3rd Semester B.Tech.

(EEE)

Detailed Syllabus

Third Semester (Electrical and Electronics Engineering)					
Theory					
Sl. No.	**Category**	**Course Code**	**Course Title**	**L-T-P**	**Credit**
1	BSC	19CM3BS01T	Mathematics-III	3-0-0	3
2	ESC	19CM3ES01T	Data Structure using C	3-0-0	3
3	ESC	19EEE3ES02T/ 19EEE3ES03T	Analog Electronics Circuit/ Digital Electronics Circuit	3-0-0	3
3	HSMC	19CM3HS01T/ 19CM3HS02T	Humanities-1(Organizational Behavior) Management-1(Engineering Economics and Costing)	3-0-0	3
4	PCC	19EEE3PC01T	PCC-1: Circuit Theory	3-0-0	3
5	PCC	19EEE3PC02T	PCC-2: Electrical Machines-I	3-0-0	3
6	MCC	19CM4MC01T	Environmental Science and Engineering	3-0-0	0
Total Credit (Theory)					18
Practical					
1	PCC	19EEE3PC01L	Network Theory and Simulation Lab	0-0-2	1
2	PCC	19EEE3PC02L	Electrical Machines-I Lab	0-0-2	1
3	ESC	19CM3ES01L	Data Structure using C Lab	0-0-2	1
4	ESC	19EEE3ES01L/ 19EEE3ES02L	Analog Electronics Circuit Lab/ Digital Electronics Circuit Lab	0-0-2	1
5	PSI	19CM3PS01L	Summer Internship/ Training	0-0-2	1
Total Credit (Practical)					5
Total Semester Credit					23

Course Code:19CM3BS01T	Course Name: Mathematics-III	L-T-P 3- 0- 0	Credit 3

COURSE OBJECTIVES:

The course should enable the students to:

Enrich the knowledge of probability on single random variables and probability distributions. Apply the concept of correlation and regression to find covariance. Analyse the given data for appropriate test of hypothesis Understand the foundations for classical inference involving confidence intervals and hypothesis testing. Knowledge of Numerical method for solving mathematical problems.

Module-1 **(8 Hours)**

Random variables: Discrete and continuous random variables, probability distribution of a random variable. Some characteristic of probability distribution. Probability mass function and probability density functions; Mathematical expectation: Mean, Variance and standard deviation of a probability distribution.

Module -2 **(8 Hours)**

Binomial distribution: Mean and variances of Binomial distribution, Recurrence formula for the Binomial distribution; Poisson distribution: Poisson distribution as a limiting case of Binomial distribution, mean and variance of Poisson distribution, Recurrence formula for the Poisson distribution; Normal distribution; Mean, Variance, Characteristics of normal distribution.

Module -3 **(10Hours)**

Methods of Sampling: Estimation, point and interval estimation, Basic data analysis, setting of hypothesis, null hypothesis and alternate hypothesis, testing of hypothesis, type I and type II errors, critical region, confidence interval, level of significance. One sided test, two-sided test. Chi-square test: Goodness of fit and test of association. Correlation: Coefficient of correlation, Computation of correlation coefficient, Regression: Lines of regression and their properties.

Module -4 **(8 Hours)**

Root Finding: Introduction, Numerical solution by Bisection Method, Newton Raphson method, Secant method, Fixed point method. Interpolation: Lagrange, Newton forward, Backward, Divided Difference Method.

Module -5 **(10 Hours)**

Numerical Integration: Trapezoidal Method ,Simpson's 1/3 rule, Gauss-quadrature 2 & 3 points method, Solution of First Order Differential equation by Euler's method, Modified Euler's method, Runge-Kutta 4th order and Predicator & Corrector methods(Adams-Bashforth Method).

COURSE OUTCOMES:

On completion of this course, students are able to:

1. Use the basic probability rules, discrete and continuous probability distributions, including requirements of mean and variance and making decisions.
2. Identify the characteristics of different discrete and continuous distributions. Identify thetype of statistical situation to which different distributions can be applied.
3. Use of continuous distribution various hypothesis of testing, Employee the principles of linear regression and correlation and significance of the correlation coefficient.
4. Use of the Numerical method for finding roots, fitting the data into a polynomial equation, integrating any integration and solve any first order ode with initial condition.

TEXT BOOKS:

1. E. Kreyszig,Advanced Engineering Mathematics, Tenth Edition, Willey.
2. Richards A Johnson, Irvin Miller and Johnson E Freund,Probability and Statistics for Engineering, 9th Edition, PHI.
3. M. K. Jain, S.R.K. Iyenger and R.K. Jain, Numerical Methods for Scientific and engineering Computations, New age International Publication (P) Ltd.

REFERENCE BOOKS:

1. S. C. Gupta , V. K. Kapur, Fundamental of Mathematical Statistics.
2. RohitKhurana, Kanti B. Datta, Engineering Mathematics, Cengage Publications.

3. Jay l. Devore, Probability and Statistics for Engineering and the Sciences. 8th edition, Cengage.
4. S Arora, SumeetArora, P N Arora. Comprehensive Statistical Methods, Schaum Series.
5. B.V. Raman, Higher Engineering Mathematics, Mc-Graw Hills Education.
6. B. S. Grewal, Higher Engineering Mathematics, Khanna Publishers.

Course Code:19CM3ES01T	Course Name: Data Structure using C	L-T-P 3- 0- 0	Credit 3

COURSE OBJECTIVES:

1. To introduce the concepts of ADT, Time and Space complexity and asymptotic performance of algorithms and apply the important algorithmic design paradigms and methods of analysis.
2. Analyse and Design of the Algorithms and how the different data structures [Linear and non-linear] are used for efficient accessing of the data and Manipulation of the data.
3. Implementation of the linear and nonlinear data structures, searching and sorting techniques and analyzing their time complexities.

Module -1 **(14Hours)**

Abstract Data Types –Adt's, Stack, Queue, Sparse Matrices

Review on structures, array of structures, pointer to structures, passing structure to a function, dynamic memory allocation

Function pointer, pointer to pointer, menu driven programs

Abstract data types – definition and representation, adt of rational number, adt of stack, datastructure and adt. Stack and its usages: reversing string, matching parentheses, in fix to postfix, decimal to binary number. Queue: linear & circular queue, deque & applications. Matrix – sparse and dense. Representation of sparse matrix, transpose & addition of sparse matrices.

Module -2

linked list and its representation **(8 Hours)**

Linked list and its representation: using array, using self-referential structure. Singly, circular anddouble linked lists. Operations on linked list – insertion, deletion, traversals. Usages of linked list, insertion sort, addition/multiplication of polynomials. Addition/multiplication of large numbers.

Module -3

Trees **(12 Hours)**

Tree: definition and terminologies, child and parent nodes, sub tree, root, leaf node, internal node, height of a tree, binary,ternary, quad tree. Binary tree traversals. Reconstruction of binary tree fromtraversals. Binary search tree – inserting a new key, deleting a key, searching a key. Avl tree –inserting a new key into an avl tree using rotations. B- tree : insertion and deletion using nodesplitting and merging.

Module -4

Sorting and searching **(6 Hours)**

Sorting and searching: bubble sort, selection sort quick sort and merge sort. Linear and binary search, fibonacci search.

Module -5

Graphs **(6 Hours)**

Basic graph algorithm: graph representation – adjacency matrix and list – pros and cons. Graph, traversals – depth first search and breadth first search.

COURSE OUTCOMES:

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

1. To understand the concept of ADT, Time and Space complexity, asymptotic performance of algorithms and understand how different data structures are used for data storage and retrieval.
2. Implement the linear data structures and non linear data structures ,various searching and sorting techniques, BST, AVL trees and graph traversal algorithms
3. Analyzing the time complexities of algorithms used in learning the subject. Analyze the situation in hand and the type of data structure to be used and implement using a programming language.

SUGGESTED BOOKS:

1. Data Structures: A Pseudocode Approach with C – Gilberg & Forouzan, 2nd Edition, Cengage, Indian Reprint 2016
2. Data Structures and Program Design in C – Kruse, Leung, 2nd Edition, Pearson,2008
3. Data Structures Using C - Yedidyah Langsam & Moshe J. Augenstein Aaron M. Tanenbaum, 3rd Edition, Pearson, 2009
4. Algorithms and Data Structures: The basic toolbox, Kurt Mehlhorn and Peter Sanders, Springer, 2010

5. Programming and Data Structures (NPTEL) – (Vodeo lectures by Dr. Naveen Garg, IIT Delhi,new course available from July 2019)

REFERENCE BOOKS:

1. Schaums Outlines Data Structures with C by Seymour Lipschutz" , Publisher: Mcgraw Hill, 2011. [SIE]
2. Data Structures Using C, Oxford University Press, 2014.
3. Data Structures, Algorithms, and Applications in C++ , McGraw-Hill international editions: Computer science series.

Course Code:	Course Name:	L-T-P	Credit
19EEE3ES02T	Analog Electronics Circuits	3- 0- 0	3

COURSE OBJECTIVES:

1. Understand the basics of construction, operation and characteristics of different transistors and its biasing techniques
2. Develop small-signal model to analyze the performance of different amplifier both for low frequency and high frequency operation.
3. Analyze the performance parameters of large signal amplifiers and feedback topologies; extend the concept of feedback in different amplifier and oscillator circuits.

Module – 1 **(8 Hours)**

Biasing of BJTs: Load lines (AC and DC); Operating Points; Different Biasing Techniques; Bias Stabilization; Bias design Examples.

Biasing of FETs and MOSFETs: Operating point, Load line, Biasing techniques of FETs and design, Bias design: Graphical and analytical Method, Complimentary MOS (Principal of oeration).

Module – 2 **(12 Hours)**

Small Signal Analysis of BJTs: Small-Signal Equivalent-Circuit Models; r_e model, Small Signal Analysis of CE, CC, CB amplifiers using r_e model, Hybrid equivalent Model, Graphical determination of hybrid parameter.

Small Signal Analysis of FETs: Small-Signal Equivalent-Circuit Model, Small Signal Analysis of CS, CD, CG Amplifiers.; Source Follower andCascadedSystem.

Two port system approach: Effects of $R_S$and $R_L$on CE amplifier operation, Effects of $R_{SIG}$and $R_L$on CS Amplifier, Small signal analysis of Cascade and Cascode configurations, Darlington Connection and Current Mirror Circuits.

