# Ch. Charan Singh University Campus Meerut

## EVALUATION SCHEME & SYLLABUS
## FOR

## B. TECH. III YEAR

Electronics & Instrumentation Engineering

## ON

## CHOICE BASED CREDIT SYSTEM (CBCS)

**[Effective from the Session: 2018-19]**

# B. Tech

# (Electronics and Instrumentation)

## *PROGRAMME OUTCOME*

The objective of this course is to familiarize the prospective engineers with techniques in sequences, multivariate integration, ordinary and partial differential equations and complex variables. It aims to equip the students to deal with advanced level of mathematics and applications that would be essential for their disciplines.

The students will learn:

- The effective mathematical tools for the solutions of differential equations that model physical processes
- To apply integral calculus in various field of engineering. Apart from some other applications students will have a basic understanding of Beta and Gamma functions.
- The tool of Fourier series for learning advanced Engineering Mathematics.
- The tools of differentiation of functions of complex variables that are used in various techniques dealing with engineering problems

1. facilitate software based learning to provide the required English Language proficiencyto students.
2. To acquaint students with specific dimensions of communication skills i.e. Reading,Writing, Listening, Thinking and Speaking.
3. To train students to use the correct and error-free writing by being well versed in rules ofEnglish grammar.
4. To cultivate relevant technical style of communication and presentation at their work placeand also for academic uses.
5. To enable students to apply it for practical and oral presentation purposes by being honed upin presentation skills and voice-dynamics.
6. To understand the basic concepts of IoT, followed by major components, its layer architecture and how IoT is impacting the Industry in the various forms along with major applications.
7. To make students aware about basic concepts of cloud computing, its benefits and different applications along with insights of major service providers.
8. To understand the basic concepts of Blockchain and its underlying technologies with its implementation as cryptocurrencies.
9. To understand the concept of Additive Manufacturing, its applications in various fields and the basic concepts of drones, their assembly and government regulations involved.
10. To introduce students to the upcoming technology and to develop the required skills for practical applications.

# B. Tech

# (Electronics and Instrumentation)

# Program specific out come

After successful completion of 160 credits, a student shall be eligible to get Under Graduate degree in Engineering. A student will be eligible to get Under Graduate degree with Honours only, if he/she completes additional university recommended courses only (Equivalent to 20 credits; NPTEL Courses of 4 Weeks, 8 Weeks and 12 Weeks shall be of 2, 3 and 4 Credits respectively) through MOOCs. For registration to MOOCs Courses, the students shall follow NPTEL Site http://nptel.ac.in/ as per the NPTEL policy and norms. The students can register for these courses through NPTEL directly as per the course offering in Odd/Even Semesters at NPTEL. These NPTEL courses (recommended by the University) may be cleared during the B. Tech degree program (not necessary one course in each semester). After successful completion of these MooCs courses the students, shall, provide their successful completion NPTEL status/certificates to the University (COE) through their college of study only. The student shall be awarded Hons. Degree (on successful completion of MOOCS based 20 credit) only if he/she secures 7.50 or above CGPA and passed each subject of that Degree Programme in single attempt without any grace marks.

## EVALUATION SCHEME

### B.Tech Electronics & Instrumentation Engineering

**YEAR 3rd, SEMESTER V**

| Sr. No. | Subject Name | L-T-P | Th/Lab Marks | Sessional | | Total | Credit |
|---|---|---|---|---|---|---|---|
| | | | ESE | CT | TA | | |
| 1 | Managerial Economics | 3--0--0 | 70 | 20 | 10 | 100 | 3 |
| 2 | Sociology/Cyber Security | 3--0--0 | 70 | 20 | 10 | 100 | 3 |
| 3 | Industrial Measuring Instruments | 3--0--0 | 70 | 20 | 10 | 100 | 3 |
| 4 | Integrated Circuits | 3--1--0 | 70 | 20 | 10 | 100 | 4 |
| 5 | Digital Signal Processing | 3--0--0 | 70 | 20 | 10 | 100 | 3 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **6** | **Deptt. Elective Course 1** | **3--1--0** | **70** | **20** | **10** | **100** | **4** |
| **7** | **Measuring Instruments Lab** | **0--0--2** | **50** | | **50** | **100** | **1** |
| **8** | **Integrated Circuits Lab** | **0--0--2** | **50** | | **50** | **100** | **1** |
| **9** | **Digital Signal Processing Lab** | **0--0--2** | **50** | | **50** | **100** | **1** |
| **10** | **Seminar** | **0--0--2** | **50** | | **50** | **50** | **1** |
| | | | **620** | **120** | **260** | **1000** | **24** |

**Departmental Elective Course 1**

1. **Fluid Mechanics**
2. **Computer Architecture and Organization**
3. **Electrical Machines**
4. **Artificial Neural Network**

**EVALUATION SCHEME**

**B.Tech Electronics & Instrumentation Engineering**

**YEAR 3rd, SEMESTER VI**

| Sr. No. | Subject Name | L-T-P | Th/ LAB Mark | Sessional | | Total | Credit |
|---|---|---|---|---|---|---|---|
| | | | ESE | CT | TA | | |
| 1 | Industrial Management | 3--0--0 | 70 | 20 | 10 | 100 | 3 |
| 2 | Sociology /Cyber Security | 3--0--0 | 70 | 20 | 10 | 100 | 3 |
| 3 | Microcontrollers for Embedded Systems | 3--0--0 | 70 | 20 | 10 | 100 | 3 |
| 4 | Digital Measurement Techniques | 3--1--0 | 70 | 20 | 10 | 100 | 4 |
| 5 | Control System I | 3--0--0 | 70 | 20 | 10 | 100 | 3 |
| 6 | Deptt. Elective Course 2 | 3--1--0 | 70 | 20 | 10 | 100 | 4 |
| 7 | Microcontrollers for Embedded Systems Lab | 0--0--2 | 50 | | 50 | 100 | 1 |
| 8 | Instrumentation Lab | 0--0--2 | 50 | | 50 | 100 | 1 |
| 9 | Control System I Lab | 0--0--2 | 50 | | 50 | 100 | 1 |
| 10 | Communication Lab | 0--0--2 | 50 | | 50 | 100 | 1 |
| | | | 620 | 120 | 260 | 1000 | 24 |

