charles H. Roth, *"Fundamentals of Logic Design"*, 5th edition, Cengage Learning, 2004
3. Randy H. Katz, Gaetano Borriello, *"Contemporary Logic Design"*, 2nd edition, PHI Learning, 2009

III Year – I Semester **L T P C**

3 1 0 3

ELECTROMAGNETIC INTERFERENCE AND ELECTROMAGNETIC COMPATIBILITY (EMI and EMC)

(PROFESSIONAL CORE ELECTIVE-I)

Pre requisites: EM Waves & Transmission Lines, Wave Propagation, Antennas.

Course Educational Objectives:

Students will be able to:

- Familiarize with the fundamentals that are essential for electronics industry in the field of EMI and EMC.
- Understand the lightning discharge and electro static discharge.
- Learn electromagnetic emissions from systems, appliances and circuits.
- Understand the various techniques for electromagnetic compatibility.
- Understand EMI measurement in Anechoic Chamber.
- Discuss electromagnetic interference measurements.

COURSE OUTCOMES:

At the end of the course the student able to learn the concepts of

CO No.	Course Outcomes
CO1	Describe the concept of electromagnetic interference and sources of EMI.
CO2	Interpret the concept of EMC related to product design & development.
CO3	Describe various Open area test sites measurement techniques.
CO4	Analyze electromagnetic emission systems and noise from relays and switches.
CO5	Utilize the techniques like grounding, shielding, bonding and EMI filters in the usage of cables , connectors and components
CO6	Interpret the various radiated and conducted interference and measurements.

COURSE OUTCOMES Vs PROGRAM OUTCOMES (CO-PO) MAPPING:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	-	-	-	1	-	-	-	-
CO2	3	3	2	1	1	-	-	1	-	-	-	1
CO3	2	-	-	1	1	1	-	-	-	1	1	-
CO4	2	3	-	-	1	-	-	-	-	-	-	-
CO5	-	3	-	-	2	-	-	-	-	-	-	-
CO6	3	-	-	2	1	1	-	-	-	1	1	-
Total	13	12	4	5	6	2	-	2	-	2	2	1
Avg.	**2.6**	**3.0**	**2.0**	**1.0**	**1.2**	**1.0**	**0.00**	**1.0**	**0.00**	**1.0**	**1.0**	**1.0**

SYLLABUS

UNIT –I:

Introduction, Natural and Nuclear Sources of EMI and EMC: Concepts of EMI and EMC and Definitions, Practical experiences and concerns, Natural and Nuclear sources of EMI, Lightning Discharge: Cloud-to-Ground Discharge, Cloud-to-Cloud Discharge, EM field produced by Lightning, Effects of Lightning Discharge on Transmission Lines, Electro Static Discharge: Charge accumulation and discharge, Model MSD waveform, ESD equivalent circuit, Radiated field from ESD.

UNIT –II:

EMI from Apparatus and Circuits, Open Area Test Sites: Electromagnetic emissions: Systems, Appliances, Noise from Relays and Switches, Nonlinearities in circuits, Cross talk in transmission lines, Transients in power supply lines, Electromagnetic interference (EMI), Open area test sites measurements: Measurement of RE and RS, Open area test site: Stationary EUT, Stationary Antenna, EUT-Antenna separation.

UNIT –III:

Radiated and Conducted Interference Measurements, ESD: Anechoic chamber, TEM cell, GH TEM Cell, Characterization of conduction currents / voltages (CM & DM interference), Conducted EM noise on power lines, Conducted EMI from equipment, Immunity to conducted EMI detectors and measurements, ESD, Electrical fast transients / bursts, Electrical surges.

UNIT -IV:

Grounding, Shielding, Bonding, Cables, Connectors, and Components: Principles and types of grounding, Shielding and bonding, Power line filter design: common-mode, differential mode and combined CM and DM filters, EMI suppression cables, EMC connectors, EMC gaskets, Opto-Isolators.

TEXT BOOKS:

1. Engineering Electromagnetic Compatibility - Dr. V.P. Kodali, IEEE Publication, Printed in India by S. Chand & Co. Ltd., New Delhi, 2000.

2. Electromagnetic Interference and Compatibility IMPACT series, IIT – Delhi, Modules 1 – 9.

REFERENCE BOOKS:

1. Introduction to Electromagnetic Compatibility - Ny, John Wiley, 1992, by C.R. Pal.
2. Henry W. Ott, "Electromagnetic Compatibility Engineering", John Wiley & Sons Inc, Newyork, 2009.
3. Daryl Gerke and William Kimmel, "EDN"s Designer"s Guide to Electromagnetic Compatibility", Elsevier Science & Technology Books, 2002.
4. W Scott Bennett, "Control and Measurement of Unintentional Electromagnetic Radiation", John Wiley & Sons Inc., (Wiley Interscience Series) 1997.
5. Dr Kenneth L Kaiser, "The Electromagnetic Compatibility Handbook", CRC Press 2005.