Module – 3 **(6 Hours)**

Frequency Response of BJT and FET Amplifiers: General Frequency Considerations,Low and High Frequency Analysis of Single Stage Amplifiers, Square Wave Testing of amplifier.

Module – 4 **(4 Hours)**

Operational Amplifier: Ideal Op-Amp, Op-Amp Parameters, Open-loop and Closed-loop Gains, OP-AMP application as weighted summer, Differentiator and Integrator, Instrumentationamplifier.

Module – 5 **(6 Hours)**

Feedback amplifier and Oscillators: Concepts of negative and positive feedback, Four Basic Feedback Topologies, Advantage of Negative feedback, Principle of oscillation, OP-AMP based sinusoidal Oscillator Circuits: Wien Bridge oscillator and R-C Phase shift oscillator; CrystalOscillators.

COURSE OUTCOME:

After completion of the course, the student will be able to

1. Analyze and understand the different biasing techniques to have excellent stabilization against internal and external parameter variation.
2. Develop small-signal model to analyze the performance of different amplifier both for low frequency and high frequency operation.
3. Apply the concept of different feedback and feedback topologies in designing various circuits used for amplification and frequency generation.
4. Analyze and design operational amplifier based amplifier and oscillator circuits by understanding its characteristics and configuration details.

TEXT BOOKS:

1. Electronic Devices and Circuits theory, R.L. Boylestad and L. Nashelsky, 10th Edition, Pearson Education.

REFERENCE BOOKS:

1. Microelectronics Circuits, A. Sedra and K.C Smith, Oxford University press

2. Electronic Circuits: Analysis and Design(SIE), Donald Neamen, Mc-Graw Hills
3. Milliman's Electronics Devices and Circuits, J. Milliman, C. Halkias, 2nd Edition, TMH

Course Code:	Course Name:	L-T-P	Credit
19EEE3ES03T	Digital Electronics 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.

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.

TEXT BOOKS:

1. Digital Design, 3rd Edition, M. Morris Mano, Pearson Education.

REFERENCE BOOKS:

1. Digital Principles And Applications, Seventh Edition , Donald P Leach, Albert Paul Malvino, Goutam Saha, ,Tata McGraw Hill Education Private limited
2. Fundamentals of digital circuits, 8th edition, A. Anand Kumar, PHI
3. Digital Fundamentals, 5th Edition, T.L. Floyd and R.P. Jain, Pearson Education, New Delhi.
4. Digital Logic Design Principles, 2nd edition, Norman Balabanian & Bradley Carlson, Wiley 2004.

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.

Course Code:	Course Name:	L-T-P	Credit
19CM3HS01T	Organizational Behavior	3- 0- 0	3

COURSE OBJECTIVES:

Developing an understanding of the behavior of individuals and groups inside organizations by enhancing the skills in appreciating individuals, interpersonal, and group process for increased effectiveness both within and outside of organizations is the goal of any organization. Through this course students will develop theoretical and practical insights and problem-solving capabilities for effectively managing the organizational processes.

Module-1: Fundamentals of OB: (6 Hours)

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: Foundations of Individual Behavior: (12 Hours)

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: Foundations of Group Behavior: (8 Hours)

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: Foundations of Organizational Behavior: (10 Hours)

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 BOOKS:

1. Organizational Behaviour, Robbins, Judge, Sanghi, Pearson.

REFERENCE BOOKS:

1. Organizational Behaviour, K. Awathappa, HPH.
2. Organizational Behaviour, VSP Rao, Excel
3. Introduction to Organizational Behaviour, Moorhead, Griffin, Cengage.
4. Organizational Behaviour,Hitt, Miller, Colella, Wiley
5. Organizational Behaviour, Suba Rao,Mishra, Himalaya
6. Organisational Behaviour – Uma Sekharan
7. Understanding Organizational Behaviour, Parek, Oxford

Course Code:	Course Name:	L-T-P	Credit
19CM3HS02T	Engineering Economics and Costing	3- 0- 0	3

Module-1 **(8 Hours)**

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 andoligopoly.Indian Banking System, Functions and Roles of Commercial Banks and ReserveBank 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 ofReturn 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.

REFERENCE BOOKS:

1. Koutsoyiannis, A., 'Modern Microeconomics', English Language Book Society, Macmillan.
2. Pindyck, R S, Rubinfeld, D L &Mehta , 'Microeconomics', 6 th Edition, Pearson Education India.
3. Varian, H R, 'Intermediate Microeconomics', 7th edition, East West Press India.

4. Samuelson, Paul A, 'Economics', 5th edition, McGraw Hill New York.
5. Basics of Engineering Economy; Leland Blank and Anthony Tarquin, TMH
6. Contemporary Engineering Economics, Chan. S Park, Pearson
7. Engineering Economics, Paneerselvam, PHI
8. Engineering Economics; Sasmita Mishra.

Course Code:	Course Name:	L-T-P	Credit
19EEE3PC01T	Circuit 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: (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: **(12 Hours)**

Solution of Electrical Networks:

Solution of first and second order differential equations for series and parallel R- L, R-C, R-L-C circuits, initial and final conditions in network elements, forced and free response, time constants, steady state and transient response.

Frequency response: Introduction, Definition of Q, Bandwidth, selectivity of series and Parallel resonance. Condition for maximum impedance, current in anti resonance, general case- resistance present in both branches, anti resonance at all frequencies.

Locus diagrams for various combination of R, L and C.

Introduction to Locus diagram: Series RL - Circuit, Series RC - Circuit, Series RLC - Circuit, Parallel combination with variation of various parameters.

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: **(10 Hours)**

Electrical Circuit Analysis Using Laplace Transforms: Review of Laplace Transform, Analysis of electrical circuits using Laplace Transform for standard inputs, convolution integral, inverse Laplace transform, transformed network with initial conditions.

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 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: **(10 Hours)**

Fourier series & its Application: Fourier series, Fourier analysis and evaluation of coefficients, Steady state response of network to periodic signals, Fourier transform and convergence, Fourier transform of some functions, Parsvel's theorem.

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 BOOKS:

1. Fundamentals of Electric Circuits – Alexander & Sadiku – Tata McGraw Hill, 5th Edition.
2. W. H. Hayt and J. E. Kemmerly, “Engineering Circuit Analysis”, McGraw Hill Education, 2013.

REFERENCE BOOKS:

1. Network Analysis and Synthesis– M E Van Valkenburg – Pearson Education, 3rd Edition.
2. Theory and problem of electrical circuits, Schaum's Outline Series, TMH – Joseph A. Edminister, MahmoodMaqvi.
3. Network theory, Sudhakar and Shymmohan, TMH Publications

Course Code:	Course Name:	L-T-P	Credit
19EEE3PC02T	Electrical Machine-I	3- 0- 0	3

COURSE OBJECTIVES:

1. To understand basic principle of operation, characteristics and performance of DC Generator.
2. To understand basic principle of operation, characteristics and performance of DC Motor.
3. To understand basic principle of operation, characteristics and performance of single-phase transformer.
4. To understand the construction and different circuit connections of three-phase transformer.
5. To analyze the performance characteristics of single-phase induction machines.

SYLLABUS

Module-1: DC Generator (10 Hours)

General principles of DC machines: Armature Windings (Simplex Lap and Simplex Wave), Expression for EMF Induced and Torque developed in the Armature counter Torque and Counter or Back EMF, Methods of Excitation, Armature Reaction, Methods of Reduction of Armature reaction, Commutation. DC Machine Characteristics: Conditions for Self Excitation, Critical Resistance and Critical Speed. Internal, External and load Characteristics for self and Separately Excited DC Generator.

Module-2: DC Motor (8 Hours)

DC Motor principle of operation, Characteristic for Speed~ Armature Current, Torque~ Armature Current and Speed~ Torque of a DC Shunt, Series and Compound Motor and Comparison. Necessity of a Starter, Starting of DC Shunt, Series and Compound Motors, Speed Control of DC Shunt and Series motor Losses, efficiency and power flow diagram DC Machines Testing: Direct test, Swinburnes's Test and Hopkinson's Test. Applications of DC Motor. Brush less DC motor, Stepper motor, and DC servo motor. The Universal series motor: constructional features and Performance characteristics.

Module-3 Single-phase Transformer (8 Hours)

Principle of operation, EMF Equation, Phasor Diagrams at No -Load and Load Conditions of an Ideal transformer and practical transformer, Equivalent Circuit, Determination of Parameters from Tests (Polarity Test, Open Circuit Test and Short Circuit Test, Back to Back

test), Per Unit Calculation and its importance, Voltage Regulation, Losses, Efficiency and all day efficiency.

Module -4 Auto-Transformer and Parallel Operation of Transformers (6 Hours)

Auto Transformer: Basic constructional features; VA conducted magnetically and electrically. Comparative study with two winding transformers. Conversion of a two-winding transformer into a single winding transformer. Parallel operation of transformers and load sharing.

Module-5Three-phase Transformer (8 Hours.)

Constructional features, as a single unit and as a bank of three singlephase transformers. Three-Phase Transformer connections, The per unit system for Three Phase Transformer, Transformer Ratings and Related problems, Two Single-Phase Transformers connected in Open Delta (V-Connection) and their rating. T-Connection (Scott Connection) of Two Single-Phase Transformers. Transformer Three phase Connections: Various Phase Displacements (0o, 180o, +30o and -30o), Connection Diagrams and Phasor Diagrams of various Vector Groups (Yy0, Dd0, Dz0, Yy6, Dd6, Dz6, Yd1, Dy1, Yz1, Yd11, Dy11, and Yz11)

COURSE OUTCOMES:

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

1. Understand electrical principle, laws, and working of DC generator and motor and losses and also conduct various tests on the DC generator.
2. Understand electrical principle, laws, and working of DC motor, losses and also conduct various tests on the DC Motor.
3. Understand electrical principle, laws, and working of 1 phase transformer and losses and also conduct various tests on the transformer.
4. Understand electrical principle, laws, and working of 3 phase transformer and losses and also conduct various tests on the three-phase transformer.
5. Analyze the transformer and convert 3 phase transformer to multi phase transformer.