**Departmental Elective Course 2**

1. Industrial Electronics
2. Opto-Electronics
3. Analog Signal Processing
4. Communication Engineering

| INDUSTRIAL MEASURING INSTRUMENTS | | |
|---|---|---|
| **Unit** | **Topic** | **Lectures** |
| I | **Generalized configurations, functional descriptions and performance characteristics of measuring instruments:** General concepts and terminology of measurement systems, transducer classification, general input-output configuration, static and dynamic characteristics of a measurement system, Statistical analysis of measurement data. Standards and Calibration.<br>**Displacement measurement**: Resistive potentiometers, Digital displacement transducers, Mechanical fly ball angular velocity sensor, Mechanical revolution counters and timers, stroboscopic method | 8 |
| II | **Force and Pressure Measurement:**<br>Standards & calibration; basic methods of force measurement; Characteristics of elastic force transducer-Bonded strain gauge, differential transformer, Piezo electric transducer.<br>Units of pressure; dead weight gauges & manometer and its types, Bellows and force balance type sensors, Bourden guage, Piezoelectric, Capacitive and Inductive Pressure pickups. | 9 |
| III | **Flow measurement:**<br>Differential pressure flowmeters: Bernoulli's theorem: pitot tube, orifice, venturi, flow nozzle, Hot wire and hot film anemometers, variable area meters (rotameter), meters, Electromagnetic flowmeters, Ultrasonic flowmeters, Drag force flow meter, Vortex shedding flow meters.<br>Measurement of level, Float type gauge, purge method, differential pressure method, conductive and capacitive method; electromechanical method. | 8 |
| IV | **Temperature measurements:**<br>Standards and calibration, thermal expansion methods, bimetallic thermometer, thermocouple, reference junction considerations, special materials, configuration & techniques, Measurement of thermocouple output, Electrical resistance sensors and thermistors, Radiation thermometers. | 7 |
| V | **Miscellaneous Measurements: Viscosity, Density and Vacuum:**<br>Measurement of Viscosity: Definitions, units, Newtonian and Newtonian behaviour, measurement of viscosity using laboratory viscometers, industrial viscometers. Viscometer selection and application.<br>**Measurement of Density:** Definitions, units, liquid density measurement, gas densitometers, its application and selection, Measurement of Vacuum: Mcleod gauge, Pirani gauge, Knudsen gauge and Ionization gauge | 8 |

**Text Books:**


1. E. O. Doebelin, "Measurements systems: Applications and Design", 4th Edition, Tata McGraw Hill.
2. B. C. Nakra and K. K. Chaudhry, "Instrumentation: Measurements & Analysis" Tata McGraw Hill
3. J.G. Joshi, Electronics Measurement and Instrumentation, Khanna Publishing House, Delhi.


**Reference Books:**

1. A. K. Sawhney, “A Course in Electrical and Electronic Measurements and Instrumentation” Dhanpat Rai Publications., 19th Edition.
2. Bela G. Liptak, "Process Measurement and Analysis, Vol. 1”, CRC Press

**Course Outcomes: At the end of this course students will demonstrate the ability to:**

1. Classify the Instrumentation and Measurement system and various measurementerrors.
2. Analyze and design voltmeter circuits, AC electronic voltmeter, digital frequencymeter and current measurement with electronic instruments.
3. Evaluate various resistance and impedance measuring methods using Bridges andQ-meter.
4. Analyze fundamental operation of CRO and some special type of oscilloscopes likeDSO, Sampling oscilloscope.
5. Demonstrate calibration method to calibrate various instruments and classify transducers like for force, pressure, motion, temperature measurement etc.

| INTEGRATED CIRCUITS | | |
|---|---|---|
| **Unit** | **Topic** | **Lectures** |
| I | **Analog Integrated circuit Design:an overview:** Current Mirrors using BJT and MOSFETs, Simple current Mirror, Base current compensated current Mirror, Wilson and Improved Wilson Current Mirrors, Widlar Current source and Cascode current Mirror<br>**The 741 IC Op-Amp:** Bias circuit, short circuit protection circuitry, the input stage, the second stage, the output stage, and device parameters; DC Analysis of 741: Small Signal Analysis of input stage, the second stage, the output stage; Gain, Frequency Response of 741; a Simplified Model, Slew Rate, Relationship Between ft and SR | 10 |
| II | **Linear Applications of IC op-amps:** An Overview of Op-Amp (ideal and non-ideal) based Circuits V-I and I-V converters, generalized Impedance converter, simulation of inductors.<br>**Filters:** Ist and IInd order LP, HP, BP BS and All pass active filters, KHN. | 8 |
| III | **Digital Integrated Circuit Design-An Overview**: CMOS Logic Gate Circuits**:** Basic Structure CMOS realization of Inverters, AND, OR, NAND and NOR Gates<br>**Latches and Flip flops:** The Latch, The SR Flip-flop, CMOS Implementation of SR Flip- flops, A Simpler CMOS Implementation of the Clocked SR Flip-flop, D Flip-flop Circuits. | 8 |
| IV | **Non-Linear applications of IC Op-amps:** Log– Anti Log Amplifiers, Precision Rectifiers, Peak Detectors, Simple and Hold Circuits, Analog Multipliers and their applications. Op- amp as a comparator, Zero crossing detector, Schmitt Trigger, Astable multi vibrator, Mono stable multi vibrator, Generation of Triangular Waveforms | 7 |
| V | **D/A and A/D converters Integrated Circuit Timer:** The 555 Circuit, Implementing a Monostable Multivibrator Using the 555 IC, Astable Multi vibrator Using the 555 IC.<br>**Phase locked loops (PLL):** Ex-OR Gates and multipliers as phase detectors**,** Block Diagram of IC PLL, Working of PLL and Applications of PLL. | 7 |

**Text Books:**


1. Sedra and Smith, "Microelectronic Circuits", 6th Edition, Oxford University Press.
2. Michael Jacob, "Applications and Design with Analog Integrated Circuits", PHI, 2nd Edition.
3. A.K. Maini, Analog Circuits, Khanna Publishing House, Delhi.


**Reference Books:**


1. Jacob Millman and Arvin Grabel, "Microelectronics", 2nd Edition, Tata McGraw Hill.
2. Behzad Razavi, "Fundamentals of Microelectronics", 2nd Edition, Wiley.
3. Mark N. Horenstein, "Microelectronic Circuits and Devices", PHI.
4. A.K. Maini, All in One Electronics Simplified, Khanna Publishing House, Delhi.
5. Paul R. Gray, Paul J. Hurst, Stephen H. Lewis and Robert G. Meyer, "Analysis and Design of Analog Integrated Circuits", Wiley.


**Course Outcomes: At the end of this course students will demonstrate the ability to:**

1. Explain complete internal analysis of Op-Amp 741-IC.
2. Examine and design Op-Amp based circuits and basic components of ICs such as various types

offilter.

