Fourth Semester					
Theory					
Sl. No.	**Category**	**Subject Code**	**Subject Name**	**L-T-P**	**Credit**
1	HSMC	19CM4HS01T/ 19CM4HS02T	**Humanities-I** Organizational Behavior/ **Management-I** Engineering Economics & Costing	3-0-0	3
2	ESC	19EC4ES01T	Digital Electronic Circuits	3-0-0	3
3	PCC	19EC4PC01T	**PCC-3:** Network Theory	3-0-0	3
4	PCC	19EC4PC02T	**PCC-4:** Electromagnetic Theory	3-0-0	3
5	PCC	19EC4PC03T	**PCC-5:** Microprocessor & Application	3-0-0	3
6	PEC	19EC4PE01T/ 19EC4PE02T/ 19EC4PE03T/	**Professional Elective-1:** Sensor and Transducer / Semiconductor Devices / Probabilistic Theory & Stochastic Process	3-0-0	3
Total Credit (Theory)					**18**
Practical					
1	ESC	19EC4ES01L	Digital Electronic Circuits Lab	0-0-2	1
2	PCC	19EC4PC01L	**PCC Lab-3:** Network Theory Lab	0-0-2	1
3	PCC	19EC4PC02L	**PCC Lab-4:** Microprocessor & Application Lab	0-0-2	1
4	PDL	19EC4PD01L	Product Development Lab	0-0-2	1
Total Credit (Practical)					**4**
Total Semester Credit					**22**

Subject Code:	Subject Name:	L-T-P:	Credit:
19CM3HS01T	Organizational Behaviour	3-0-0	3

COURSE OBJECTIVES:

1. Developing an understanding of the behaviour of individuals and groups inside organizations by enhancing the skills in appreciating individuals, interpersonal, and group effectiveness.
2. Through this course students will develop theoretical and practical insights and problem-solving capabilities for effectively managing the organizational processes.
3. The course will enable to equip students to understand the organizational change and cultural expansion in an organization context.

SYLLABUS:

Module-1 **(6 Hours)**

Fundamentals of OB:

Definition, scope and importance of OB, Relationship between OB and the individual, Evolution of OB, Models of OB. Learning; Theories and their applications

Module-2 **(12 Hours)**

Foundations of Individual Behavior:

Personality and values : Definition and importance of Personality for performance, The Myers-Briggs Type Indicator and The Big Five personality model, Significant personality traits suitable to the workplace (personality and job – fit theory), Personality Tests and their practical applications. Attitude; ABC Model. Perception: Meaning and concept of perception, Factors influencing perception, Selective perception, Perceptual errors.

Motivation: Definition & Concept of Motive & Motivation, The Content Theories of Motivation (Maslow's Need Hierarchy & Herzberg's Two Factor model Theory), The Process Theories (Vroom's expectancy Theory & Porter Lawler model), Contemporary Theories – Equity Theory of Work Motivation.

Module-3 **(8 Hours)**

Foundations of Group Behavior:

Group Dynamics, Types of Groups, The Five – Stage Model of Group Development. Developing Work Teams, Team Effectiveness & Team Building.

Leadership:

Concept, Types & Styles of Leadership, Traditional & Contemporary theories of leadership Success stories of today's Global and Indian leaders.

Module- 4 **(10 Hours)**

Foundations of Organizational Behavior:

Organizational Culture; creating and maintenance. Organizational Change; concept and technique and theories of change. Organizational Development; concept and methods of doing development.

COURSE OUTCOMES:

1. Students will understand the essential of maintaining the inter-personal relationships in organizations.
2. Personality factors will be effectively used to understand the communication among groups.
3. The reasons for conflict will be known and prescriptive methods can be devised to enhance higher productivity in organizations.
4. Being an employee in an organization the importance of organizational change and culture can be known to all.

TEXT BOOK:

1. Robbins, Judge, Sanghi, *Organizational Behaviour*, 9th Edition, Pearson,2019

REFERENCE BOOKS:

1. K. Awathappa, *Organizational Behaviour*, 11th Revised Edition , Himalaya Publishing House, 2013
2. VSP Rao, *Organizational Behaviour*, 4th Edition,Excel,2009
3. Moorhead, Griffin, *Introduction to Organizational Behaviour*, 11th Edition, Cengage, 2014

4. Parek ,*Understanding Organizational Behaviour*, 4th Edition, Oxford,2016

DIGITAL LEARNING RESOURCES:

Course Name	Organizational Behaviour
Course Link	https://epgp.inflibnet.ac.in/Home/ViewSubject
Course Instructor	

Subject Code:	Subject Name:	L-T-P:	Credit:
19CM3HS02T	Engineering Economics & Costing	3- 0- 0	3

COURSE OBJECTIVES:

1. Aware the students about general economic conditions of a country, and how engineers can benefit from this study of demand, supply and other micro-economic studies.
2. The objective is to study various factors of production, laws of production in short-run as well as in long-run, and the behavior of cost curves with regard to output.
3. The course helps engineers determine price of a commodity, and also let them know the production level at which a firm would break even.
4. The course will help engineers know about financial system of our country including the banking system and its operation.
5. This course will enable engineers to take crucial investment decisions using some financial tools and techniques.
6. This course helps engineers deal with public projects. It also helps in determining depreciation of long-term assets and its impact on firm's profitability

SYLLABUS:

Module-1 **(8 Hour)**

Introduction to Economics:

Definition, scope and nature of economics, consumption laws, demand & supply analysis, elasticity of demand & supply, indifference curve analysis.

