

**B.Tech. III Year I Semester**

S.No.	Category	Subject Code	Title	L	T	P	C
1	PCC	23EC5T06	Analog & Digital IC Applications	3	0	0	3
2	PCC	23EC5T07	Digital communications	3	0	0	3
3	PCC	23EC5T08	Antennas and Wave Propagation	3	0	0	3
4	PE-I	23EC5D01	Digital System Design through HDL	3	0	0	3
		23EC5D02	Artificial Intelligence				
		23EC5D03	Electronic Measurements and Instrumentation				
		23EC5D04	Computer Organization and Architecture				
		23EC5D05	12 WEEK MOOCS SWAYAM/NPTEL COURSE RECOMMENDED BY THE BOS				
5	OE-I	23CS5E02	Computer Organization and Architecture	3	0	0	3
6	PCC	23EC5L05	Analog & Digital IC Applications Lab	0	0	3	1.5
7	PCC	23EC5L06	Analog and digital communications Lab	0	0	3	1.5
8	SEC	23SC5L03	Applications of Lab view for Instrumentation & Communications	0	1	2	2
9	ES	23ES5L02	Design of PCB & Antennas Lab	0	0	2	1
10		23EC5I01	Evaluation of Community Service Internship	-	-	-	2
<b>Total</b>				<b>15</b>	<b>1</b>	<b>10</b>	<b>23</b>
<b>MC</b>		Minor Course (Student may select from the same specialized minors pool)		3	0	3	4.5
<b>MC</b>		Minor Course through SWAYAM / NPTEL (Minimum 12 Week, 3 credit course)		3	0	0	3
<b>HC</b>		Honors Course (Student may select from the same Honors pool)		3	0	0	3
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**B.Tech. III Year II Semester**

S.No.	Category	Subject Code	Title	L	T	P	C
1	PCC	23EC6T09	VLSI Design	3	0	0	3
2	PCC	23EC6T10	Microprocessors & Microcontrollers	3	0	0	3
3	PCC	23EC6T11	Digital Signal Processing	3	0	0	3
4	PE-II	23EC6D07	Analog IC Design	3	0	0	3
		23EC6D08	Satellite Communication				
		23EC6D09	Smart and Wireless Instrumentation				
		23EC6D10	Machine Learning				
		23EC6D11	12 WEEK MOOCS SWAYAM/NPTEL COURSE RECOMMENDED BY THE BOS				
5	PE-III	23EC6D12	Bio Medical Instrumentation	3	0	0	3
		23EC6D13	Microwave Engineering				
		23EC6D14	Embedded Systems				
		23EC6D15	Optical Communications				
		23EC6D16	12 WEEK MOOCS SWAYAM/NPTEL COURSE RECOMMENDED BY THE BOS				
6	OE-II			3	0	0	3
7	PCC	23EC6L07	VLSI Design Lab	0	0	3	1.5
8	PCC	23EC6L08	Microprocessors & Microcontrollers Lab	0	0	3	1.5
9	SEC	23SC6L03	Machine Learning Lab	0	1	2	2
10	AC	23NC6T03	Research methodology and IPR	2	0	0	-
		Total		20	1	08	23
Mandatory Industry Internship of 08 weeks duration during summer vacation							
MC		Student may select from the same minors pool		3	0	3	4.5
MC		Minor Course (Student may select from the same specialized minors pool)		3	0	0	3
HC		Student may select from the same honors pool		3	0	0	3
HC		Honors Course ( Student may select from the honors pool)		3	0	0	3

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**List of open elective courses offered by department of ECE:****Pool 1: Open Elective 1 (Either of the 4 subjects)**

S.No.	Category	Subject Code	Title	L	T	P	C
1	OE1	23EC5E01	Electronic Devices and Circuits	3	0	0	3
2		23EC5E02	Signals and Systems	3	0	0	3
3		23EC5E03	Probability Theory and Random variables	3	0	0	3
4		23EC5E04	Network Analysis	3	0	0	3

**Pool 2: Open Elective 2 (Either of the 4 subjects)**

S.No.	Category	Subject Code	Title	L	T	P	C
5	OE2	23EC6E05	Linear and Digital IC Applications	3	0	0	3
6		23EC6E06	Principles of communications	3	0	0	3
7		23EC6E07	Principles of Signal Processing	3	0	0	3
8		23EC6E08	Microprocessors & Microcontrollers	3	0	0	3

**Pool 3: Open Elective 3 (Either of the 4 subjects)**

S.No.	Category	Subject Code	Title	L	T	P	C
9	OE3	23EC7E09	Fundamentals of VLSI Design	3	0	0	3
10		23EC7E10	Digital Electronics	3	0	0	3
11		23EC7E11	Electronic measurements and Instrumentations	3	0	0	3
12		23EC7E12	Optical communications	3	0	0	3

**Pool 4: Open Elective 4 (Either of the 4 subjects)**

S.No.	Category	Subject Code	Title	L	T	P	C
9	OE4	23EC7E13	Principles of Cellular & Mobile communications	3	0	0	3
10		23EC7E14	Fundamentals of Satellite Communications	3	0	0	3
11		23EC7E15	Embedded Systems	3	0	0	3
12		23EC7E16	Transducers and Signal Conditioning	3	0	0	3

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III Year-I Semester					
23EC5T06	<b>ANALOG &amp; DIGITAL IC APPLICATIONS</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**Course Outcomes:**

- Analyze and design various configurations of operational amplifiers, and applications such as instrumentation amplifiers, voltage regulators, comparators, and waveform generators. (BL4)
- Design and implement active filters and waveform generators using op-amps, IC-555, and IC-565, and evaluate their performance for signal processing applications (BL4)
- Compare different data conversion techniques (DAC and ADC) and implement digital-to-analog and analog-to-digital conversion circuits in real-time applications. (BL3)
- Apply combinational logic ICs such as multiplexers, de-multiplexers, encoders, decoders, and arithmetic circuits to solve complex digital design problems. (BL3)
- Develop sequential circuits using flip-flops, counters, and shift registers, and analyze their use in digital memory systems, including ROM, RAM, and their variants (BL3)

**UNIT-I**

**Operational Amplifier:** Ideal and Practical Op-Amp, Op-Amp Characteristics, DC and AC Characteristics, features of 741 Op-Amp, Modes of Operation-Inverting, Non-Inverting, Differential, Instrumentation Amplifier, AC Amplifier, Differentiators and Integrators, Comparators, Schmitt Trigger, Introduction to Voltage Regulators, Features of 723 Regulator, Three Terminal Voltage Regulators. (TEXT: D. Roy Chowdhury, Salivahana) 14Hrs

**UNIT-II**

**Op-Amp, IC-555 & IC565 Applications:** Introduction to Active Filters, Characteristics of Band pass, Band reject and All Pass Filters, Analysis of 1<sup>st</sup> order LPF & HPF Butterworth Filters, Waveform Generators – Triangular, Sawtooth, Square Wave, IC555 Timer-Functional Diagram, Monostable and Astable Operations, Applications, IC565 PLL-Block Schematic, principle and Applications. (TEXT: Ramakanth A. Gayakwad, D. Roy Chowdhury) 14Hrs

**UNIT-III**

**Data 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

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ADC, Counter Type ADC, Successive Approximation ADC and Dual Slope ADC, DAC and ADC Specifications.( TEXT: Ramakanth A.Gayakwad, D.Roy Chowdhury ) 12Hrs

#### UNIT-IV

**Combinational Logic ICs:** Specifications and Applications of TTL-74XX & CMOS 40XX Series ICs - Code Converters, Decoders, LED & LCD Decoders with Drivers, Encoders, Priority Encoders, Multiplexers, De-multiplexers, Priority Generators/Checkers, Parallel Binary Adder/Subtractor, Magnitude Comparators.(TEXT: FloydandJain,John.F.Wakerly) 12Hrs

#### UNIT-V

**Sequential Logic IC's and Memories:** Familiarity with commonly available 74XX & CMOS40XX Series ICs - All Types of Flip-flops, Synchronous Counters, Decade Counters, Shift Registers. Memories - ROM Architecture, Types of ROMS & Applications, RAM Architecture, Static & Dynamic RAMs.(TEXT: John.F.Wakerly) 10Hrs

#### TEXTBOOKS:

1. RamakanthA.Gayakwad-Op-Amps&LinearICs,PHI,2003.
2. FloydandJain-DigitalFundamentals,8<sup>th</sup>Ed.,PearsonEducation,2005.

#### REFERENCEBOOKS:

1. D.RoyChowdhury–LinearIntegratedCircuits,NewAgeInternational(p)Ltd,2<sup>nd</sup>Ed.,2003.
2. John.F.Wakerly–DigitalDesignPrinciplesandPractices,3<sup>rd</sup>Ed.,Pearson,,2009.
3. Salivahana-LinearIntegratedCircuitsandApplications,TMH,2008.
4. WilliamD.Stanley-OperationalAmplifierswithLinearIntegratedCircuits,4<sup>th</sup>Ed.,Pearson Education India, 2009.

#### URL:

1. <https://www.coursera.org/lecture/electronics/2-1-introduction-to-op-amps-and-ideal-behavior-Q5Di2>
2. <http://www.nptelvideos.in/2012/11/analog-ics.html>
3. [https://www.tutorialspoint.com/linear\\_integrated\\_circuits\\_applications/index.htm](https://www.tutorialspoint.com/linear_integrated_circuits_applications/index.htm)
4. [https://en.wikipedia.org/wiki/Sequential\\_logic/](https://en.wikipedia.org/wiki/Sequential_logic/)
5. <https://www.engineersgarage.com/tutorials/sequential-logic-circuits-de-part-17/>

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III Year-I Semester					
23EC5T07	<b>DIGITAL COMMUNICATIONS</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**Course Outcomes:**

- To Describe basic components of Digital Communication Systems and to determine the performance of different pulse digital modulation techniques[BL3]
- To determine the performance of digital modulation techniques for the generation and digital representation of the signals.[BL3]
- To design optimum receiver for Digital Modulation techniques and to determine the probability of error for various digital modulation schemes[BL4]
- To compute and analyze error detecting and error correction codes block codes, cyclic codes.[BL5]
- To compute and analyze convolution codes and Turbo codes.[BL5]

**UNIT I**

**PULSE DIGITAL MODULATION:** 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, noise in PCM and DM systems, Time division multiplexing, Frequency division multiplexing. [15 Hrs]

**UNIT II**

**DIGITAL MODULATION TECHNIQUES:** Introduction, ASK, FSK, PSK, DPSK, DEPSK, QPSK, M-ary PSK, ASK, FSK, similarity of BFSK and BPSK. [12 Hrs]

**UNIT III**

**DATA TRANSMISSION:** Base band signal receiver, probability of error, the optimum filter, matched filter, probability of error using matched filter, coherent reception, non-coherent detection of FSK, calculation of error probability of ASK, BPSK, BFSK, QPSK. [9 Hrs]

**UNIT IV**

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**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, BCH codes **[10 Hrs]**

## UNIT V

**CONVOLUTION CODES:** Introduction, encoding of convolution codes, time domain approach, transform domain approach. Graphical approach: state, tree and trellis diagram decoding using Viterbi algorithm, Turbo Codes. **[10 Hrs]**

## TEXT BOOKS:

1. Digital communications - Simon Haykin, John Wiley, 2005
2. Principles of Communication Systems – H. Taub and D. Schilling, TMH, 2003
3. Digital Communications- J.Das, S.K.Mullick, P.K.Chatterjee, John willy & sons, 1986.

## REFERENCES:

1. Digital and Analog Communication Systems - Sam Shanmugam, John Wiley, 2005.
2. Digital Communications – John Proakis, TMH, 1983.
3. Communication Systems Analog & Digital – Singh & Sapre, TMH, 2004
4. Modern Analog and Digital Communication – B.P.Lathi, Oxford reprint, 3rd edition, 2004.
5. Digital Communications – 2009, by Dr. Sanjay Sharma
6. Digital communications J.S.Chitode, Technical Publications, 2009

## Web Resources

W1: <https://nptel.ac.in/courses/117101051/>

W2: [https://www.tutorialspoint.com/digital\\_communication/](https://www.tutorialspoint.com/digital_communication/)

W3: <https://archive.nptel.ac.in/courses/117/104/117104120/>

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III Year-I Semester					
23EC5T08	<b>ANTENNAS AND WAVE PROPAGATION</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**Course Outcomes:**

- Identify basic antenna parameters.[BL3]
- Quantify the fields radiated by various types of antennas.[BL3]
- Design and analyze antenna arrays.[BL4]
- Design and analyze wire antennas, loop antennas, reflector antennas, lens antennas, horn antennas and micro-strip antennas[BL6]
- Analyze antenna measurements to assess antenna's performance[BL4]

**UNIT-I:**

**ANTENNA FUNDAMENTALS:** Introduction, Radiation Mechanism – Single Wire, 2-Wire, dipoles, Current Distribution on a thin wire antenna. Antenna Parameters - Radiation Patterns, Patterns in Principal Planes, Field Regions, Main Lobe and Side Lobes, Beam width, Radiation Intensity, Directivity, Antenna Efficiency, Gain, Beam Efficiency, Bandwidth, Polarization, Input Impedance, Beam Area and Resolution, Antenna Apertures, Aperture Efficiency, Effective Height, illustrated Problems.

**UNIT-II:**

**THIN LINEAR WIRE ANTENNAS:** Retarded Potentials, Radiation from Small Electric Dipole, Quarter wave Monopole and Half wave Dipole – Current Distributions, Evaluation of Field Components, Power Radiated, Radiation Resistance, **Radiation Efficiency**, Beam width, Directivity, Effective Area and Effective Height. Natural current distributions, fields and patterns of Thin Linear Center-fed Antennas of different lengths, Radiation Resistance at a point which is not current maximum, Antenna Theorems – Applicability and Proofs for equivalence of directional characteristics, Loop Antennas: Small Loops - Field Components, Comparison of far fields of small loop and short dipole, Concept of short magnetic dipole, D and R<sub>r</sub> relations for small loops

**UNIT-III:**

**ANTENNA ARRAYS :** 2 element arrays – different cases, Principle of Pattern Multiplication, N element Uniform Linear Arrays – Broadside, End-fire Arrays, EFA with Increased Directivity, Derivation of their characteristics and comparison; Concept of Scanning Arrays. Directivity Relations (no derivations), Related Problems. Binomial Arrays, Effects of Uniform and Non-uniform Amplitude Distributions, Design Relations Arrays with Parasitic Elements, Yagi-Uda Arrays, Folded Dipoles and their characteristics

**UNIT-IV**

**BROADBAND ANTENNAS:** Log periodic antenna, Basic principle, Helical Antennas –

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Significance, Geometry, basic properties; Design considerations for monofilar helical antennas in Axial Mode and Normal Modes (Qualitative Treatment).

#### **UHF AND MICROWAVE ANTENNAS:**

**Horn Antennas** – Types, Optimum Horns, Design Characteristics of Pyramidal Horns; **Paraboloidal Reflectors:** – Geometry, characteristics, types of feeds, F/D Ratio, Spill Over, Back Lobes, Aperture Blocking, Off-set Feeds, Case grain Feeds.

**Microstrip Antennas**-Introduction, Features, Advantages and Limitations, Rectangular Patch Antennas –Geometry and Parameters, Impact of different parameters on characteristics, illustrated Problems.

#### **UNIT-V**

**ANTENNA MEASUREMENTS:** Friis Transmission Equation, Patterns Required, Set Up, Distance Criterion, Directivity and Gain Measurements (Comparison, Absolute and 3-Antenna Methods).

**WAVE PROPAGATION:** TYPES of propagations. Sky Wave Propagation – Formation of Ionospheric Layers and their Characteristics, Mechanism of Reflection and Refraction, Critical Frequency, MUF and Skip Distance; Space Wave Propagation – Mechanism, LOS and Radio Horizon, Field strength equation, illustrated Problems.

#### **TEXT BOOKS:**

1. Antenna Theory: Analysis And Design- Constantine A. Balanis, 3<sup>rd</sup> Edition, A John Wiley & Sons, Inc., Publication
2. Antennas for All Applications – John D. Kraus and Ronald J. Marhefka, 3<sup>rd</sup> Edition, TMH, 2003.
3. Electromagnetic Waves and Radiating Systems – E.C. Jordan and K.G. Balmain, PHI, 2<sup>nd</sup> Edition, 2000.

#### **REFERENCES:**

1. Antennas and Wave Propagation-G.S.N. Raju, Pearson publications, 2006.
2. Transmission and Propagation – E.V.D. Glazier and H.R.L. Lamont, The Services Text Book of Radio, vol. 5, Standard Publishers Distributors, Delhi.
3. Antennas – John D. Kraus, McGraw-Hill, 2<sup>nd</sup> Edition, 1988.

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**PROFESSIONAL ELECTIVES-1**

<b>III Year-I Semester</b>					
<b>23EC5D01</b>	<b>DIGITAL SYSTEM DESIGN THROUGH HDL</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**Course Outcomes:**

- Understand the language constructs and programming fundamentals of Verilog HDL.
- Choose the suitable abstraction level for a particular digital design
- Construct Combinational and sequential circuits in different modelling styles using Verilog HDL
- Design and synthesize combinational and sequential logic circuits
- Analyze and Verify the functionality of digital circuits/systems using test benches.

**UNIT-I: Introduction to Verilog HDL and Gate Level Modelling:**

Verilog as HDL, Levels of Design Description Basics of Concepts of Verilog, Data Types, System Task, Compiler directives, modules and ports. AND Gate Primitive, Module Structure, Other Gate Primitives, Illustrative Examples, Tri-State Gates, Array of Instances of Primitives, Additional Examples, Design of Flipflops with Gate Primitives, Delay.

**UNIT-II: Behavioural Modelling:**

Introduction, structured processors, procedural assignments, timing controls, conditional statements, multi-way branching, loops, sequential and parallel blocks, generate blocks, Design of Decoders, Multiplexers, Flip-flops, Registers & Counters in Behavioral model.

**UNIT-III: Modelling at Data flow Level:**

Introduction, Continuous Assignment Structures, Delays and Continuous Assignments, Assignment to Vectors, Operators, Design of Decoders, Multiplexers, Flip-flops, Registers & Counters in dataflow model, Switch Level Modelling: Introduction, Basic Transistor Switches, CMOS Switch, Bi-directional Gates, Time Delays with Switch Primitive delays.

**UNIT-IV: FSM Design:**

Functions, Tasks, User-defined, Primitives: Introduction, Function, Tasks, User-Defined Primitives (UDP), FSM Design (Moore and Mealy Machines), Encoding Style: From Binary to One Hot. Introduction to Synthesis, Synthesis of combinational logic, Synthesis of sequential logic with latches and flip-flops, Synthesis of Explicit and Implicit State Machines

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**UNIT-V: Components Test and Verification:**

Test Bench – Combinational Circuits Testing, Sequential Circuits Testing, Test Bench Techniques, Design Verification, Assertion Verification

**Text Books:**

1. Samir Palnitkar, “Verilog HDL A Guide to Digital and Synthesis” ,2<sup>nd</sup> Edition, Pearson Education,2006.
2. Michael, D. Ciletti, “Advanced digital design with the Verilog HDL”, Pearson Education India,2005.

**Reference Books:**

1. Padmanabhan, Tripura Sundari -Design through Verilog HDL, Wiley, 2016
2. S. Brown, Zvonko – Vranesic, Fundamentals of Digital Logic with Verilog Design, TMH, 3<sup>rd</sup> Edition 2014.
3. J. Bhasker, A Verilog HDL Primer 2<sup>nd</sup> edition, BS Publications, 2001.

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III Year-II Semester					
23EC5D02	<b>ARTIFICIAL INTELLIGENCE</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**Course Outcomes:**

- Understand the concepts of computational intelligence like machine learning
- Ability to get the skill to apply machine learning techniques to address the real time Problems in different areas
- Understand the Neural Networks and its usage in machine learning application.
- Apply principles and algorithms evaluate models generated from data
- Apply the algorithms to a real world problems

**UNIT-1**

What is AI (Artificial Intelligence)? : The AI Problems, The Underlying Assumption, What are AI Techniques, The Level Of The Model, Criteria For Success, Some General References, One Final

Word Problems, State Space Search & Heuristic Search Techniques: Defining The Problems As A State Space Search, Production Systems, Production Characteristics, Production System, Characteristics And Issues In The Design Of Search Programs, Additional Problems. Generate-And-Test, Hill Climbing, Best-First Search, Problem Reduction, Constraint Satisfaction, Means-Ends Analysis.