TEXT BOOKS:

1. P S Bimbhra – Electrical Machinery –Khanna Publishers.
2. B.S.Guru & H.R.Hiziroglu-‘Electric Machinery & Transformers’-3rd Ed-Oxford Press, 2014

REFERENCE BOOKS:

1. P.C.Sen-'Principles of Electric Machines and Power Electronics'-2nd Edition, John Wiley and Sons, Wiley India Reprint, 2014.
2. A.E.Fitgerland, Charles Kingslay Jr. & Stephen D. Umans -Electric machinery – 6th Edition Mc Graw Hill – Reprint 2015.
3. D.P. Kothari & I.J. Nagrath - Electric Machines – 4th Edition Mc Graw Hill – Reprint 2015.
4. Stephen J. Chapman-'Electric Machinery and Fundamentals'- Mc Graw Hill International Edition, (Fourth Edition), 2015.
5. M.G.Say-'Alternating Current Machines', English Language Book Society (ELBS)/Longman , 5th Edition, Reprinted 1990.

Course Code:	Course Name:	L-T-P	Credit
19EEE3PC01L	Circuit Theory and Simulation 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

SYLLABUS

Select any 10 experiments from the list of 13 experiments

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 two port network parameters.
5. Frequency response of Low pass and High Pass Filters.
6. Frequency response of Band pass and Band Elimination Filters.
7. Determination of self inductance, mutual inductance and coupling coefficient of a single phase two winding transformer representing a coupled circuit.
8. Study of resonance in R-L-C series and R-L-C Parallel circuit using oscilloscope.
9. Spectral analysis of a non-sinusoidal waveform.
10. Determination of Response of different DC circuits using MATLB Simulink/ PSpice.
11. Determine the frequency response of Series RLC and Parallel RLC circuit Using MATLAB Simulink.
12. Determination self inductance, Mutual inductance , of Coupled coils and their response using MATLB Simulink
13. Evaluation of Two – port Network parameters using MATLAB Simulink/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.

Course Code:	Course Name:	L-T-P	Credit
19EEE3PC02L	Electrical Machine-I Laboratory	0- 0- 2	1

COURSE OBJECTIVES:

1. To understand the characteristics of DC generator.
2. To understand the characteristics of DC motor
3. To understand the different types of losses of a single phase transformer.
4. To study the voltage regulation and performance of single phase transformer.
5. To study different three-phase transformer connections and applications.

SYLLABUS

Select any 8 experiments from the list of 10 experiments [Using Hardware]

1. Determination of critical resistance and critical speed from no load test of a DC shunt generator.
2. Plotting of external and internal characteristics of a DC shunt generator.
3. Speed control of DC shunt motor by armature voltage control and flux control method.
4. Determination of efficiency and losses of a DC shunt motor using Swinburne's method.
5. Determination of efficiency and losses of a DC machines using regenerative or Hopkinson's method.
6. Determination of Efficiency and Voltage Regulation by Open Circuit and Short Circuit test on single phase transformer.
7. Parallel operation of two single phase transformers.
8. Back-to Back test or Sumpner's test on two single phase transformers.
9. Study of open delta and Scott connection of two single phase transformers.
10. Separation of hysteresis and eddy current losses in a transformer.

COURSE OUTCOMES:

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

1. Acquire hands on experience of conducting various tests on dc machines andobtaining their performance indices using standard analytical method
2. Acquire hands on experience of conducting various tests on 1-phase and 3-phase transformer

Course Code:	Course Name:	L-T-P	Credit
19CM3ES01L	Data Structure using C Lab	0- 0- 2	1

COURSE OBJECTIVES:

1. To choose the appropriate data structure and algorithm design method for a specified application and finding the performance of the programs.
2. To understanding about writing algorithms and step by step approach in solving problems with the help of fundamental data structures.
3. To solve problems using data structures such as linear lists, stacks, queues, hash tables, binary trees, heaps, binary search trees, and graphs and writing programs for these solutions.
4. Students should acquire skills in using generic principles for data representation & manipulation with a view for efficiency, maintainability, and code-reuse.

SYLLABUS

1. Revisiting structure, union, dynamic memory allocation and pointers, pointers to structures and function pointers, menu driven programs.
2. Infix to postfix conversion and evaluation of postfix expressions using STACK.
3. Insert and delete operations on a Linear Queue.
4. Sparse matrix representation and addition of two sparse matrices.
5. Implementing a singly linked list – operations include insert [beg, mid, end], delete [beg, mid, end], traverse [fwd, backward], Reversing it, count nodes.
6. Polynomial representation and addition of 2 polynomials using linked list.
7. Performing various operations on a Binary Search tree – Create, traverse, find min, find max, mirror, delete, count internal and external nodes Related programs using BST.
8. Implementing various searching and sorting algorithms

COURSE OUTCOMES:

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

1. Able to identify the appropriate data structure for given problem.
2. Determine and analyze the time and space complexity of given Linear and Non-Linear data structures Algorithms.

3. Implement operations like searching, insertion, and deletion, traversing mechanism etc. on various data structures [linear and non linear] and analyzing the complexity of each operation.
4. Have practical knowledge on the applications of data structures.

TEXT BOOKS:

1. Data Structures: A Pseudocode Approach with C – Gilberg & Forouzan, 2nd Edition, Cengage, Indian Reprint 2016
2. Data Structures and Program Design in C – Kruse, Leung, 2nd Edition, Pearson,2008
3. Data Structures Using C - Yedidyah Langsam & Moshe J. Augenstein Aaron M. Tanenbaum, 3rd Edition, Pearson, 2009
4. Algorithms and Data Structures: The basic toolbox, Kurt Mehlhorn and Peter Sanders, Springer, 2010
5. Programming and Data Structures (NPTEL) – (Vodeo lectures by Dr. Naveen Garg, IIT Delhi,new course available from July 2019)

REFERENCE BOOKS:

1. Schaums Outlines Data Structures with C by Seymour Lipschutz" , Publisher: Mcgraw Hill, 2011. [SIE]
2. Data Structures Using C, Oxford University Press, 2014.

Course Code:	Course Name:	L-T-P	Credit
19EEE3ES01L	Analog Electronics Lab	0- 0- 2	1

COURSE OBJECTIVE:

1. To illustrate the students different electronic circuit and their application in practice.
2. To impart knowledge on assessing performance of electronic circuit through monitoring of sensitive design and modeling parameters.

LIST OF EXPERIMENTS:

(At least 10 out of 13 experiments should be done)

1. Determination of cut- off and saturation voltage of a BJT and its application as a switch.
2. Assemble and test of BJT bias circuits: Fixed bias and feedback bias.
3. Design, assemble and test of BJT bias circuits: Voltage divider bias
4. Design, assemble and test of JEET bias circuits: fixed bias and self bias.
5. Design, assemble and test of BJT common-emitter circuit – D.C and A.C performance: Voltage gain, input impedance and output impedance with bypassed and un-bypassed emitterresistor.
6. Design, assemble and test of BJT emitter-follower – D.C and A.C performance: A.C. voltage gain, input impedance and outputimpedance.
7. Design, assemble and Test of JFET/MOSFET common-source amplifiers – D.C and A.C performance: Voltage gain, input impedance and outputimpedance.
8. Determination of Bandwidth of a common-emitter amplifier from its frequency response.
9. Determination of Bandwidth of a BJT CE amplifier using Square wave testing.
10. Design and test of Differential amplifier circuits with its DC and AC performance.
11. Design and test of Darlington connection/ current mirrorcircuits.
12. Graphical determination of h-parameters of a CE amplifier.
13. Design Wien Bridge/R-C phase shift oscillator.

COURSE OUTCOMES:

After completion of the course, the student will be able to

1. Test and experiment different types of BJT/JFET based electronic circuit and analyze their operation under different operating conditions.

2. Evaluate possible causes of discrepancy in experimental observations in comparison to theoretical outcome.
3. Practice different types of wiring and instruments connections keeping in mind technical, Economical, safety issues.
4. Prepare professional quality textual and graphical presentations of laboratory data and Computational results.

Course Code:	Course Name:	L-T-P	Credit
19EEE3ES02L	Digital Electronics Lab	0- 0- 2	1

COURSE OBJECTIVES:

1. 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.

4th Semester B.Tech.

(EEE)

Detailed Syllabus

National Institute of Science and Technology (Autonomous)
Institute Park, Pallur Hills, Berhampur, Odisha - 761008

Fourth Semester(Electrical and Electronics Engineering)					
Theory					
Sl. No.	**Category**	**Course Code**	**Course Title**	**L-T-P**	**Credit**
1	PCC	19EEE4PC01T	PCC-3: Electrical Machines-II	3-0-0	3
2	PCC	19EEE4PC02T	PCC-4: Electrical Measurement and Instrumentation	3-0-0	3
3	PCC	19EEE4PC03T	PCC-5: Electrical Power Transmission and Distribution	3-0-0	3
4	HSMC	19CM4HS01T/ 19CM4HS02T	Organizational Behavior/ Engineering Economics and Costing	3-0-0	3
5	ESC	19EEE4ES01T/ 19EEE4ES02T	Analog Electronics Circuit/ Digital Electronics Circuit	3-0-0	3
6	PEC	19EEE4PE01T/ 19EEE4PE02T/ 19EEE4PE03T/ 19EEE4PE04T	Modeling and Simulation of Dynamical Systems in Electrical Engineering / Electromagnetic Theory / Power Generation Systems/Signals and Systems	3-0-0	3
Total Credit (Theory)					**18**
Practical					
1	PCC	19EEE4PC01L	Electrical Machine-II Lab	0-0-2	1
2	PCC	19EEE4PC02L	Electrical Measurement and Instrumentation Lab	0-0-2	1
3	PCC	19EEE4PC03L	Electrical Power Transmission and Distribution Lab	0-0-2	1
4	ESC	19EEE4ES01L/ 19EEE4ES02L	Analog Electronics Circuit Lab/ Digital Electronics Circuit Lab	0-0-2	1
Total Credit (Practical)					**4**
Total Semester Credit					**22**

Course Code:	Course Name:	L-T-P	Credit
19EEE4PC01T	Electrical Machine-II	3- 0- 0	3

COURSE OBJECTIVES:

1. To understand the operation, characteristics of cylindrical rotor synchronous generator.
2. To understand the basic principle of operation, construction and performance characteristics of salient pole synchronous generator.
3. To analyze the performance characteristics of three-phase synchronous motor.
4. To understand the basic principle of operation, construction and performance characteristics of three phase induction motor.