3. Implement the concept of Op-Amp to design Op-Amp based non-linear applications and wave-shaping circuits.
4. Analyse and design basic digital IC circuits using CMOS technology.
5. Describe the functioning of application specific ICs such as 555 timer ,VCO IC 566 and PLL.

6. Data Sheet: http://www.ti.com/lit/ds/symlink/tl082.pdf
7. Application Note: http://www.ti.com/lit/an/sloa020a/sloa020a.pdf
8. MPY634 Data Sheet: http://www.ti.com/lit/ds/symlink/mpy634.pdf
9. Application Note: http://www.ti.com/lit/an/sbfa006/sbfa006.pdf
10. ASLK Pro Manual: ASLK Manual .

| DIGITAL SIGNAL PROCESSING | | |
|---|---|---|
| **Unit** | **Topics** | **Lectures** |
| I | Realization of Digital Systems: Introduction, direct form realization of IIR systems, cascade realization of an IIR systems, parallel form realization of an IIR systems, Ladder structures: continued fraction expansion of H (z), example of continued fraction, realization of a ladder structure, example of a ladder realization, FIR Filter Realization: Direct & Cascade, FIR Linear Phase Realization. | 8 |
| II | Design of Infinite Impulse Response Digital Filters: Introduction to Filters, Impulse Invariant Transformation, Bi-Linear Transformation, All- Pole Analog Filters: Butterworth and Chebyshev, Design of Digital Butterworth and Chebyshev Filters, Frequency Transformations. | 8 |
| III | Finite Impulse Response Filter Design: Windowing and the Rectangular Window, Other Commonly Used Windows, Examples of Filter Designs Using Windows, The Kaiser Window, Finite Word length effects in digital filters. | 8 |
| IV | DFT & FFT: Definitions, Properties of the DFT, Circular Convolution, Linear Convolution using Circular Convolution, Decimation in Time (DIT) Algorithm, Decimation in Frequency (DIF) Algorithm**.** | 8 |
| V | Multirate Digital Signal Processing: Introduction, Decimation, Interpolation, Sampling rate conversion: Single and Multistage, Subband Coding of Speech signals, Quadrature mirror filters. | 8 |

**Text Book:**

1. Johnny R. Johnson, .Digital Signal Processing., PHI Learning Pvt Ltd., 2009.

**Reference Books:**

1. John G Prokias, Dimitris G Manolakis, .Digital Signal Processing. Pearson Education.
2. Oppenheim & Schafer, . Digital Signal Processing. PHI

**Course Outcomes:** At the end of this course students will demonstrate the ability to:

1. Design and describe different types of realizations of digital systems (IIR and FIR) and their utilities.
2. Select design parameters of analog IIR digital filters (Butterworth and Chebyshev filters) and implement various methods such as impulse invariant transformation and bilinear transformation of conversion of analog to digital filters.
3. Design FIR filter using various types of window functions.
4. Define the principle of discrete Fourier transform & its various properties and concept of circular and linear convolution. Also, students will be able to define and implement FFT i.e.a fast computation method of DFT.
5. Define the concept of decimation and interpolation. Also, they will be able to implement itin various practical applications.

## LABORATORY

## MEASURING INSTRUMENTS LAB

**List of Experiments**:

1. 1.Characteristics of resistance transducer (i) Potentiometer (ii) StrainGauge
2. 2.Characteristics of LVDT.
3. Characteristics of capacitive transducer (i) Variable area (ii) Variable distance.
4. Characteristics of Thermistors
5. Characteristics of RTD.
6. Characteristics of Thermocouples
7. Characteristics of LDR, PhotoDiode, and Phototransistor: (i) Variable Illumination. (ii) Linear Displacement.
8. Measurement of resistance by Wheatstone bridge and measurement of bridge sensitivity.
9. Measurement of Capacitance by De'Sautys and Schering Bridge.
10. Measure of low resistance by Kelvin's double bridge.
11. Characteristics of diaphragm m type pressure transducer.
12. Characteristics of one Solid State sensor/Fiber optic sensor.
13. Project based on SENSOR ( Hardware).

## INTEGRATED CIRCUITS LAB

**Objective: -** To design and implement the circuits to gain knowledge on performance of the circuit and its application. These circuits should also be simulated on Pspice and implemented using TL082, LM741, NE555, ASLK, MPY634 KP connecting wires, Power Supply, function generator and oscilloscope.

1. Design and test a function generator that can generate square wave and triangular wave output for a given frequency and cascade a multiplier MPY634KP in feedback loop to form VCO
2. Voltage to current and current to voltage convertors.
3. Second order filters using operational amplifier in universal active filter topology for –
    a. Low pass filter of specified cutoff frequency
    b. High pass filter of specified frequency
    c. Band pass filter with unit gain of specified pass band
    d. Design a notch filter to eliminate 50Hz power line frequency
4. Wien bridge oscillator using operational amplifier.
5. Astable and monostable multivibrator using IC 555.
6. Design the following amplifiers:
    a. A unity gain amplifier
    b. A non-inverting amplifier with a gain of ‟A‟
    c. An inverting amplifier with a gain of „A‟
    d. Log and antilog amplifiers.
    e. Voltage comparator and zero crossing detectors.
7. Design and test a PLL to get locked to a given frequency „f‟. Measure the locking range of the system and also measure the change in phase of the output signal as input frequency is varied within the lock range.
8. Design and test the integrator for a given time constant.
9. Design and test a high-Q Band pass self-tuned filter for a given center frequency.
10. Design and test an AGC system for a given peak amplitude of sine-wave output.
11. Design and test a Low Dropout regulator using op-amps for a given voltage regulation characteristic and compare the characteristics with TPS7250IC.
12. Design of a switched mode power supply that can provide a regulated output voltage for a given input range using the TPS40200 IC

**Note:** All listed experiments are compulsory. In addition to it, the Institutes may include more experiments based on the expertise.

## DIGITAL SIGNAL PROCESSING LAB

**List of Experiments :**

1. To study about DSP Processors and architecture of TMS320C6713 DSP processor.
2. Introduction to MATLAB and Code Composer Studio or its equivalent open source software.

   OR

   Introduction to Scilab Open Source Software (Using Spoken Tutorial MOOCs)
3. Write a Program for the generation of basic signals such as unit impulse, unit step, ramp, exponential, sinusoidal and cosine.
4. To study matrix multiplication using code composer studio.
5. Evaluate 4 point DFT of and IDFT of $x(n) = 1, 0 \leq n \leq 3; 0$ elsewhere.
6. To implement FFT algorithm.
7. Verify Blackman and Hamming windowing techniques.
8. Implement IIR Butterworth analog Low Pass for a 4 KHz cut off frequency.
9. Verify Circular Convolution using code composer studio.
10. Verify Linear convolution of two sequence using code composer studio.
11. To implement Tone Generation.
12. To implement floating point arithmetic.