**UNIT-2**

Knowledge Representation Issues: Representations And Mappings, Approaches To Knowledge Representation. Using Predicate Logic: Representation Simple Facts In Logic, Representing Instance And Isa Relationships, Computable Functions And Predicates, Resolution. Representing Knowledge Using Rules: Procedural Versus Declarative Knowledge, Logic Programming, Forward Versus Backward Reasoning.

**UNIT-3**

Symbolic Reasoning Under Uncertainty: Introduction To Non-monotonic Reasoning, Logics For Non-monotonic Reasoning. Statistical Reasoning: Probability And Bayes' Theorem, Factors And Rule-Based Systems, Bayesian Networks, Dempster Shafer Theory

**UNIT-4**

Fuzzy Logic. Weak Slot-and-Filler Structures: Semantic Nets, Frames. Strong Slot-and-Filler Structures: Conceptual Dependency, Scripts, CYC

**UNIT-5**

Game Playing: Overview, And Example Domain: Overview, Mini Max, Alpha-Beta Cut-off, Refinements, Iterative deepening, The Blocks World, Components Of A Planning System,

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Goal Stack Planning, Nonlinear Planning Using Constraint Posting, Hierarchical Planning, Reactive Systems, Other Planning Techniques. Understanding: What is understanding? What makes it hard? As constraint satisfaction

Natural Language Processing: Introduction, Syntactic Processing, Semantic Analysis, Semantic Analysis, Discourse And Pragmatic Processing, Spell Checking Connectionist Models: Introduction: Hopfield Network, Learning In Neural Network, Application Of Neural Networks, Recurrent Networks, Distributed Representations, Connectionist AI And Symbolic AI

**Text Books:**

1. Elaine Rich and Kevin Knight “Artificial Intelligence”, 2<sup>nd</sup> Edition, Tata Mcgraw-Hill, 2005.
2. Stuart Russel and Peter Norvig, “Artificial Intelligence: A Modern Approach”, 3<sup>rd</sup> Edition, Prentice Hall, 2009.

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III Year-I Semester					
23EC5D03	<b>ELECTRONIC MEASUREMENTS AND INSTRUMENTATION</b>	L	T	P	C
		3	0	0	3

**Course Outcomes:**

- Understand the various Analog and Digital measuring Instruments
- Aware of the principles and operations of various oscilloscopes
- Learn measurements using various bridges
- Familiarize different Signal Generators and function generators
- Learn various transducers and Intelligent sensors

**UNIT I**

**Measuring Instruments:** Introduction, Errors in Measurement, Accuracy, Precision, Resolution and Significant figures, Basic PMMC Meter- construction and working, DC and AC Voltmeters- Multirange, Range extension, DC Ammeter, Multimeter for Voltage, Current and resistance measurements.

**Digital Instruments:** Digital Voltmeters – Introduction, DVM's based on V-T, V-F and Successive approximation principles, Resolution and sensitivity, General specifications, Digital Multimeters, Digital frequency meters, Digital measurement of time.

**UNIT II**

**Oscilloscopes:** Introduction, Block diagram of CRO, Basic principle of CRT, CRT Construction and features, vertical amplifiers, horizontal deflection system- sweep, trigger pulse, delay line, sync selector circuits. Dual beam and dual trace CROs, Sampling and Digital storage oscilloscopes.

**UNIT III**

**Bridges:** DC Bridges for Measurement of resistance - Wheat stone bridge, Kelvin's Bridge, AC Bridges for Measurement of inductance- Maxwell's bridge, Hay's Bridge, Anderson bridge, Measurement of capacitance - Schering Bridge, Wien Bridge, Errors and precautions in using bridges.

**UNIT IV**

**Signal Generators:** Introduction, Fixed and variable AF oscillator, Standard signal generator, Laboratory type signal generator, AF sine and Square wave generator, Function generator, Square and Pulse generator, Sweep frequency generator.

**UNIT V**

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**Transducers:** Introduction, Types of Transducers, Electrical transducers, Selecting a transducer, Resistive transducer, Strain gauges, Piezoelectric transducer, Photoelectric transducer, Photovoltaic transducer, Temperature transducers-RTD, LVDT.

**Intelligent Sensors:** definition of intelligent instrumentation, types of instruments, Classification, Smart sensors, Cogent Sensors, Soft or Virtual sensors, Self-Adaptive Sensors, Self-Validating Sensors, Temperature Compensating Intelligent Sensors, Pressure Sensor, Indirect Sensing. (**Text Book 3**)

### TEXT BOOKS

1. H. S. Kalsi, “Electronic Instrumentation”, Third edition, Tata McGraw Hill, 2010.
2. A. D. Helfrick and W.D. Cooper, “Modern Electronic Instrumentation and Measurement Techniques”, PHI, 6th Edition, 2010.
3. Manabendra Bhuyan, —Intelligent Instrumentation: Principles and Applications CRC Press, 2011.

### REFERENCE BOOKS

1. A.K. Sawhney, Dhanpat Rai & Co., “A course in Electrical and Electronic Measurements and Instrumentation”, 9<sup>th</sup> Edition, 2010.
2. David A. Bell, “Electronic Instrumentation & Measurements”, PHI, 2nd Edition, 2006.

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III Year-I Semester					
23CS5E02	<b>COMPUTER ORGANIZATION AND ARCHITECTURE</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**Course Outcomes:**

- Understand the representation of data, the register transfer language and Micro operations.
- Know the basic computer organization and design, programming the basic computer and design the micro programmer control unit.
- Know the development of central processing unit and explain various algorithms for computer arithmetic operations.
- Interface various Peripheral devices and various data transfer operations.
- Study the memory Hierarchy and different types of memories.

**UNIT-1 :**

**Introduction:** Digital Computers, Von Neumann computers, Basic organization of a computer, **Data Representation:** Data types, Complements, Fixed-point representation, Conversion of fractions, Floating-point representation.

**Register Transfer and Micro operations:** Register transfer language, Register transfer, Bus and Memory transfers, Arithmetic Micro operations, Logic Micro operations, Shift Micro operations, Arithmetic Logic Shift Unit

**UNIT-2**

**Basic Computer Organization and Design:** Instruction Codes, Computer Registers, Computer Instructions, Timing and Control, Instruction Cycle, Memory-Reference instructions, Input-Output and Interrupt, Complete Computer Description, Design of Basic computer

**Programming the Basic Computer:** Introduction, Machine Language, Assembly language, The Assembler, Program Loops, Programming Arithmetic and Logic Operations

**Micro programmed Control:** Control Memory, Address Sequencing, Micro program Example, Design of Control Unit (**Preferably from Reference Book 2** )

**UNIT-3**

**Central Processing Unit:** Introduction, General Register Organization, Stack organization, Instruction Formats, Addressing Modes, Data transfer and Manipulation, Program Control, Reduced Instruction Set Computer

**Computer Arithmetic:** Introduction, Addition and Subtraction, Multiplication Algorithms, Division Algorithms, Floating-Point Arithmetic Operations, Decimal Arithmetic Unit, Decimal Arithmetic Operations.

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**UNIT – 4**

**Input-Output organization :** Peripheral Devices, Input-Output Interface, Asynchronous Data Transfer, Modes of Transfer, Priority Interrupt, Direct Memory Access (DMA), Input-Output Processor (IOP), Serial Communication.

**UNIT– 5**

**Memory Organization:** Memory Hierarchy, Main Memory, Auxiliary Memory, Associative Memory, Cache Memory, Virtual Memory, Memory Management Hardware.

**Text Book**

1. M.Morris Mano,” Computer System Architecture,” Pearson Publishers, Revised Third Edition

**Reference Books**

1. John P Hayes, “Computer Architecture and Organization,”Mc-Graw Hill Publishers, Third Edition
2. Carl Hamacher, “Computer Organization,” Tata Mc-Graw Hill Publishers, Fifth Edition.

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III Year-I Semester					
23EC5L05	ANALOG AND DIGITAL IC APPLICATIONS LAB	L	T	P	C
		0	0	3	1.5

**Course Outcomes:**

- Design and analyze various circuits using IC 741 op-amp for non-linear applications. (BL4)
- Design first order Active filter circuits using IC 741 op-amp Analyze and design amplifiers, active filters and waveform generators.(BL4)
- Design the various applications of 555 timer and IC 565 – PLL and IC 566 – VCO (BL4)
- Develop HDL source code for Combinational Circuit ICs and obtained simulation results using XST synthesizer. (BL4)
- Develop HDL source code for Sequential Circuit ICs and obtained simulation results using XST synthesizer. (BL4)

**PART-A:** (Minimum **SIX** Experiments to be conducted):

1. OP AMP Applications – Adder, Subtractor, Comparator Circuits.
2. Integrator and Differentiator Circuits using IC 741.
3. Active Filter Applications – LPF, HPF (first order)
4. Active Filter Applications – BPF, Band Reject (Wideband) and Notch Filters.
5. IC 741 Oscillator Circuits – Phase Shift and Wien Bridge Oscillators.
6. Function Generator using OP AMPs.
7. IC 555 Timer – Astable& Mono-stable Operation Circuit.
8. Schmitt Trigger Circuits – using IC 741 and IC 555.
9. IC 565 – PLL Applications.
10. IC 566 – VCO Applications.
11. 4 bit DAC using OP AMP.

## Equipment required for Laboratories:

1. RPS
2. CRO
3. Function Generator
4. Multi Meters
5. IC Trainer Kits (Optional)

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6. Bread Boards
7. Components:- IC741, IC555, IC565, IC1496, IC723, 7805, 7809, 7912 etc.
8. Analog IC Tester

**PART-B:** (Minimum **SIX** Experiments to be conducted):

The students are required to design and draw the internal structure of the following Digital Integrated Circuits and to develop HDL(VHDL, Verilog HDL) source code, perform simulation using relevant simulator and analyze the obtained simulation results using appropriate synthesizer. Further, it is required to verify the logic with necessary hardware.

**List of Experiments:**

1. Realization of Logic Gates
2. 3 to 8 Decoder- 74138
3. 8\*1 Multiplexer-74151 and 2\*1 De-multiplexer-74155
4. 4-Bit Comparator-7485.
5. D Flip-Flop- 7474
6. Decade Counter- 7490
7. Universal shift register-74194/195
8. RAM (16\*4)-74189 (read and write operations)

**Equipment Required:**

- 1.Xilinx Vivado/Equivalent Standard IDE
2. Personal computer with necessary peripherals
- 3.Hardware kits- Various FPGA families.

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III Year-I Semester					
23EC5L06	ANALOG AND DIGITAL COMMUNICATIONS LAB	L	T	P	C
		0	0	3	1.5

COs	Statement	BL
CO1	Experiment with Analog , digital modulation and Demodulation ,conversion Techniques .	BL3
CO2	Construct the sampling theorem and to apply in domain of pulse modulation and demodulation techniques	BL3
CO3	Illustrate multiplexing and demultiplexing techniques	BL2
CO4	Evaluate various Source / Channel encoding & decoding methods	BL5
CO5	Utilize the Matlab Simulink and Matlab communication Tool box to perform the relevant experiments	BL3

**List of Experiments:**

(Fourteen experiments to be done-**The students have to calculate the relevant parameters**)–

(a. Hardware, b. MATLAB Simulink c. MATLAB Communication toolbox)

**Part-A**

1. Amplitude Modulation-Modulation & Demodulation
2. AM-DSBSC-Modulation & Demodulation
3. Diode Detector
4. Pre-emphasis & De-emphasis
5. Frequency Modulation-Modulation & Demodulation
6. Verification of Sampling Theorem
7. Pulse Amplitude Modulation & Demodulation
8. PWM,PPM–Modulation & Demodulation

**Part-B**

1. Time division multiplexing.
2. Frequency Division Multiplexing
3. Pulse code modulation.
4. Differential pulse code modulation.
5. Delta modulation.
6. Frequency shift keying.
7. Phase shift keying.
8. Differential phase shift keying.

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9. Companding
10. Source Encoder and Decoder
11. Linear Block Code-Encoder and Decoder and Binary Cyclic Code-Encoder and Decoder
12. Convolution Code-Encoder and Decoder

Note: All the above experiments are to be executed/completed using hardware boards and also to be simulated on Mat lab.

### **Equipment &**

#### **Software required:**

#### **Software:**

- i) Computer Systems with latest specifications
- ii) Connected in LAN(Optional)
- iii) Operating system(Windows/Linux software)
- iv) Simulations software(Simulink & MATLAB)

#### **Equipment:**

1. RPS -0 –30V
2. CRO -0–20MHz.
3. Function Generators -0–1MHz
4. Components and Breadboards
5. Multi meters and other meters

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III Year-I Semester					
23SC5L03	<b>APPLICATIONS OF LAB VIEW FOR INSTRUMENTATION &amp; COMMUNICATIONS</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>0</b>	<b>1</b>	<b>2</b>	<b>2</b>

**Course Outcomes:**

- Develop loops, case structures, arrays, and clusters.[BL3]
- Realize real time applications using NI DAQ hardware[BL2]
- Implement Coding techniques using Lab VIEW[BL3]
- Design automation and process control application[BL6]
- Apply Lab VIEW for data processing applications[BL3]

**Unit I:**

**Introduction to LabVIEW & Virtual Instrumentation:** Overview of LabVIEW: Graphical programming paradigm, LabVIEW Environment: Front panel, block diagram, data flow programming, Creating simple Virtual Instruments (VIs), Debugging and troubleshooting techniques, Implementing loops, case structures, arrays, and clusters.

**Unit II:**

**Data Acquisition & Signal Processing:** Interfacing sensors (temperature, pressure, light, etc.) with LabVIEW, Real-time data acquisition using NI DAQ hardware, Signal generation: Sine, Square, Triangular waves, Fourier Transform (FFT) for frequency analysis, Filtering techniques: Low-pass, High-pass, Band-pass filters.

**Unit III:**

**Communication System Implementation:** AM and FM Modulation/Demodulation using LabVIEW, Simulation of Digital Modulation Schemes (ASK, PSK, FSK), Eye diagrams and constellation plots for digital signals, Error detection and correction: Parity, CRC, Hamming Code.

**Unit IV: Instrumentation & Automation Applications:**

Real-time data logging and file handling (Excel/CSV), PID Controller Design for automation and process control, Motor speed control using LabVIEW and DAQ, Signal visualization and user interface design.

**Unit V: Advanced Applications:**

Image Processing using LabVIEW, Wireless communication using Bluetooth & Wi-Fi in LabVIEW, IoT Integration-Cloud-based monitoring and remote data access, Project-based learning-

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**Textbooks & References**

1. R. W. Larsen, LabVIEW for Engineers, 1st ed., Prentice Hall, 2011.
2. G. W. Johnson and R. Jennings, LabVIEW Graphical Programming, 4th ed., McGraw-Hill, 2017.
3. National Instruments, "LabVIEW Tutorials & Documentation," Available: <https://www.ni.com>. J. Jerome, Virtual Instrumentation Using LabVIEW, 1st ed., PHI Learning Pvt.

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III Year-I Semester					
23ES5L02	<b>DESIGN OF PCB &amp; ANTENNAS LAB</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>0</b>	<b>0</b>	<b>2</b>	<b>1</b>

CO1:Demonstrate to antenna simulation software tools	BL2
CO2:Design and analysis of wire antennas	BL6
CO3:Identify the radiation characteristics of Antennas	BL3
CO4:Analysis of microwave antennas	BL4
CO5:Analysis of Linear Antenna Arrays	BL4

### Merits of PCB Machine:

1. CNC based for Better Accuracy and results.
2. Etching, Engraving and Drilling can be done with same Machine
3. Maintenance free machine compared to chemical method.
4. Compatible with multiple software Gerber / G code.
5. Reduction of time and Inventory.
6. Height mapping for bed level and depth sensing.
7. Surface mapping of bed
8. Power Optimized system ability to run on ups systems unlike other Machines.
9. High precision lead screw
10. 5umeter resolution, 0.001 repeatability, 2 layer with FR4
11. Scalability from a single prototype to a batch of 10-50 PCBs.

### Scope of learning:

1. In house PCB proto type manufacturing process.
2. How to convert simulation results into real time Electronic boards/ Projects.
3. Designing according to project requirements.
4. Along with PCB other Multi materials support carbon fiber sheets, Drone frames, Engraved
5. Acrylic sheets. Engraving on aluminium.
6. Latest multi domain projects extension 3D printing and Additive Manufacturing.
7. Exposure to design the proto type products.

### ANTENNAS LAB:

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**List of experiments: (Any Ten experiments using any simulation software)**

1. Generation of EM-Wave
2. Impedance Matching using Smith Chart
3. Calculation of phase and group velocity calculation
4. Plot of Radiation pattern of dipole antenna
5. Plot of Radiation pattern of monopole antenna
6. Plot of Radiation pattern of Uniform Linear Array
7. Measurement of radiation pattern of all wired and aperture antennas
8. Measurement of radiation pattern of planar antennas
9. Measurement of radiation pattern of reflector antennas
10. Measurement of radiation pattern of array antennas
11. Analysis of co-polarization and cross polarization
12. Performance analysis of Yagi -Uda antenna
13. Performance analysis of Helix antenna
14. Radio wave propagation path loss calculations

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III Year-II Semester					
23EC6T09	VLSI DESIGN	L	T	P	C
		3	0	0	3

**Course Outcomes:**

- Demonstrate a clear understanding of CMOS fabrication flow and technology scaling.[BL2]
- Design MOSFET based logic circuit and apply scaling principles and limitations.[BL4]
- Design basic building blocks in Analog IC design.[BL4]
- Design various CMOS logic circuits for design of Combinational logic circuits. [BL4]
- Distinguish among various FPGA technologies and families, emerging device technologies. . [BL4]

**UNIT-I:****INTRODUCTION AND BASIC ELECTRICAL PROPERTIES OF MOS CIRCUITS: VLSI**

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

(TEXT BOOK-1, TEXT BOOK-4)

14Hrs

**UNIT-II:**

**BASIC CIRCUIT CONCEPTS:** Sheet Resistance, Sheet Resistance concept applied to MOS transistors and Inverters, Area Capacitance of Layers, Standard unit of capacitance, some area Capacitance Calculations, The Delay Unit, Inverter Delays, driving large capacitive loads, Propagation Delays, Wiring Capacitances, Choice of layers.

**SCALING OF MOS CIRCUITS:** Scaling models and scaling factors, Scaling factors for device parameters, Limitations of scaling, Limits due to sub threshold currents, Limits on logic levels and supply voltage due to noise and current density.

(TEXT BOOK-1, TEXT BOOK-4)

10Hrs

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**UNIT-III:**

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

(TEXT BOOK-1, TEXT BOOK-3, TEXT BOOK-4)

10Hrs

**UNIT-IV:****CMOS COMBINATIONAL AND SEQUENTIAL LOGIC CIRCUIT DESIGN:**

**Static CMOS Design:** Complementary CMOS, Rationed Logic, Pass-Transistor Logic, design of Half adder, full adder, multiplexer, decoder.

**Dynamic CMOS Design:** Dynamic Logic-Basic Principles, Speed and Power Dissipation of Dynamic Logic, Issues in Dynamic Design, Cascading Dynamic Gates,—Design examples of sequential circuits: Cross coupled NAND and NOR flipflops, D flipflop, SR JK flip flop, SR Master Slave flip flop.

(TEXT BOOK-1, TEXT BOOK-4)

16Hrs

**UNIT-V:**

**FPGA DESIGN:** FPGA design flow, Basic FPGA architecture, FPGA Technologies, Introduction to FPGA Families.

**INTRODUCTION TO ADVANCED TECHNOLOGIES:** Giga-scale dilemma, Short channel effects, High-k, Metal Gate Technology, FinFET, TFET.

(TEXT BOOK-1, TEXT BOOK-4, REFERENCE-2, REFERENCE-3)

10Hrs

**TEXTBOOKS:**

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

**REFERENCES:**

1. "Introduction to VLSI Circuits and Systems", John P. Uyemura, John Wiley & Sons, reprint 2009.
2. Integrated Nanoelectronics: Nanoscale CMOS, Post-CMOS and Allied Nanotechnologies  
Vinod Kumar Khanna, Springer India, 1<sup>st</sup> edition, 2016.
3. FinFETs and other multi-gate transistors, ColingeJP, Editor New York, Springer, 2008.