III Year – II Semester **L T P C**

- - 2 1

VLSI LABORATORY

PRE-REQUISITES FOR THE COURSE:

Students are expected to have knowledge on the following topics:

S. No	Topic
1.	CMOS technology.
2.	Digital electronics circuits.

COURSE OBJECTIVES:

Students will be able to:

1. Understand the physics and modeling of MOSFET.
2. Fabricate steps and layout of CMOS integrated circuits.
3. Analyze the performance of CMOS inverter and various circuits.
4. Design CMOS circuits using various design rules

COURSE OUTCOMES:

At the end of the course, the students will develop ability to:

1. Design CMOS logic circuits.
2. Simulate the circuit with tanner EDA tools.
3. Apply the design rules to get the layout of the circuits.
4. Apply lambda based design rules and solve the problem in the design of CMOS logic circuits.
5. Design various gates, adders, encoders and flip-flops.
6. Understand various design rules to obtain the CMOS logic circuits.

COURSE OUTCOMES vs. PROGRAM OUTCOMES (CO-PO) MAPPING:

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2-Medium, 3 – High).

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	3	-	-	3	-	-	3	-	-	-	-	-
CO2	-	-	-	2	-	-	-	-	-	-	-	-
CO3	-	-	-	-	-	2	3	2	2	3	3	3
CO4	2	-	-	-	-	-	-	-	-	-	-	-
CO5	-	2	-	2	3	-	2	-	-	-	2	3
CO6	-	3	-	-	-	-	-	-	-	-	-	-
Avg	2.5	2.3	-	-	-	2	2.3	2	2	3	2.5	3

VLSI LABORATORY USING EDA TOOL(SCHEMATIC AND LAYOUT DIAGRAMS)

The students are required to design the schematic diagrams using CMOS logic and to draw the layout diagrams to perform the following experiments using 130nm technology with the Industry standard EDA Tools.

1. Implementation of an inverter using CMOS logic.
2. Implementation of the universal gates using CMOS logic.
3. Implementation XOR gate using CMOS logic.
4. Full Adder using CMOS logic.
5. Full Subtractor using CMOS logic.
6. Implementation of SR latch using CMOS logic.
7. Implementation of D latch using CMOS logic.
8. Design of Decoder using CMOS logic.
9. Design of Static RAM cell using CMOS logic.
10. Design of Differential Amplifier using CMOS logic.
11. Design of flip flop using CMOS logic.

Software Required:

i. Mentor Graphics Software / Equivalent Industry Standard Software.
ii. Personal computer system with necessary software to run the programs and to implement.

NRI INSTITUTE OF TECHNOLOGY

(An Autonomous Institution Permanently Affiliated to JNTUK, Kakinada)
(Accredited by NAAC with "A" Grade and ISO 9001:2015 Certified Institution)
POTHAVARAPPADU (V), (VIA) NUNNA, AGIRIPALLI (M), PIN – 521 212

DIGITAL SIGNAL PROCESSING LABORATORY

Practicals:	2 Hours	**Internal Marks:**	40
Credits:	1	**External Marks:**	60

Prerequisites:

Signals and Systems and Basic Simulation Lab

Course Objectives:

- To acquire the knowledge of generation of various signals and perform different operations on them using MATLAB tool
- To understand the concept and importance of Discrete Fourier Transforms and Fast Fourier Transforms.
- To analyze the frequency response of IIR and FIR digital filters.
- To perform decimation and interpolation processes on a sequence.

Course Outcomes:

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

CO1	Make use of a software tool to generate various discrete time signals and perform different operations on them.
CO2	Examine Linear and Circular Convolution of discrete time signals.
CO3	Evaluate the Discrete Fourier Transform of a signal and its inverse.
CO4	Analyze the Frequency response of IIR Filters using Butterworth and Chebyshev Approximations.
CO5	Analyze the Frequency Response of FIR filters using windowing techniques.
CO6	Illustrate the Decimation and Interpolation processes on a given Sequence.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2- Medium, 3 – High)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	3	2	2		3						2	2
CO2	3	3	2		3						2	2
CO3	3	2	2		3						2	2
CO4	3	3	3	2	3						2	2
CO5	3	3	3	2	3						2	2
CO6	3	2	2		3						2	2