**Spoken Tutorial (MOOCs):**

Spoken Tutorial MOOCs, ' Course on Scilab', IIT Bombay (http://spoken-tutorial.org/)

## DEPARTMENTAL ELECTIVE COURSE- 1

| FLUID MECHANICS | | |
|---|---|---|
| **Unit** | **Topic** | **Lectures** |
| I | Introduction: Fluids and continuum: Physical properties of fluids, ideal and rearfluids, Newtonian and non-Newtonian fluids, measurement of surface tension. Kinematics of Fluid Flow: Steady and unsteady, uniform and non-uniform, laminar and turbulent flows, one, two and three dimensional flows, streamlines, streak lines and path lines, | 8 |
| II | Fluid statics: Pressure-density-height relationship, manometers, pressure on plane and curved surfaces, centre of pressure, buoyancy, stability of immersed and floating bodies. Dynamics of Fluid flow: Euler's equation of motion along a streamline and its integration, Bernoulli's | 8 |
| III | Laminar and Turbulent Flow: Equation of motion for laminar flow through pipes, Stoke's law, flow between parallel plates, flow through porous media, fluidization, measurement of viscosity, transition from laminar to turbulent low, turbulent flow, equation for turbulent flow, eddy viscosity, mixing length concept and velocity distribution in turbulent flow, Hot-wire anemometer and LDA. | 8 |
| IV | Dimensional Analysis and Hydraulic Similitude: Dimensional analysis, Buckingham's theorem, important dimensionless numbers and their significance, geometric, Kinematic and dynamic similarity, model studies. Pipe Flow: Nature of turbulent flow in pipes, equation for velocity distribution Over smooth and rough surfaces, resistance coefficient and its variation, flow in sudden expansion, contraction, diffusers, bends, valves and siphons, concept of Equivalent length, branched pipes, pipes in series and parallel, simple networks. Compressibility Effects in pipe flow | 8 |

**Spoken Tutorial (MOOCs):**

Spoken Tutorial MOOCs, 'Course on OpenFOAM ', IIT Bombay (http://spoken-tutorial.org/)

**Text Books:**


1. Sadhu Singh, Fluid Mechanics, Khanna Publishing House, Delhi.
2. S.S. Rattan, Fluid Mechanics and Hydraulic Machines, Khanna Book Publishing Co., Delhi
3. Som and Biswas, "Introduction to fluid mechanics and machines", Tata McGraw Hill Publication.
4. S.K.Agrawal, "Fluid mechanics and machinery", Tata McGraw Hill Publication.


### Course Outcomes: At the end of this course students will demonstrate the ability to:

1. Explain the working of measurement systems and different types of sensors andtransducers.
2. Formulate the sensor to measure various physical parameters used in Industryand normal measurement applications.
3. Analyze the working principle of resistive, inductive and capacitive transducersand their applications.
4. Differentiate the thermocouples, piezoelectric and pyro-electric transducers

andapply them in various applications.

5. Describe acoustic, optical sensors and other sensors and their applications.

| Computer Architecture and Organization | | |
|---|---|---|
| **Unit** | **Topic** | **Lectures** |
| I | Introduction to Design Methodology: System Design - System representation, Design Process, the gate level (revision), the register level components and PLD (revision), register level design The Processor Level: Processor level components, Processor level design. | 8 |
| II | Processor basics: CPU organization- Fundamentals, Additional features Data Representation - Basic formats, Fixed point numbers, Floating point numbers. Instruction sets - Formats, Types, Programming considerations. | 8 |
| III | Data path Design: Fixed point arithmetic - Addition and subtraction, Multiplication and Division, Floating point arithmetic, pipelining. | 8 |
| IV | Control Design: basic concepts - introduction, hardwired control, Micro programmed control -introduction, multiplier control unit, CPU control unit, Pipeline control- instruction pipelines, pipeline performance. | 8 |
| V | Memory organization: Multi level memories, Address translation, Memory allocation, Caches - Main features, Address mapping, structure vs performance, System Organization: Communication methods- basic concepts, bus control. Introduction to VHDL. | 8 |

**TextBooks:**

1. John P Hayes "Computer Architecture and Organisation", McGraw Hill Publication.

**Reference Books:**

1. M Morris Mano, "Computer System Architecture", Pearson Publication.
2. Carl Hamacher, Zvonko Vranesic and Safwat Zaky, "Computer Organization and Embedded Systems", McGraw Hill Publication.
3. David A. Patterson and John L. Hennessy, "Computer Organization and Design: The Hardware/Software Interface", Elsevier Publication.
4. I. Singh, Computer Organisation and Architecture, Khanna Publishing House

**Course Outcomes:** At the end of this course students will demonstrate the ability to:

1. Discuss about the basic concepts of system design methodology and processor level design.
2. Explain the basics of processor and basic formats of data representation.
3. Perform fixed and floating point arithmetic operations.
4. Describe the basic concepts of control design and pipeline performance.
5. Explain the architecture and functionality of central processing unit.

| ELECTRICAL MACHINES | | |
|---|---|---|
| **Unit** | **Topic** | **Lectures** |
| I | Basic concept of rotating machines: Elementary machines - synchronous machines, dc machine, generated emf, rotating magnetic field, torque in round rotor machines. Operations of Basic Machine types - synchronous, asynchronous, ac machines, dc machines, matching characteristics of electric machines and load. | 8 |
| II | DC Machine: Introduction, emf equation, torque equation, power balance, linear magnetization, circuit model, generating mode, motoring mode, armature reaction, compensating winding, commutation, method of excitation, characteristics of dc shunt, series and compound motors and generators. Starting of dc motor, speed control of dc motor, breaking of dc motor. | 8 |
| III | Synchronous machines: Introduction of basic synchronous machine model, circuit model of synchronous machine, determination of armature reaction ampere turn and leakage reactance of synchronous machine, synchronizing to infinite bus bar, operating characteristics, power flow equations, parallel operation of synchronous generators, hunting in synchronous machines. | 8 |
| IV | Induction Motor: Introduction, construction, flux and mmf phasor in induction motors, slip and frequency of rotor currents, rotor emf, power, induction motor phasor diagram, torque slip characteristics, determination of equivalent circuit parameters, circle diagram, starting of induction motor, speed control | 8 |
| V | Single Phase Motors: Introduction, types of single phase motor, single phase induction motor, split phase motors, single phase commutator motor, single phase synchronous motor, stepper motor. | 8 |

**Text Book:**


1. DP Kothari & I J Nagrath, "Electric Machines", Tata McGraw Hill Publication.
2. G.C. Garg, Electrical Machines – I, II, Khanna Publishing House, Delhi.