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**LINKS:**

1. <https://ocw.mit.edu/courses/6-012-microelectronic-devices-and-circuits-fall-2009/pages/lecture-notes/>
2. [https://www.electronics-tutorials.ws/transistor/tran\\_8.html](https://www.electronics-tutorials.ws/transistor/tran_8.html)
3. <https://eceagmr.wordpress.com/wp-content/uploads/2014/08/cmos-unit4-uk.pdf>
4. <https://nptel.ac.in/courses/117101058>
5. <https://jccluque.wordpress.com/wp-content/uploads/2016/09/capitulo6.pdf>
6. <https://cds.cern.ch/record/1100537/files/p231.pdf>

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III Year-II Semester					
23EC6T10	<b>MICROPROCESSORS &amp; MICROCONTROLLERS</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**Course Outcomes:**

- Understand the architecture of 8086 and its operation.
- Develop the students to compose the assembly language program for 8086.
- Applying 8086 processor to interface with necessary peripherals.
- Understand the architecture of 8051 and interfacing with necessary peripherals.
- Understand the introductory concepts of advanced processors, viz., ARM processors.

**UNIT-1:**

**Introduction:** Microprocessor based system, Origin of microprocessors, Harvard and Von Neumann architectures with examples, Microprocessor Unit versus Microcontroller Unit.

**8086 Architecture:** internal architecture of 8086 microprocessor, register organization, physical memory organization, general bus operation.---12Hrs

**UNIT-2:**

**8086 Programming:** instruction set, addressing modes, assembler directives, programming with assembler, writing simple programs with an assembler, stack and stack structure, interrupts and interrupt service routines, interrupt cycle of 8086.---9Hrs

**UNIT-3:**

**8086 Interfacing:** Semiconductor memories interfacing (RAM, ROM), Intel 8255 programmable peripheral interface, Interfacing switches and LEDs, Interfacing seven segment displays, Intel 8251 USART architecture and interfacing, stepper motor, A/D and D/A converters—12Hrs

**UNIT-4:****Intel 8051 MICROCONTROLLER and Interfacing**

Introduction to microcontrollers, internal architecture of 8051 microcontroller, I/O ports and memory organization, MCS51 addressing modes and instruction set, assembly language programming, simple programs, counters/timers, serial data input/output, interrupts. Interfacing to 8051: A/D and D/A Convertors, keyboard, LCD Interfacing.---12Hrs

**UNIT-5:**

**ARM Architectures and Processors:** introduction to CISC and RISC architectures, ARM

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Architecture, ARM Processors Families, Introduction to 16/32 bit processors, ARM7 architecture and organization, Thumb instructions, ARM Cortex-M3 Processor Functional Description.—9Hrs

### TEXTBOOKS:

1. Advanced microprocessors and peripherals by K. M. Bhurchandi, A. K. Ray 3e
2. The 8051 Microcontrollers and Embedded systems Using Assembly and C, Muhammad Ali Mazidi and Janice Gillespie Mazidi and Rollin D.McKinlay; Pearson 2-Edition,2011.
3. Microprocessors and Microcontrollers by N. Senthil Kumar, M. Saravanan and S. Jeevanathan Oxford higher education

### REFERENCEBOOKS:

1. Embedded Systems Fundamentals with Arm Cortex-M based Microcontrollers: A Practical Approach in English, by Dr. Alexander G. Dean, Published by Arm EducationMedia,2017.
2. Cortex-M3TechnicalReference Manual.
3. TheDefinitiveGuidetoARMCortex-M3andCortex-M4ProcessorsbyJosephYiu.,Newnes Third edition

### WEB RESOURCES:

W1. <https://nptel.ac.in/courses/108105102/7>

W2. <https://freevideolectures.com/course/3018/microprocessors-and-microcontrollers>

W3. <https://www.tutorialspoint.com/microprocessor/>

W4. <https://www.geeksforgeeks.org/microprocessor-tutorials/>

W5. <https://nptel.ac.in/courses/108107029/>

W6 <https://freevideolectures.com/course/3018/microprocessors-and-microcontrollers>

W7. <http://www.satishkashyap.com/2012/02/video-lectures-on-microprocessors-and.html>

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III Year-II Semester					
23EC6T11	<b>DIGITAL SIGNAL PROCESSING</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**Course Outcomes:**

- Understand the concepts of discrete signals and discrete systems with its characteristics [BL2]
- Calculate z-Transform, Fourier Transform, Discrete Fourier Transform of discrete signals.[BL6]
- Understand the algorithms for the efficient computation of DFT coefficients of signals[BL2]
- Design the FIR and IIR filters.[BL6]
- Know the architectures of various DSP processors and its addressing modes, assembly language instructions.[BL5]

**UNIT-1:**

**Introduction:** Signals, Systems, and Signal Processing, Classification of Signals, The Concept of Frequency in Continuous Time and Discrete Time Signals

**Discrete Time Signals and Systems:** Discrete Time Signals, Discrete Time Systems, Analysis of Discrete Time Linear Time Invariant Systems, Discrete Time Systems Described by Difference Equations, Implementation of Discrete Time Systems, Correlation of Discrete Time Signals.

**Frequency Analysis of Signals:** Frequency Analysis of Continuous Time Signals, Frequency Analysis of Discrete Time Signals, Frequency Domain and Time Domain Signal Properties, Properties of the Fourier Transform for Discrete Time Signals. **Frequency Domain Analysis of LTI Systems:** Frequency domain characteristics of LTI systems, Frequency response of LTI systems.

**UNIT-2:**

**The z-Transform and Its Applications to the Analysis of LTI Systems:** The z-Transform, Properties, Rational z Transforms, Inversion of the z-Transform, Analysis of Linear Time Invariant Systems in the z-Domain, The One sided z-Transform. (**Review only for entirez – Transform topic**).

**The Discrete Fourier Transform: Its Properties and Applications:** Frequency Domain Sampling: The Discrete Fourier Transform, Properties of the DFT, Linear Filtering Methods Based on the DFT, Frequency Analysis of Signals Using DFT

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**UNIT-3:**

**Efficient Computation of the DFT: Fast Fourier Transform Algorithms:** Direct Computation of the DFT, Radix-2 FFT Algorithms.

**Implementation of Discrete Time Systems:** Structures for the Realization of Discrete Time Systems, **Structures for FIR Systems:** Direct Form Structure, Cascade Form Structures, Frequency Sampling Structures.

**Structures for IIR Systems:** Discrete Form Structures, Signal Flow Graphs and Transposed Structures, Cascade Form Structures, Parallel Form Structures.

**UNIT-4:**

**Design of Digital Filters:** General Considerations: Causality and Its Implications, Characteristics of Practical Frequency Selective Filters.

**Design of FIR Filters:** Symmetric and Antisymmetric FIR Filters, Design of Linear Phase FIR Filters Using Windows, Design of Linear Phase FIR Filters by the Frequency Sampling Method.

**Design of IIR Filters From Analog Filters:** IIR Filter Design by Approximation of Derivatives, IIR Filter Design by Impulse Invariance, IIR Filter Design by the Bilinear Transformation.

**Frequency Transformations:** Frequency Transformations in the Analog Domain, Frequency Transformations in the Digital Domain.

**UNIT-5:**

**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, Auxiliary Register Compare Register, Block Move Address Register, Block Repeat Registers, Parallel Logic Unit, Memory mapped registers, program controller, some flags in the status registers, On- chip memory, On-chip peripherals.TMS320C5X Assembly Language Instructions.

**TEXT BOOKS:**

1. Digital Signal Processing, Principles, Algorithms, and Applications: John G. Proakis, DimitrisG.Manolakis, 4<sup>th</sup> Edition, Pearson Education, 2007.
2. Digital Signal Processors – Architecture, Programming and Applications,,B.Venkataramani, M.Bhaskar, TATA McGraw Hill, 2002.

**Reference Books:**

1. Discrete Time Signal Processing – A.V.Oppenheim and R.W. Schaffer, 3<sup>rd</sup> Edition, Pearson, 2014.
2. Digital Signal Processing-P. Ramesh Babu, 5<sup>th</sup> Edition, SCITECHPublishers.

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**PROFESSIONAL ELECTIVES-II**

<b>III Year-II Semester</b>					
<b>23EC6D07</b>	<b>ANALOG IC DESIGN</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**Course Outcomes:**

- Understand the concepts of MOS Devices and Modeling.
- Design and analyze any Analog Circuits in real time applications.
- Extend the Analog Circuit Design to Different Applications in Real Time.
- Understand of Open-Loop Comparators and Different Types of Oscillators

**UNIT -I:**

**MOS Devices and Modelling:** The MOS Transistor, Passive Components- Capacitor & Resistor, Integrated circuit Layout, CMOS Device Modelling - Simple MOS Large-Signal Model, Other Model Parameters, Small-Signal Model for the MOS Transistor, Computer Simulation Models, Sub-threshold MOS Model.

**UNIT -II:****Analog CMOS Sub-Circuits:**

MOS Switch, MOS Diode, MOS Active Resistor, Current Sinks and Sources, Current Mirrors-Current mirror with Beta Helper, Degeneration, Cascode current Mirror and Wilson Current Mirror, Current and Voltage References, Band gap Reference.

**UNIT -III: CMOS Amplifiers:**

Inverters, Differential Amplifiers, Cascode Amplifiers, Current Amplifiers, Output Amplifiers, High Gain Amplifiers Architectures. CMOS Operational Amplifiers: Design of CMOS Op Amps, Compensation of Op Amps, Design of Two-Stage Op Amps, Power- Supply Rejection Ratio of Two-Stage Op Amps, Cascode Op Amps, Measurement Techniques of OP Amp.

**UNIT -IV:**

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

**UNIT -V:**

**Oscillators & Phase-Locked Loops:** General Considerations, Ring Oscillators, LC Oscillators, Voltage Controlled Oscillators. Simple PLL, Charge Pump PLLs, Non-Ideal

Dr T S S Phani, Professor & Head of the Department, ECE, BVCITS, Batlapalem	Dr. NVS Narasimha Sarma Professor, Dept of ECE,NIT, Warangal.	Dr.Neti. V L Narasimha Murty, Professor Department of Electrical Engineering Indian Institute of Technology,Tirupathi	Dr. BT Krishna, Professor, Dept of ECE,UCEK,JNT UK, Kakinada,	Dr. M Chakravarthy, Scientist 'F', Head of antenna Directorate,DRDL,DR DO, Hyderabad.	Dr.CH Venkata Ravi sankar, Associate Professor, Dept of ECE,Aditya University,.Surampalem.

Effects in PLLs, Delay Locked Loops, Applications.

**TEXT BOOKS:**

1. Design of Analog CMOS Integrated Circuits- Behzad Razavi, TMH Edition, Second Edition.
2. CMOS Analog Circuit Design - Philip E. Allen and Douglas R. Holberg, Oxford University Press, International Second Edition/Indian Edition, 2010.

**REFERENCES:**

1. Analysis and Design of Analog Integrated Circuits- Paul R. Gray, Paul J. Hurst, S. Lewis and R. G. Meyer, Wiley India, Fifth Edition, 2010.
2. Analog Integrated Circuit Design- David A. Johns, Ken Martin, Wiley Student Edn, 2013.

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III Year-II Semester					
23EC6D08	<b>SATELLITE COMMUNICATION</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**Course Outcomes:**

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

**UNIT I**

**INTRODUCTION:** Origin of Satellite Communications, Historical Back-ground, Basic Concepts of Satellite Communications, Frequency allocations for Satellite Services, Applications, Future Trends of Satellite Communications. **ORBITAL MECHANICS AND LAUNCHERS:** Orbital Mechanics, Look Angle determination, Orbital perturbations, Orbit determination, launches and launch vehicles, Orbital effects in communication systems performance.

**UNIT II**

**SATELLITE SUBSYSTEMS:** Attitude and orbit control system, telemetry, tracking, Command and monitoring system, power systems, communication subsystems, Satellite antennas, Equipment reliability and Space qualification.

**UNIT III**

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

**UNIT IV**

**MULTIPLE ACCESS:** Frequency division multiple access (FDMA): Intermodulation, Calculation of C/N. Time division Multiple Access (TDMA); Frame structure, Examples. Code Division Multiple access (CDMA): Spread spectrum transmission and reception.

**EARTH STATION TECHNOLOGY:** Introduction, basic architecture, Transmitters, Receivers, Antennas, Tracking systems, Terrestrial interface, Primary power test methods.

**UNIT V**

**LOW EARTH ORBIT AND GEO-STATIONARY SATELLITE SYSTEMS:** Orbit consideration, coverage and frequency considerations, Delay & Throughput considerations,

Dr T S S Phani, Professor & Head of the Department, ECE, BVCITS, Batlapalem	Dr. NVS Narasimha Sarma Professor, Dept of ECE,NIT, Warangal.	Dr.Neti. V L Narasimha Murty, Professor Department of Electrical Engineering Indian Institute of Technology,Tirupathi	Dr. BT Krishna, Professor, Dept of ECE,UCEK,JNT UK, Kakinada,	Dr. M Chakravarthy, Scientist 'F', Head of antenna Directorate,DRDL,DR DO, Hyderabad.	Dr.CH Venkata Ravi sankar, Associate Professor, Dept of ECE,Aditya University,.Surampalem.

System considerations, Operational NGSO constellation Designs **GLOBAL NAVIGATION SATELLITE SYSTEM(GNSS):**

Introduction, various GNSS: GPS, GLONASS, GALILEO, BeiDou, QZSS, IRNSS. GPS-location principle, GPS navigation message, GPS receiver operation, differential GPS; IRNSS-introduction, IRNSS satellites, IRNSS constellation, IRNSS configuration, IRNSS services, navigation data, applications of IRNSS; multi GNSS.

**TEXT BOOKS:**

1. Satellite Communications – Timothy Pratt, Charles Bostian and Jeremy Allnutt, WSE, Wiley Publications, 3<sup>RD</sup> Edition, 2020.
2. Satellite Communications Engineering – Wilbur L. Pritchard, Robert A Nelson and Henri G.Suyderhoud, 2nd Edition, Pearson Publications, 2003.

**REFERENCES:**

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

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III Year-II Semester					
23EC6D09	<b>SMART AND WIRELESS INSTRUMENTATION</b>	L	T	P	C
		3	0	0	3

## Course Outcomes:

- Analyze Smart and Wireless Instrumentation with respect to various performance parameters.
- Design and develop Applications using WSN (Wireless sensor Network).
- Demonstration of various Node architectures.
- Demonstration of Fundamentals of wireless digital communication
- Analyze the power sources, Demonstrate an ability to design strategies as per needs and specifications

## UNIT – 1: Introduction:

Smart Instrumentation(Materials, automation systems, ensign and Sensors, Sensor Classifications, Wireless Sensor Networks, History of Wireless Sensor networks (WSN), Communication in a WSN, important design constraints of a WSN like Energy, Self Management, Wireless Networking, Decentralized Management, Design Constraints, Security etc.

UNIT – 2: Node architecture: The sensing subsystem, Analog to Digital converter, the processor subsystem, architectural overview, microcontroller, digital signal processor, application specific integrated circuit, field programmable gate array (FPGA), comparison, communication interfaces, serial peripheral interface, inter integrated circuit, the IMote node architecture, The XYZ node architecture, the Hog throb node architecture.

UNIT – 3: Fundamentals of Wireless Digital Communication: Basic components, source encoding, the efficiency of a source encoder, pulse code modulation and delta modulation, channel encoding, types of channels, information transmission over a channel, error recognition and correction, modulation, modulation types, quadratic amplitude modulation, signal propagation.

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UNIT – 4: Frequency of Wireless Communication: Development of Wireless Sensor Network based on Microcontroller and communication device-Zigbee Communication device. Power sources- Energy Harvesting Solar and Lead acid batteries-RF Energy /Harvesting-Energy Harvesting from vibration Thermal Energy Harvesting-Energy Management Techniques Calculation for Battery Selection.

UNIT – 5: Applications:

Structural health monitoring - sensing seismic events, single damage detection using natural frequencies, multiple damage detection using natural frequencies, multiple damage detection using mode shapes, coherence, piezoelectric effect, traffic control, health care - available sensors, pipeline monitoring, precision agriculture, active volcano, underground mining.

#### Text Books:

1. Fundamentals of wireless sensor networks : theory and practice - WaltenegusDargie, Christian Poellabauer, A John Wiley and Sons, Ltd., Publication.
2. Smart Sensors, Measurement and Instrumentation ,Subhas Chandra Mukhopadhyay, Springer Heidelberg, New York, Dordrecht London, 2013.
3. Wireless Sensors and Instruments: Networks, Design and Applications, HalitEren, CRC Press, Taylor and Francis Group, 2006.

#### Reference Books:

1. UvaisQidwai, Smart Instrumentation: A data flow approach to Interfacing“, Chapman & Hall; 1st Edn, December 2013.
2. Wireless Sensor Networks: Architectures and Protocols, Edgar H. Callaway Jr. and Ed gar H. Callaway.

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III Year-II Semester					
23EC6D10	<b>MACHINE LEARNING</b>	L	T	P	C
		3	0	0	3

**Course Outcomes:**

- Define machine learning and its different types and understand their applications.
- Explain the various techniques involved in pre-processing of data for Data Analysis
- Apply various supervised learning algorithms including decision trees and k-nearest neighbours (k-NN) etc.
- Implement unsupervised learning techniques, viz., K-means clustering etc.
- Learn about various performance metrics and explore them in various applications of implementing Machine learning Algorithms.

**UNIT-I: Introduction to Machine Learning:**

What is Machine Learning?, Traditional programming approach vs Machine learning approach, History and Evolution of Machine Learning, Learning by Rote vs Learning by Induction, **Paradigms for ML** - Supervised ML, Unsupervised ML, Reinforcement ML, **Datatypes in ML** - Quantitative data (Continuous, Discrete), Qualitative data (Structured, Semi structured, Unstructured), Nominal data, Ordinal data, Interval data, Ratio data, Stages involved in Machine Learning, Main challenges of ML, Applications of Machine Learning, **IDE's for ML Programming** - Jupyter Notebook, Spyder, PyCharm, Google Colab, R Studio, VS Code, **Basic packages to deal with ML** - Numpy, Scipy, Pandas, Scikit-learn, Matplotlib, Seaborn, **Programming Languages for Machine Learning** - Python, Java, R, JavaScript, C++

**UNIT - II: Explorative Data Analysis (EDA):**

What is EDA? Why EDA is important?, **Types of EDA** - Univariate Analysis, Bivariate Analysis, Multivariate Analysis, **Data Cleaning** - Data Acquisition, Analyzing the data Dealing with duplicate data, Dealing with missing values, Dealing with outliers **Scaling and Transformations** - Feature Scaling and Transformation, Univariate nonlinear Transformations, **Dimensionality Reduction** - Principal Component Analysis (PCA), **Feature Engineering** - Handling Categorical attributes (One-Hot-Encoding), **Feature Expansion** - Interactions and Polynomials, **Automatic Feature Selection** - Univariate Statistics, Model-Based Feature Selection, Iterative Feature Selection

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**UNIT-III: Supervised Machine Learning:**

What is Supervised Machine Learning?, General architecture of Supervised ML, **Types of Supervised ML** - Classification and Regression, **Different Classification Algorithms** - K-Nearest Neighbor (KNN) Classifier, Linear Models, Logistic Regression, Naive Bayes Classifiers, Decision Tree Classifier, **Ensemble learning and Decision Trees** - Voting, Bagging and pasting, Random Forests, AdaBoost, Gradient Boosting, Stacking, Support Vector Classifier (SVC) Neural Networks, **Different Regression Algorithms** - K-Neighbors Regressor, Linear Regression, Ridge Regression, Lasso Regression, Polynomial Regression, Support Vector Regressor (SVR), Decision Tree Regressor, Random Forest Regressor

**UNIT-IV: Unsupervised Machine Learning –**

What is Unsupervised Machine Learning?, General architecture of Unsupervised Machine Learning, Challenges in Unsupervised ML, **Clustering** - Introduction to Clustering, Soft clustering vs Hard Clustering, K-Means Clustering algorithm, Centroid-based clustering algorithm, Divisive Clustering and Agglomerative Clustering, DBSCAN

**UNIT V- Model Evaluation metrics, Fine tuning the model and Visualizations -**

**Evaluation Metrics for Classification** - Confusion Matrices, Accuracy, Precision, Recall, F1-Score, Precision-recall curves, ROC (Receiver Operating Characteristics) curves, Confusion Matrix, **Evaluation Metrics for Regression** -  $R^2$ , Mean Squared Error (MSE), Mean Absolute Error (MAE), Root Mean Squared Error (RMSE), **Evaluation Metrics for clustering** - Adjusted Rand Index (ARI), Normalized Mutual Information (NMI), **Cross Validation** - Cross-Validation in scikit-learn, benefits of cross-validation, stratified k-fold cross validation, **Grid Search**- Simple Grid search, Grid search with cross validation, Randomized search, **Visualization** - Univariate Analysis (Bar plot, Box plot, Count plot, Density plot, Histogram, Pieplot), Bivariate Analysis (Pair plot, Scatter plot, Bar plot, Stacked barplot, Multivariate Analysis (Heat Maps)

**Text Books:**

1. “Introduction to Machine Learning with Python”, Andreas C.Muller&Sarah Guido, O’Reilly Publications
2. “Hands-on Machine Learning with Scikit-Learn, Keras& TensorFlow”, Aurelien Geron, O’Reilly Publications
3. “Machine Learning Theory and Practice”, M N Murthy, V S Ananthanarayana, Universities Press (India), 2024

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**Reference Books:**

1. “Machine Learning”, Tom M. Mitchell, McGraw-Hill Publication, 2017
2. “Machine Learning in Action”, Peter Harrington, DreamTech
3. “Introduction to Data Mining”, Pang-Ning Tan, Michel Stenbach, Vipin Kumar, 7<sup>th</sup> Edition, 2019.