Module-2 **(10 Hours)**

Production:

Factors of production, production function, law of variable proportion, laws of return to scale, elasticity of factor-substitution, optimal combination of factor-inputs, production efficiency, economies of scales, Cost of Production: types of costs, economic costs: fixed cost and variable costs, short-run and long-run cost functions.

Module-3 **(10 Hours)**

Market Structure:

Pure competition, perfect competition, imperfect market, monopoly and oligopoly. Indian Banking System, Functions and Roles of Commercial Banks and Reserve Bank of India.

Module-4: **(12 Hours)**

Time value of money and interest formulae, Nominal and effective rate of interest, Present, Annual and Future worth analysis, Rate of Return Analysis, Cost-Benefit analysis in Public sector projects.

Module-5: (as per choice of faculty) **(8 Hours)**

Portion covered can be tested through Internal evaluation only not to be included in University examination.

COURSE OUTCOMES:

1. Study of micro-economics concepts like demand, supply and their elasticity shall help engineers apply those concepts in socio-economic problems.
2. Study of Short-run production functions, Long-run production functions, and Scale economies and scale diseconomies would help engineers know how to start business and what is optimum plant size.
3. Determination of equilibrium price and change in it, break-even analysis would help engineers set right price of products as well as know when to start making profit.
4. Study of Money market, Capital market, Functions of banks including RBI, Inflation, and GDP etc. would help engineers know about country's economy and operation of various entities**.**
5. Study of various financial tools like PW, FW, EAW, and IRR methods and their comparison would help engineers take appropriate financial decisions.
6. Use of B/C Ratio to deal with public projects, methods of calculating depreciation, and after-tax economic evaluations would help engineers prepare financial statements of businesses and to deal with public utility projects.

TEXT BOOK:

1. Deviga Vengedasalam, and Karunagaran Madhavan, *Principles of Economics*, Oxford Publications
2. Riggs, Bedworth and Randhawa, *Engineering Economics*, McGraw Hill Education, India

REFERENCE BOOKS:

1. Sasmita Mishra, *Engineering Economics & Costing*, Prentice Hall of India

2. Sullivan and Wicks, *Engineering Economics*, Pearson
3. D.M. Mithani, *Principles of Economics*, Himalaya Publishing House

DIGITAL LEARNING RESOURCES:

Course Name	Economics, Management and Entrepreneurship
Course Link	https://nptel.ac.in/courses/110/105/110105067/
Course Instructor	Prof. Pratap K. J. Mohapatra, IIT Kharagpur

Subject Code:	Subject Name:	L-T-P:	Credit:
19EC4ES01T	Digital Electronic Circuits	3- 0- 0	3

COURSE OBJECTIVES:

1. To provide insight about the requirement of designing low cost and high speed Digital systems.
2. To gain inclusive knowledge about combinational and sequential logic blocks.
3. To get the idea of designing complex digital circuits.
4. To understand the different types of memory and their working principles.
5. To familiarize with various technologies used for Integrated Circuit design.

SYLLABUS:

Module-1 **(6 Hours)**

Digital Fundamentals and Binary Codes:

Introduction to Digital System, Binary Data Representation, Codes: BCD, Excess-3, Gray Code, One-Hot Code, ASCII Code, Logic Levels, Logic gates, Boolean Operators and Expressions.

Simplification of Boolean Functions:

Representation of min-terms and max-terms, Simplification of Boolean Functions using K-Map up to 5 variables, K-Map with don't care inputs.

Function Implementations: AND-OR, OR-AND, NAND-NAND, NOR-NOR, AOI, OAI.

Module-2 **(8 Hours)**

Arithmetic Circuits:

Introduction to Combinational Circuit, Half Adder, Full Adder, Half Subtractor, Full Subtractor, Adder-Subtractor, Binary Parallel Adder, BCD Adder, CLA Adder, Multiplier, Square circuit, Magnitude Comparator.

Combinational Circuits:

Gray –to- Binary and Binary –to- Gray Code Converter, Encoder, Priority encoder, Decoder, Cascading of Decoders, Multiplexer, Cascading of Multiplexer, Function Implementations using Multiplexer, De-Multiplexer, Decoder.

Module-3 **(6 Hours)**

Sequential Components:

Latches, Flip-Flops, Analysis of Flip-Flops: Functional Table, Characteristic Table, Characteristic Equation, State Diagram, Excitation Table, Timing Diagram, Positive-Edge-Triggered D Flip-Flop, Master-Slave JK-FF, Flip-Flop conversions.