**Reference Book:**


1. Fitzgerald, C. Kingsley and S.Umans , "Electric Machinery", Tata McGraw Hill Publication.
2. P.S. Bimbhra, Electrical Machines, Khanna Book Publishing Co. (P) Ltd., Delhi.


**Course outcomes:**

1. Describe the characteristics, operation of power switching devices and identify their ratings and applications.
2. Recognize the requirement of SCR Protection and describe the Functioning of SCR.
3. Analyze and design Power Converter based on SCR for various Industrial Applications.
4. Explain High Frequency Heating Systems, Timers, Relevant Sensors & Actuator and their application in industrial setting.
5. Explain and apply Data Communication, Telemetry & SCADA System in industrial applications.

| Artificial Neural Network | | |
|---|---|---|
| **Unit** | **Topic** | **Lectures** |
| I | **Introduction to ANN**<br>Features, structure and working of Biological Neural Network Trends in Computing Comparison of BNN and ANN.<br>**Basics of Artificial Neural Networks** -<br>History of neural network research, characteristics of neural networks terminology, models of neuron McCulloch - Pitts model, Perceptron, Ada line model, Basic learning laws, Topology of neural network architecture. | 8 |
| II | **Back propagation networks** : (BPN) Architecture of feed forward network, single layer ANN, multilayer perceptron, back propagation learning, input - hidden and output layer computation, back propagation algorithm, applications, selection of tuning parameters in BPN, Numbers of hidden nodes, learning. | 8 |
| III | **Activation & Synaptic Dynamics** :<br>Introduction, Activation Dynamics models, synaptic Dynamics models, stability and convergence, recall in neural networks.<br>**Basic functional units of ANN for pattern recognition tasks:** Basic feed forward, Basic feedback and basic competitive learning neural network. Pattern association, pattern classification and pattern mapping tasks. | 8 |
| IV | **a)Feedforward neural networks** -<br>- Linear responsibility X-OR problem and solution. - Analysis of pattern mapping networks summary of basic gradient search methods.<br>**b) Feedback neural networks Pattern**<br>Storage networks, stochastic networks and simulated annealing, Boltzmann machine and Boltzmann learning. | 8 |
| V | **Competitive learning neural networks** :<br>Components of CL network pattern clustering and feature. Mapping network, ART networks, Features of ART models, character recognition using ART network.<br>**Applications of ANN**: Pattern classification - Recognition of Olympic games symbols, Recognition of printed Characters. Neocognitron - Recognition of handwritten characters. NET Talk: to convert English text to speech. Recognition of consonant vowel (CV) segments, texture classification and segmentation. | 8 |

**Text Book:**

1. B. Yegnanarayana, "Artificial neural Networks", PHI Publication.

**Reference Books:**

1. S. Raj Sekaran , Vijayalakshmi Pari," Neural networks, Fuzzy logic and Genetic Algorithms", PHI Publication.

2. Elaine Rich and Kevin Knight, "Artificial Intelligence", TMH Publication.
3. Rajiv Chopra, Machine Learning, Khanna Publishing House

**Course Outcome:** After completion of the course student will be able to-

1. Recall the functionality of human brain neurons and design the basic artificial model for neuron.
2. Understand the various learning process for artificial neural model.
3. Construct the artificial neural model for pattern mapping, pattern recognition and pattern classification.
4. Explain feed forward and feedback network for artificial neural network.
5. Summarize the concept of artificial neural network and practical application of ANN.

| Microcontrollers for Embedded Systems | | |
|---|---|---|
| **Sr. No.** | **Topic** | **Lectures** |
| I | Introduction , Microcontrollers and Embedded systems, Overview of the 8051, Inside the 8051, Addressing modes, assembly programming, 8051 data types and directives, Interfacing with 8051, Programming the 8051 timers | 6 |
| II | MSP430x5x series block diagram, address space, on-chip peripherals (analog and digital), and Register sets. Instruction set, instruction formats, and various addressing modes of 16-bit microcontroller; Sample embedded system on MSP430 microcontroller. Memory Mapped Peripherals, programming System registers, I/O pin multiplexing, pull up/down registers, GPIO control. Interrupts and interrupt programming. | |
| III | Watch dog timer, system clocks, Timer & Real Time Clock (RTC), PWM control, timing generation and measurements. Analog interfacing and data acquisition ADC and Comparator in MSP430, data transfer using DMA. | 10 |
| IV | Serial communication basics, Synchronous/Asynchronous interfaces (like UART, USB, SPI, and I2C). UART protocol, I2C protocol, SPI protocol. Implementing and programming UART, I2C, SPI interface using MSP430, Interfacing external devices. | 10 |
| V | Internet of Things (IoT) overview and architecture, Overview of wireless sensor networks and design examples. Various wireless connectivity: NFC, ZigBee, Bluetooth, Bluetooth Low Energy, Wi-Fi. Adding Wi-Fi capability to the Microcontroller, Embedded Wi-Fi, User APIs for Wireless and Networking applications, Building IoT applications using CC3100 user API for connecting sensors. | 6 |

**Text Book:**


1. Mazidi Ali Muhammad, Mazidi Gillispie Janice, and Mc Kinlay Rolin D " The 8051 Microcontroller and Embedded Systems using Assembly and C", Pearson Publication.
3. John H Davies, "MSP430 Microcontroller Basics" Newnes Publication.