Dr T S S Phani, Professor & Head of the Department, ECE, BVCITS, Batlapalem	Dr. NVS Narasimha Sarma Professor, Dept of ECE,NIT, Warangal.	Dr.Neti. V L Narasimha Murty, Professor Department of Electrical Engineering Indian Institute of Technology,Tirupathi	Dr. BT Krishna, Professor, Dept of ECE,UCEK,JNT UK, Kakinada,	Dr. M Chakravarthy, Scientist ‘F’, Head of antenna Directorate,DRDL,DR DO, Hyderabad.	Dr.CH Venkata Ravi sankar, Associate Professor, Dept of ECE,Aditya University,.Surampalem.

**PROFESSIONAL ELECTIVES-III**

III Year-II Semester					
23EC6D12	<b>BIO-MEDICAL INSTRUMENTATION</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**Course Outcomes:**

- Demonstrate a foundational understanding of the anatomy and physiology of the human body.
- Apply knowledge of different techniques used for measuring various physiological parameters.
- Explain modern imaging techniques employed in medical diagnosis and identify the diverse therapeutic equipment utilized in the biomedical field.
- Understand and apply bio-telemetry principles for transmitting bioelectrical variables.
- Analyze patient safety measures and evaluate recent advancements in the medical field.

**UNIT – 1:Introduction:** Factors to be considered in the design of medical instrumentation systems, Basic objectives of medical instrumentation system, Physiological systems of human body, Sources of Bioelectric potentials: Resisting and Action Potentials, Propagation of Action Potentials, The Bioelectric Potentials. Electrodes: Electrode theory, Bio Potential Electrodes, Biochemical Transducers, Introduction to bio-medical signals.

**UNIT – 2: The Cardiovascular System:** The Heart and Cardiovascular System, The Heart, Blood Pressure, Characteristics of Blood Flow, Heart Sounds, Cardio Vascular Measurements, Electrocardiography, Measurement of Blood Pressure, Measurement of Blood Flow and Cardiac output, Plethysmo graphy, Measurement of Heart Sounds, Event detection, PQRS & T-Waves in ECG, the first & second Heart beats, ECG rhythm analysis, the di-crotic notch in the carotid pulse detection of events and waves, analysis of exercise ECG, analysis of event related potentials, correlation analysis of EEG channels, correlation of muscular contraction.

**UNIT – 3: Patient Care & Monitory and Measurements in Respiratory System:** The elements of Intensive Care Monitory, Diagnosis, Calibration and reparability of Patient Monitoring equipment, other instrumentation for monitoring patients, pace makers, defibrillators, the physiology of respiratory system, tests and instrumentation for mechanics of breathing, respiratory theory equipment, analysis of respiration.

**UNIT – 4: Bio telemetry and Instrumentation for the Clinical Laboratory,** Introduction to bio telemetry, Physiological parameters adaptable to bio telemetry, the components of bio telemetry system, implantable units, applications of telemetry in patient care – The blood, tests

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on blood cells, chemical test, automation of chemical tests.

**UNIT – 5: X-ray and radioisotope instrumentation and electrical safety of medical equipment:** Generation of Ionizing radiation, instrumentation for diagnostic X-rays, special techniques, instrumentation for the medical use of radioisotopes, radiation therapy - Physiological effects of electrical current, shock Hazards from electrical equipment, Methods of accident prevention, Modern Imaging Systems: Tomography, Magnetic Resonance Imaging System, Ultrasonic Imaging System, Medical Thermography.

**Text Books:**

1. Biomedical Instrumentation and Measurements C.Cromwell,F.J.Weibell,E.A.Pfeiffer – Pearson education.
2. Biomedical Signal Analysis – Rangaraj, M. Rangayya – Wiley Inter Science – JohnWiley & Sons Inc.

**Reference Books:**

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

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III Year-II Semester					
23EC6D13	<b>MICROWAVE ENGINEERING</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**Course Outcomes:**

- Design different mode sin waveguide structures[BL4]
- Calculate S-matrix for various waveguide components and splitting the microwave energy in a desired direction[BL3]
- Distinguish between Microwave tubes and Solid State Devices, calculation of efficiency of devices.[BL4]
- Measure various microwave parameters using a Micro wave test bench[BL3]

**UNIT-I**

**MICROWAVE TRANSMISSION LINES:** Introduction, Microwave Spectrum and Bands, Applications of Microwaves. Rectangular Waveguides – TE/TM mode analysis, Expressions for Fields, Characteristic Equation and Cut-off Frequencies, Filter Characteristics, Dominant and Degenerate Modes, Sketches of TE and TM mode fields in the cross-section, Mode Characteristics – Phase and Group Velocities, Wavelengths and Impedance Relations; Power Transmission and Power Losses in Rectangular Guide. Related Problems. MICROSTRIP LINES– Introduction, Zo Relations, Effective Dielectric Constant, Losses, Q factor.

(TEXT BOOK-1, TEXT BOOK-2)

14Hrs

**UNIT II**

**MICROWAVE TUBES :** Limitations and Losses of conventional tubes at microwave frequencies. Microwave tubes – O type and M type classifications. O-type tubes : 2 Cavity Klystrons – Structure, Reentrant Cavities, Velocity Modulation Process and Applegate Diagram, Bunching Process and Small Signal Theory – Expressions for o/p Power and Efficiency. Reflex Klystrons – Structure, Applegate Diagram and Principle of working, Mathematical Theory of Bunching, Power Output, Efficiency, Electronic Admittance; Oscillating Modes and o/p Characteristics, Electronic and Mechanical Tuning. Applications.

(TEXT BOOK-1, TEXT BOOK-2)

16Hrs

**UNIT-III**

**HELIX TWTS:** Significance, Types and Characteristics of Slow Wave Structures; Structure of TWT and Amplification Process (qualitative treatment), Suppression of Oscillations, Nature of the four Propagation Constants, Gain Considerations(qualitative treatment). **M-type Tubes** Introduction, Cross-field effects, Magnetrons – Different Types, 8-Cavity Cylindrical Travelling Wave Magnetron – Hull Cut-off and Hartree Conditions, Modes of Resonance and PI-Mode Operation, Separation of PI-Mode, o/p characteristics.

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(TEXT BOOK-1, TEXT BOOK-2)

10Hrs

**UNIT-IV**

**WAVEGUIDE COMPONENTS AND APPLICATIONS :** Coupling Mechanisms – Probe, Loop, Aperture types. Waveguide Discontinuities – Waveguide irises, Tuning Screws and Posts, Matched Loads. Waveguide Attenuators – Resistive Card, Rotary Vane types; Waveguide Phase Shifters – Dielectric, Rotary Vane types, Scattering Matrix– Significance, Formulation and Properties, S-Matrix Calculations for – 2,3,4 port Junctions: E-plane and H-plane Tees, Magic Tee, Hybrid Ring; Directional Couplers – 2Hole, Bethe Hole types, S-Matrix Calculations Ferrite Components– Faraday Rotation, Gyrator, Isolator, Circulator, Related Problems.

(TEXT BOOK-1, TEXT BOOK-2)

15Hrs

**UNIT-V**

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

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

(TEXT BOOK-1, TEXT BOOK-2)

12Hrs

**TEXT BOOKS:**

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

**REFERENCES:**

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

**LINKS:**

1. <https://www.youtube.com/watch?v=MrzaUQbRT9U&t=492s>
2. [https://www.youtube.com/watch?v=1\\_z3v0T1oL4&t=663s](https://www.youtube.com/watch?v=1_z3v0T1oL4&t=663s)
3. <https://www.youtube.com/watch?v=sOgfb07M7Ck&t=685s>

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III Year-II Semester					
23EC6D14	<b>EMBEDDED SYSTEMS</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**Course Outcomes:**

- Know basics of embedded system, classification, memories, different communication interface and what embedded firmware is and its role in embedded system, different system components.
- Distinguish all communication devices in embedded system, other peripheral device.
- Distinguish concepts of C versus embedded C and compiler versus cross-compiler.
- Choose an operating system, and learn how to choose an RTOS

**Unit-I:**

**Introduction:** Embedded System-Definition, History, Classification, application areas and purpose of embedded systems, The typical embedded system-Core of the embedded system, Memory, Sensors and Actuators, Communication Interface, Embedded firmware, PCB and passive components. Characteristics, Quality attributes of an Embedded systems, Application-specific and Domain-Specific examples of an embedded system, Main processing elements of embedded system, hardware and software partitions.

**Unit-II:**

**Embedded Hardware Design:** Analog and digital electronic components, I/O types and examples, Serial communication devices, Parallel device ports, Wireless devices, Timer and counting devices, Watch dog timer, Real time clock.

**Unit-III:**

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

**Unit-IV:**

**Real Time Operating System:** Operating system basics, Types of operating systems, Tasks, Process and Threads, Multiprocessing and Multitasking, Threads, Processes and Scheduling, Task Scheduling, Communication, Synchronization, Device Drivers, How to choose an RTOS.

Electronics and Communication Engineering

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**Hardware Software Co-Design:** Fundamental Issues in Hardware Software Co-Design, Computational models in embedded design, Hardware software Trade-offs, Integration of Hardware and Firmware, ICE.

**Unit-V:**

**Embedded System Development:** The integrated development environment, Types of files generated on cross-compilation, Disassembler/De-compiler, Simulators, Emulators and Debugging, Target hardware debugging, Boundary Scan, Embedded Software development process and tools.

**Embedded System Implementation And Testing:** The main software utility tool, CAD and the hardware, Translation tools-Pre-processors, Interpreters, Compilers and Linkers, Debugging tools, Quality assurance and testing of the design, Testing on hostmachine, Simulators, Laboratory Tools. Test and evolution of an embedded systems (Build in selftest etc).

**Case study**-typical embedded system design flow with an example.

**Text Books:**

1. Embedded Systems Architecture By Tammy Noergaard, Elsevier Publications, 2005
2. Embedded System Design, Frank Vahid, Tony Givargis, John Wiley Publications.

**References:**

1. Embedding system building blocks By Labrosse, CMP publishers.

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III Year-I Semester					
23EC6D15	OPTICAL COMMUNICATIONS	L	T	P	C
		3	0	0	3

**Course Outcomes:**

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

**UNIT I**

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

**UNIT II**

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

**UNIT III**

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

**UNIT IV**

Optical sources-LEDs, Structures, Materials, Quantum efficiency, Power, Modulation, Power bandwidth product. Injection Laser Diodes- Modes, Threshold conditions, External quantum efficiency, Laser diode rate equations, Resonant frequencies, Reliability of LED&ILD, Optical

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detectors- Physical principles of PIN and APD, Detector response time, Comparison of Photo detectors, Related problems.

### UNIT V

Source to fiber power launching - Output patterns, Power coupling, Power launching, Equilibrium Numerical Aperture, Laser diode to fiber coupling, Optical receiver operation- Fundamental receiver operation, Digital signal transmission, error sources, Receiver configuration, Digital receiver performance, Probability of Error, Quantum limit, Analog receivers. Optical system design - Point-to- point links- Component choice and considerations, Link power budget, Rise time budget with examples, Line coding in Optical links, WDM, Necessity, Principles, Measurement of Attenuation and Dispersion, Eye pattern.

### TEXTBOOKS:

1. Optical Fiber Communications–Gerd Keiser, McGraw-Hill International edition, 3rd Edition, 2000.
2. Fiber Optic Communications– Joseph C. Palais, 4th Edition, Pearson Education, 2004.

### REFERENCES:

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

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III Year-II Semester					
23EC6L07	VLSI DESIGN LAB	L	T	P	C
		0	0	3	1.5

CO1: Understand and implement basic logic gates and combinational logic circuits.[BL3]

CO2: Analyze and design sequential logic circuits using latches and counters. [BL4]

CO3: Demonstrate the design and working principles of memory circuits.[BL4]

CO4: Design and evaluate analog circuits used in digital systems.[BL6]

CO5: Apply knowledge of digital design principles in implementing timing-related circuits.[BL3][

### Laboratory Objective

The objective of this laboratory course is to enable students to design, simulate, and implement CMOS-based digital and analog circuits using industry-standard Electronic Design Automation (EDA) tools. Students are expected to develop a comprehensive understanding of schematic capture, layout design, and verification methodologies as per current CMOS technology standards.

### List of Experiments:

Students shall design the schematic diagrams using CMOS logic, generate corresponding layout diagrams, and perform simulation and analysis using the latest CMOS process technology with the aid of **professional-grade EDA tools (Cadence/Synopsys/Mentor Graphics/Tanner/Microwind or any Industry Standard EDA Tools)**.

The following experiments shall be carried out:

1. Design and implementation of an inverter
2. Design and implementation of universal gates
3. Design and implementation of full adder
4. Design and implementation of full Subtractor
5. Design and implementation of RS-latch
6. Design and implementation of D-latch
7. Design and implementation asynchronous counter
8. Design and Implementation of static RAM cell
9. Design and Implementation of differential amplifier
10. Design and Implementation of ring oscillator

### Equipment Required:

1. Cadence/Synopsys/Mentor Graphics/Tanner/Microwind or any Industry Standard EDA Tools
2. Personal computer with necessary peripherals.

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III Year-II Semester					
23EC6L08	MICROPROCESSOR AND MICROCONTROLLERS LAB	L	T	P	C
		0	0	3	1.5

S.NO	COURSE OUTCOME	BLOOM'S TAXONOMY LEVEL
CO1	<u>Find</u> how different instructions are affected before and after execution.	BL2
CO2	<u>Experiment with</u> various 8086 ALP microprocessor programs like arithmetic operations, sorting and factorial of given numbers using MASM Software	BL3
CO3	<u>Demonstrate</u> various interfacing modules of 8255PPI, ADC, DAC Keyboard/Display and generates different waveforms using ALPs with 8086 microprocessor	BL3
CO4	<u>Experiment with</u> various assembly language programs of 8051 microcontroller using Keilµ Vision software	BL3
CO5	<u>Construct</u> various interfacing modules using ALPs of 8051 microcontroller that operates LED display, Stepper motor and Traffic light controller	BL3
CO6	<u>Experiment with</u> various programs On ARM CORTEX M3 using ARM Kiel MDK software	BL3

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

1. Programs for 16 -bit arithmetic operations (using Various Addressing Modes).
  - a. Addition and subtraction of n-BCD numbers.
  - b. Multiplication and Division operations.
  - c. Addition of an array of numbers with overflow detection.
2. Program for sorting an array.
3. Program for Factorial of given n-numbers.
4. Interfacing ADC to 8086
5. Interfacing DAC to 8086.
6. Interfacing stepper motor to 8086.
7. Interfacing Seven-Segment display to 8086
8. Keyboard interface with 8086

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

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1. Finding number of 1's and number of 0's in a given 8-bit number
2. Average of n-numbers.
3. Program and verify Timer/ Counter in 8051.
4. Interfacing Traffic Light Controller to 8051.
5. UART operation in 8051
6. Interfacing LCD to 8051.
7. Interfacing temperature sensor (LM 35) with 8051
8. Stepper motor control with 8051

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

1. Write an assembly program to multiply of 2 16-bit binary numbers.
2. Write an assembly program to find the sum of first 10 integers numbers.
3. Write a program to toggle LED every second using timer interrupt.
4. PWM signal generation
5. Analog signal measurement (ADC)
6. Interfacing with serial communication (UART)

**Equipment Required:**

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

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III Year-II Semester					
23NC6T03	<b>RESEARCH METHODOLOGY AND IPR</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>2</b>	<b>0</b>	<b>0</b>	<b>0</b>

**Course Outcomes:**

- Understand research problem formulation.
- Analyze research related information, Follow research ethics
- Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.
- Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular.
- Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits.

**Unit 1 :**

Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem, Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations

**Unit 2:**

Effective literature studies approaches, analysis Plagiarism, Research ethics, Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee

**Unit 3:**

Nature of Intellectual Property: Patents, Designs, Trademarks and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT

**Unit 4:**

Patent Rights: Scope of Patent Rights, Licensing and transfer of technology, Patent information and databases, Geographical Indications.

**Unit 5:**

New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc, Traditional knowledge Case Studies, IPR and IITs

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**TEXT BOOKS**

1. Stuart Melville and Wayne Goddard, “Research methodology: an introduction for science& engineering students”.
2. Wayne Goddard and Stuart Melville, “Research Methodology: An Introduction”

**REFERENCE BOOKS**

1. Ranjit Kumar, 2nd Edition , “Research Methodology: A Step by Step Guide for beginners”
2. Halbert, “Resisting Intellectual Property”, Taylor & Francis Ltd,2007.
3. Mayall , “Industrial Design”, McGraw Hill,1992.

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**OPEN ELECTIVES-I**

<b>III Year-I Semester</b>					
<b>23EC5E01</b>	<b>ELECTRONIC DEVICES AND CIRCUITS</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**Course Outcomes:**

- Apply the basic concepts of semiconductor physics.
- Understand the formation of p-n junction and how it can be used as a p-n junction as diode in different modes of operation.
- Know the construction, working principle of rectifiers with and without filters with relevant expressions and necessary comparisons.
- Understand the construction, principle of operation of transistors, BJT and FET with their V-I characteristics in different configurations.
- Know the need of transistor biasing, various biasing techniques for BJT and FET and stabilization concepts with necessary expressions.

**UNIT-I:**

**Review of Semi Conductor Physics:** Hall effect, continuity equation, law of junction, Fermi Dirac function, Fermi level in intrinsic and extrinsic Semiconductors

**Junction Diode Characteristics :** Energy band diagram of PN junction Diode, Open circuited p-n junction, Biased p-n junction, p-n junction diode, current components in PN junction Diode, diode equation, V-I Characteristics, temperature dependence on V-I characteristics, Diode resistance, Diode capacitance.

**UNIT-II:**

**Special Semiconductor Devices:** Zener Diode, Breakdown mechanisms, Zener diode applications, LED, Varactor Diode, Photodiode, Tunnel Diode, UJT, PNP Diode, SCR. Construction, operation and V-I characteristics.

**Rectifiers and Filters:** Basic Rectifier setup, half wave rectifier, full wave rectifier, bridge rectifier, derivations of characteristics of rectifiers, rectifier circuits-operation, input and output waveforms, Filters, Inductor filter(Series inductor), Capacitor filter(Shunt inductor),  $\pi$ -Filter, comparison of various filter circuits in terms of ripple factors.

**UNIT- III: Transistor Characteristics:**

Dr T S S Phani, Professor & Head of the Department, ECE, BVCITS, Batlapalem	Dr. NVS Narasimha Sarma Professor, Dept of ECE,NIT, Warangal.	Dr.Neti. V L Narasimha Murty, Professor Department of Electrical Engineering Indian Institute of Technology,Tirupathi	Dr. BT Krishna, Professor, Dept of ECE,UCEK,JNT UK, Kakinada,	Dr. M Chakravarthy, Scientist 'F', Head of antenna Directorate,DRDL,DR DO, Hyderabad.	Dr.CH Venkata Ravi sankar, Associate Professor, Dept of ECE,Aditya University,.Surampalem.