Module-4 **(10 Hours)**

Sequential Circuits:

Design Procedure, Counter: Asynchronous and Synchronous Counter, **Shift Registers:** Shift of Binary Bits, SISO, SIPO, PISO, PIPO, Ring Counter, Johnson Counter, Design and Analysis of Clocked Sequential Circuits, FSM Fundamentals: Melay and Moore Machines.

Module-5 **(6 Hours)**

Memory Blocks:

Types of Memory, Memory Decoding, Read-Only Memory (ROM), Random Access Memory (RAM). Logic Families: Characteristics of DTL, RTL, TTL and CMOS Logic.

COURSE OUTCOMES:

1. Acquire basic knowledge about binary codes and the simplification of logic function using Boolean laws and mapping methods.
2. Understand the behavior of combinational and sequential circuits and use them for development of complex digital systems.
3. Acquire fundamental knowledge about the operation of memory and their application towards synchronous circuits.
4. Illustrate the operation of different logic families and their application in designing integrated circuits for serving the mankind in day to day life.

TEXT BOOKS:

1. M. Morris Mano, Michael D Ciletti, *Digital Design*, 5th Edition, Pearson Publication, 2016, New Delhi.

REFERENCE BOOKS:

1. Donald P Leach, Albert Paul Malvino, Goutam Saha , *Digital Principles And Applications*, 8th Edition ,Tata McGraw Hill Education, 2015, New Delhi.
2. A Anand Kumar, *Fundamentals of digital circuits*, 4th edition, PHI, 2016, New Delhi.
3. T.L. Floyd and R.P. Jain, *Digital Fundamentals*, 7th Edition, Pearson Education, 2005, Bangalore.
4. Norman Balabanian & Bradley Carlson, *Digital Logic Design Principles*, 2nd edition, John Wiley & Sons, 2004, New York.

DIGITAL LEARNING RESOURCES:

Course Name	Digital Circuits and Systems
Course Link	https://nptel.ac.in/courses/117/106/117106086/
Course Instructor	Prof. S. Srinivasan Department of Electrical Engineering, IIT Madras

Subject Code:	Subject Name:	L-T-P:	Credit:
19EC4PC01T	Network Theory	3- 0- 0	3

COURSE OBJECTIVES:

1. To understand Coupled Circuits, Network Topology and Resonance.
2. To analyze transients in Electrical systems using Laplace transforms and harmonic analysis of electrical system by using Fourier series and Fourier Transforms.
3. To evaluate Network parameters of given Electrical network
4. To design basic filter configurations and Construction of electrical network using network synthesis

SYLLABUS:

Module-1 **(6 Hours)**

Network Theorems and Network Topology :

Network Theorems: (AC Circuits only)

Superposition theorem, Reciprocity Theorem, Thevenin's theorem, Norton's Theorem, and Maximum Power transfer theorem, Tellegen's theorem, Millman's theorem, Compensation theorem. Concept of duality, and dual networks.

Network Topology:

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

Module-2 **(8 Hours)**

Solution of Electrical Networks, Frequency response and Magnetically Coupled Circuit:

Time Domain analysis of RL, RC, RLC circuits, concept of damping, series resonance and parallel resentence, Concept of bandwidth, Q factor, selectivity

Magnetically 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.

Module-3 **(6 Hours)**

Electrical Circuit Analysis Using Laplace Transforms:

Transient analysis of electrical circuits using Laplace Transforms: 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.

Module–4 **(10 Hours)**

Two Port Network and Network Functions:

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.

Network functions: Significance of Poles and Zeros, Restriction on location of Poles and Zeros, Time domain behavior from Pole-Zero plots.

Module-5 **(6 Hours)**

Network Synthesis:

Network Synthesis: Realizability concept, Hurwitz property, Positive realness, and properties of positive real functions. Synthesis of R-L, R-C and L-C driving point functions in Foster and Cauer forms.

COURSE OUTCOMES:

At the end of this course, students will demonstrate the ability to

1. Apply network theorems for the analysis of electrical circuits.
2. Obtain the transient and steady-state response of electrical circuits.
3. Analyze two port circuit behavior and also analyze the harmonics with their amplitude and frequency spectrum of electrical system.

4. Design the filter circuit and construct the electrical systems by using synthesis methods.

TEXT BOOK:

1. Alexander & Sadiku, *Fundamentals of Electric Circuits*, 5th Edition, Tata McGraw Hill, 2012, India.
2. W. H. Hayt and J. E. Kemmerly, *Engineering Circuit Analysis*, 8th Edition, McGraw Hill Education, 2013, India.
3. M E Van Valkenburg, *Network Analysis and Synthesis,* 3rd Edition, Pearson Education, 1980, India.

REFERENCE BOOK:

1. S P Ghosh and A K Chakraborty, *Network Analysis and Synthesis,* 1st Edition, Tata McGraw Hill, 2009, New Delhi.
2. Ravish R Singh, *Network Analysis And Synthesis*, 2nd edition,,Mc Graw Hill Education,2013, New Delhi.
3. Joseph A. Edminister, MahmoodMaqvi, *Theory and problem of electrical circuits*, Schaum's Outline Series, 6th Edition, Tata McGraw Hill, 2014, New Delhi.
4. Abhijit Chakrabarthi , Circuit Theory (Analysis and Synthesis), 7th Revised Edition, Dhanapatarai & Co. (P) LTD. Educational & Technical publishers, 2018, New Delhi.