**Reference Book:**


1. TI MSP430x5xx and MSP430x6xx Family User's Guide.


**Course Outcomes: At the end of this course students will demonstrate the ability to**

1. Demonstrate the basic architecture of 8085.
2. Illustrate the programming model of microprocessors & write program using 8085 microprocessor.
3. Demonstrate the basics of 8086 Microprocessor and interface different external PeripheralDevices like timer, USART etc. with Microprocessor (8085/8086).
4. Compare Microprocessors & Microcontrollers, and comprehend the architecture of 8051 microcontroller

Illustrate the programming model of 8051 and implement them to design projects on real timeproblems

| DIGITAL MEASUREMENT TECHNIQUES | | |
|---|---|---|
| **Unit** | **Topics** | **Lectures** |
| I | Philosophy of digital measurements.<br><br>Digital Time Measurement Techniques: Measurement of time interval between two events, Error in time interval measurement, Vernier technique for small time measurement, Measurement of time interval with constraints, Measurement of periodic time, phase, Time interval between two events defined by voltage levels, Capacitance, Quality factor of ringing circuit, Decibel meter | 8 |
| II | Digital Frequency Measurement Techniques:<br><br>Measurement of frequency, Ratio of two frequencies, Product of two frequencies, High frequency, average Frequency difference, Deviation of power frequency, Peak frequency. Fast low-frequency measurement. | 6 |
| III | Digitally Programmable Circuits: **Single mode switching, Group mode switching**, Resistors, Potentiometers, Amplifiers, Schmitt trigger, Dual polarity gain amplifiers. Programmable gain amplifier with dual output, Two stage programming, Programmable Biquads. | 9 |
| IV | Digital to Analog Converters: Output Input relation, DACs derived from programmable gain amplifiers, Weighted-resistor DAC, Weighted current DAC, Weighted reference voltage DAC, Ladder DAC, Switches. | 9 |
| V | Digital Voltage Measurement Techniques: Sampling theorem, Time-division multiplexing, Quantization, Indirect type A/D converters, Direct type A/D converters, Input circuitry of a digital voltmeter. | 8 |

**Text Book:**


1. "Digital Measurement Techniques", T. S. Rathore, by Narosa Publishing House, 1996
2. A.K. Maini, All in One Electronics Simplified, Khanna Publishing House, Delhi


**Course Outcomes: At the end of this course students will demonstrate the ability to**

1. Demonstrate the basic architecture of 8085.
2. Illustrate the programming model of microprocessors & write program using 8085 microprocessor.
3. Demonstrate the basics of 8086 Microprocessor and interface different external PeripheralDevices like timer, USART etc. with Microprocessor (8085/8086).
4. Compare Microprocessors & Microcontrollers, and comprehend the architecture of 8051 microcontroller

Illustrate the programming model of 8051 and implement them to design projects on real timeproblems

| CONTROL SYSTEM-I | | |
|---|---|---|
| **Unit** | **Topic** | **Lectures** |
| I | Basic Components of a control system, Feedback and its effect, types of feedback control systems. Block diagrams Reduction and signal flow graphs, Modeling of Physical systems: electrical networks, mechanical systems elements, equations of mechanical systems, sensors and encoders in control systems, DC motors in control systems, Analogous Systems. | 8 |
| II | State-Variable Analysis: Vector matrix representation of state equation, state transition matrix, state-transition equation, relationship between state equations and high-order differential equations, relationship between state equations and transfer functions. Similarity Transformation, Decomposition of transfer functions, Controllability and observability, Eigen Value and Eigen Vector, Diagonalization. | 8 |
| III | Time domain Analysis of Control Systems: Time response of continuous data systems, typical test signals for the time response of control systems, the unit step response and time-domain specifications, Steady-State error, time response of a first order system, transient response of a prototype second order system. | 8 |
| IV | Stability of Linear Control Systems: Bounded-input bounded-output stability continuous data systems, zero-input and asymptotic stability of continuous data systems, Routh Hurwitz criterion. Root-Locus Technique: Introduction, Properties of the Root Loci, Design aspects of the Root Loci. | 8 |
| V | Frequency Domain Analysis: Mr (resonant peak) and ωr (resonant frequency) and bandwidth of the prototype Second order system, effects of adding a zero to the forward path, effects of adding a pole to the forward path, **Polar Plot**, Nyquist stability criterion, relative stability: gain margin and phase margin, stability analysis with the Bode plot. | 8 |

**Text Book:**

1. B.C. Kuo & Farid Golnaraghi, "Automatic Control Systems", 8th Edition, John Wiley India, 2008.

**Reference Books:**

J. Nagrath & M. Gopal, "Control System Engineering", New Age International Publishers

2.2. A. Ambikapathy, Control Systems, Khanna Publishing House, Delhi.

3. Joseph J. Distefano III, Allen R. Stubberud, Ivan J. Williams, "Control Systems" Schaums Outlines Series, 3rdEdition, Tata McGraw Hill, Special Indian Edition 2010.

4. William A. Wolovich, “Automatic Control Systems”, Oxford University Press, 2010.

**Course Outcomes: At the end of this course students will demonstrate the ability to:**

1. Describe the basics of control systems along with different types of feedback and its effect. Additionally they will also be able to explain the techniques such as block diagrams reduction, signal flow graph and modelling of various physical systems along with modellingof DC servomotor.
2. Explain the concept of state variables for the representation of LTI system.
3. Interpret the time domain response analysis for various types of inputs along with the timedomain specifications.
4. Distinguish the concepts of absolute and relative stability for continuous data systems alongwith different methods.
5. Interpret the concept of frequency domain response analysis and their specifications.

## LABORATORY

## MICROCONTROLLERS FOR EMBEDDED SYSTEMS LAB

1. Write a program of Flashing LED connected to port 1 of the 8051 Micro Controller
2. Write a program to generate 10 kHz square wave using 8051.
3. Write a program to show the use of INT0 and INT1 of 8051.
4. Write a program for temperature & to display on intelligent LCD display.
5. Write a program to generate a Ramp waveform using DAC with micro controller.
6. Write a program to Interface GPIO ports in C using MSP430 (blinking LEDs , push buttons)
7. Write a program Interface potentiometer with GPIO.
8. Write a program of PWM based Speed Control of Motor controlled by potentiometer connected to GPIO.
9. Write a program of PWM generation using Timer on MSP430 GPIO.
10. Write a program to Interface an accelerometer.
11. Write a program using USB (Sending data back and forth across a bulk transfer-mode USB connection.)
12. Write a program for Master Slave Communication between 2 MSP430s using SPI
13. Write a program of basic Wi-Fi application – Communication between two MSP430 based sensor nodes.
14. Setting up the CC3100 as a HTTP server.
15. Review of User APIs for TI CC3100 & Initialization and Setting of IP addresses.

## INSTRUMENTATION LAB

List of Experiments:

1. Instrumentation Amplifier: Design for specific gain and verification of CMRR.
2. Realization of PCM signal using ADC and reconstruction using DAC using 4-bit/8bit systems. Observe the Quantization noise in each case.
3. Study of low noise and low frequency amplifier for biomedical application.
4. Design of temperature transmitter using RTD.
5. Design of cold junction compensation circuit.
6. Design of Linearization circuit for thermistor.
7. Design of pressure transmitter.
8. Performance evaluation of pressure gauges using Dead weight tester.
9. Measurement of level using capacitance probe, differential pressure transmitter.
10. Measurement of flow using orifice, electromagnetic and positive displacement flowmeters.