**BJT:** Junction transistor, transistor current components, transistor equation, transistor configurations, transistor as an amplifier, characteristics of transistor in Common Base, Common Emitter and Common Collector configurations, Ebers-Moll model of a transistor, punch through/reach through, Photo transistor, typical transistor junction voltage values.

**FET:** FET types, construction, operation, characteristics  $\mu$ ,  $g_m$ ,  $r_d$  parameters, MOSFET-types, construction, operation, characteristics, comparison between JFET and MOSFET.

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

#### UNIT- V: Small Signal Low Frequency Transistor Amplifier Models:

**BJT:** Two port network, Transistor hybrid model, determination of h-parameters, conversion of h-parameters, generalized analysis of transistor amplifier model using h-parameters, Analysis of CB, CE and CC amplifiers using exact and approximate analysis, Comparison of transistor amplifiers.

**FET:** Generalized analysis of small signal model, Analysis of CG, CS and CD amplifiers, comparison of FET amplifiers.

#### Text Books:

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

#### References:

1. Integrated Electronics-J. Millman, C. Halkias, Tata Mc-Graw Hill, Second Edition, 2009
2. Electronic Devices and Circuits-K. Lal Kishore, BS Publications, Fourth Edition, 2016.

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III Year-I Semester					
23EC5E02	SIGNALS AND SYSTEMS	L	T	P	C
		3	0	0	3

**Course Outcomes:**

- Differentiate the various classifications of signals and systems
- Analyze the frequency domain representation of signals using Fourier concepts
- Classify the systems based on their properties and determine the response of LTI Systems.
- Know the sampling process and various types of sampling techniques.
- Apply Laplace and z-transforms to analyze signals and Systems (continuous & discrete).

**UNIT- I: INTRODUCTION:** Definition of Signals and Systems, Classification of Signals, Classification of Systems, Operations on signals: time-shifting, time-scaling, amplitude-shifting, amplitude-scaling. Problems on classification and characteristics of Signals and Systems, Complex exponential and sinusoidal signals, Singularity functions and related functions: impulse function, step function signum function and ramp function.

**UNIT-II: FOURIER SERIES AND FOURIER TRANSFORM:**

Fourier series representation of continuous time periodic signals, Dirichlet's conditions, Trigonometric Fourier series and Exponential Fourier series, Relation between Trigonometric and Exponential Fourier series, Complex Fourier spectrum. Deriving Fourier transform from Fourier series, Fourier transform of standard signals, properties of Fourier transforms, Fourier transforms involving impulse function and Signum function. Related problems

**UNIT-III:**

**CORRELATION:** Auto-correlation and cross-correlation of functions, properties of correlation function, Energy density spectrum, Parseval's theorem, Power density spectrum, Relation between Convolution and correlation, Detection of periodic signals in the presence of noise by correlation.

**SAMPLING THEOREM:** Graphical and analytical proof or Band Limited Signals, impulse sampling, Natural and Flat top Sampling, Reconstruction of signal from its samples, Aliasing, Related problems.

**UNIT-IV:**

**LAPLACE TRANSFORMS:** Introduction, Concept of region of convergence (ROC) for Laplace transforms, constraints on ROC for various classes of signals, Properties of L.T's,

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Inverse Laplace transform, Relation between L.T's, and F.T. of a signal. Laplace transform of certain signals using waveform synthesis.

### UNIT-V:

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

### TEXT BOOKS:

1. Signals, Systems & Communications-B.P.Lathi,BSPublications,2003.
2. Signals and Systems-A.V. Oppenheim, A.S. Willsky and S.H. Nawab,PHI,2ndEdn,1997
3. Signals & Systems-SimonHaykinand Van Veen,Wiley,2ndEdition,2007

### REFERENCE BOOKS:

1. PrinciplesofLinearSystemsandSignals–BPLathi,OxfordUniversityPress,2015
2. Signals and Systems–TK Rawat, Oxford University press,2011.

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III Year-I Semester					
23EC5E03	<b>PROBABILITY THEORY AND RANDOM VARIABLES</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**Course Outcomes:**

- Mathematically model the random phenomena and solve simple probabilistic problems
- Identify different types of random variables and compute statistical averages of these random variables.
- Characterize the random processes in the time and frequency domains.
- Analyze the LTI systems with random inputs

**UNIT I**

**THE RANDOM VARIABLE:** Introduction, Review of Probability Theory, Definition of a Random Variable, Conditions for a Function to be a Random Variable, Discrete, Continuous and Mixed Random Variables, Distribution and Density functions, Properties, Binomial, Poisson, Uniform, Gaussian, Exponential, Rayleigh, Conditional Distribution, Conditional Density, Properties.

**UNIT II**

**OPERATION ON ONE RANDOM VARIABLE - EXPECTATIONS:** Introduction, Expected Value of a Random Variable, Function of a Random Variable, Moments about the Origin, Central Moments, Variance and Skew, Chebychev's Inequality, Characteristic Function, Moment Generating Function, Transformations of a Random Variable: Monotonic Transformations for a Continuous Random Variable, Non-monotonic Transformations of Continuous Random Variable.

**UNIT III**

**MULTIPLE RANDOM VARIABLES:** Vector Random Variables, Joint Distribution Function, Properties of Joint Distribution, Marginal Distribution Functions, Conditional Distribution and Density, Statistical Independence, Sum of Two Random Variables, Sum of Several Random Variables, Central Limit Theorem: Unequal Distribution, Equal Distributions.

**OPERATIONS ON MULTIPLE RANDOM VARIABLES:** Joint Moments about the Origin, Joint Central Moments, Joint Characteristic Functions, Jointly Gaussian Random Variables: Two Random Variables case, N Random Variables case, Properties, Transformations of Multiple Random Variables, Linear Transformations of Gaussian Random Variables.

**UNIT IV**

**RANDOM PROCESSES – TEMPORAL CHARACTERISTICS:** The Random Process Concept, Classification of Processes, Deterministic and Nondeterministic Processes, Distribution and Density Functions, Concept of Stationarity and Statistical Independence. First-Order

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Stationary Processes, Second-order and Wide-Sense Stationarity,  $N^{\text{th}}$ -order and Strict -Sense Stationarity, Time Averages and Ergodicity, Autocorrelation Function and its Properties, Cross-Correlation Function and its Properties, Covariance Functions, Gaussian Random Processes, Poisson Random Process.

#### UNIT V

**RANDOM PROCESSES - SPECTRAL CHARACTERISTICS:** The Power Density Spectrum: Properties, Relationship between Power Density Spectrum and Autocorrelation Function, The Cross-Power Density Spectrum, Properties, Relationship between Cross-Power Density Spectrum and Cross-Correlation Function.

**LINEAR SYSTEMS WITH RANDOM INPUTS:** Random Signal Response of Linear Systems: System Response – Convolution, Mean and Mean-squared Value of System Response, Autocorrelation Function of Response, Cross-Correlation Functions of Input and Output, Spectral Characteristics of System Response: Power Density Spectrum of Response, Cross-Power Density Spectra of Input and Output, Band pass, Band-Limited and Narrowband Processes, Properties.

#### TEXT BOOKS:

1. Probability, Random Variables & Random Signal Principles, Peyton Z. Peebles, TMH, 4<sup>th</sup> Edition, 2001.
2. Probability, Random Variables and Stochastic Processes, Athanasios Papoulis and S.Unnikrishna, PHI, 4<sup>th</sup> Edition, 2002.
3. Probability Theory and Stochastic Processes – B. PrabhakaraRao, BS Publications.

#### REFERENCE BOOKS:

1. Probability and Random Processes with Applications to Signal Processing, Henry Stark and John W. Woods, Pearson Education, 3<sup>rd</sup> Edition.
2. Schaum's Outline of Probability, Random Variables, and Random Processes.
3. An Introduction to Random Signals and Communication Theory, B.P. Lathi, International Textbook, 1968.
4. Probability Theory and Random Processes, P. Ramesh Babu, McGrawHill, 2015.

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III Year-I Semester					
23EC5E04	NETWORK ANALYSIS	L	T	P	C
		3	0	0	3

**Course Outcomes:**

- Gain the knowledge on basic network elements.
- Will analyze the RLC circuit's behavior in detailed.
- Analyze the performance of periodic waveforms
- Gain the knowledge in characteristics of two port network parameters (Z,Y,ABCD,h& g).
- Analyze the filter design concepts in real world applications.

**UNIT – I**

**Introduction to Electrical Circuits :** Network elements classification, Electric charge and current, Electric energy and potential, Resistance parameter – series and parallel combination, Inductance parameter – series and parallel combination, Capacitance parameter – series and parallel combination. Energy sources: Ideal, Non-ideal, Independent and dependent sources, Source transformation, Kirchoff's laws, Mesh analysis and Nodal analysis problem solving with resistances only including dependent sources also.

**Definitions of terms associated with periodic functions:** Time period, Angular velocity and frequency, RMS value, Average value, Form factor and peak factor- problem solving, Phase angle, Phasor representation, Addition and subtraction of phasors, mathematical representation of sinusoidal quantities, explanation with relevant theory, problem solving. Principal of Duality with examples

**Definitions** of branch, node, tree, planar, non-planar graph, incidence matrix, basic tie set schedule, basic cut set schedule.

**UNIT – II**

**Transients :**First order differential equations, Definition of time constants, R-L circuit, R-C circuit with DC excitation, Evaluating initial conditions procedure, second order differential equations, homogeneous, non-homogenous, problem solving using R-L-C elements with DC excitation and AC excitation, Response as related to s-plane rotation of roots. Solutions using Laplace transform method.

**UNIT – III**

**Steady State Analysis of A.C Circuits:** Impedance concept, phase angle, series R-L, R-C, R-L-C circuits problem solving. Complex impedance and phasor notation for R-L, R-C, R-L-C problem solving using mesh and nodal analysis, Star-Delta conversion, problem solving.

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**Coupled Circuits :** Coupled Circuits: Self inductance, Mutual inductance, Coefficient of coupling, analysis of coupled circuits, Natural current, Dot rule of coupled circuits, Conductively coupled equivalent circuits- problem solving.

**UNIT – IV Resonance:** Introduction, Definition of Q, Series resonance, Bandwidth of series resonance, Parallel resonance, Condition for maximum impedance, current in anti resonance, Bandwidth of parallel resonance, general case-resistance present in both branches, anti resonance at all frequencies.

**Network Theorems:** Thevenin's, Norton's, Milliman's, Reciprocity, Compensation, Substitution, Superposition, Max Power Transfer, Tellegens- problem solving using dependent sources also

**UNIT – V Two-port Networks:** Relationship of two port networks, Z-parameters, Y-parameters, Transmission line parameters, h-parameters, Inverse h-parameters, Inverse Transmission line parameters, Relationship between parameter sets, Parallel connection of two port networks, Cascading of two port networks, series connection of two port networks, problem solving including dependent sources also.

### TEXT BOOKS:

1. Network Analysis – ME Van Valkenburg, Prentice Hall of India, 3rd Edition, 2000.
2. Network Analysis by K.Satya Prasad and S Sivanagaraju, Cengage Learning
3. Electric Circuit Analysis by Hayt and Kimmarle, TMH

### REFERENCES:

1. Network lines and Fields by John. D. Ryder 2<sup>nd</sup> edition, Asia publishing house.
2. Basic Circuit Analysis by DR Cunningham, Jaico Publishers.
3. Network Analysis and Filter Design by Chadha, Umesh Publications.

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**OPEN ELECTIVE-II**

<b>III Year-II Semester</b>					
<b>23EC6E05</b>	<b>LINEAR AND DIGITAL IC APPLICATIONS</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**Course Outcomes:**

- Analyze and design various configurations of operational amplifiers, and applications such as instrumentation amplifiers, voltage regulators, comparators, and waveform generators.
- Design and implement active filters and waveform generators using op-amps, IC-555, and IC-565, and evaluate their performance for signal processing applications
- Compare different data conversion techniques (DAC and ADC) and implement digital-to-analog and analog-to-digital conversion circuits in real-time applications.
- Apply combinational logic ICs such as multiplexers, de-multiplexers, encoders, decoders, and arithmetic circuits to solve complex digital design problems.
- Develop sequential circuits using flip-flops, counters, and shift registers, and analyze their use in digital memory systems, including ROM, RAM, and their variants

**UNIT-I**

**Operational Amplifier:** Ideal and Practical Op-Amp, Op-Amp Characteristics, DC and AC Characteristics, features of 741 Op-Amp, Modes of Operation-Inverting, Non-Inverting, Differential, Instrumentation Amplifier, AC Amplifier, Differentiators and Integrators, Comparators, Schmitt Trigger, Introduction to Voltage Regulators, Features of 723 Regulator, Three Terminal Voltage Regulators.

**UNIT-II**

**Op-Amp, IC-555 & IC565 Applications:** Introduction to Active Filters, Characteristics of Bandpass, Band reject and All Pass Filters, Analysis of 1<sup>st</sup> order LPF & HPF Butterworth Filters, Waveform Generators – Triangular, Sawtooth, Square Wave, IC555 Timer-Functional Diagram, Monostable and Astable Operations, Applications, IC565 PLL-Block Schematic, principle and Applications.

**UNIT-III**

**Data 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

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ADC, Counter Type ADC, Successive Approximation ADC and Dual Slope ADC, DAC and ADC Specifications.

#### UNIT-IV

**Combinational Logic ICs:** Specifications and Applications of TTL-74XX & CMOS 40XX Series ICs - Code Converters, Decoders, LED & LCD Decoders with Drivers, Encoders, Priority Encoders, Multiplexers, De-multiplexers, Priority Generators/Checkers, Parallel Binary Adder/Subtractor, Magnitude Comparators.

#### UNIT-V

**Sequential Logic IC's and Memories:** Familiarity with commonly available 74XX & CMOS40XX Series ICs - All Types of Flip-flops, Synchronous Counters, Decade Counters, Shift Registers.

Memories - ROM Architecture, Types of ROMS & Applications, RAM Architecture, Static & Dynamic RAMs.

#### TEXTBOOKS:

1. Ramakanth A.Gayakwad-Op-Amps & LinearICs, PHI,2003.
2. FloydandJain-DigitalFundamentals,8<sup>th</sup>Ed.,Pearson Education,2005.

#### REFERENCEBOOKS:

1. D.Roy Chowdhury–Linear Integrated Circuits, NewAge International(p)Ltd ,2<sup>nd</sup>Ed.,2003.
2. John.F.Wakerly–DigitalDesignPrinciplesandPractices,3<sup>rd</sup>Ed.,Pearson,,2009.
3. Salivahana-Linear Integrated Circuits and Applications,TMH,2008.
4. William D.Stanley-Operational Amplifiers with Linear Integrated Circuits, 4<sup>th</sup>Ed.,Pearson Education India, 2009

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III Year-II Semester					
23EC6E06	<b>PRINCIPLES OF COMMUNICATIONS</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**Course Outcomes:**

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

**UNIT1 :** Basic tools for communication, Fourier Series/Transform, Properties, Autocorrelation, Energy Spectral Density, Parsevals Relation, Amplitude Modulation (AM), Spectrum of AM, Envelope Detection, Power Efficiency, Modulation Index.

**UNIT2 :** Double Sideband Suppressed Carrier (DSB-SC) Modulation, Demodulation, Costas Receiver, Single Sideband Modulation (SSB), Hilbert Transform, Complex Pre-envelope/Envelope, Demodulation of SSB, Vestigial Sideband Modulation (VSB)

**UNIT 3 :** Angle Modulation, Frequency Modulation (FM), Phase Modulation (PM), Modulation Index, Instantaneous Frequency, Spectrum of FM Signals, Carsons Rule for FM Bandwidth, Narrowband FM Generation, Wideband FM Generation via Indirect Method, FM Demodulation

**UNIT 4 :** Introduction to Sampling, Spectrum of Sampled Signal, Aliasing, Nyquist Criterion, Signal Reconstruction from Sampled Signal, Pulse Amplitude Modulation, Quantization, Uniform Quantizers – Midrise and Midtread, Quantization noise, , Non uniform Quantizers, Delta Modulation, Differential Pulse Code Modulation (DPCM)

**UNIT 5: :** Basics of Probability, Conditional Probability, MAP Principle, Random Variables, Probability Density Functions, Applications in Wireless Channels, Basics of Random Processes ,Gaussian Random Process, Noise.

**TEXTBOOKS:**

- Simon Haykin, Communications Systems, 4th Edition. John Wiley and Sons, Inc
- Fundamentals of Wireless Communication by David Tse

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III Year-II Semester					
23EC6E07	<b>PRINCIPLES OF SIGNAL PROCESSING</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**Course Outcomes:**

- Acquire the knowledge in signals and systems.
- Get familiarized with various transforms to analyze continuous time signals.
- Understand sampling theorem and z-transform.
- Get familiarized with the transforms of discrete time signals.
- Design the digital filter design

**Unit- I: Introduction:**

Definition of Signals and Systems, Classification of Signals, Classification of Systems, Operations on signals: time-shifting, time-scaling, amplitude-shifting, Amplitude - scaling. Problems on classification and characteristics of Signals and Systems. Complex exponential and sinusoidal signals, impulse Function, step function, signum function and ramp function. Introduction, Linear system, impulse response, Linear time invariant (LTI) system, Linear time invariant(LTV) system, Concept of convolution in time domain and frequency domain, Graphical representation of convolution, Transfer function of a LTI system, Related problems.

**Unit-II: Analysis of continuous time signals****Fourier Series and Fourier Transform:**

Fourier series representation of continuous time periodic signals, Dirichlet's conditions, Trigonometric Fourier series and Exponential Fourier series,. Deriving Fourier transform from Fourier series, Fourier transform of standard signals, properties of Fourier transforms, Related problems.

**Laplace Transforms:**

Introduction, Concept of region of convergence (ROC) for Laplace transforms, Properties of L.T's, Inverse Laplace transform, Relation between Laplace Transform and Fourier Transform of a signal.

**Unit III:**

**Sampling Theorem:** Graphical and analytical proof or Band Limited Signals, impulse sampling, Reconstruction of signal from its samples, Aliasing

**Z-Transforms:** Concept of Z-Transform of a discrete sequence. Region of convergence in Z-Transform, Inverse Z-transform, properties of Z-transforms

**Unit IV:**

**Fourier Transforms of discrete signal:** Fourier Transform of Discrete Signal, Properties, and Inverse Fourier Transforms, related problems

**Discrete Fourier Transforms:** Definition, Properties, Inverse DFT, related problems.

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**Fast Fourier Transform:** Decimation in Time domain and Decimation in Frequency Algorithms.

**Unit V:**

**Digital Filters: Structures of IIR filters and FIR filters:** Director form–1 and Direct form 2; cascade form; parallel form **Analog filter design** LPF, BPF, HPF and BEF filter design using Butterworth **Frequency Transformations:** Analog to Analog; Digital and Digital **IIR Filter Design:** IIR filter from analog filter – IIR filter design by Impulse Invariance, Bilinear transformation. **FIR Filter Design:** Filter design using windowing techniques. Rectangular Window, Hamming Window, Hanning Window

**Text Books:**

1. Signals, Systems & Communications - B. P. Lathi, BS Publications, 2003.
2. Digital Signal Processing - P. Ramesh Babu, 5<sup>th</sup> Edition, SCITECH Publishers.

**Reference Books:**

1. Signals & Systems – Simon Haykin and VanVeen, Wiley, 2<sup>nd</sup> Edition, 2007.
2. Signals and Systems-A.V. Oppenheim, A.S. Willsky and S.H. Nawab, PHI, 2<sup>nd</sup>Edn, 1997.
3. Discrete Time Signal Processing – A.V.Oppenheim and R.W. Schaffer, 3rd Edition, Pearson, 2014.

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III Year-II Semester					
23EC6E08	<b>MICROPROCESSORS &amp; MICROCONTROLLERS</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**Course Outcomes:**

- Understand the architecture of 8086 and its operation.
- Develop the students to compose the assembly language program for 8086.
- Applying 8086 processor to interface with necessary peripherals.
- Understand the architecture of 8051 and interfacing with necessary peripherals.
- Understand the introductory concepts of advanced processors, viz., ARM processors.

**UNIT-1:**

**Introduction:** Microprocessor based system, Origin of microprocessors, Harvard and Von Neumann architectures with examples, Microprocessor Unit versus Microcontroller Unit.

**8086 Architecture:** internal architecture of 8086 microprocessor, register organization, physical memory organization, general bus operation.

**UNIT-2:**

**8086 Programming:** instruction set, addressing modes, assembler directives, programming with assembler, writing simple programs with an assembler, stack and stack structure, interrupts and interrupt service routines, interrupt cycle of 8086.