SYLLABUS

Module-1: Cylindrical Rotor Synchronous Generator (10 Hours)

Three Phase Synchronous Generators: Synchronous Generator Construction (both Cylindrical Rotor and Salient Pole type), the Speed of Rotation of a Synchronous Generator, Induced voltage in A.C Machines, The Internal Generated Voltage of a Synchronous Generator, The Equivalent Circuit of a Synchronous Generator (Armature Reaction Reactance, Synchronous Reactance and Impedance). Cylindrical Rotor type Three Phase Synchronous Generators: The Phasor Diagram of a Synchronous Generator, Power and Torque in Synchronous Generators (Power Angle Equation and Power Angle Characteristic), Measuring Synchronous Generator Model Parameters (Open Circuit and Short Circuit Tests and Determination of Synchronous Impedance and Reactance, The Short Circuit Ratio), Voltage Regulation and Speed Regulation. Voltage Regulation by Synchronous Impedance Method

Module-2: Salient-pole Synchronous Generator (8 Hours)

Salient Pole type Three Phase Synchronous Generators: Two Reaction Concept, Development of the Equivalent Circuit of a Salient Pole type Three Phase Synchronous Generator (Direct axis and Quadrature axis Reactance, Phasor Diagram for various load power factors,), Torque and Power Equations of Salient Pole Synchronous Generator (Power Angle Equation and Power Angle Characteristic with stator resistance neglected). Slip Test for determination of Direct axis and Quadrature axis Reactance.

Parallel operation of Three Phase A.C. Synchronous Generators.The Conditions Required for Paralleling, The General Procedure for Paralleling Generators, Frequency - Real Power and Voltage – Reactive Power Characteristics of a Three Phase Synchronous Generator.

Module-3: Three-phase Synchronous Motor (10 Hours)

Basic Principles of Motor operation, Steady State Synchronous Motor operation, Starting Synchronous Motors, Synchronous Generators and Synchronous Motors, Operation of synchronous motors connected to bus and phasor diagrams for normal, under and over excited conditions, Salient pole synchronous motor phasor diagram under lagging, leading and unity power factor load, Synchronous condenser, V and Λ curves, Synchronous Motor Ratings and Application.

Module-4 Three-phase Induction Motor (8 Hours)

Constructional features and types; 3-phase distributed winding production of rotating magnetic field, Principle of Operation, The Effect of Coil Pitch and distribution factor on A.C. Machines, winding factor, Concept of Slip, Slip Speed; Phasor diagram and Development of equivalent circuit and derivation of torque equation; Typical torque-slip characteristic and influence of different parameters on it, No-Load and Blocked Rotor tests, Determination of Parameters, power flow diagram, Losses and Efficiency, Methods of starting and speed control. Cogging, Crawling.

Module-5 (6Hours)

Single phase induction machines: Double field revolving theory, Methods of starting using auxiliary winding, development of equivalent circuit. No-Load and Blocked Rotor tests, Determination of Parameters Speed Control of Single Phase Induction Motors.

COURSE OUTCOMES:

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

1. Understand electrical principle, laws, and working of cylindrical rotor synchronous generator.
2. Understand electrical principle, laws, and working of salient pole synchronous generator.
3. To impart the knowledge on constructional details, principle of operation, performance of 3 phases synchronous motor.
4. To impart the knowledge on starting methods and applications of synchronous motor.

5. To impart the knowledge on fundamental of AC rotating machine.
6. To impart the knowledge on constructional details, principle of operation, performance, starter, speed control and braking of 3 phase induction motor.
7. To impart the knowledge on constructional details, principle of operation, type of 1 phase induction motor and special machine.

TEXT BOOKS:

1. P S Bimbhra – Electrical Machinery –Khanna Publishers.
2. B.S.Guru & H.R.Hiziroglu-'Electric Machinery & Transformers'-3rd Ed-Oxford Press, 2014

REFERENCE BOOKS:

1. P.C.Sen-'Principles of Electric Machines and Power Electronics'-2nd Edition, John Wiley and Sons, Wiley India Reprint, 2014.
2. A.E.Fitgerland, Charles Kingslay Jr. & Stephen D. Umans -Electric machinery – 6th Edition Mc Graw Hill – Reprint 2015.
3. D.P. Kothari & I.J. Nagrath – Electric Machines – 4th Edition Mc Graw Hill – Reprint 2015.
4. Stephen J. Chapman-'Electric Machinery and Fundamentals'- Mc Graw Hill International Edition, (Fourth Edition), 2015.
5. M.G.Say-'Alternating Current Machines', English Language Book Society (ELBS)/ Longman , 5th Edition, Reprinted 1990.

Course Code:	Course Name:	L-T-P	Credit
19EEE4PC02T	Electrical Measurement and Instrumentation	3- 0- 0	3

COURSE EDUCATIONAL OBJECTIVE (CEO/COB):

1. Exposure to different types of measurement standards and their gradation.
2. Relevant knowledge in bridge circuits for measuring electrical components.
3. Detail insight of construction, operation and working principle of various electrical and electronics measuring instrument.

SYLLABUS

Module- 1 **(8 Hours)**

Measurement, Error and Standards of Measurement: Definition, Accuracy and Precision, Significant Figures, Types of Errors, Classification of Standards, Electrical Standards, IEEE, **Measurement of Resistance, Inductance and Capacitance**: Resistance: Measurement of Low Resistance by Kelvin's Double Bridge, Measurement of Medium Resistance, Measurement of High Resistance, Measurement of Resistance of Insulating Materials, Measurement of Insulation Resistance when Power is ON. Inductance: Measurement of Self Inductance by Ammeter and Voltmeter, and AC Bridges (Maxwell's, Hay's and Anderson Bridges). Capacitance: Measurement of Capacitance by Ammeter and Voltmeter, and AC Bridges (Owen's, Schering & Wien's Bridge), Screening of Bridge Components and Wagnor Earthing Device.

Module-2 **(6 Hours)**

Galvanometer: Construction, Theory and Principle of operation of D' Arsonval, Vibration (Moving Magnet & Moving Coil types), Influence of Resistance on Damping, Damping, Logarithmic decrement, Calibration of Galvanometers. **Potentiometer:** Principle of operation of DC Potentiometers (Crompton, Vernier, and Deflectional Potentiometer); AC Potentiometers (Drysdale-Tinsley and Gall-Tinsley Potentiometer).

Module-3 **(8 Hours)**

Current Transformer and Potential Transformer: Construction, Theory, Characteristics and Testing of CTs and PTs. **Electronic Instruments for Measuring Basic Parameters:** Amplified DC Meters, AC Voltmeters using Rectifiers, True RMS Voltmeter, Considerations for choosing an Analog Voltmeter, Digital Voltmeters (Block Diagrams only), Q-meter.

Module-4 **(6 Hours)**

Measurement of Power, Energy, Frequency and Power factor: Measurement of single phase and three phase power by wattmeter. Construction, Theory and Principle of operation of (a) Electro-Dynamometer and Induction type Watt meters, (b) Induction Type Watt-hour meters, (c) Frequency Meters, and (d) Power Factor Meters.

Module-5

CRO & DSO: Block Diagrams, Delay Line and Working principle, Oscilloscope Probes, Oscilloscope measurement: Phase, Time and Frequency, DSO and Spectrum Analyzer.

COURSE OUTCOMES:

After completion of this course the students will be able to:

1. To enable students to classify measuring instruments on the basis of performance indices and familiarization with standards of measurement.
2. To measure resistance, inductance and capacitance by different methods based on its rang and type.
3. To analyze the construction and operation of Galvanometers, ammeter, voltmeter, potentiometer and oscilloscope in measuring ac and dc parameters.
4. To analyze the construction and operation of different types of energy, power and frequency measuring instruments.

TEXT / REFERENCES:

1. A Course in Electrical and Electronic Measurements and Instrumentation – A K Sawhney – Dhanpat Rai & Co.
2. Electronic Measurement and Instrumentation – Oliver & Cage – Tata McGraw Hill.
3. Electrical Measurements and Measuring Instruments – Golding & Widdis – 5th Edition, Reem Publication.
4. Modern Electronic Instrumentation and Measurement Techniques – Helfrick & Cooper – Pearson Education.

Course Code:	Course Name:	L-T-P	Credit
19EEE4PC03T	Electrical Power Transmission &Distribution	3- 0- 0	3

COURSE EDUCATIONAL OBJECTIVE (CEO/COB):

1. Understanding the concept of per unit system and calculation of line constants in different types of transmission lines.
2. Modeling and performance of transmission line for the analysis of power system.
3. Application of different types of overhead line insulators and Mechanical design of transmission lines.
4. Application of insulated cables, earthing system and different electrical distribution system for the transmission of electrical power.

SYLLABUS

Module-1 **(8 Hours)**

Line Constant Calculations:

Per unit system, Determination of transmission line resistance, Inductors and Inductance, Magnetic field Intensity due to long current carrying conductors, Inductance of two wire transmission line, Flux linkages with one conductor in a group of conductors, Transposition of power lines, Composite Conductors, Inductance of Composite Conductors, Inductance of double circuit three phase line, Concept of GMD, Bundled conductors, Skin and Proximity effect.

Capacitance of Transmission Lines:

Electric Field of a Line of charge, Straight Conductor, Potential Difference between Two Points due to a line Charge, Two infinite lines of charge, Capacitance of a Two Wire Line, Capacitance of a Three Phase Line with Unsymmetrical Spacing, Capacitance of a double circuit line, Effect of Earth on the Capacitance of conductors.

Module-2 **(8 Hours)**

Performance of Lines:

Short Transmission Lines, Medium Transmission Lines, Long Transmission Line, ABCD parameters, Ferranti Effect Hyperbolic Form of The Equations, The Equivalent Circuit of a Long Line, Power Flow Through Transmission Line, Reactive Power Compensation, Series and Shunt compensation of a Transmission Line, Effect of Corona loss in a transmission line.

Module-3 **(6 Hours)**

Overhead Line Insulators:

Insulator Materials, Types of Insulators, Voltage Distribution over Insulator String.

Mechanical Design of Overhead Transmission Lines:

Catenary curve, Sag Tension calculation, supports at different levels, Stringing chart, sag Template, Equivalent span, Stringing of Conductors, Vibration and Vibration Dampers.