LIST OF EXPERIMENTS

- **All the following experiments are to be simulated using MATLAB or equivalent software.**

1. Generation of discrete time signals.
2. Addition of sinusoidal signals.
3. Computation of Linear Convolution.
4. Computation of Circular Convolution.
5. Computation of DFT and IDFT.
6. Computation of N-Point FFT.
7. Frequency response of IIR low pass and high pass Butterworth filter.
8. Frequency response of IIR low pass and high pass Chebyshev filter.
9. Frequency response of FIR low pass and high pass filter using Rectangular window.
10. Frequency response of FIR low pass and high pass filter using Triangular window.

Experiments to be conducted beyond the syllabus

1. Implementation of Decimation and Interpolation on a sequence/signal.
2. Verification of Linear Convolution and Circular Convolution of sequences using Code Composer Studio (CCS).

REFERENCE 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.
3. Digital Signal Processors – Architecture, Programming and Applications,, B.Venkataramani,M.Bhaskar, TATA McGraw Hill, 2002.
4. Digital Signal Processing – K Raja Rajeswari, I.K. International Publishing House.

E-RESOURCES:

1. https://nptel.ac.in/courses/117/102/117102060/
2. https://www.mathworks.com/

III Year – II Semester

L	T	P	C
0	0	2	2

MICROPROCESSOR & MICROCONTROLLERS LAB

PER-REQUISITES

Switching Theory Logic Design, Computer Organization and Architecture, Programming Languages

OBJECTIVES

1. To develop assembly language program skills of 8086 microprocessor.
2. To providing the basic knowledge of interfacing various peripherals to 8086 microprocessor.
3. To develop assembly language program skills of 8051 microcontroller.
4. To develop different applications based on 8086 and 8051.

COURSE OUTCOMES

At the end of the course student can able to

CO 1: Develop the assembly language Programs for 8086 Microprocessor

CO 2: Use the cross compiler such as MASM to verify and simulate the 8086 codes

CO 3: Interfacing of various peripheral chips to 8086 microprocessor.

CO 4: Develop the assembly language Programs for 8051 Microcontroller

CO 5: Use the KEIL Software to verify and simulate the 8051 codes.

CO 6: Develop 8086 and 8051 based different kinds of applications.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	**3**	**2**	**2**		**2**						**3**	
CO 2	**3**	**3**	**3**		**2**						**2**	
CO 3	**2**		**2**								**2**	
CO 4	**3**	**2**	**2**		**2**						**3**	
CO 5	**3**	**3**	**3**		**2**						**2**	
CO 6	**3**				**3**							

SYLLABUS

PART-I: MICROPROCESSOR 8086

1. Introduction to MASM/TASM.
2. Arithmetic Operations - Multi byte addition and subtraction, multiplication and division, ASCII Arithmetic Operations.
3. Logic operations - Shift and Rotate, Converting packed BCD to Unpacked BCD, BCD to ASCII conversion.
4. By using string operations and instruction prefix: Move, Block, Reverse string, Sorting, Inserting, Deleting, Length of the string and string comparison.
5. Factorial on a given Number
6. Sum of square and Sum of Cubes of a given number

PART-II: INTERFACING WITH MICROPROCESSOR 8086 (Any 2 Experiments)

1. 8259-Interrupt Controller –Generate interrupt using 8259 timer.
2. 8279-Keyboard Display-write a ALP to display a string of character.
3. 8255-PPI-write ALP to generate sinusoidal wave, triangular and saw tooth wave using PPI.
4. 8251 USART Write ALP to establish communication between two processors.

PART-III: MICROCONTROLLER 8051 (Any 3 Experiments)

1. Switches and LEDs.
2. Traffic light Controller.
3. Finding No of 1's and 0's in a given 8 bit number
4. Addition of even number from a given array
5. Serial Communication

Text Books

1. A. K. Ray and K.M. Bhurchandani, "Advanced Microprocessors and Peripherals", TMH, 2nd edition, 2006
2. Kenneth. J. Ayala, "The 8051 Microcontroller", 3rd Edition, Cengage Learning, 2010.

Reference Books

1. D. V. Hall' "Microprocessors and Interfacing", TMH, 2nd edition 2006. .
2. Muhammad Ali Mazidi, Janice Gillispie Mazidi and Rolin D. McKinlay, "The 8051 Microcontrollers and Embedded Systems", Pearson, 2nd Edition.
3. Barry B.Brey, "The Intel Microprocessors", PHI, 7th Edition, 2006.