DIGITAL LEARNING RESOURCES:

Course Name	Network Analysis
Course Link	https://nptel.ac.in/courses/108/105/108105159/
Course Instructor	Prof. Tapas Kumar Bhattacharya, Department of Electrical and Electronics Engineering, IIT Kharagpur

Subject Code:	Subject Name:	L-T-P:	Credit:
19EC4PC02T	Electromagnetic Theory	3- 0- 0	3

COURSE OBJECTIVE:

1. To impart knowledge on Diasporas of Maxwell's equations in both static and time varying field.
2. Introduce wave propagation in different medium and its governing law.
3. To impart knowledge on response of EM field during interaction with different boundary along with different polarization.
4. To elucidate Telegraph equations to solve impedance mismatching by smith chart as well as solution of waveguide through the knowledge of Maxwell's equations.

SYLLABUS:

Module-1 **(13 Hours)**

Review of Maxwell's equations for static field:

Maxwell's equations for static field in differential and integral form, Boundary conditions for electrostatics and magnetostatics.

Maxwell's equations for time varying field:

Faraday's Law, Transformer and Motional EMFs, Displacement Current, Maxwell's Equations in Final Forms, Time-Varying Potentials, Time-Harmonic Fields

Module-2 **(6 Hours)**

Electromagnetic Wave Propagation:

Waves in General, Wave Propagation in Lossy Dielectrics, Plane Waves in Lossless Dielectrics, Plane Waves in Free Space, plane Waves in Good Conductors, Power and the Poynting Vector.

Module-3 **(6 Hours)**

EM Wave: Reflection and Refraction:

Polarization of Electromagnetic waves (Linear, Elliptical and Circular), Reflection of a plane wave at Normal incidence and Oblique incidence, Brewster's Angle.

Module-4: **(6 Hours)**

Transmission line & Analysis:

The lumped-element circuit model for transmission line, Telegraph equation, Lossless line and distortion less line, Terminated lossless transmission line, Smith chart, Quarter-wave transformer.

Module-5: **(7 Hours)**

Wave Guide:

Transverse Electric wave propagation in Rectangular Waveguide, Transverse Magnetic wave propagation in Rectangular Waveguide, Impossibility of TEM mode in rectangular waveguide, Rectangular Cavity Resonator.

COURSE OUTCOME:

1. Able to state several laws related to EM fields and apply the vector calculates to describe electromagnetic phenomena.
2. Ableto visualize and evaluate wave in spacio domain as well as formulate and solve realistic problems on wave propagation in different medium.
3. Able to apply the knowledge of reflection and the refraction of EM waves to understand the utilization of waves in medical application as well as wireless connection under shading.
4. Able to apply the Telegraph Equations to design simple distributed circuit components and calculate transmission line parameters withimpedance measurement using smith chart as well as understand the concept of EM energy transportation through guided device.

TEXT BOOK:

1. Matthew. N.O. Sadiku & Kulkarani, *Principles of Electromagnetics*, 6th Edition, Oxford University Press, First Indian Edition 2015, New Delhi.
2. D. M. Pozar, *Microwave Engineering*, 4th Edition, John Wiley & Sons, Inc. 2012, USA
3. William H. Hayt Jr. and John A Buck, *Engineering Electromagnetics*, 8th Edition, Tata McGraw Hill, 2012, New Delhi.

REFERENCE BOOKS:

1. L. D. Landau, E. M. Lifshitz, Lev, *The Classical Theory of Fields*, 4th Edition, Butterworth-Heinemann, 2003, London.
2. Allen Taflove, Susan C. Hagness, *Computational Electrodynamics: The Finite-Difference Time-Domain Method*, 3rd Edition, Artech House, 2005, London
3. J.A.Edminister, Mahmood Nahvi, *Schaum's Outlines of Electromagnetics*, 4th Edition, (Schaum's Outlineseries), Tata McGraw hill, 2014, New Delhi.
4. J. D Kraus and Daniel Fleisch, *Electromagenetics with Applications*, 5th Edition, McGraw Hill International Editions, 2010, New Delhi.
5. Bhag Singh Guru and Huseyin R. Hiziroglu, *Electromagnetic Field Theory Fundamentals*, 4th Revised Edition, Cambridge University Press 2014, UK.

DIGITAL LEARNING RESOURCES:

Course Name	**Electro Magnetic Theory**
Course Link	https://nptel.ac.in/courses/115/104/115104088/
Course Instructor	Prof. Manoj Harbola, Dept. of Physics, IIT Kanpur

Course Name	**Electro Magnetic Theory**
Course Link	https://nptel.ac.in/courses/115/101/115101005/
Course Instructor	Prof. D. K Ghosh, Dept. of Physics, IIT Bombay

Subject Code:	Subject Name:	L-T-P:	Credit:
19EC4PC03T	Microprocessor & Application	3- 0- 0	3

COURSE OBJECTIVE:

1. Understand the main components and working principle of the Intel 8086 microprocessor.
2. Understand the Memory organization, interfacing and the interrupt concept of 16-bit microprocessor
3. Program and debug in assembly language program
4. Understand the properties and interfacing of the I/O devices using programmable interfacing devices.
5. Understand the basic components and working principle of the Intel 32-bit processor 80386.