Module-4 **(8 Hours)**

Distribution and Symmetrical Components:

Comparison of various Distribution Systems, AC three-phase four-wire Distribution System, Types of Primary Distribution Systems, Types of Secondary Distribution Systems, Voltage Drop in DC Distributors, Voltage Drop in AC Distributors, Kelvin's Law, Symmetrical components and Fault analysis.

Module-5 **(6 Hours)**

Insulated Cables:

The Insulation, Extra High Voltages Cable, Insulation Resistance of Cable, Grading of Cables, Capacitance of Single Core Cables, Heating of cables, Current rating of cables, Overhead lines Vs Underground Cables, Types of cable.

COURSE OUTCOMES:

After completion of this course the students will be able to:

1. Design of power system using per unit reactance diagram and calculation of inductance and capacitance for different types of transmission lines.
2. Design of equivalent circuit and calculation of efficiency and voltage regulation for short, medium and long transmission lines.
3. Measure the potential distribution over a string of suspension insulators and calculation of sag and tension for transmission lines.
4. Grade the insulated cables and calculate the insulation resistance and capacitance of underground cables.
5. Calculate the voltage drop, earth resistance and soil resistivity in different type of electrical distribution line.

TEXT BOOKS:

1. B.M Weedy & B.J Cory, "Electric Power Systems", Wiley India.

2. C. L. Wadhwa, “Electrical Power Systems”, New Age International Publishers.

REFERENCE BOOKS:

1. John J. Grainger & W.D Stevenson, “Power System Analysis” Tata McGraw-Hill.
2. B.R Gupta, “Power System Analysis & Design”, S. Chand Publications.

Course Code:	Course Name:	L-T-P	Credit
19CM4HS01T	Organizational Behavior	3- 0- 0	3

COURSE OBJECTIVES:

Developing an understanding of the behavior of individuals and groups inside organizations by enhancing the skills in appreciating individuals, interpersonal, and group process for increased effectiveness both within and outside of organizations is the goal of any organization. Through this course students will develop theoretical and practical insights and problem-solving capabilities for effectively managing the organizational processes.

Module-1: Fundamentals of OB: (6 Hours)

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: Foundations of Individual Behavior: (12 Hours)

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: Foundations of Group Behavior: (8 Hours)

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: Foundations of Organizational Behavior: (10 Hours)

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 BOOKS:

1. Organizational Behaviour, Robbins, Judge, Sanghi, Pearson.

REFERENCE BOOKS:

1. Organizational Behaviour, K. Awathappa, HPH.
2. Organizational Behaviour, VSP Rao, Excel.
3. Introduction to Organizational Behaviour, Moorhead, Griffin, Cengage.
4. Organizational Behaviour,Hitt, Miller, Colella, Wiley.
5. Organizational Behaviour, Suba Rao,Mishra, Himalaya.
6. Organisational Behaviour – Uma Sekharan.
7. Understanding Organizational Behaviour, Parek, Oxford.

Course Code:	Course Name:	L-T-P	Credit
19CM4HS02T	Engineering Economics and Costing	3- 0- 0	3

Module-1: **(8 Hours.)**

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 andoligopoly.Indian Banking System, Functions and Roles of Commercial Banks and ReserveBank 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 ofReturn 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.

REFERENCE BOOKS:

1. Koutsoyiannis, A., 'Modern Microeconomics', English Language Book Society, Macmillan.
2. Pindyck, R S, Rubinfeld, D L &Mehta , 'Microeconomics', 6 th Edition, Pearson Education India.
3. Varian, H R, 'Intermediate Microeconomics', 7th edition, East West Press India.
4. Samuelson, Paul A, 'Economics', 5th edition, McGraw Hill New York.
5. Basics of Engineering Economy; Leland Blank and Anthony Tarquin, TMH.

6. Contemporary Engineering Economics, Chan. S Park, Pearson.
7. Engineering Economics, Paneerselvam, PHI.
8. Engineering Economics; Sasmita Mishra.

Course Code:	Course Name:	L-T-P	Credit
19EEE4ES01T	Analog Electronics Circuits	3- 0- 0	3

COURSE OBJECTIVES:

1. Understand the basics of construction, operation and characteristics of different transistors and its biasing techniques
2. Develop small-signal model to analyze the performance of different amplifier both for low frequency and high frequency operation.
3. Analyze the performance parameters of large signal amplifiers and feedback topologies; extend the concept of feedback in different amplifier and oscillator circuits.

Module – 1 **(8 Hours)**

Biasing of BJTs: Load lines (AC and DC); Operating Points; Different Biasing Techniques; Bias Stabilization; Bias design Examples.

Biasing of FETs and MOSFETs: Operating point, Load line, Biasing techniques of FETs and design, Bias design: Graphical and analytical Method, Complimentary MOS (Principal of oeration).

Module – 2 **(12 Hours)**

Small Signal Analysis of BJTs: Small-Signal Equivalent-Circuit Models; r_e model, Small Signal Analysis of CE, CC, CB amplifiers using r_e model, Hybrid equivalent Model, Graphical determination of hybrid parameter.

Small Signal Analysis of FETs: Small-Signal Equivalent-Circuit Model, Small Signal Analysis of CS, CD, CG Amplifiers.; Source Follower and Cascaded System.

Two port system approach: Effects of R_S and R_L on CE amplifier operation, Effects of R_{SIG} and R_L on CS Amplifier, Small signal analysis of Cascade and Cascode configurations, Darlington Connection and Current Mirror Circuits.

Module – 3 **(6 Hours)**

Frequency Response of BJT and FET Amplifiers: General Frequency Considerations, Low and High Frequency Analysis of Single Stage Amplifiers, Square Wave Testing of amplifier.

Module – 4 **(4 Hours)**

Operational Amplifier: Ideal Op-Amp, Op-Amp Parameters, Open-loop and Closed-loop Gains, OP-AMP application as weighted summer, Differentiator and Integrator, Instrumentationamplifier.

Module – 5 **(6 Hours)**

Feedback amplifier and Oscillators: Concepts of negative and positive feedback, Four Basic Feedback Topologies, Advantage of Negative feedback, Principle of oscillation, OP-AMP based sinusoidal Oscillator Circuits: Wien Bridge oscillator and R-C Phase shift oscillator; CrystalOscillators.

COURSE OUTCOMES

After completion of the course, the student will be able to

1. Analyze and understand the different biasing techniques to have excellent stabilization against internal and external parameter variation.
2. Develop small-signal model to analyze the performance of different amplifier both for low frequency and high frequency operation.
3. Apply the concept of different feedback and feedback topologies in designing various circuits used for amplification and frequency generation.
4. Analyze and design operational amplifier based amplifier and oscillator circuits by understanding its characteristics and configuration details.

TEXT BOOKS:

1. Electronic Devices and Circuits theory, R.L. Boylestad and L. Nashelsky, 10th Edition, Pearson Education.

REFERENCE BOOKS:

1. Microelectronics Circuits, A. Sedra and K.C Smith, Oxford University press
2. Electronic Circuits: Analysis and Design(SIE), Donald Neamen, Mc-Graw Hills

3. Milliman's Electronics Devices and Circuits, J. Milliman, C. Halkias, 2nd Edition, TMH

Course Code:	Course Name:	L-T-P	Credit
19EEE4ES02T	Digital Electronics 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.

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.

TEXT BOOKS:

1. Digital Design, 3rd Edition, M. Morris Mano, Pearson Education.

REFERENCE BOOKS:

1. Digital Principles And Applications, Seventh Edition , Donald P Leach, Albert Paul Malvino, Goutam Saha, ,Tata McGraw Hill Education Private limited
2. Fundamentals of digital circuits, 8th edition, A. Anand Kumar, PHI
3. Digital Fundamentals, 5th Edition, T.L. Floyd and R.P. Jain, Pearson Education, New Delhi.
4. Digital Logic Design Principles, 2nd edition, Norman Balabanian & Bradley Carlson, Wiley 2004.

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.

Course Code:	Course Name:	L-T-P	Credit
19EEE4PE01T	Modeling and Simulation ofDynamicalSystems in Electrical Engineering	3- 0- 0	3

COURSE OBJECTIVES:

1. Recognize the main principles of dynamic systems modeling and simulation.
2. Familiarize with various numerical methods for solving differential equations.
3. Convey the analytical and practical details of a range of modelling techniques for non-linear systems.
4. Gain basic knowledge using different tools and methods in a unified approach to perform dynamic simulations dynamical systems.

SYLLABUS

Module- I **(6 Hours)**

Introduction: Overview of dynamical system and classification; dynamic modeling approaches; state-space modeling of dynamic system; selection of variables in state vector; development of state-space model of series RL, RC and RLC circuit; derivation of Swing equation: dynamics of synchronous machine.

Module-2 **(9 Hours)**.

Numerical integration of ordinary differential equations: Classification of numerical integration algorithms: Taylor series-based methods, single-step and multi-step methods, self-starting and non-self-starting methods; accuracy and stability of numerical integration methods: accuracy comparison, stability through Eigen value analysis, significance of Eigen values.

Module-3 **(8 Hours.)**

Fixed-Step Numerical Integration Methods and Applications: Demonstration of fixed-step numerical integration methods: Forward Euler method, Backward Euler method, Trapezoidal method, Runge-Kutta fourth order method: clarification about order of the method;

application of above methods to linear (series RL, RC and RLC circuit excited by (i) DC and (ii) AC) and non-linear electrical systems (Swing equation).

Module -4 (8 Hours)

Variable-Step Numerical Integration Method and Applications: Demonstration of variable-step numerical integration methods; features of variable-step methods; algorithm of Dormand-Prince method; application of Dormand-Prince method to linear (series RL, RC and RLC circuit excited by (i) DC and (ii) AC) and non-linear electrical systems (Swing equation).

Module -5(9 Hours)

Dynamic Modeling of Some Electrical Machines: Induction motor model: fifth order induction motor model, per-unit representation of the induction motor model; reduced order model for induction machine; modeling of DC motor-driven synchronous generator: DC motor modeling, DC motor driving a synchronous generator, synchronous generator supplying a pure resistive load/ series RL load.