## CONTROL SYSTEM LAB

List of Experiments:

1. Different Toolboxes in MATLAB, Introduction to Control Systems Toolbox or its equivalent open source freeware software like Scilab using Spoken Tutorial MOOCs.
2. Determine transpose, inverse values of given matrix.
3. Plot the pole-zero configuration in s-plane for the given transfer function.
4. Determine the transfer function for given closed loop system in block diagram representation.
5. Plot unit step response of given transfer function and find delay time, rise time, peak time and peak overshoot.
6. Determine the time response of the given system subjected to any arbitrary input.
7. Plot root locus of given transfer function, locate closed loop poles for different values of k. Also find out Wd and Wnat for a given root.
8. Create the state space model of a linear continuous system.
9. Determine the State Space representation of the given transfer function.
10. Plot bode plot of given transfer function. Also determine the relative stability by measuring gain and phase margins.
11. Determine the steady state errors of a given transfer function.
12. Plot Nyquist plot for given transfer function and to discuss closed loop stability. Also determine the relative stability by measuring gain and phase margin.

**Spoken Tutorial (MOOCs):**

Spoken Tutorial MOOCs, ' Course on Scilab', IIT Bombay (http://spoken-tutorial.org/)

## COMMUNICATION LAB

1. With the help of Fourier series,
   i. To construct a triangular wave with the help of Fundamental Frequency and its Harmonic component,
   ii.To construct a Square wave with the help of Fundamental Frequency and its Harmonic component.
2. Amplitude Modulation & Demodulation
   i. To generate amplitude modulated wave and determine the percentage modulation,
   ii.To demodulate the modulated wave using envelope detector.
3. To study DSB-SC and SSB modulation & determine power in side bands.
4. Frequency Modulation & Demodulation
   i. To study frequency modulation and determine its modulation factor
   ii. To demodulate a Frequency Modulated signal using FM detector
5. To study Pulse Amplitude Modulation, Pulse Width Modulation and Pulse Position Modulation.
6. To study and verify the sampling theorem and reconstruction of sampled wave form.
7. Study of Pulse code modulation (PCM) and its demodulation.
8. To verify the operation of Time Division Multiplexing.
9. To study of Amplitude shift keying modulator and demodulator.
10. To study of Frequency shift keying modulator and demodulator.
11. To study of Phase shift keying modulator and demodulator
12. Design and implement a Transmitter and receiver for the corresponding modulation system.

## DEPARTMENTAL ELECTIVE COURSE – 2

| INDUSTRIAL ELECTRONICS | | |
|---|---|---|
| Unit | Topics | Lectures |
| I | **Power Semiconductor Devices**: Power semiconductor devices their symbols and static characteristics and specifications of switches, types of power electronic circuits Operation, steady state & switch characteristics & switching limits of Power Transistor Operation and steady state characteristics of Power MOSFET and IGBT<br>Thyristor – Operation V- I characteristics, two transistor model, methods of turn-on Operation of GTO, MCT and TRIAC. | 8 |
| II | **Phase Controlled Rectifiers:** Phase Angle Control, Single-phase Half-wave Controlled Rectifier (One quadrant), Single-phase Full-wave Controlled Rectifier (Two quadrant Converters),Performance Factors of Line-commutated Converters, The Performance Measures of Two-pulse Converters, Three phase Controlled Converters<br>**Inverters**: Introduction Thyristor Inverter Classification, Series Inverters, Parallel Inverter, Three-phase Bridge Inverters, Three-phase Bridge Inverter with Input-circuit Commutation. | 8 |
| III | **Choppers:** Introduction, Principle of Chopper Operation, Control Strategies, stepup/Down Chopper, Jones Chopper. Introduction to basic Cycloconverters. Control of D.C. Drives: Introduction, Basic Machine Equations, Breaking Modes, Schemes for D.C. Motor Speed Control, Single-phase Separately Excited Drives, Braking Operation of Rectifier Controlled Separately excited Motor, Single-phase Separately Excited Drives, Power Factor Improvement, Three-phase Separately Excited Drives, D.C. Chopper Drives | 8 |
| IV | **Control of A.C. Drives:** Introduction, basic Principle of Operation, Squirrel-cage Rotor Design, Speed Control of Induction Motors, stator Voltage Control, Variable Frequency control, Rotor Resistance Control, Slip Power Recovery Scheme, Synchronous Motor Drives | 8 |
| V | **Protection of device and circuits:** Introduction, Cooling and heat sinks, Thermal Modeling of Power Switching devices, Snubber Circuits, Reverse Recovery Transients, Supply- and Load- side Transients, Voltage Protection, Current Protections, Electromagnetic Interference. | 8 |

**Text Books:**

1. M. H. Rashid, “Power Electronics”, 3rd Edition, Pearson Education.

2. M. D. Singh & K. Khanchandani, “Power Electronics”, Tata McGraw Hill.

**Reference Books:**

1. V.R. Moorthy, “Power Electronics: Devices, Circuits and Industrial Applications”, Oxford University Press,2007.

2. M.S. Jamil Asghar, “Power Electronics”,PHI.

3. Chakrabarti& Rai, “Fundamentals of Power Electronics &Drives”Dhanpat Rai & Sons.

4. Ned Mohan, T.M.Undeland and W.P.Robbins, “Power Electronics:Converters, Applications and Design”, Wiley India.

5. S.N.Singh, “A Text Book of Power Electronics”,Dhanpat Rai & Sons.

**Course Outcomes: At the end of this course students will demonstrate the ability to:**

1. Describe the basics of control systems along with different types of feedback and its effect. Additionally they will also be able to explain the techniques such as block diagrams

reduction, signal flow graph and modelling of various physical systems along with modellingof DC servomotor.