SYLLABUS:

Module-1 **(10 Hour)**

8086 Microprocessor:

Introduction: Overview of Microcomputer organization

Intel 8086 Microprocessor: Introduction, 8086 Programmer's model: Register organization, **Hardware Architecture**: Bus interface unit (BIU), Execution unit (EU), Pipelined operation, physical address generation and Memory segmentation.

8086 Pin description: Common, Minimum and maximum mode Pin and Signals, Bus cycle and System configuration.

Module-2 **(6 Hours)**

8086 Memory Interfacing and Interrupt technique

8086 Memory Interfacing: External Memory addressing, EPROM and RAM interface with 8086.

8086 Interrupt: Interrupt Processing, sources of interrupt in 8086, Interrupt Instructions, Interrupt types, IVT, Hardware Interrupts and Interrupt priorities.

Module-3 **(6 Hours)**

8086 Instruction set and programming

8086 Addressing modes, Instruction sets, Assembler directives and programming

Module-4 **(12 Hours)**

Peripheral interfacing

Introduction to basic I/O interface, I/O interfacing techniques in 8086

Interfacing devices: 8255 PPI, 8254 Timer, 8251 USART, ADC-0808/0809, DAC-0800 interfacing using PPI.

Module-5 **(8 Hours)**

32-bit Microprocessor 80386

Salient features of 80386, Architecture and Signal Description of 80386. Register Organization of 80386, Hardware Memory organization 80386 Memory management: Real mode, Segment translation, protected mode, Memory paging mechanism and Virtual 8086 Mode.

COURSE OUTCOME:

On Completion of this Subject/ Course the students should be able to:

1. Gain deep knowledge on 8086 microprocessor architecture and pin and signals and demonstrate the memory interfacing and illustrate the use of interrupts.
2. Indentify the addressing modes and illustrate the different classification and functions of 8086 microprocessor instructions and apply the knowledge in assembly language programming.
3. Illustrate the design aspect of I/O interface and Design and development of interfacing various I/O devices using programmable peripheral devices with the 8086 microprocessor.
4. Study and understand the architecture and memory management system of 80386 advanced microprocessors.

TEXT BOOK:

1. A. K. Ray and K. M. Bhurchandi, *Advanced Microprocessors and Peripherals*, 3rd Edition, Tata McGrawHill, 2015, New Delhi.
2. Walter A Triebel and Avtar Singh, *The 8088 and 8086 Microprocessors, Programming, Interfacing, Software, Hardware and Applications*, 4th Edition, Pearson Education, 2007, Noida.

REFERENCE BOOKS:

1. Barry B. Brey, The Intel Microprocessors, Architecture, Programming and Interfacing, 8th Edition, Pearson Education, 2009, Noida.
2. Doughlas. V. Hall, Microprocessor and Interfacing: Programming and Hardware, 3rd Edition, McGraw Hill, 2012, New Delhi.
3. Yu-Cheng liu and Glenn A. Gibson, Microcomputer Systems: The 8086/8088 Family Architecture, Programming & Design, 2nd Edition, Prentice Hall of India, 2007, New Delhi.

DIGITAL LEARNING RESOURCES:

Course Name	Microprocessors and Microcontrollers
Course Link	https://nptel.ac.in/courses/108/105/108105102/
Course Instructor	Prof. Santanu Chattopadhyay, Department of Electronics and Electrical Communication Engineering, IIT Kharagpur

Course Name	Microprocessors and interfacing
Course Link	https://nptel.ac.in/courses/108/103/108103157/
Course Instructor	Prof. Shaik Rafi Ahamed, Department of electrical and electronics engineering, IIT Guwahati

Subject Code:	Subject Name:	L-T-P:	Credit:
19EC4PE01T	Sensor and Transducers	3- 0- 0	3

COURSE OBJECTIVE:

1. Should be able to mathematically analyze instruments up to first and second order. Also should have understanding of Static and dynamic characteristic's of instruments.
2. Should have knowledge of working principle and characteristic's of major industrial sensor's likes strain gauge, Thermocouple, RTD and Thermistor etc.
3. Should be able to formulate suitable signal conditioning circuits of various sensors.
4. Should have the idea of smart sensors and how it could be used as a transmitter.

SYLLABUS:

Module–1 **(Hours)**

Elements of a general measurement system:

Measurement system, Static Characteristics: systematic characteristics, statistical characteristics, calibration; Dynamic characteristics of measurement systems: transfer functions of typical sensing elements, step and frequency response of first and second order elements, and dynamic error in measurement systems.

Module–2 **(Hours)**

Accuracy and Errors in measurement system:

Measurement error of a system of ideal elements, the error probability density function of a system of non-ideal elements and error reduction techniques.