COURSE OUTCOMES:

1. Construct dynamical models of electrical engineering systems and shall master different engineering tools for dynamic modeling and simulation including basic programming skills.
2. Demonstrate a basic understanding of differential equations and their role in engineering simulation.
3. Carry out independent modeling and simulation of dynamic systems, from physical description to mathematical models described by a set of differential equations, and further to solve the equations in a simulation (integration) process.
4. Explain the fundamental practical limitations of numerical simulation of dynamical systems and know how to recognize them.

TEXT BOOKS:

1. Power System Analysis: A dynamic perspective, K. N. Shubhanga, Pearson India Education Services Pvt. Ltd., 2018 Edition.
2. Dynamic Simulation of Electric Machinery: Using MATLAB/Simulink, Chee-MunOng, Prentice Hall, 1998.

REFERENCE BOOKS:

1. Dynamic systems: Modeling, Analysis and Simulation, Finn Haugen, Tapir Academic, 2004 Edition.
2. Linear Systems Theory and Design, Chi-Tsong Chen, Oxford University Press, NY, 1999.

Course Code:	Course Name:	L-T-P	Credit
19EEE4PE02T	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.

Module-1 **(7+6 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 **(6Hour)**

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

EM Wave: Reflection and Refraction(6hours)

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

Module-4

Transmission line & Analysis: (6hours)

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 **(7hour)**

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 OUTCOMES:

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 BOOKS:

1. Matthew. N.O. Sadiku&Kulkarani "Elements of Electromagnetics", sixth Edition, Oxford University Press, First Indian Edition 2015.
2. D.M Pozar, Microwave Engineering ,Fourth Edition,JohnWiley& Sons, Inc.

3. William H.Hayt Jr. and John A Buck "Engineering electromagnetics", Tata McGraw Hill 8th Revised Edition, 2011.

REFERENCE BOOKSs

1. Lifshitz, Evgeny; Landau, Lev (1980). The Classical Theory of Fields (4th ed.). Butterworth-Heinemann. ISBN 0-7506-2768-9
2. Taflove, Allen; Hagness, Susan C. (2005). Computational Electrodynamics: The Finite-Difference Time-Domain Method (3rd ed.). Artech House. ISBN 1-58053-832-0.
3. J.A.Edminister, "Schaum's Outlines of Electromagnetics", Third Edition, (Schaum'sOutlineseries), Tata McGraw hill 2010.
4. Kraus and Fleisch "Electromagenetics with Applications", McGraw Hill International Editions, 5th Edition 2010.
5. Bhag Singh Guru and Huseyin R. Hiziroglu, "Electromagnetic Field Theory Fundamentals" Cambridge University Press, 4th Revised Edition, 2014.
6. **Cui**, Tie Jun, **Smith**, David, **Liu**, Ruopeng,(2010) Metamaterials Theory, Design, and Applications, Springer, ISBN 978-1-4419-0573-4
7. Constantine A. Balanis, Antenna Theory: Analysis and Design, 3rd Edition, ISBN: 978-1-118-58573-3
8. MatteoPastorino, Microwave Imaging, ISBN: 978-0-470-27800-0
9. Smith, A. Mark (1996). Ptolemy's Theory of Visual Perception– An English translation of the Optics. The American Philosophical Society. ISBN 0-87169-862-5.

Course Code:	Course Name:	L-T-P	Credit
19EEE4PE04T	Signals and Systems	3- 0- 0	3

COURSE OBJECTIVE:

1. Basic knowledge about CT and DT signal and system,modeling concept, and analysis of LTI system
2. To develop expertise in time-domain and frequency domain analysis of CT and DT signals and systems.

Module-1: Introduction to Signals and Systems: Continuous and Discrete Time Signals and Systems (10 Hours)

Continuous time and Discrete signal, Classification of CT and DT signals: energy, power, periodic, aperiodic, even, odd, random, causal, anti-causal, standard signals, CT and DT system Classification : linear, non linear, time varying, time invariant, causal, non causal, stable, unstable, static, dynamic, Mathematical operations on CT and DT signals : amplitude scaling, time scaling, time shifting, folding, addition, multiplication, Convolution and Correlation of CT and DT signals: Convolution properties, correlation of energy and power signals, properties of correlation.

Module-2 Continuous Time Fourier Series and Fourier Transform (6 Hours)

Introduction, Fourier Series (FS) : Trigonometric, exponential , Gibb's phenomena, properties of Fourier series, Fourier Transform (FT) for CT signals: Introduction, FT of aperiodic signals, Convergence of FT, and Fourier Transform (FT) and its properties,FT of periodic signals, Analysis of CT systems using FT, energy spectral density and power spectral density.

Module-3 Laplace Transform (7 Hours)

Concept of complex frequency "S" Definition of Laplace transform and inverse Laplace transform, condition for existence, Laplace transform theorems, Differentiation and

Integration, Concept of initial condition, Laplace transform of commonly used functions (sine, cos, unit step function etc.), Initial value theorem, Final value Theorem

Module-4Discrete Time Fourier Series & Discrete Time Fourier Transform (6Hours)

Introduction, Discrete time Fourier Series (DTFS): Evaluation of DTFS coefficients and Fourier Spectra,properties of DTFS,DTFT of aperiodic DT signals, periodicity, convergence, and properties.

Module-5Z transform (7 Hours)

Z transform: Introduction, One sided and Two sided Z transform, Relationship with other transform, ROC, Properties, Inverse Z transform by long division , residue method and partial fraction method, Analysis of Linear Time Invariant (LTI) DT system using Z transform.

COURSE OUTCOMES:

Upon successful completion of this course the students will be able to:

1. Be able to describe continuous time signals and analyze the response of continuous time LTI system using different types of time domain analysis.
2. Able to analyze continuous time signal in frequency domain by using different properties of Fourier series and Fourier transform.
3. Be able to describe discrete time signals and analyze the response of discrete time LTI system using different types of time domain analysis.
4. Able to understand frequency domain analysis of Discrete time signal and system using various transform and its properties.

TEXT BOOKS:

1. Signals and Systems by Tarun Kumar Rawat , Oxford University Press
2. Signals and Systems by A. Nagoorkani, TMH

REFERENCE BOOKS:

1. Signals and Systems by A. V. Oppenheim, A.S. Wilsky, S. H. Nawab, Pearson 2nd Edition.
2. Signals and Systems by I.J. Nagrath, S. N. Sharan, R. RanjanTMH ,2nd Edition.
3. Signals and systems by Ramesh Babu, Scitech Publication.

Course Code:	Course Name:	L-T-P	Credit
19EEE4PC02L	Electrical Machine-II Laboratory	0- 0- 2	1

COURSE OBJECTIVES:

1. To study the performance characteristic of cylindrical rotor synchronous generator.
2. To study the performance characteristic of salient pole synchronous generator.
3. To study the performance characteristic of three-phase synchronous Motor.
4. To study the performance characteristics of three-phase induction motor.

SYLLABUS

Select any 8 experiments from the list of 10 experiments [Using Hardware]

LIST OF EXPERIMENT:

1. Determination of the voltage regulation of an alternator by synchronous impedance method and zero power factor (zpf) method
2. Determination of the V and inverted V curves of a synchronous motor
3. Determination of parameters of synchronous machine Positive sequence reactance, Negative sequence reactance and Zero sequence reactance
4. Determination of power angle characteristics of an alternator
5. Study of parallel operation of two alternators
6. Measurement of direct and quadrature axis reactance of a salient pole synchronous machine
7. Measurement of transient and sub transient reactance of a salient pole alternator.
8. Determination of parameters of three phase induction motor from No load Test and Blocked Rotor Test.
9. Determination of Efficiency, Plotting of Torque-Slip Characteristics of Three Phase Induction motor by Brake Test.
10. Determination of parameter of a single phase induction motor and study of

a) Capacitor start induction motor

b) Capacitor start and capacitor run induction motor

COURSE OUTCOMES:

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

1. Acquire hands on experience of conducting various tests on alternator and obtaining their performance indices using standard analytical method.
2. Acquire hands on experience of conducting various tests on 3-phase induction motor and obtaining their performance indices using standard analytical method

Course Code:	Course Name:	L-T-P	Credit
19EEE4PC03L	Electrical Measurement and Instrumentation Lab	0- 0- 2	1

COURSE EDUCATIONAL OBJECTIVE (CEO/COB):

1. Exposure to different types of measuring equipment.
2. Exposure to different types of Bridge circuit and its measurement techniques.
3. Measurement of various electrical quantities and calibration of electrical instruments.

SYLLABUS

1. Measurement of Low Resistance by Kelvin‟s Double Bridge & Wheatstone Bridge.
2. Measurement of Self Inductance and Capacitance using Bridges.
3. Study of Galvanometer and Determination of Sensitivity and Galvanometer Constants.
4. Calibration of Voltmeters and Ammeters using Potentiometers.
5. Testing of Energy meters (Single phase type).
6. Measurement of Iron Loss from B-H Curve by using CRO.
7. Measurement of R, L, and C using Q-meter.
8. Measurement of Power in a single-phase circuit by using CTs and PTs.
9. Measurement of Power and Power Factor in a three phase AC circuit by two wattmeter method.
10. Study of Spectrum Analyzers.

COURSE OUTCOME:

After completion of this course the students will be able to:

1. Measure components value by different AC and DC bridge techniques.
2. Calibrate different electrical instrument.
3. Measure power, energy and frequency of single and three phase circuits.

Course Code:	Course Name:	L-T-P	Credit
19EEE4PC04L	Electrical Power Transmission and Distribution Lab	0- 0- 2	1

COURSE EDUCATIONAL OBJECTIVE (CEO/COB):

1. To enhance understanding of electrical power system parameters including: Ferranti Effect, ABCD parameters, string efficiency.
2. To get the knowledge of reactive power and reactive power compensation in an electrical circuit.
3. To know the concept of corona discharge and different types of lighting arrester in a transmission line unit.

SYLLABUS

1. Study of Ferranti Effect.
2. Determination of ABCD parameters of a transmission line.
3. Determination of string efficiency.
4. Earth resistance measurement.
5. Series and shunt capacitance computation in transmission line.
6. Transformer oil test.
7. Study of various lightning arresters.
8. Distribution system power factor improvement using switched capacitor.
9. Study of corona discharge.

COURSE OUTCOME

After completion of this course the students will be able to:

1. Determine the different parameters like ABCD parameters, Ferranti effect and string efficiency in a transmission line.

2. Know the fundamentals concept of reactive power and its components in an actual transmission line.
3. Understand the concept of corona discharge and the application of lightning arrestor in a power system line.