**UNIT-3:**

**8086 Interfacing:** Semiconductor memories interfacing (RAM, ROM), Intel 8255 programmable peripheral interface, Interfacing switches and LEDs, Interfacing seven segment displays, Intel 8251 USART architecture and interfacing, stepper motor, A/D and D/A converters

**UNIT-4:****Intel 8051 MICROCONTROLLER and Interfacing**

Introduction to microcontrollers, internal architecture of 8051 microcontroller, I/O ports and memory organization, MCS51 addressing modes and instruction set, assembly language programming, simple programs, counters/timers, serial data input/output, interrupts. Interfacing to 8051: A/D and D/A Convertors, keyboard, LCD Interfacing.

**UNIT-5:**

**ARM Architectures and Processors:** introduction to CISC and RISC architectures, ARM Architecture, ARM Processors Families, Introduction to 16/32 bit processors, ARM7 architecture and organization, Thumb instructions, ARM Cortex-M3 Processor Functional

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Description.

**TEXTBOOKS:**

4. Advanced microprocessors and peripherals by K. M. Bhurchandi, A. K. Ray 3e
5. The 8051 Microcontrollers and Embedded systems Using Assembly and C, Muhammad Ali Mazidi and Janice Gillespie Mazidi and Rollin D.McKinlay; Pearson 2-Edition,2011.
6. Microprocessors and Microcontrollers by N. Senthil Kumar, M. Saravanan and S. Jeevanathan Oxford higher education

**REFERENCEBOOKS:**

4. Embedded Systems Fundamentals with Arm Cortex-M based Microcontrollers: A Practical Approach in English, by Dr. Alexander G. Dean, Published by Arm EducationMedia,2017.
5. Cortex-M3TechnicalReference Manual.
6. TheDefinitiveGuidetoARMCortex-M3andCortex-M4ProcessorsbyJosephYiu.,Newnes Third edition

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**HONORS:**

The following points may be considered to choose appropriate theory and laboratories to obtain B.Tech (Honors).

- The Student has to opt for any of the Six subjects / Five Theory and Two laboratories with the approval of the University BoS Chairman.
- Further, if any of these subjects are opted as Open Electives or Program Electives then such Subjects should not be considered to obtain the B.Tech (Honors).
- The Student can opt for the NPTEL/SWAYAM online Courses with 12 weeks/16 weeks duration and also with Proctored Examinations.
- Further, the student has to take permission for such NPTEL/SWAYAM Courses from the University BoS Chairman.
- In addition to the program elective given in Regular Courses & Structure, the following subjects are also included, that can be opted for B.Tech (Honors)
- In case of Laboratories, student may opt for virtual Laboratories only with the permission from chairman BoS.
- It is recommended to choose the laboratories along with pre-requisite theory subjects is mandatory

S.No.	SUBJECT	L-T-P	CREDITS
1	Advanced Communications	3-0-0	3
2	EMI/EMC	3-0-0	3
3	VLSI Signal Processing	3-0-0	3
4	CMOS Mixed Signal Design	3-0-0	3
5	Adaptive Signal Processing	3-0-0	3
6	RTOS	3-0-0	3
7	PC based Data Acquisition Systems	3-0-0	3
8	Digital Control Systems	3-0-0	3
9	Microstrip Antennas	3-0-0	3
10	Image & Video Processing	3-0-0	3
1	Advanced Communications Lab	0-0-3	1.5

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2	CMOS Mixed Signal Design Lab	0-0-3	1.5
3	RTOS Lab	0-0-3	1.5
4	Digital Control Systems Lab	0-0-3	1.5
5	Antennas and Microwave Lab	0-0-3	1.5
6	Image & Video Processing Lab	0-0-3	1.5
<b>Student shall take up at least TWO NPTEL/SWAYAM of 12-week duration for 3 credits.</b>			

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**MINOR:**

Student can choose any SIX Theory or any FIVE theory and TWO Laboratories in the list given below which are not chosen as Open electives/in Regular Courses, are to be considered for Minor Degree. Prior Approval BoS Chairman is required

S.No.	SUBJECT	L-T-P	CREDITS
1	Electronics Devices and Basic Circuits	3-0-0	3
2	Digital Electronics	3-0-0	3
3	Principles of Communication	3-0-0	3
4	Signal Analysis	3-0-0	3
5	Microcontrollers and Applications	3-0-0	3
6	Embedded System Design	3-0-0	3
7	Internet of things	3-0-0	3
8	Digital Signal Processing	3-0-0	3
9	Electronics Devices and Basic Circuits LAB	0-0-3	1.5
10	Digital Electronics LAB	0-0-3	1.5
11	Internet of things LAB	0-0-3	1.5
12	Digital Signal Processing LAB	0-0-3	1.5
<b>Student shall take up at least ONE NPTEL/SWAYAM of 12-week duration for 3 credits.</b>			

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Honor Course	ADVANCED COMMUNICATIONS	L	T	P	C
		3	0	0	3

**COURSE OUTCOMES:**

- Learn 5G Technology advances and their benefits
- Learn the key MIMO,SDR changes required to support 5G
- Learn Device to device communication with Wireless Networks
- Implementation options for 5G

**UNIT I:**

**SPREAD SPECTRUM AND MULTIPLE ACCESS TECHNIQUES:** Introduction, Pseudo noise sequence, DS spread spectrum with coherent binary PSK, processing gain, FH spread spectrum, multiple access techniques wireless communication, TDMA and CDMA in wireless communication systems, source coding of speech for wireless communications.

**UNIT II:**

Wireless channel modeling (microwave, mmWave, and teraHertz): Propagation mechanism, reflection, refraction, diffraction and scattering. Fading channels- Multipath and small-scale fading Doppler shift, statistical multipath channel models, narrowband and wideband fading models, coherence bandwidth, and coherence time.

**UNIT III:**

Multiple-Input, Multiple-Output (MIMO) wireless communication: Basic MIMO model, MIMO capacity in fading channels, Diversity multiplexing trade off, Space-time code for MIMO wireless communication.

Software Define Radio (SDR): Characteristics and benefits of a software radio, design principles of software radio, enhanced flexibility with software radios, receiver design challenges.

**UNIT IV:**

**Wireless Networks** Introduction to wireless Networks, Advantages and disadvantages of Wireless Local Area Networks, WLAN Topologies, WLAN Standard IEEE 802.11, IEEE 802.11 Medium Access Control, Comparison of IEEE 802.11 a,b,g and n standards, IEEE 802.16 and its enhancements, Wireless PANs, HiperLan, WLL

**UNIT V:**

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**5G Communication:** 5G spectrum landscape and requirements, Spectrum access modes and sharing scenarios, 5G spectrum technologies. 5G CHANNEL MODEL: The 5G wireless Propagation Channels: Channel modeling requirements, propagation scenarios and challenges in the 5G modeling. 5G USE CASES AND SYSTEM CONCEPT: Use cases and requirements, 5G system concept. 5G waveforms, OFDM, OTFS, OFDMA, carrier aggregation, dual connectivity. Beyond 5G key enablers: Intelligent reflecting surfaces (IRS), wireless energy harvesting, SWIPT, integrated sensing and communication

Text Books:

1. Wireless Communications, Principles, Practice – Theodore, S. Rappaport, 2<sup>nd</sup> Ed., 2002, PHI.
2. S. Haykin and M. Moher, Modern Wireless Communication, Pearson Education, 2005.
3. Jeffrey H. Reed, Software Radio: A Modern Approach to Radio Engineering, Prentice Hall, May 2002

References Books:

1. C. Oestges and B. Clerckx, MMIO Wireless Communications, 1st Ed, 2007.
2. Paul Burns, Software Defined Radio for 3G, Artech House Inc., 2003.
3. Afif Osseiran, Jose F Monserrat, Patrick Marsch, “5G Mobile and Wireless Communications Technology”, Cambridge University Press, 2016
4. Wireless Sensor Networks: An Information Processing Approach, 1st edition, Feng Zhao, Leonidas Guibas, Elsevier Science imprint, Morgan Kauffman Publishers, 2005, rp2009

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Honor Course	EMI/EMC	L	T	P	C
		3	0	0	3

**COURSE OUTCOMES:**

- Discuss effects of EMI and counter measures by EMC-techniques.
- Apply the knowledge gained in selecting proper gadget/device/appliance/system, as per EMC- norms specified by regulating authorities.
- Students shall choose career in the fields of EMI/EMC as an Engineer/Researcher/Entrepreneur in India/abroad.
- Understand the various aspects of shielding & PCB Tracing ,termination& Implementation
- Identifying of EMI Hotspot and various techniques like grounding filtering soldering etc

**UNIT – I:**

Natural and Nuclear sources of EMI / EMC: Introduction, Electromagnetic environment, History, Concepts, Practical experiences and concerns, frequency spectrum conservations. An overview of EMI/ EMC, Natural and Nuclear sources of EMI

**UNIT – II:**

EMI from apparatus, circuits and open area test sites: Electromagnetic emissions, noise from relays and switches, non-linearity in circuits, passive inter-modulation, cross talk in transmission lines, transients in power supply lines, electromagnetic interference (EMI). Open area test sites and measurements.

**UNIT – III:**

Radiated and conducted interference measurements: Anechoic chamber, TEM cell, GH TEM Cell, characterization of conduction currents / voltages, conducted EM noise on power lines, conducted EMI from equipment, Immunity to conducted EMI detectors and measurements.

**UNIT – IV:**

ESD, Grounding, shielding, bonding and EMI filters: Principles and types of grounding, shielding and bonding, characterization of filters, power lines filter design. ESD, Electrical fast transients / bursts, electrical surges.

**UNIT – V:**

Cables, connectors, components: Introduction, EMI suppression cables, EMC connectors, EMC gaskets, Isolation transformers, optoisolators, Transient and Surge Suppression Devices.

EMC standards- National / International: Introduction, Standards for EMI and EMC, MIL-Standards, IEEE/ANSI standards, CISPR/IEC standards, FCC regulations, EMI/EMC standards in JAPAN, Conclusions.

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Text Books:

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

References Books:

1. Introduction to Electromagnetic Compatibility, NY, John Wiley, 1992, by C.R. Pal.
2. Electromagnetic Interference and Compatibility IMPACT series, IIT – Delhi.

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Honor Course	VLSI SIGNAL PROCESSING	L	T	P	C
		3	0	0	3

**COURSE OUTCOMES:**

- Understand Pipelining, and parallel processing.
- Use VLSI design for digital filters
- Optimize VLSI architectures for basic DSP algorithms
- Analyze various parallel processing algorithms
- Be familiar with VLSI algorithms and architectures for DSP.
- Be able to implement basic architectures for DSP using CAD tools

**UNIT-I:**

**Introduction to DSP:** Typical DSP algorithms, DSP algorithms benefits, Representation of DSP algorithms. **Pipelining and Parallel Processing:** Introduction, Pipelining of FIR Digital filters, Parallel Processing, Pipelining and Parallel Processing for Low Power. **Retiming:** Introduction – Definitions and Properties – Solving System of Inequalities – Retiming Techniques

**UNIT-II:**

**Folding:** Introduction -Folding Transform - Register minimization Techniques – Register minimization in folded architectures – folding of multirate systems

**Unfolding:** Introduction – An Algorithm for Unfolding – Properties of Unfolding – critical Path, Unfolding and Retiming – Applications of Unfolding

**UNIT-III:****Systolic Architecture Design**

Introduction – Systolic Array Design Methodology – FIR Systolic Arrays – Selection of Scheduling Vector – Matrix Multiplication and 2D Systolic Array Design – Systolic Design for Space Representations contain Delays

**UNIT-IV:****Fast Convolution**

Introduction – Cook-Toom Algorithm – Winograd algorithm – Iterated Convolution – Cyclic Convolution – Design of Fast Convolution algorithm by Inspection

**UNIT-V:****Low Power Design**

Scaling Vs Power Consumption –Power Analysis, Power Reduction techniques – Power Estimation Approaches Programmable DSP: Evaluation of Programmable Digital Signal Processors, DSP Processors for Mobile and Wireless Communications, Processors for Multimedia Signal Processing.

**TEXT BOOKS:**

1. VLSI Digital Signal Processing- System Design and Implementation – Keshab K. Parhi,

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1998, Wiley Inter Science.

2. VLSI and Modern Signal Processing – Kung S. Y, H. J. While House, T. Kailath, 1985, Prentice Hall.

**REFERENCE BOOKS:**

1. Design of Analog – Digital VLSI Circuits for Telecommunications and Signal Processing – Jose E. France, YannisTsividis, 1994, Prentice Hall.

2. VLSI Digital Signal Processing – Medisetti V. K, 1995, IEEE Press (NY), USA.

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Honor Course	CMOS MIXED SIGNAL DESIGN	L	T	P	C
		3	0	0	3

**COURSE OUTCOMES:**

- Appreciate the fundamentals of data converters and also optimized their performances.
- Understand the design methodology for mixed signal IC design
- Analyze the design of PLL and operational amplifiers
- Design the CMOS digital circuits and implement its layout.
- Design the Switched Capacitor Circuits for different applications.

**UNIT-I: Switched Capacitor Circuits**

Introduction to Switched Capacitor circuits- basic building blocks, Operation and Analysis, Non-ideal effects in switched capacitor circuits, Switched capacitor integrators first order filters, Switch sharing, biquad filters.

**UNIT-II: Phased Lock Loop (PLL)**

Basic PLL topology, Dynamics of simple PLL, Charge pump PLLs-Lock acquisition, Phase/Frequency detector and charge pump, Basic charge pump PLL, Non-ideal effects in PLLs-

PFD/CP non-idealities, Jitter in PLLs, Delay locked loops, applications.

**UNIT-III: Data Converter Fundamentals**

DC and dynamic specifications, Quantization noise, Nyquist rate D/A converters- Decoder based converters, Binary-Scaled converters, Thermometer-code converters, Hybrid converters

**UNIT-IV: Nyquist Rate A/D Converters**

Successive approximation converters, Flash converter, Two-step A/D converters, Interpolating A/D converters, Folding A/D converters, Pipelined A/D converters, Time-interleaved converters.

**UNIT-V: Oversampling Converters**

Noise shaping modulators, Decimating filters and interpolating filters, Higher order modulators, Delta sigma modulators with multibit quantizers, Delta sigma D/A

**TEXT BOOKS:**

1. Analog Integrated Circuit Design- David A. Johns, Ken Martin, Wiley Student Edition, 2016
2. CMOS Analog Circuit Design - Philip E. Allen and Douglas R. Holberg, Oxford University Press, International Second Edition/Indian Edition, 2010.
3. Design of Analog CMOS Integrated Circuits- Behzad Razavi, TMH Edition, 2002

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**REFERENCE BOOKS:**

1. CMOS Integrated Analog-to- Digital and Digital-to-Analog converters-Rudy Van De Plassche, Kluwer Academic Publishers, 2003
2. Understanding Delta-Sigma Data converters-Richard Schreier, Wiley Interscience, 2005.
3. CMOS Mixed-Signal Circuit Design - R. Jacob Baker, Wiley Interscience, 2009.

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Honor Course	ADAPTIVE SIGNAL PROCESSING	L	T	P	C
		3	0	0	3

**COURSE OUTCOMES:**

- Review the Adaptive Systems and Understand the various measures to be opted for developing adaptive systems
- Understand different algorithms to develop the adaptive filtering
- Apply adaptive filter theory for different problems
- Perform RLS & Kalman Filtering

**Unit -I**

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

**Unit-II**

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

**Unit-III**

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

**Unit-IV**

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

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### Unit-V

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

### Text Books

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

### Reference Books

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

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Honor Course	RTOS	L	T	P	C
		3	0	0	3

**COURSE OUTCOMES:**

- List the mathematical model of the system and to develop real time algorithm for task scheduling.
- Categorize capabilities Handling Resource Sharing and dependencies among Real-time Tasks generate a high-level analysis for Scheduling Real-time tasks in multiprocessor and distributed systems
- Analyze the working of real time operating systems and real time database.
- Apply the fault tolerance techniques, evaluation of reliability.

**UNIT-I: Introduction**

OS Services, Process Management, Timer Functions, Event Functions, Memory Management, Device, File and IO Systems Management, Interrupt Routines in RTOS Environment and Handling of Interrupt Source Calls, Real-Time Operating Systems, Basic Design Using an RTOS, RTOS Task Scheduling Models, Interrupt Latency and Response of the Tasks as Performance Metrics, OS Security Issues.

**UNIT-II: RTOS Programming**

Basic Functions and Types of RTOS for Embedded Systems, RTOS mCOS-II, RTOS Vx Works, Programming concepts of above RTOS with relevant Examples, Programming concepts of RTOS Windows CE, RTOS Linux 2.6.x and RTOS RT Linux.

**UNIT-III: Program Modeling – Case Studies**

case study of digital camera hardware and software architecture, Case Study of Embedded System for an Adaptive Cruise Control (ACC) System in Car, Case Study of Embedded System for a Smart Card, Case Study of Embedded System of Mobile Phone Software for Key Inputs.

**UNIT-IV: Target Image Creation & Programming in Linux**

Operating System Software, Target Image Creation for Window XP Embedded, Porting RTOS on a Micro Controller based Development Board. Overview and programming concepts of Unix/Linux Programming, Shell Programming, System Programming

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**UNIT-V:      Programming in RT Linux**

Overview of RT Linux, Core RT Linux API, Program to display a message periodically, semaphore management, Mutex, Management, Case Study of Appliance Control by RT Linux System

**TEXT BOOKS:**

1. Rajkamal: “Embedded Systems-Architecture, Programming and Design”, Tata McGraw Hill Publications, Second Edition, 2008.
2. Dr. K.V.K.K. Prasad: “Embedded/Real-Time Systems” Dream Tech Publications, 2005 Edition, Black pad book.

**REFERENCES:**

1. Labrosse, “Embedding system building blocks “, CMP publishers.
2. Rob Williams,” Real time Systems Development”, Butterworth Heinemann Publications.

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Honor Course	<b>PC BASED DATA ACQUISITION SYSTEMS</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**COURSE OUTCOMES:**

- Be able to identify a data acquisition system, objectives and different configurations
- Be familiar with different methods of linear/Nonlinear Analog-to-Digital conversion and their role in real time applications
- Be familiar with different methods of linear/Nonlinear Digital to Analog Conversion. and their role in real time applications
- Be able to identify the type of interface used to get a digital signal/Analog signal into a microprocessor and familiar with Monolithic Converters.
- Be familiar with different noise reduction techniques in DAS and case studies of Data Converter

**UNIT-I**

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

**UNIT-II**

**ANALOG TO DIGITAL CONVERTERS (ADCS):** Classification of A/D converters. Parallel feed back – Successive approximation – Ramp comparison – Dual slope integration – Voltage to frequency – Voltage to Time – Logarithmic types of ADCS.

**NON-LINEAR DATA CONVERTERS (NDC):** Basic NDC configurations – Some Common NDACS and NADCS – Programmable non-linear ADCS – NADC using optimal sized ROM –High speed hybrid NADC – PLS based NADC – Switched capacitor NDCS.

**ADC APPLICATIONS:** Data Acquisition systems – Digital signal processing systems – PCM voice communication systems – Test and measurement instruments – Electronic Weighing machines.

**UNIT-III**

**DIGITAL TO ANALOG CONVERTERS (DACs):** Principles and design of – Parallel R–2R, Weighted resistor, inverted ladder, D/A decoding – Codes other than ordinary binary.

**DATA CONVERTER APPLICATIONS:** DAC applications – Digitally programmable V/I sources – Arbitrary waveform generators – Digitally programmable gain amplifiers – Analog multipliers/ dividers – Analog delay lines.

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#### UNIT-IV

Monolithic data converters: typical study of monolithic DACS and ADCS. Interfacing of DACS and ADCS to a  $\mu$ P.

#### UNIT-V

**Error budget of DACS and ADCS:** Error sources, error reduction and noise Reduction techniques in DAS. Error budget analysis of DAS, case study of a DAC and an ADC.