Loading Effects and Two-port Networks: Electrical loading: Thevenin and Norton equivalent circuit and Two-port networks.

Signals and Noise in Measurement Systems: Introduction, Statistical representation of random signals, Effects of noise and interference on measurement circuits, Noise sources and coupling mechanisms and Methods of reducing effects of noise and interference.

Module–3 **(Hours)**

Sensing elements:

Resistive sensing elements: potentiometers, Resistance Temperature Detector (RTD), thermistors, strain gages. Capacitive sensing elements: variable separation, area and dielectric; Inductive sensing elements: variable reluctance and LVDT displacement sensors. Electromagnetic sensing elements: velocity sensors

Module-4 **(Hours)**

Thermoelectric sensing elements: laws, thermocouple characteristics, installation problems, cold junction compensation.

Elastic sensing elements: Bourdon tube, bellows, and diaphragms for pressure sensing, force and torque measurement.

Piezoelectric sensing elements: Piezoresistive sensing elements and Electrochemical sensing elements

Module–5 **(Hours)**

Signal Conditioning Elements:

Deflection bridges: design of resistive and reactive bridges, push-pull configuration for improvement of linearity and sensitivity Amplifiers: Instrumentation amplifier and filters. A.C. carrier systems and current transmitters and IC temperature sensor.

COURSE OUTCOME:

1. Use transient analysis knowledge from basic control system course to understand the response of first order and second order instruments.
2. Should know what calibration is and static and dynamic characteristics.
3. Mathematically formulate every dynamics of sensor and identify its characteristics, drawbacks and compensations.
4. Should be able to analyze instrumentation amplifier, design and select suitable resistive and reactive bridges and understand the idea of an AC carrier system and also architecture of a transmitter.

TEXT BOOK:

1. J. P. Bentley, *Principles of Measurement Systems,* 3rd Edition, Pearson Education, 2007, New Delhi.
2. E. O. Doeblin, *Measurement Systems Application and Design,* 4th Edition, McGraw-Hill, 1990, New York.

REFERENCE BOOK:

1. Arun. K. Ghosh, *Introduction to Measurements and Instrumentation,* 4th Edition, PHI, 2012, New Delhi.
2. J. W. Dally, W. F. Riley and K. G. McConnel, *Instrumentation for Engineering Measurements,* 2nd Edition, John Wiley, 2003, New York.
3. T. R. Padmanabhan, *Industrial Instrumentation Principles and Design,* 1st Edition, Springer, 2000, London.

DIGITAL LEARNING RESOURCES:

Course Name	Sensor and Transducers/Industrial Instrumentation
Course Link	https://nptel.ac.in/courses/108/105/108105064/#
Course Instructor	Prof. Alok Barua, Department of Electrical Engineering, IIT Kharagpur

Subject Code:	Subject Name:	L-T-P:	Credit:
19EC4PE02T	Semiconductor Devices	3-0-0	3

COURSE OBJECTIVE:

1. To enhance comprehension capabilities of students through understanding the formation of energy band diagram and physics for intrinsic, extrinsic and compensated materials.
2. To study the drift and diffusion current densities due to carrier transport in semiconductors
3. To understand and analyze the physics of depletion under biasing conditions and junction breakdown of PN junction
4. To apply the previous acquired knowledge for analyzing the operation and performance of BJT, MOSFET, JFET etc.

SYLLABUS:

Module-1 **(8 Hours)**

Basics of Semiconductor and Energy bands:

Formation of energy bands, Metals, Semiconductors, & Insulators, k-space, Density of State, Thermal equilibrium, F-D distribution, Fermi Energy, Electron and hole concentration of Intrinsic and Extrinsic Semiconductors, Variation of Fermi level with doping concentration and temperature, Compensated semiconductor.

Module-2 **(8 Hours)**

Carrier Transport in Semiconductors:

Carrier Concentration and Mobility, diffusion and drift of carriers, Einstein relation, continuity equation, Injected minority carrier charge, Recombination and generation of charge carriers.

Module-3 **(10 Hours)**

P- N Junction:

Basic device technologies for fabrication of a p-n junction, Energy band diagram, Built-in potential, Depletion layer model: charge, field and potential profiles in p-n junctions, current flow at biased P-N junctions, diode equation and diode characteristics, temperature dependence,

Capacitance of p-n junction diode, Junction Breakdown, Metal–Semiconductor junction (Schottky and Ohmic contact).

Module-4 **(8 Hours)**

Bipolar Junction Transistor:

Introduction, Modes of operation; Minority Carrier distribution, Collector current, Base current, current gain factors, Base width Modulation, Breakdown mechanism, Equivalent Circuit Models: Ebers -Moll Model.

Module-5 **(6 Hours)**

MOSFET:

MOS structure, MOS capacitor operation with band diagram, Flatband and threshold voltage, Frequency effect, Fixed oxide and interface charge effect, Basic operation of Enhancement & Depletion mode MOSFET, IV characteristics.