Course Code:	Course Name:	L-T-P	Credit
19EEE4ES01L	Analog Electronics Circuit Lab	0- 0- 2	1

COURSE OBJECTIVE:

1. To illustrate the students different electronic circuit and their application in practice.
2. To impart knowledge on assessing performance of electronic circuit through monitoring of sensitive design and modeling parameters.

List of Experiments:

(At least 10 out of 13 experiments should be done)

1. Determination of cut- off and saturation voltage of a BJT and its application as a switch.
2. Assemble and test of BJT bias circuits: Fixed bias and feedback bias.
3. Design, assemble and test of BJT bias circuits: Voltage divider bias
4. Design, assemble and test of JEET bias circuits: fixed bias and self bias.
5. Design, assemble and test of BJT common-emitter circuit – D.C and A.C performance: Voltage gain, input impedance and output impedance with bypassed and un-bypassed emitterresistor.
6. Design, assemble and test of BJT emitter-follower – D.C and A.C performance: A.C. voltage gain, input impedance and outputimpedance.
7. Design, assemble and Test of JFET/MOSFET common-source amplifiers – D.C and A.C performance: Voltage gain, input impedance and outputimpedance.
8. Determination of Bandwidth of a common-emitter amplifier from its frequency response.
9. Determination of Bandwidth of a BJT CE amplifier using Square wave testing.

10. Design and test of Differential amplifier circuits with its DC and AC performance.
11. Design and test of Darlington connection/ current mirrorcircuits.
12. Graphical determination of h-parameters of a CE amplifier.
13. Design Wien Bridge/R-C phase shift oscillator.

COURSE OUTCOME

After completion of the course, the student will be able to

1. Test and experiment different types of BJT/JFET based electronic circuit and analyze their operation under different operating conditions.
2. Evaluate possible causes of discrepancy in experimental observations in comparison to theoretical outcome.
3. Practice different types of wiring and instruments connections keeping in mind technical, Economical, safety issues.
4. Prepare professional quality textual and graphical presentations of laboratory data and Computational results.

Course Code:	Course Name:	L-T-P	Credit
19EEE4ES02L	Digital Electronics Circuit Lab	0- 0- 2	1

COURSE OBJECTIVES:

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

LIST OF EXPERIMENTS:

2. Digital Logic Gates: Investigate logic behavior of AND, OR, NAND, NOR, EX-OR, and Inverter gates.
3. Gate-level minimization: Two level and multi-level implementation of Boolean functions.
4. Design and Testing of combinational circuits: Half-Adder, Half-Subtraction, and Full Adder.
5. Design of binary to Gray, Gray to Binary Code Converter, and Seven Segment Display Decoder.
6. Design and implementation of 2-bit Binary Multiplier
7. Testing of Multiplexer and function implementation using suitable Multiplexer.
8. Testing of Decoder and function implementation using suitable Decoder.
9. Testing of basic SR Latch and FFs: D-FF, JK-FF
10. Design and Testing of SISO, SIPO Shift Registers
11. 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.

5th Semester B.Tech.

(Electrical and Electronics Engineering)

Detailed Syllabus

Fifth Semester (Electrical and Electronics Engineering)					
Theory					
Sl. No.	**Category**	**Subject Code**	**Subject Name**	**L-T-P**	**Credit**
1	PCC	19EEE5PC01T	PCC-6: Power Electronics	3-0-0	3
2	PCC	19EEE5PC02T	PCC-7: Control System Engineering	3-0-0	3
3	PCC	19EEE5PC03T	PCC-8: Digital Signal Processing	3-0-0	3
4	PEC	19EEE5PE01T/ 19EEE5PE02T/ 19EEE5PE03T/ 19EEE5PE04T	Power Station Engineering and Economy/ Sensors and Transducers/ Renewable Power Generation Systems/ Electrical Properties of Materials	3-0-0	3
5	OEC	19EEE5OE01T	Sensors and Instrumentation	3-0-0	3
6	OEC	19EEE5OE02T	Introduction to Electrical Properties of Materials	3-0-0	3
7	MC	19CM5MC01T/ 19CM5MC02T	Mandatory(Constitution of India/ Essence of Indian Tradition Knowledge)	1-0-0	0
Total Credit (Theory)					18
Practical					
1	PCC	19EEE5PC01L	Power Electronics Lab	0-0-2	1
2	PCC	19EEE5PC02L	Control System Engineering Lab	0-0-2	1
3	PCC	19EEE5PC03L	Digital Signal Processing Lab	0-0-2	1
4	PSI	19EEE5PS01L	Summer Internship/Training	0-0-2	1
Total Credit (Practical)					4
Total Semester Credit					22

Subject Code :	**Subject Name:**	**L-T-P**	**Credit 3**

19EEE5PC01T	**Power Electronics**	**3- 0- 0**	

COURSE OBJECTIVES:

1. To study the characteristics of power semi-conductor devices and commutation circuits.
2. To study and design the single phase half wave and full wave controlled converter.
3. To study the three phase converters with R, RL and RLE loads.
4. To study the operational characteristics of AC voltage controllers and power electronics applications.
5. To study the operation of Choppers and Inverters.

SYLLABUS

Module-1 **(10 Hours)**

Power Semiconductor Devices

Switching and V-I characteristic of devices: power diode, Thyristor family: SCR, TRIAC, GTO, Transistor Family: BJT, IGBT and MOSFET, Series and parallel grouping of SCR.

Triggering Methods

SCR: (Cosine Firing Scheme), BJT gate drive, IGBT gate drive, TRIAC firing circuit, Isolation of gate and base drive, Commutation Schemes: Current and Voltage Commutation, Line Commutation.

Protection of Devices

SCR: Over voltage, Over Current, dv/dt, di/dt, Gate Protection. Transistor: protection of power BJT, IGBT and power MOSFET, dv/dt & di/dt limitation.

Module-2 **(6 Hours)**

AC to DC converter

Un-controlled Diode rectifier: Single phase half wave and full wave rectifiers with R-L and R-L-E load, 3 phase bridge rectifier with R-L and R-L-E load. Phase Controlled Converter: Principle of phase controlled converter operation, single phase full converter with R-L and R-L-E load, 3 phase full converter with R-L and R-L-E load ,single phase semi converter with R-L and R-L-E load, 3 phase semi-converter with R-L and R-L-E load and effect of source inductance.

Module-3 **(6 Hours)**

AC –AC converter

AC voltage controller: Single phase bi-directional controllers with R and R-L load, Power Electronics converters for renewable energy systems.

Applications:
UPS, SMPS, Battery Chargers, SVC.

Module-4 **(6 Hours)**

DC to AC converter

Inverters: Single phase Bridge Inverters, 3-Phase Inverters-180° mode conduction, 120°mode conduction. Voltage control of 3-Phase Inverters by Sinusoidal PWM, Current Source Inverter.

Module-5: **(6 Hours)**

DC to DC converter

Classification: First quadrant, second quadrant, first and second quadrant, third and fourth quadrant, fourth quadrant converter. Switching mode regulators: Buck regulators, Boost regulators, Buck-Boost regulators, Isolated Types: Fly Back Converters, Forward converters, Push Pull Converters, Bridge Converter and Bi-directional Converters.

COURSE OUTCOMES:

After completion of this course the students would gain enough knowledge.

1. Acquire knowledge about fundamental concepts and techniques used in power electronics.
2. Ability to analyze various single phase and three phase power converter circuits and understand their applications.
3. Foster ability to identify basic requirements for power electronics based design application.
4. To develop skills to build, and troubleshoot power electronics circuits.
5. Foster ability to understand the use of power converters in commercial and industrial applications.

TEXT BOOKS:

1. Power Electronics: Circuits, Devices and Applications by M H Rashid, 4th Edition, Pearson Education, 2017.
2. Power Electronics: By P. C. Sen, Tata McGraw Hill Education, 2nd Edition, 2017.

REFERENCE BOOKS:

1. Power Electronics: Converters, Applications and Design by Ned Mohan, Tore M Undeland, William P Robbins, 3rd Edition, John Wiley and Sons Publications, 2007.
2. Power Electronics by P.S. Bimbhra, Khanna Publishers, Sixth Edition, 2018.
3. Elements of Power Electronics: Philip T. Krein, Oxford University Press, 2nd Edition, 2017.
4. Power Electronics by M.D. Singh and K.B. Khanchandani, Tata McGraw Hill Education.

DIGITAL LEARNING RESOURCES:

Couse Name	Power Electronics
Course Link	https://nptel.ac.in/courses/108/101/108101038/
Course Instructor	Prof. B.G Fernandes, Electrical Engineering, IIT Bombay

Subject Code: 19EEE5PC02T	Subject Name: Control System Engineering	L-T-P 3- 0- 0	Credit 3

COURSE OBJECTIVES:

1. The students should be able to learn the type of System, dynamics of physical systems, classification of control system, analysis and design objective.
2. The students should learn how to represent system by transfer function and block diagram reduction method and Mason's gain formula.
3. The students should able to learn time response analysis and demonstrate their knowledge to frequency response.
4. Students can be able to learn stability analysis of system using Root locus, bode plot, polar plot and Nyquist plot.

SYLLABUS

Module-1: **(10Hours)**

Mathematical Modeling of Physical Systems and Transfer Function Representation

Introduction: Basic Concepts of Control Systems, Open loop and closed loop systems.

Feedback Characteristics of Control Systems: Feedback and Non-feedback System, effect of Feedback on Overall gain, stability, sensitivity, and external disturbance or noise. Types of feedback control systems, linearizing effect of feedback,

Mathematical Modeling of Physical Systemsand Transfer function representation: Impulse response and transfer functions of linear systems, Applications of Laplace Transform to Control System, Determination of Transfer functions by block diagram algebra, and Signal Flow Graphs. Concepts of State and state variable model, modeling of physical systems. Linearization of Nonlinear systems, systems with transport lag.

Control System and Components: Servo Mechanism/Tracking System, Modeling of DC Servomotor, AC Servomotor, Synchros.

Module-2: **(10Hours)**

Time Domain Analysis and Stability of Linear control systems

Time response Analysis: Typical test Signals for Time response of control systems Steady State Errors and Static Error Constants. Step and impulse responses of first order, second order and higher order systems, time domain specifications, Transient response of a prototype second order systems, time domain analysis of a position- control systems, effects of adding poles and zeros to transfer functions.