2. Explain the concept of state variables for the representation of LTI system.
3. Interpret the time domain response analysis for various types of inputs along with the timedomain specifications.
4. Distinguish the concepts of absolute and relative stability for continuous data systems alongwith different methods.
5. Interpret the concept of frequency domain response analysis and their specifications.

| OPTO ELECTRONICS | | |
|---|---|---|
| **Unit** | **Topics** | **Lectures** |
| I | Introduction to optical waveguide, Photo sources and detectors: Optical wave guide modes-Theory of Dielectrics lab waveguides-Symmetric and Asymmetric Slab waveguide, Channel waveguide Light emitting diode (LED), materials, constructions, Drive circuitry, Fundamentals of lasers and its applications | 8 |
| II | Electro Optic Effects: Birefringence phenomenon EO Retardation, EO Amplitude and Phase Modulator, Electro optic Intensity Modulators, Beam deflection, Acousto-optics, A-O Modulators, Integrated optic spectrum analyzer. | 8 |
| III | Optical Fiber Sensors: Multi mode fiber Sensors-Displacement, pressure, stress, strain. Intensity modulated sensors, Active multimode FO sensors, Micro-bend optical fiber sensor, Current sensors, Magnetic sensors, Single mode FO sensors, Phase modulated, Polarization modulated, Fibre Optic Gyroscope | 8 |
| IV | Optical detection principles: Absorption Quantum efficiency Responsivity, Long wavelength cutoff, Photon detectors: Photodiodes, PIN photodiode, APD, photomultipliers, Thermal detector: Bolometers and thermisters, Pyroelectric detector | 8 |
| V | Optical Computing: Analog arithmetic operation- addition/subtraction, multiplication, division, averaging, differentiation and integration. Digital logic: modified signed digit number system, residue number system, logarithmic number system. Arithmetic operations: MSD, residue, signed logarithmic arithmetic, threshold logic, threshold devices, spatial light modulators. | 8 |

**Text Books:**

1. J.Wilson and J.Hawkes,“Optoelectronics-AnIntroduction”,PHI.

2. M.A.Karim,“OpticalComputing–Anintroduction”,WileyIndia.

**Reference Books:**

1. A.Yariv, P.Yeh,“Photonics”,6th Ed.,OxfordUniversityPress.

2. Emmanuel Rosencher and BorgeVinter, "Optoelectronics", Cambridge University Press.

3. Optical fiber communications: principles and practice, John. M. Senior

| ANALOG SIGNAL PROCESSING | | |
|---|---|---|
| Unit | Topics | Lectures |
| I | Introduction to domains and the analogue/digital trade off, Introduction to current conveyor, current feedback amplifier. Analog signal filtering: introduction to bilinear transfer functions and active realizations. Second-order filter realization, filter design parameters (Q and $\omega_0$), frequency response, Three op-amp biquad, effect of finite gain of op-amp over filters, Sallen-Key biquad. | 10 |
| II | Ideal low-pass filter, Buttreworth and Chebyshev magnitude response, pole locations, low-pass filter specifications, comparison of Maximally flat and Equal ripple responses. | 8 |
| III | Delay equalization: equalization procedures, equalization with first-order and second order modules, strategies for equalization design. Definition of Bode sensitivity. | 7 |
| IV | The General Impedance Convertor (GIC), optimal design of the GIC, realization of simple ladders, Gorski-Popiel's Embedding Technique, Bruton's FDNR technique, creating negative components. | 8 |
| V | Elementary transconductor building blocks, resistors, integrators, amplifiers, summers, Gyrator, First and second order filters, Higher order filters | **7** |

**Text Book:**


1. R. Schaumann and M.E. Valkenberg,"Design of Analog Circuits", Oxford University Press.
2. A.K. Maini, Analog Circuits, Khanna Publishing House, Delhi.


**Course Outcomes:At the end of this course students will demonstrate the ability to:**

1. Explain the basic learning of Optical waveguides, photo source and detectors.
2. Demonstrate the concept of Electro Optic effects.
3. Analyze the working of optical fiber sensor.
4. Interpret the basics of optical detection principles
5. Express the basics of optical computing.

| COMMUNICATION ENGINEERING | | |
|---|---|---|
| **Unit** | **Topic** | **Lectures** |
| I | Amplitude modulation: The Communication Process, Modulation Process, The Layered Approach, Example of communication Amplitude Modulation: Introduction, Amplitude modulation, Double Sideband-Suppressed Carrier modulation, Quadrature-Carrier Multiplexing, Single-Sideband and Vestigial Sideband Methods of modulation, Introduction to Multiplexing, Frequency Translation, Frequency- Division Multiplexing | 9 |
| II | Phase and Frequency Modulation: Introduction, Basic Definitions, Frequency Modulation Phase Modulation , Phase Locked Loop, Foster Seeley Detector , Ratio Detector, Nonlinear Effects in FM Systems, The Super-heterodyne Receiver | 6 |
| III | Noise in analog modulation & digital representation of analog signals: Introduction, white noise ,power spectral densities, Noise in DSB-SC Receivers, Noise in AM receivers, Noise in FM Receivers, Pre-emphasis and De-emphasis in FM Digital Representation of Analog Signals: Introduction, Digitization of Analog Sources, The Sampling Process, The Quantization Process, Pulse-Amplitude Modulation, Pulse-Position Modulation, Pulse-Code Modulation, Delta Modulation, Time-Division Multiplexing, Comparison of Frequency Division Multiplexing & Time-Division Multiplexing | 10 |
| IV | Baseband Transmission of digital Signals: Introduction, Baseband Pulses and matched Filter Detection, Line Coding Techniques: NRZ, RZ and Manchester ,Probability Of Error Due to Noise, Inter symbol Interference, Eye Pattern, NyquistCriterion for Distortion less Transmission, Baseband M-ary PAM Transmission, Tapped Delay Line Equalization. | 6 |
| V | Band-pass transmission of digital signals & information and forward error correction: Introduction, band-Pass Transmission Model, Transmission Binary ASK ,PSK and FSK, Orthogonal Frequency Division Multiplexing (OFDM), Information and Forward Error Correction: Introduction, Uncertainty, Information and Entropy, Information rate, Channel capacity, Source-Coding Theorem, Lossless Data Compression, Discrete memory less channel | 9 |

**Text Books:**


1. Simon Haykin& Michael Moher, “Communication Systems”, 5 thEdition, Wiley India.
2. Herbert Taub and Donald L. Schilling, “Principles of Communication Systems”, Tata McGraw Hill.
3. Rishabh Anand, Communication Systems, Khanna Publishing House, Delhi.


**Reference Books:**


1. B.P. Lathi&ZhiDing, “Modern Digital and Analog Communication Systems”, International 4thEdition, Oxford University Press.
2. R.P. Singh and Sapre, “Communication Systems:Analog and Digital”,3rd Edition ,McGraw Hill.
3. H.P.HSU & D.Mitra,“Analog and Digital communication” ,2nd Edition ,Tata McGraw Hill.


**Course Outcomes: At the end of this course students will demonstrate the ability to:**

1. Identify the issues and challenges in the architecture of a network.
2. Analyze the services and features of various protocol layers in data layer.
3. Demonstrate the knowledge of multiple access to design a access technique for a

particular application.

4. Realize protocols at different layers of a network hierarchy.
5. Recognize security issues in a network and various application of application layer.

4.