COURSE OUTCOME:

1. Impart knowledge in physical properties of semiconducting materials that affects the operation of semiconductor devices
2. A solid understanding of the operating principles of conventional/advanced semiconductor devices
3. Apply the knowledge of mathematics and engineering to solving practical problems to develop semiconductor devices
4. Acquire fundamental knowledge about VLSI designing and semiconductor device fabrication

TEXT BOOK:

1. Donald A. Neamen, *Semiconductor Physics and Devices*, 3rd Edition, Tata McGraw Hill Publishing Company Limited, 2003, New Delhi.
2. Ben. G. Streetman and Sanjay Banarjee, *Solid State Electronics Devices*, 6th Edition, Pearson Education, 2010, New Delhi.

REFERENCE BOOK:

1. Dillip K. Roy, *Physics of Semiconductor Devices*, 2nd Edition, University Press (India) Pvt. Ltd., 2004, Hyderabad.

2. S.M. Sze and Kwok K. Ng, *Physics of Semiconductor Devices*, 3rd Edition, Wiley India Pvt. Limited, 2006, New Delhi.

DIGITAL LEARNING RESOURCES:

Course Name	Solid State Devices
Course Link	https://nptel.ac.in/courses/117/106/117106091/
Course Instructor	Prof. S. Karmalkar, Department of Electrical Engineering, IIT Madras

Subject Code:	Subject Name:	L-T-P:	Credit:
19EC4PE03T	Probabilistic Theory & Stochastic Process	3- 0- 0	3

COURSE OBJECTIVES:

The objective of this course is:

1. To introduce fundamental probability concepts.
2. How to deal with multiple random variables? Conditional probability and Conditional expectation, joint distribution and independence, mean square estimation
3. To provide necessary basic concepts in probability and random processes for applications such as random signals, linear systems etc in communication engineering

SYLLABUS:

Module-1 **(6 Hours)**

Probability: Various definitions of probability, The Axioms of probability, basic properties derived from the axioms, conditional probability, total probability and Bayes' Theorem, Independence of events, Repeated Trials: combined experiments and independence

Module-2 **(8 Hours)**

Random variables:

Distribution functions, Density functions, specific random variables: examples of continuous, discrete and mixed random variables, Conditional distribution and density functions, Expectation, variance, moments of random variable, Moment generating functions, Transformation of a random variable

Module-3 **(8 Hours)**

Multiple random variables:

Vector random variables, Joint distribution function and its properties, Joint density and its properties, marginal density functions, Independence of random variables, distribution and density of a sum of random variables, Central limit theorem.

Module-4 **(8 Hours)**

Random processes:

Random process: classification, Stationary and independence- wide-sense stationary, strict-sense stationary, autocorrelation function, cross-correlation function, covariance functions, Gaussian random processes, complex random processes.

Module-5 **(6 Hours)**

Spectral Characteristics of Random processes:

Introduction, power spectrum and its properties, relationship between power spectrum and autocorrelation function, cross power spectral density and its properties, relation between cross power spectrum and cross-correlation function.

COURSE OUTCOMES:

At the end of the course student will be able to

1. Understand the axiomatic formulation of modern Probability Theory and analyze random variables as an intrinsic need for the analysis of random phenomena.
2. Characterize probability models and function of random variables based on single & multiples random variables.
3. Evaluate and apply moments & characteristic functions and understand the concept of inequalities and probabilistic limits.
4. Understand the concept of random processes and determine covariance and spectral density of stationary random processes.

TEXT BOOKS:

1. Peyton Peebles, *Probability, Random Variables and Random Signal Principles*, McGraw Hill Education, 4th Edition, 2017
2. Athanasios Papoulis and S. Unnikrishna Pillai, *Probability, Random Variables and Stochastic Processes*, 4th Edition, TMH, 2002

REFERENCES:

1. Scott Miller, Donald Childers, *Probability and Random Processes*, 2nd Edition, Elsevier, 2012.
2. Frank Beichelt, *Applied Probability and Stochastic Processes*, 2nd Edition, CRC press, 2016

Subject Code:	Subject Name:	L-T-P:	Credit:
19EC4ES01L	Digital Electronic Circuits Lab	0- 0- 2	1

COURSE OBJECTIVES:

To understand the procedure for designing fundamental building blocks and observes their outputs.

LIST OF EXPERIMENTS:

1. Digital Logic Gates: Investigate logic behavior of AND, OR, NAND, NOR, EX-OR, and Inverter gates.
2. Gate-level minimization: Two level and multi-level implementation of Boolean functions.
3. Design and Testing of combinational circuits: Half-Adder, Half-Subtraction, and Full Adder.
4. Design of binary to Gray, Gray to Binary Code Converter, and Seven Segment Display Decoder.
5. Design and implementation of 2-bit Binary Multiplier
6. Testing of Multiplexer and function implementation using suitable Multiplexer.
7. Testing of Decoder and function implementation using suitable Decoder.
8. Testing of basic SR Latch and FFs: D-FF, JK-FF
9. Design and Testing of SISO, SIPO Shift Registers
10. Design and testing of 3-bit binary Asynchronous UP-Counter and Modulo-6 counter.