#### TEXT BOOKS:

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

#### REFERENCES:

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

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Honor Course	<b>DIGITAL CONTROL SYSTEMS</b>	L	T	P	C
		3	0	0	3

**COURSE OUTCOMES:**

- Have the awareness of Discrete Time Control Systems
- Calculate the Z-transforms and use its concepts of Discrete control systems
- Get familiarize with design of Discrete control systems using various Approaches
- Understand the State Space approach to analyze the discrete system
- Have the concepts of Controllability and Observability of discrete control system

**UNIT –I: Introduction to Discrete Time Control Systems:**

Introduction, Digital Control Systems, Quantizing and Quantization Error, Data Acquisition, Conversion, and Distribution Systems

**UNIT-II:****The Z – Transforms:**

Introduction, The Z Transform, Z-Transform of elementary functions, properties and theorems of Z-Transform, Inverse Z-Transform, Z-Transform method for solving difference equations

**Z-Plane Analysis of Discrete-Time Control System:**

Introduction, Impulse Sampling and Data Hold, Obtaining the Z-Transform by the convolutional integral method, Reconstruction of original signals from sampled signals, Pulse transfer function,

Realization of digital controllers and digital filters

**UNIT –III: Design of Discrete Time Control Systems by Conventional Methods:**

Introduction, Mapping between the s plane and the z plane, stability analysis of closed loop systems in the z plane, transient and steady response analysis, design based on the Root-Locus method, design based on the frequency response method, Analytical design method.

**UNIT-IV: State Space Analysis:**

Introduction, State Space Representation of discrete time systems, solving discrete time state space equations, Pulse Transfer function matrix, Discretization of continuous time state – space equations, Liapunov stability analysis

**UNIT –V: Controllability and Observability:**

Introduction, Controllability, Observability, Useful Transformations in State Space Analysis and Design.

**TEXT BOOKS:**

1. K. Ogata - “Discrete-Time Control systems” - Pearson Education/PHI, 2nd Edition.

**REFERENCE BOOKS:**

1. Kuo - “Digital Control Systems”- Oxford University Press, 2nd Edition, 2003.
2. M. Gopal - “Digital Control and State Variable Methods”- TMH.

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Honor Course	MICROSTRIP ANTENNAS	L	T	P	C
		3	0	0	3

**Course Outcomes:**

- Remember the antenna basics and planar antennas.
- Describe and discuss characteristics and principles of microstrip antennas.
- Demonstrate and implement the CP patch antennas and micro strip antenna arrays.
- Analyze planar slot antennas and planar monopole antennas.
- Evaluate characteristics and design aspects of electrically small antennas.
- Investigate planar antennas for special applications for wireless access.

**UNIT –I:**

**Planar Radiators:** Introduction to antennas (radiation pattern, directivity, efficiency, gain, impedance, axial ratio etc.), different types of planar antennas, applications of planar antennas, Brief description of fabrication process of planar antennas.

**UNIT –II:**

**Microstrip Patch Antennas-I:** Characteristics of microstrip patch antennas, radiation from microstrip antenna, field configurations, different types of feeding techniques. Design equations for rectangular and circular microstrip patches, analysis of microstrip antennas using transmission line model and cavity method. Broadband techniques using stacked patch antennas, proximity-coupled and aperture-coupled microstrip antennas, slot-loaded and slit-loaded microstrip antennas, microstrip antennas with shorted pin, effect of finite ground plane on the performance of microstrip antennas, principle of planar fractal antennas.

**UNIT –III:**

**Microstrip Patch Antennas-II:** Methods of generating circular polarization in microstrip antennas using single feed and double feed, methods of generating multiple frequencies using microstrip antennas, miniaturization techniques for microstrip antennas. Design techniques of microstrip antenna arrays with feed network, effect of mutual coupling, microstrip phased array antenna design.

**UNIT –IV:**

**Planar Slot Antennas:** Geometry and design of microstrip slot antenna, radiation pattern, CPW-fed slot antennas, design of folded slot antenna, annular slot antenna.

**Planar Monopole Antennas:** Feeding methods and characteristics of planar triangle monopole,

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Sierpinski monopole, planar bi-conical monopole antenna and roll monopole antenna.

**UNIT –V:**

**Planar Antennas for Special Applications:** Planar mobile handset antennas, planar laptop computer antennas, planar antennas for USB modem, planar antennas for WLAN and UWB communication.

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Honor Course	IMAGE & VIDEO PROCESSING	L	T	P	C
		3	0	0	3

**COURSE OUTCOMES:**

- Describe the Image Processing system, scope of digital image processing and compare various image transforms.
- Apply filtering operations on images both in spatial and frequency domain; describe image restoration in presence of noise and degradation.
- Analyze various segmentation techniques and compression methods on digital images.
- Describe the fundamental of digital video, sampling and filtering of video signals.
- Explain various methods for two dimensional motion estimation and their applications in video processing

**Unit – I**

**Introduction:** Introduction to Image Processing, Examples of fields that use Digital Image Processing, Fundamental steps in digital image processing, components of an image processing system, Examples of the fields that use Digital Image Processing. Image sensing and acquisition, image sampling and quantization, Some basic relationships between pixels.

**Image Transforms:** Need for image transforms, Image transforms, Fourier Transform, 2D Discrete Fourier Transform and its properties, Walsh Transform, Hadamard transform, Haar Transform, Slant transform, Discrete Cosine transform, KL Transform, Singular Value Decomposition.

**Unit – II****Image Enhancement:**

Spatial domain methods: Histogram processing, Fundamentals of Spatial filtering, Smoothing spatial filters, Sharpening spatial filters.

**Filtering in frequency domain:** Basics of filtering in frequency domain, image smoothing, image sharpening, Selective filtering.

**Image Restoration:**

A model of the image degradation / Restoration process, Noise models, restoration in the presence of noise only-Spatial Filtering, Periodic Noise Reduction by frequency domain filtering, Linear, Position –Invariant Degradations, Estimating the degradation function, Inverse filtering, Minimum mean square error (Wiener) filtering.

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### Unit – III

Image segmentation: Fundamentals, point, line, edge detection, thresholding, and Region – based segmentation. Image compression: Fundamentals, Basic compression methods: Huffman coding, Golomb coding, Arithmetic coding, LZW coding, Run-Length coding, Block Transform coding, Predictive coding.

### Unit – IV

#### Basic Steps of Video Processing:

Analog Video, Digital Video. Time-Varying Image Formation models: Three-Dimensional Motion Models, Geometric Image Formation, Photometric Image Formation, Sampling of Video signals, Filtering operations.

### Unit – V

#### 2-D Motion Estimation:

Optical flow, General Methodologies, Pixel Based Motion Estimation, Block- Matching Algorithm, Mesh based Motion Estimation, Global Motion Estimation, Region based Motion Estimation, Multi resolution motion estimation

#### TEXT BOOKS:

1. Digital Image Processing – Gonzalez and Woods, 3<sup>rd</sup> Ed., Pearson.
2. Digital Video Processing – M. Tekalp, Prentice Hall International.
3. Video Processing and Communication – Yao Wang, Joern Ostermann and Ya-qin Zhang. 1<sup>st</sup> Ed., PH Int.

#### REFERENCE BOOKS:

5. Fundamentals of Digital Image Processing – Anil K. Jain, Prentice Hall of India, 9th Edition, Indian Reprint, 2002.
6. Digital Image Processing – S. Jayaraman, S. Esakkirajan, and T. Veerakumar, McGraw-Hill Education, 2018.

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Honor Course	ADVANCED COMMUNICATIONS LAB	L	T	P	C
		0	0	3	1.5

**List of Experiments : ( Minimum of Twelve Experiments has to be performed)**

1. Implementation of Linear Block Code Encoder and Decoder
2. Implementation of Binary Cyclic Codes Encoder and Decoder
3. Implementation of Convolution Encoder- Decoder
4. Determination of Losses in Optical Fiber
5. Characteristics of LASER Diode.
6. Study of Satellite Communication System, uplink transmitter, down link receiver and transponder
7. Signal to noise ratio and Link Failure operations in satellite communication
8. Carrier to Noise Ratio in Satellite Communication
9. Study of Direct Sequence Spread Spectrum Modulation & Demodulation using CDMA- DSS BER Trainer
10. Efficiency of DS Spread- Spectrum Technique
11. Simulation of Frequency Hopping (FH) system
12. Generation of PN sequence and Gold Sequence
13. Outdoor propagation model - Okumura model and Hata model
14. Free space propagation – path loss model
15. Study of WLAN / network topologies

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Honor Course	CMOS MIXED SIGNAL DESIGN LAB	L	T	P	C
		0	0	3	1.5

List of Experiments:

Cycle 1:

- 1) Fully compensated op-amp with resistor and miller compensation
- 2) High speed comparator design
  - i. Two stage cross coupled clamped comparator
  - ii. Strobed Flip-flop
- 3) Data converter

Cycle 2:

- 1) Switched capacitor circuits
  - i. Parasitic sensitive integrator
  - ii. Parasitic insensitive integrator
- 2) Design of PLL
- 3) Design of VCO
- 4) Band gap reference circuit
- 5) Layouts of All the circuits Designed and Simulated

Lab Requirements:

Software: Mentor Graphics/ Cadence/ Tanner/Industry Equivalent Standard Software Tools

Hardware: Personal Computer with necessary peripherals, configuration and operating System.

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Honor Course	RTOS Lab	L	T	P	C
		0	0	3	1.5

- The Students are required to write the programs using C-Language according to the Experiment requirements using RTOS Library Functions and macros ARM-926 developer kits and ARM-Cortex.
- The following experiments are required to develop the algorithms, flow diagrams, source code and perform the compilation, execution and implement the same using necessary hardware kits for verification. The programs developed for the implementation should be at the level of an embedded system design.
- The students are required to perform at least SIX experiments from Part-I and TWO experiments from Part-II.

**List of Experiments:****Part-I: Experiments using ARM-926 with PERFECT RTOS**

1. Register a new command in CLI.
2. Create a new Task.
3. Interrupt handling.
4. Allocate resource using semaphores.
5. Share resource using MUTEX.
6. Avoid deadlock using BANKER'S algorithm.
7. Synchronize two identical threads using MONITOR.
8. Reader's Writer's Problem for concurrent Tasks.

**Part-II: Experiments on ARM-CORTEX processor using any open source RTOS.**  
(Coo-Cox-Software-Platform)

1. Implement the interfacing of display with the ARM- CORTEX processor.
2. Interface ADC and DAC ports with the Input and Output sensitive devices.
3. Simulate the temperature DATA Logger with the SERIAL communication with PC.
4. Implement the developer board as a modem for data communication using serial port communication between two PC's.

**Lab Requirements:****Software:**

- Eclipse IDE for C and C++ (YAGARTO Eclipse IDE), Perfect RTOS Library, COO-COX Software Platform, YAGARTO TOOLS, and TFTP SERVER.

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- LINUX Environment for the compilation using Eclipse IDE & Java with latest version.

**Hardware:**

- The development kits of ARM-926 Developer Kits and ARM-Cortex Boards.
- Serial Cables, Network Cables and recommended power supply for the board.

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Honor Course	<b>DIGITAL CONTROL SYSTEMS LAB</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>0</b>	<b>0</b>	<b>3</b>	<b>1.5</b>

1. To study
  - a. Conversion of a transfer function from continuous domain to discrete domain.
  - b. Conversion of a transfer function from the continuous domain to the digital domain.
  - c. Pole Zero Map of a discrete transfer function
2. To determine
  - a. Z transform of a discrete-time signal
  - b. Inverse Z transform of a discrete-time signal
  - c. Factored form and partial fraction form of a rational z function
  - d. Pole zero map of a digital system
3. To study
  - a. Closed loop response of a discrete-time system
  - b. Comparison of time responses of continuous time and discrete time systems
  - c. Effect of sampling time on system response and system parameters
4. To design a lead compensator to obtain system response with the desired accuracy, and less overshoot.
5. To design a lag compensator to meet performance specification parameters
6. To study a. The effect of variation in controller parameters on system response
7. To obtain
  - a. Transfer function model from a state model
  - b. State model from transfer function model
  - c. Step response of a system represented by its state model
8. To determine
  - a. Eigenvalues from state model
  - b. Eigenvalues from transfer function model
  - c. Stability of a system
9. To study the effect of common nonlinearities such as relay, dead zone, and saturation on the response of a 2nd order control system

**Softwares Required**

1. Matlab Software
2. Simulink Tool

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Honor Course	ANTENNAS and MICROWAVE LAB	L	T	P	C
		0	0	3	1.5

**LIST OF EXPERIMENTS : ( Minimum of Ten Experiments has to be performed)**

1. Calculation of transmission line parameters (R, L, G and C) for two wire line, coaxial line and Strip line.
2. Study on the standing wave pattern along a transmission line when the line is open-circuited, Short circuited and terminated by a resistive load at the load end.
3. Investigate the effect of length of transmission line on the input impedance at the sending end.
4. Familiarization of Smith chart on MATLAB platform.
5. Radiation resistance of electric and magnetic dipoles as a function of electrical size.
6. Feed (input terminal) impedance of an electric dipole as a function of antenna length.
7. 3D radiation pattern of a half-wavelength dipole antenna in both horizontal and vertical Orientations
8. Radiation patterns for electric dipoles of various electrical lengths.
9. Characteristics and radiation patterns of Linear array, Planar and Circular arrays.
10. Variation of normalized input impedance with Feeding position in Inset-Fed Microstrip patch Antenna
11. Design of Rectangular Microstrip Patch antenna.

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Honor Course	IMAGE & VIDEO PROCESSING LAB	L	T	P	C
		0	0	3	1.5

**List of Experiments:**

**Note: In the first 10 experiments, atleast 8 experiments; In the last three experiments, atleast 2 experiments must be executed.**

1. Perform basic operations on images like addition, subtraction etc.
2. Perform Pixel based operations (Point based operations) for Image enhancement
3. Plot the histogram of an image and perform histogram equalization
4. Filtering in Spatial Domain
5. Computation of 2D-DFT and Perform filtering in Frequency domain
6. Implementation of Image Restoration methods
7. Implementation of JPEG compression Algorithm (Without using Library function)
8. Comparison of coding Techniques for image compression (Bit plane, Predictive, Arithmetic, Huffman coding).
9. Detections of edges in an image (Prewitt, Sobel, Krisch and Laplacian of Gaussian Operators, Canny operators) and compare
10. Image Segmentation based on thresholding.
11. Basic operations on Video, and identification of key frame
12. Computation of optical flow velocities for a moving object in a Video
13. Implementation of two dimensional motion estimation

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Minor Course	<b>ELECTRONICS DEVICES AND BASIC CIRCUITS</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**COURSE OUTCOMES:**

- Understand the semiconductor physics, their concepts and characteristics of p-n junction diode.
- Understand V-I characteristics of various semiconductor devices.
- Learn the operation of transistor and its characteristics in various configurations, Biasing of transistor
- Analyze the transistor using h-parameters and its equivalent model.
- Describe the operation of FET and MOSFET, their application as an amplifier.

**UNIT I:**

**Review of Semiconductor Physics:** Mobility and Conductivity, Intrinsic and extrinsic semiconductors, Hall effect

**Junction Diode Characteristics :** Energy band diagram of PN junction Diode, Open circuited p-n junction, Biased p-n junction, p-n junction diode, current components in p-n junction Diode, Qualitative explanation of Diode equation ( Derivation not required) , V-I Characteristics, temperature dependence on V-I characteristics, Diode resistance, Diode capacitance

**UNIT II:**

**Special Semiconductor Devices:** Zener Diode, Breakdown mechanisms, Zener diode applications, Varactor Diode, LED, Photodiode, Tunnel Diode and its characteristics with the help of energy band diagram, UJT and its application, PNP Diode, SCR, Construction, operation and V-I characteristics.

**Diode Circuits:** Clipping (limiting) circuits, Peak Detector, Clamping circuits, Comparators, Basic Rectifier setup, half wave rectifier, full wave rectifier, bridge rectifier, Inductor filter, Capacitor filter

**UNIT III:**

**Transistor Characteristics:** Junction transistor, transistor current components, transistor equation in CB configuration, transistor as an amplifier, characteristics of transistor in Common Base and Common Emitter configurations, punch through/ reach through, typical transistor junction voltage values.

**Transistor Biasing and Thermal Stabilization :** Need for biasing, operating point, load line analysis, BJT biasing- methods, basic stability, fixed bias, collector to base bias, self bias,

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Stabilization against variations in  $V_{BE}$ ,  $I_c$ , and  $\beta$ , Stability factors,  $(S, S', S'')$ , Bias compensation, Thermal runaway, Thermal stability.

#### UNIT IV:

##### Small Signal Low Frequency Transistor Amplifier Models

**BJT:** Two port network, Transistor hybrid model, determination of h-parameters, Millers theorem and Dual of Millers theorem, Analysis of CB, CE and CC amplifiers using exact analysis, Comparison of transistor amplifiers.

#### UNIT V:

**FET:** FET types, JFET operation and characteristics (qualitative explanation only), small signal model of JFET.

**MOSFET:** MOSFET Structure, Operation of MOSFET, MOSFET as a variable resistor, derivation of V-I characteristics of MOSFET, Comparison of Bipolar and MOS devices.

**CMOS amplifiers:** General Considerations, Common Source Stage, Common Gate Stage, Source Follower, comparison of FET amplifiers.

#### Text Books:

1. Electronic Devices and Circuits- J. Millman, C. C. Halkias, Mc-Graw Hill Education.
2. Integrated Electronics-J. Millman, C. Halkias, Mc-Graw Hill Education.
3. Fundamentals of Microelectronics-Behzad Razavi, Wiley, 3<sup>rd</sup> edition, 2021.

#### References:

1. Electronics devices & circuit theory- Robert L.Boylestad and LouiNashelsky, Pearson, 11<sup>th</sup> edition, 2015.
2. Electronic Devices and Circuits - David A. Bell, Oxford University Press, 5<sup>th</sup> edition, 2008.
3. Electronic Devices and Circuits- S. Salivahanan, N. Suresh Kumar, Mc-Graw Hill, 5<sup>th</sup> edition, 2022.

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Minor Course	<b>DIGITAL ELECTRONICS</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**COURSE OUTCOMES:**

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

**UNIT – I****REVIEW OF NUMBER SYSTEMS & CODES:**

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

**UNIT – II****BOOLEAN THEOREMS AND LOGIC OPERATIONS:**

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

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

**UNIT – III**

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

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### COMBINATIONAL LOGIC CIRCUITS DESIGN USING MSI &LSI :

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

**UNIT – IV SEQUENTIAL CIRCUITS :** Classification of sequential circuits (synchronous and asynchronous) , operation of NAND & NOR Latches and flip-flops; truth tables and excitation tables of RS flip-flop, JK flip-flop, T flip-flop, D flip-flop with reset and clear terminals. Conversion from one flip-flop to another flip-flop. Design of Sripple counters, design of synchronous counters, Johnson counter, ring counter. Design of registers - Buffer register, control buffer register, shift register, bi directional shift register, universal shift, register.

**UNIT-V INTRODUCTION OF PLD's :** PLDs: PROM, PAL, PLA -Basics structures, realization of Boolean functions, Programming table. ROM: Internal structure, Static RAM: Internal structure, Dynamic RAM: Internal structure.

### TEXT BOOKS:

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

### REFERENCES:

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

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Minor Course	<b>PRINCIPLES OF COMMUNICATION</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**COURSE OUTCOMES:**

- Analyze the performance of analog modulation schemes in time and frequency domains.
- Analyze the performance of angle modulated signals.
- Characterize analog signals in time domain as random processes and noise
- Characterize the influence of channel on analog modulated signals
- Determine the performance of analog communication systems in terms of SNR

**UNIT I :** Basic tools for communication, Fourier Series/Transform, Properties, Autocorrelation, Energy Spectral Density, Parseval's Relation, Amplitude Modulation (AM), Spectrum of AM, Envelope Detection, Power Efficiency, Modulation Index

**UNIT II :** Double Sideband Suppressed Carrier (DSB-SC) Modulation, Demodulation, Costas Receiver, Single Sideband Modulation (SSB), Hilbert Transform, Complex Pre-envelope/ Envelope, Demodulation of SSB, Vestigial Sideband Modulation (VSB)

**UNIT III :** Angle Modulation, Frequency Modulation (FM), Phase Modulation (PM), Modulation Index, Instantaneous Frequency, Spectrum of FM Signals, Carson's Rule for FM Bandwidth, Narrowband FM Generation, Wideband FM Generation via Indirect Method, FM Demodulation

**UNIT IV :** Introduction to Sampling, Spectrum of Sampled Signal, Aliasing, Nyquist Criterion, Signal Reconstruction from Sampled Signal, Pulse Amplitude Modulation, Quantization, Uniform Quantizers – Midrise and Midtread, Quantization noise, Non uniform Quantizers, Delta Modulation, Differential Pulse Code Modulation (DPCM)

**UNIT V :** Basics of Probability, Conditional Probability, MAP Principle, Random Variables, Probability Density Functions, Applications in Wireless Channels, Basics of Random Processes, Gaussian Random Process, Noise.

**TEXT BOOKS:**

- Simon Haykin, Communications Systems, 4th Edition. John Wiley and Sons, Inc
- Fundamentals of Wireless Communication by David Tse

**References:**

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1. Principles of Communication Systems – Simon Haykin, John Wiley, 2nd Edition.
2. Electronics & Communication System – George Kennedy and Bernard Davis, TMH 2004.

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Minor Course	SIGNAL ANALYSYS	L	T	P	C
		3	0	0	3

**COURSE OUTCOMES:**

- To be able to determine if a given system is linear/causal/stable
- Capable of determining the frequency components present in a deterministic signal
- Capable of characterizing LTI systems in the time domain and frequency domain
- To be able to compute the output of an LTI system in the time and frequency domains

**UNIT I: CLASSIFICATION OF SIGNALS AND SYSTEMS**

Standard signals- Step, Ramp, Pulse, Impulse, Real and complex exponentials and Sinusoids\_ Classification of signals – Continuous time (CT) and Discrete Time (DT) signals, Periodic & Aperiodic signals, Deterministic & Random signals, Energy & Power signals - Classification of systems- CT systems and DT systems- – Linear & Nonlinear, Time-variant & Time-invariant, Causal & Non-causal, Stable & Unstable.

**UNIT II: ANALYSIS OF CONTINUOUS TIME SIGNALS** Fourier series for periodic signals - Fourier Transform – properties- Laplace Transforms and properties

**UNIT III: LINEAR TIME INVARIANT CONTINUOUS TIME SYSTEMS**

Impulse response - convolution integrals- Differential Equation- Fourier and Laplace transforms in Analysis of CT systems - Systems connected in series / parallel.

**UNIT IV: ANALYSIS OF DISCRETE TIME SIGNALS**

Baseband signal Sampling – Fourier Transform of discrete time signals (DTFT) – Properties of DTFT - Z Transform & Properties

**UNIT V: LINEAR TIME INVARIANT-DISCRETE TIME SYSTEMS**

Impulse response – Difference equations-Convolution sum- Discrete Fourier Transform and Z Transform Analysis of Recursive & Non-Recursive systems-DT systems connected in series and parallel.

**TEXT BOOKS:**

1. Allan V.Oppenheim, S.Wilsky and S.H.Nawab, —Signals and Systems, Pearson, 2015

**REFERENCES BOOKS**

1. B. P. Lathi, —Principles of Linear Systems and Signals, Second Edition, Oxford, 2009.
2. R.E.Zeimer, W.H.Tranter and R.D.Fannin, —Signals & Systems - Continuous and Discrete, Pearson,
3. John Alan Stuller, —An Introduction to Signals and Systems, Thomson, 2007.

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Minor Course	MICROCONTROLLERS AND APPLICATIONS	L	T	P	C
		3	0	0	3

**Course Outcomes:**

- Understand the architecture and operation of common microcontrollers.
- Write and debug assembly/C programs for microcontrollers.
- Interface microcontrollers with input/output devices.
- Interface microcontrollers with various advanced peripherals.
- Design and implement microcontroller-based applications.

**Unit 1: Introduction to Microcontrollers**

Evolution of microcontrollers and comparison with microprocessors, Microcontroller families (8051, PIC, AVR, ARM), Architecture of 8051 microcontroller, Memory organization, registers, and flags, Overview of development tools (IDE, simulators, programmers)

**Unit 2: Programming of Microcontrollers**

Instruction set of 8051, Assembly language programming, Introduction to Embedded C programming, Debugging and simulation tools

**Unit 3: Interfacing with Input/Output Devices**

Basics of interfacing and role of GPIO, Interfacing LEDs, switches, and push buttons, Interfacing 7-segment displays and buzzers, Interfacing LCDs (16x2 and 20x4, Keypad interfacing for user inputs

**Unit 4: Interfacing with Advanced Peripherals and Communication Devices**

Interfacing sensors (temperature, light, and proximity sensors),  
Interfacing actuators (motors: DC, stepper, and servo).  
Communication interfaces: UART (serial communication with PC), SPI and I2C (interfacing EEPROM and sensors), ADC/DAC interfacing (e.g., analog sensors and audio signals).  
Interfacing wireless modules (Bluetooth, ZigBee, ESP8266/ESP32 for IoT applications)

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### Unit 5: Advanced Microcontrollers

Introduction to ARM Cortex-M series, Comparison of ARM with 8051 and PIC, Overview of Arduino and Raspberry Pi platforms, Embedded IoT basics

**Real-Time Applications and Case Studies:** Microcontroller applications in robotics, automation, and consumer electronics, Designing energy-efficient systems with microcontrollers; Case studies: Home automation, Smart agriculture systems, Healthcare monitoring.

### Textbook:

1. Mazidi and Mazidi, The 8051 Microcontroller and Embedded Systems, 4th Impression, PHI, 2000.
2. Raj Kamal, Microcontrollers Architecture, Programming, Interfacing and System Design, 2nd Edition, Pearson Education, 2005.

### Reference Books:

1. Kenneth J. Ayala, *The 8051 Microcontroller: Architecture, Programming, and Applications*, Cengage Learning.
2. John Boxall, *Arduino Workshop: A Hands-On Introduction with 65 Projects*, No Starch Press.

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Minor Course	<b>EMBEDDED SYSTEM DESIGN</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**COURSE OUTCOMES:**

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

**UNIT-I**

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

**UNIT-II**

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

**UNIT-III**

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

**UNIT-IV**

**REAL TIME OPERATING SYSTEM:** Operating system basics, Types of operating systems, Tasks, Process and Threads, Multiprocessing and Multitasking, Task Scheduling, Threads, Processes and Scheduling, Task communication, Task synchronization.

**HARDWARE SOFTWARE CO-DESIGN:** Fundamental Issues in Hardware Software Co-Design, Computational models in embedded design, Hardware software Trade-offs, Integration of Hardware and Firmware.

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**UNIT-V:**

**EMBEDDED SYSTEM DEVELOPMENT, IMPLEMENTATION AND TESTING:** The integrated development environment, Types of files generated on cross-compilation, Deassembler/ De-compiler, Simulators, Emulators and Debugging, Target hardware debugging,

Embedded Software development process and tools, Interpreters, Compilers and Linkers, debugging tools, Quality assurance and testing of the design, Testing on host machine, Simulators, Laboratory Tools.

**Text Books:**

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

**References:**

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

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Minor Course	INTERNET OF THINGS	L	T	P	C
		3	0	0	3

**COURSE OUTCOMES:**

- Understand the new computing technologies
- Able to apply the latest computing technologies like cloud computing technology and Big Data
- Ability to introduce the concept of M2M (machine to machine) with necessary protocols
- Get the skill to program using python scripting language which is used in many IoT devices

**Unit I**

Introduction to Internet of Things –Definition and Characteristics of IoT, Physical Design of IoT – IoT Protocols, IoT Communication Models, Iot Communication APIs IoT enabled Technologies – Wireless Sensor Networks, Cloud Computing, Big data analytics, Communication protocols, Embedded Systems, IoT Levels and Templates Domain Specific Iots – Home, City, Environment, Energy, Retail, Logistics, Agriculture, Industry, Health and Lifestyle(Chap 1 and 2)

**Unit II**

IoT and M2M – Software defined networks, network function virtualization, difference between SDN and NFV for IoT Basics of IoT System Management with NETCOZF, YANGNETCONF, YANG, SNMP NETOPEER(Chapter 3 and 4)

**Unit III**

IOT Platform design Methodology, Introduction to Python - Language features of Python, Data types, data structures, Control of flow, functions, modules, packaging, file handling, data/time operations, classes, Exception handling Python packages - JSON, XML, HTTPLib, URLLib, SMTPLib(Chapter 5 and 6)

**Unit IV**

IoT Physical Devices and Endpoints - Introduction to Raspberry PI-Interfaces (serial, SPI, I2C) Programming – Python program with Raspberry PI with focus of interfacing external gadgets, controlling output, reading input from pins., other IOT Devices(Chapter 7)

**Unit V**

IoT Physical Servers and Cloud Offerings – Introduction to Cloud Storage models and communication APIs Webserver – Web server for IoT, Cloud for IoT, Python web application framework Designing a RESTful web API, Amazon web services for IOT, Skynet IOT messaging platform(Chapter 8)

**Text Books:**

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1. Internet of Things - A Hands-on Approach, ArshdeepBahga and Vijay Madiseti, Universities Press, 2015, ISBN: 9788173719547
2. Getting Started with Raspberry Pi, Matt Richardson & Shawn Wallace, O'Reilly (SPD),2014, ISBN: 9789350239759

**Reference Books:**

1. The Internet of Things – Key applications and Protocols, Olivier Hersent, David Boswarthick, Omar Elloumi and Wiley, 2012 (for Unit 2).
2. From Machine-to-Machine to the Internet of Things – Introduction to a New Age of Intelligence, Jan Ho"ller, VlasiosTsiatsis, Catherine Mulligan, Stamatis, Karnouskos, Stefan Avesand. David Boyle and Elsevier, 2014.
3. Architecting the Internet of Things, Dieter Uckelmann, Mark Harrison, Michahelles and Florian (Eds), Springer, 2011.
4. Recipes to Begin, Expand, and Enhance Your Projects, 2nd Edition, Michael Margolis, Arduino Cookbook and O'Reilly Media, 2011.

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Minor Course	<b>DIGITAL SIGNAL PROCESSING</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**COURSE OUTCOMES:**

- Understand the concepts of discrete signals and discrete systems with its characteristics
- Calculate z-Transform, Fourier Transform, Discrete Fourier Transform of discrete signals.
- Understand the algorithms for the efficient computation of DFT coefficients of signals
- Know the various filter structures for FIR and IIR filters.
- Design the FIR and IIR filters.

**Unit -I**

**Introduction:** Signals, Systems, and Signal Processing, Classification of Signals, The Concept of Frequency in Continuous Time and Discrete Time Signals

**Discrete Time Signals and Systems:** Discrete Time Signals, Discrete Time Systems, Analysis of Discrete Time Linear Time Invariant Systems, Discrete Time Systems Described by Difference Equations, Implementation of Discrete Time Systems, Correlation of Discrete Time Signals

**Frequency Analysis of Signals:** Frequency Analysis of Continuous Time Signals, Frequency Analysis of Discrete Time Signals, Frequency Domain and Time Domain Signal Properties, Properties of the Fourier Transform for Discrete Time Signals.

**Unit –II**

**Frequency Domain Analysis of LTI Systems:** Frequency domain characteristics of LTI systems, Frequency response of LTI systems.

**The z-Transform and Its Applications to the Analysis of LTI Systems:** The z-Transform, Properties, Rational z Transforms, Inversion of the z-Transform, Analysis of Linear Time Invariant Systems in the z-Domain, The One sided z-Transform.

**Unit –III**

**The Discrete Fourier Transform: Its Properties and Applications:** Frequency Domain Sampling: The Discrete Fourier Transform, Properties of the DFT, Linear Filtering Methods Based on the DFT, Frequency Analysis of Signals Using DFT

**Efficient Computation of the DFT: Fast Fourier Transform Algorithms:** Direct Computation of the DFT, Radix-2 FFT Algorithms.

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#### Unit –IV

**Implementation of Discrete Time Systems:** Structures for the Realization of Discrete Time Systems. **Structures for FIR Systems:** Direct Form Structure, Cascade Form Structures.

**Structures for IIR Systems:** Discrete Form Structures, Signal Flow Graphs and Transposed Structures, Cascade Form Structures, Parallel Form Structures.

#### Unit –V

**Design of Analog Filters:** Butterworth filters... Low Pass Filter, High Pass filter, Band Pass Filter, Band Reject Filter. **Design of Digital Filters:** General Considerations: Causality and Its Implications, Characteristics of Practical Frequency Selective Filters.

**Design of FIR Filters:** Symmetric and Antisymmetric FIR Filters, Design of Linear Phase FIR Filters Using Windows, Design of Linear Phase FIR Filters by the Frequency Sampling Method.

**Design of IIR Filters From Analog Filters:** IIR Filter Design by Approximation of Derivatives, IIR Filter Design by Impulse Invariance, IIR Filter Design by the Bilinear Transformation.

**Frequency Transformations:** Frequency Transformations in the Analog Domain, Frequency Transformations in the Digital Domain.

#### TEXT BOOKS:

1. Digital Signal Processing, Principles, Algorithms, and Applications: John G. Proakis, Dimitris G.Manolakis, 4<sup>th</sup> Edition, Pearson Education, 2007.

#### Reference Books:

1. Discrete Time Signal Processing – A.V.Oppenheim and R.W. Schaffer, 3<sup>rd</sup> Edition, Pearson, 2014.
2. Digital Signal Processing-P. Ramesh Babu, 5<sup>th</sup> Edition, SCITECH Publishers.

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Minor Course	ELECTRONICS DEVICES AND BASIC CIRCUITS LAB	L	T	P	C
		0	0	3	1.5

**List of Experiments:** (Minimum of Ten Experiments has to be performed)

1. P-N Junction Diode Characteristics  
Part A: Germanium Diode (Forward bias & Reverse bias)  
Part B: Silicon Diode (Forward Bias only)
2. Zener Diode Characteristics  
Part A: V-I Characteristics  
Part B: Zener Diode as Voltage Regulator
4. Rectifiers (without)  
Part A: Half-wave Rectifier  
Part B: Full-wave Rectifier
5. BJT Characteristics (CE Configuration)
6. FET Characteristics (CS Configuration)
7. Transistor Biasing
8. CRO Operation and its Measurements
9. BJT-CE Amplifier
10. Emitter Follower-CC Amplifier
11. FET-CS Amplifier

**Equipment required:**

1. Regulated Power supplies
2. Analog/Digital Storage Oscilloscopes
3. Analog/Digital Function Generators
4. Digital Multi-meters
5. Decade Resistance Boxes/Rheostats
6. Decade Capacitance Boxes
7. Ammeters (Analog or Digital)
8. Voltmeters (Analog or Digital)
9. Active & Passive Electronic Components

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Minor Course	<b>DIGITAL ELECTRONICS LAB</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>0</b>	<b>0</b>	<b>3</b>	<b>1.5</b>

**List of Experiments: (Minimum of Ten Experiments has to be performed)**

1. Verification of truth tables of Logic gates  
Two input (i) OR (ii) AND (iii) NOR (iv) NAND (v) Exclusive OR (vi) Exclusive NOR
2. Design a simple combinational circuit with four variables and obtain minimal SOP expression and verify the truth table using Digital Trainer Kit
3. Verification of functional table of 3 to 8 line Decoder/De-multiplexer
4. four variable logic function verification using 8 to 1 multiplexer.
5. Design full adder circuit and verify its functional table.
6. Verification of functional tables of  
(i) JK Edge triggered Flip–Flop (ii) JK Master Slav Flip–Flop (iii) DFlip–Flop
7. Design a four bit ring counter using D Flip–Flops/JK Flip Flop and verify output
8. Design a four bit Johnson’s counter using D Flip-Flops/JK Flip Flops and verify output
9. Verify the operation of 4-bit Universal Shift Register for different Modes of operation.
10. Draw the circuit diagram of MOD-8 ripple counter and construct a circuit using T- Flip-Flops and Test it with a low frequency clock and Sketch the output wave forms.
11. Design MOD–8 synchronous counter using T Flip- Flop and verify the result and Sketch the output wave forms.
12. (a) Draw the circuit diagram of a single bit comparator and test the output  
(b) Construct 7 Segment Display Circuit Using Decoder and 7 Segment LED and test it.

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Minor Course	INTERNET OF THINGS LAB	L	T	P	C
		0	0	3	1.5

**List of Experiments: (Minimum of Twelve Experiments has to be performed)**

1. Getting started with Raspberry Pi, Install Raspian on your SD card.
2. Python-based IDE(integrated development environments) for the Raspberry Pi and how to trace and debug Python code on the device.
3. Display a word on LCD, Interfacing with Raspberry Pi.
4. Using Raspberry Pi, Display Seven Segment.
5. Servo Motor Controlling with Interfacing using Raspberry Pi.
6. Soil Moisture detecting with soil moisture sensor using Raspberry Pi.
7. Calculate the distance using distance sensor Using Node MCU.
8. Basic LED functionality Using Node MCU
9. Familiarization with ARM keil MDK for programming and debugging an application on the PSoC 4 BLE chip and perform necessary software installation.
10. To interface Push button/Digital sensor (IR/LDR) with ARM keil MDK on PSoC4 BLE chip and write a program to turn ON LED when push button is pressed or at sensor detection.
11. Setup a Bluetooth Low Energy (namely Bluetooth Smart) connection between the PSoC BLE kit and a smart phone and use an app to send and receive data to and from the BLE Pioneer kit.
12. To interface capacitor sensor (touch sensor) with smart phone and write a program to turn RGB LED ON/OFF when „1“/“0“ is received from smart phone using Bluetooth.
13. Automatic street light control to control the street light (Turn on and off based on the light) using Arduino/Node MCU/Raspberry Pi
14. Smoke Detection using MQ-2 Gas Sensor
15. Detecting obstacle with IR Sensor and Arduino/Node MCU/Raspberry Pi

**Equipment required for Laboratories:**

- Arduino/Node MCU/Raspberry Pi+PSoC4 BLE Bluetooth Low Energy Pioneer Kit + Hardware, MQ-2 Gas Sensor, Ultrasonic sound sensor.

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Minor Course	<b>DIGITAL SIGNAL PROCESSING LAB</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>0</b>	<b>0</b>	<b>3</b>	<b>1.5</b>

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

**PART-A**

List of the Experiments

1. Generation of DT signals.
2. Verify the Linear Convolution of two DT signals
  - a) Using MATLAB
  - b) Using Code Composer Studio (CCS)
3. Verify the Circular Convolution of two DT signals
  - a) Using MATLAB
  - b) Using Code Composer Studio (CCS)
4. Find the sum of DT sinusoidal signals.
5. Computation of Discrete Fourier Transform (DFT) and Inverse Discrete Fourier Transform (IDFT)
  - a) Using MATLAB
  - b) Using Code Composer Studio (CCS)
6. Compute N-point DFT of a given DT sequence using Decimation in Time. (Without Using Library Function)
7. Compute N-point DFT of a given DT sequence using Decimation in Frequency. (Without Using Library Function)

**PART-B :** Following Experiments are to be done using a TI DSP Starter Kit.

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

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## DEAPRTMENT EEE [PROFESSIONAL ELECTIVE-1]

III B.Tech. - I Semester	23EC5D06	L	T	P	C
		3	0	0	3
Communication systems					

**Course Outcomes:**

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

**UNIT – I**

Basic tools for communication, Fourier Series/Transform, Properties, Autocorrelation, Energy Spectral Density, Parsevals Relation, Amplitude Modulation (AM), Spectrum of AM, Envelope Detection, Power, Efficiency, Modulation Index

**UNIT2** : Double Sideband Suppressed Carrier (DSB-SC) Modulation, Demodulation, Costas Receiver, Single Sideband Modulation (SSB), Hilbert Transform, Complex Pre-envelope/ Envelope, Demodulation of SSB, Vestigial Sideband Modulation (VSB)

**UNIT 3** : Angle Modulation, Frequency Modulation (FM), Phase Modulation (PM), Modulation Index, Instantaneous Frequency, Spectrum of FM Signals, Carsons Rule for FM Bandwidth, Narrowband FM Generation, Wideband FM Generation via Indirect Method, FM Demodulation.

**UNIT 4** : Introduction to Sampling, Spectrum of Sampled Signal, Aliasing, Nyquist Criterion, Signal Reconstruction from Sampled Signal, Pulse Amplitude Modulation, Quantization, Uniform Quantizers – Midrise and Midtread, Quantization noise, , Non uniform Quantizers, Delta Modulation, Differential Pulse Code Modulation (DPCM)

**UNIT 5** : Basics of Probability, Conditional Probability, MAP Principle, Random Variables, Probability Density Functions, Applications in Wireless Channels, Basics of Random Processes ,Gaussian Random Process, Noise.

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TEXTBOOKS:

1. Simon Haykin, Communications Systems, 4th Edition. John Wiley and Sons, Inc
2. Fundamentals of Wireless Communication by David Tse

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