COURSE OUTCOMES:

1. Test the different digital ICs and use them for designing different combinational and sequential circuits.
2. Verify and debug the outputs for developing an error free circuit.

Subject Code:	Subject Name:	L-T-P:	Credit:
19EC4PC01L	Network Theory Lab	0- 0- 2	1

COURSE OBJECTIVES:

1. To understand Resonance and coupled circuits.
2. To study the Steady state and Transient behavior of Electrical Circuits
3. To check the applicability of Network theorems for calculating the Electric circuit response.
4. To evaluate Network parameters of given Electrical network and also understand the basic filter circuit response to design

LIST OF EXPERIMENTS:

(Select any 8 experiments from the list of 11 experiments [Using Hardware])

1. Verification of Network Theorems in DC circuits. (Norton's theorem, Reciprocity theorem, Maximum Power transfer theorem, Milliman's theorem & Compensation Theorem).
2. Verification of Network Theorems in AC circuits. (Superposition theorem, Reciprocity theorem, Maximum Power transfer theorem).
3. Study of DC and AC Transients for R-L, R-C & R-L-C circuits using storage oscilloscope.
4. Determination of circuit parameters: Open Circuit and Short Circuit parameters.
5. Determination of circuit parameters: Hybrid and Transmission parameters.
6. Frequency response of Low pass and High Pass Filters.
7. Frequency response of Band pass and Band Elimination Filters.
8. Determination of self inductance, mutual inductance and coupling coefficient of a single phase two winding transformer representing a coupled circuit.
9. Study of resonance in R-L-C series circuit using oscilloscope.
10. Study of resonance in R-L-C parallel circuit using oscilloscope.
11. Spectral analysis of a non-sinusoidal waveform.

Select any 2 experiments from the list of 4 experiments [Using Simulation]

1. Determination of Response of different DC circuits using PSpice
2. Determine the frequency response of Series RLC and Parallel RLC circuit Using PSpice.
3. Determination self inductance, Mutual inductance , of Coupled coils and their response using PSpice
4. Evaluation of Two – port Network parameters using PSpice

COURSE OUTCOMES:

At the end of this course, students will demonstrate the ability to

1. Apply network theorems for the analysis of electrical circuits.
2. Obtain the Steady state and transient response of electrical circuits
3. Obtain frequency repose of the electrical circuits.
4. Analyze two port circuit behavior, Filter circuits.

Subject Code:	Subject Name:	L-T-P:	Credit:
19EC4PC02L	Microprocessor & Application Lab	0- 0- 2	1

COURSE OBJECTIVE:

1. To introduce the basic concept of 16-bit Microprocessor.

2. To become familiar with the architecture and Instruction set of 8086 processor.

3. To provide practical hands on experience with Assembly language programming using 8086 processor.

4. To develop the I/O interfacing skill with 8086 processor like DAC 0800, 8255 PPI, 8253/8254 Timer, DC motor , Stepper Motor etc.

5. To provide the knowledge regarding real time applications of Microprocessors.

10 EXPERIMENTS FROM THE FOLLOWING LIST

GROUP-A: ***OPTIONAL***

Programs Involving Arithmetic operations (Any three)

1. Programs for 16 bit addition and subtraction operations using 8086.

2. Programs for 16 bit multiplication and division operations using 8086.

3. Write an 8086 ASM program to find the factorial of a given number.

4. Write an 8086 ASM program to find the square of a number by adding successive odd numbers.

5. Program for decimal arithmetic operation using 8086.

GROUP-B: ***COMPULSORY***

Programs Involving Data transfer operation (with and without string)

6. Write an 8086 ASM program to move block of data from memory to memory.

GROUP-C: ***OPTIONAL***

Programs Involving Bit manipulation operation (Any Two)

7. Write an 8086 ASM program to separate odd and even numbers.

8. Write an 8086 ASM program for finding out the number of positive, negative and zeros from the given data set.

9. Write an 8086 ASM program to find number of 1's and 0's in a given 16-bit data.

GROUP-D: *COMPULSORY*

Programs Involving Branch/ Loop instructions

10. Programs for Sorting (Ascending or Descending) and Searching (Largest or Smallest) (Using 8086).

GROUP-E: *OPTIONAL*

Interfacing programs (Any Three)

11. Program to generate different types of analog signal using DAC0800 interfacing with 8086.

12. Program to generate square wave at PPI port in BSR and I/O mode mode-0.

13. Program to generate square wave using timer 8253/8254 interfaced with 8086.

14. Interfacing and Programming of DC Motor using 8086.

15. Interfacing and Programming of Stepper Motor using 8086.

COURSE OUTCOME:

1. Understand and apply the fundamentals of assembly language programming on 16-bit Microprocessor.

2. Understand the branching, Loop, string function and Count & Time delay concept of 8086 microprocessor.

3. Familiarize with 8086 microprocessor real time interfaces like DAC, PPI , Timer, Motor etc.

4. Troubleshoot interactions between software and hardware

Subject Code:	Subject Name:	L-T-P:	Credit:
19EC4PD01L	Product Development Lab	0- 0- 2	1