Stability of Linear control systems: Concept of stability, BIBO stability, zero-input and asymptotic stability of continuous – data systems, methods of determining stability, Rout-Hurwitz Criterion.

Root locus Technique: Basic properties of the root loci, properties and construction of Root Loci. Root Contour.

Module-3: **(10Hours)**

Frequency Domain Analysis and Stability in Frequency Domain

Frequency Response Analysis: Frequency response of closed – Loop systems, frequency domain specifications. Correlation between time response and frequency Response Characteristics.

Stability in Frequency Domain: Mathematical Preliminaries, Stability analysis using Bode plot, polar plot, Nyquist Stability Criterion, Relative stability.

Closed loop frequency response: Constant – M Loci in the G (jω) -plane, Constant – Phase Loci in the G (jω) – plane, Constant – M Loci in the Magnitude – Phase Plane: Nichols Chart.

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

Design of Control Systems

Design of control systems with PD, PI, PID, Phase – Lead, Phase – Lag, and Lead- Lag Controllers. Forward and Feed Forward Controllers.

Module-V: State Space Analysis of Continuous Time Systems **(6 Hours)**

State Variable Analysis: State transition Matrix, solution of state equations, controllability and observability, Conversion of state space model to transfer function model, Conversion of transfer function model to state space model.

COURSE OUTCOMES:

After completion of this course the students will be able to:

1. Identify open and closed loop control system, Formulate mathematical model for physical systems and Simplify representation of complex systems using reduction techniques.
2. Use standard test signals to identify performance characteristics of first and second-order systems.
3. Apply root locus technique for stability analysis.
4. Analyze performance characteristics of system using Frequency response methods

TEXT BOOKS:

1. "Modern Control Engineering" by K. Ogata, 5th edition, WordPress publications (2016).
2. "Control Systems Engg." by I.J. Nagrath and M.Gopal, 6th Edition, New Age International Publishers (2017).

REFERENCE BOOKS:

1. "Automatic Control Systems" by Benjamin C. Kuo, 7th Edition, Prentice-Hall India publication (1995)
2. "Modern Control Systems" by Richard Dorf, and Robert Bishop, 13thEdition, PearsonPublications (2016).
3. "Design of Feedback control systems" by Stephani, Shahain, Savant and Hostetter, 4th edition, Oxford publications (2006).

DIGITAL LEARNING RESOURCES:

Course Name	Control Engineering
Course Link	https://nptel.ac.in/courses/108/102/108102043/
Course Instructor	Prof. Madan Gopal, Department of Electrical Engineering, IIT Delhi

Subject Code: 19EEE5PC03T	Subject Name: Digital Signal Processing	L-T-P: 3-0-0	Credit: 3

COURSE OBJECTIVES:

The objective of this course is to introduce students to

1. Understand thoroughly the frequency domain analysis of discrete time signals.
2. Do mathematical modeling of digital filters.
3. Structural Implementation of digital filters.
4. Find the concepts of multi-rate signal processing and use of adaptive filter in real-time applications of DSP.

SYLLABUS

Module-1 **(8 Hours)**

Z-Transform & its Applications:

Overview of Discrete time signals and systems. Z-Transform and Its Application to the Analysis of LTI Systems: Direct Z-Transform, Properties of the Z- Transform, Inverse Z-Transform by Power Series Expansion, and Partial-Fraction Expansion, Analysis of Linear Time Invariant Systems in the Z-Domain.

Module-2 **(10 Hours)**

Discrete Fourier Transform:

Frequency-Domain Sampling and Reconstruction of Discrete-Time Signals, DFT as a Linear Transformation, Relationship of DFT to other Transforms, Properties of DFT. Use of DFT in Linear Filtering: Sectional Convolution. Introduction to the Fast Fourier Transform (FFT) algorithm, Radix 2 Decimation in Time (DIT), Radix 2 Decimation in Frequency (DIF).

Module-3 **(8 Hours)**

Digital Filter Design:

Design of FIR filters: Impulse Response of ideal LPF, HPF, BPF and BSF, Frequency response of linear phase FIR filters by Windowing methods and Frequency Sampling method.

Design of IIR filters: Butterworth, and Chebyshev, Conversion to digital IIR Filter using Impulse Invariance Technique and Bilinear Transformation. Frequency transformation in analog and digital domain.

Module-4 **(4Hours)**

Structure and Implementation of FIR and IIR Filter:

Structure of IIR Systems: Direct form – I realization Direct form – II realization. Structure of FIR Systems: Direct- Form Structure, Cascade-Form Structure, and Frequency Sampling Structure.

Module-5 **(6Hours)**

Multi-rate DSP & Adaptive Filter:

Multi-rate DSP: Introduction to Multi-rate DSP, Decimation, Interpolation, Sampling rate conversion by rational factor, Implementation of sampling rate conversion.

Adaptive filters: Adaptive Wiener filter and LMS algorithm, Application of Adaptive Filters: System Identification or System Modeling, Adaptive Channel Equalization, Adaptive Line Enhancer, Adaptive Noise Cancelation.

COURSE OUTCOMES:

On Completion of this course, the students should be able to:

1. Apply the discrete time transform techniques to analyze the discrete time signals and systems.
2. Implement various digital signal processing algorithms for realization of efficient systems by reducing computational complexity.
3. Design, analyze and compare digital filters based on their complexity and stability.
4. Apply multi-rate signal processing and adaptive filter theory in practical applications used for signal processing.

TEXT BOOKS:

1. Digital Signal Processing by J. G. Proakis and D. G. Manolakis, 4th Edition, 2007, Pearson Publication.
2. Digital Signal Processing by Tarun K. Rawat, 2015, Oxford University Press.

REFERENCE BOOKS:

1. Digital Signal Processing, a Computer-Based Approach, Sanjit K. Mitra, 1987, TMH
2. Digital Signal Processing, S. Salivahan, A. Vallavraj and C. Gnanapriya, 2001, TMH.
3. Statistical Digital Signal Processing and Modelling, Manson H. Hayes, 1996, Wiley.
4. Advanced Digital Signal Processing, Shalia D. Apte, 2013, Willey Publication

DIGITAL LEARNING RESOURCES:

Course Name	Digital Signal Processing
Course Link	https://nptel.ac.in/courses/117/102/117102060/
Course Instructor	Prof. S. C. Dutta Roy, IIT Delhi

Course Name	Digital Signal Processing
Course Link	https://nptel.ac.in/courses/117/105/117105144/
Course Instructor	Prof. Govind Sharma, IIT Kanpur

Subject Code: 19EEE5PE01T	**Subject Name: Power Station Engineering & Economy**	**L-T-P 3- 0- 0**	**Credit 3**

COURSE OBJECTIVES:

1. The students will be able to learn the general concepts of energy scenario in India, and what are the different factors affecting to power generation.
2. After some introductory lectures, the students will be investigating the problems related to factors and to know about power plant economics.

3. The students should learn topics related to nuclear power station and brief study of various types of reactors.
4. The students should learn topics related to hydro power stations and various types of turbines.
5. Students can be able to learn the thermal power station and different types of boilers. The students will have an idea about chimney, condenser, evaporators and electrostatic precipitator.

SYLLABUS

Module-1 **(10 Hours)**

Introduction: Introduction to different sources of energy and general discussion on their application to generation, Indian energy scenario, Load duration curves, load factor, Capacity factor, Reserve factor, Demand factor, demand factor, problems related to all factors,

ECONOMICS OF POWER GENERATION: Construction costs, Fixed cost and Depreciation, Fuel cost, Economic scheduling principle, Annual Operating Costs, Effect of Load Factor on cost per kWh,

NUCLEAR POWER STATION: Introduction to fission & fusion, reactor construction, controlled chain reaction, operational control of reactors, Brief study of various types of reactors, Boiling water, pressurized water, heavy water, breeder, Location and layout of nuclear power plant.

Module-2 **(12 Hours)**

Nuclear power station: Introduction to fission & fusion, Principle of Nuclear Energy, Reactor Construction, Controlled Chain Reaction, Brief study of various Types of Power Reactor, Operational Control of Reactors, Location and layout of nuclear power plant, Economics of Nuclear Power Station.

Module-3 **(8 Hours)**

Hydro Electric power station: Selection of site for hydro-electric power plant. Hydrology: Hydrological cycle, precipitation, run-off and its measurement, hydrograph, flow duration and mass curves, Estimation of amount stored by a dam across the river, Storage and Pondage, Elementary idea about Earthen and Concrete Dam.

Module-4 **(8 Hours)**

Types of Turbines: Operational principle of Kaplan and Francis Turbine and Pelton wheel, Speed and Pressure Regulation, Work done and Efficiency. Arrangement and location of Hydroelectric Station: Catchment area, Reservoir, Dam, Head Gate, Spillways, Pen stock,

Surge Tanks, Scroll case, Draft tubes and Tail Race, Power House, Classification of Hydroelectric Power Plants.

Module-5 **(10 Hours)**

Thermal power station: Selection of site for thermal power plant. Main Parts and Working of a Steam Station: Overall Block Diagram indicating the air circuit, coal and ash circuit, water and steam circuit, various types of steam turbines, ash and coal handling system, High Pressure and High capacity water tube boilers, Economizer, Superheaters, De-Superheater, Re-heater, Air Pre-heater Draft System: Natural, Induced Forced and Balance Draft, PA fan, FD fan, ID fan, Chimney. Condensers, Feed water heaters, Evaporators, Make-up water, bleeding of steam, cooling water system. Electrostatic Precipitator: Basic working Principle and constructional details Governors, Plant auxiliaries.

COURSE OUTCOMES:

After completion of this course the students will be able to:

1. Gains about the Indian energy scenario and learn about the various factors affecting generation. The students have the idea of power plant economics.
2. Learn about the nuclear power station. The students will design the layout of nuclear power plant.
3. Design the layout of hydro power plant and learn about various types of turbines.
4. Design overall diagram of thermal power plant and have the idea about the electrostatic precipitator.

TEXT BOOKS:

1. P. K. Nag, “Power Plant Engineering”, 3rd Edition, Tata McGraw Hill Publication.
2. M. V. Deshpande, “Elements of Electrical Power Station Design”, PHI.
3. Bernhardt G. A. Skrotzki, William A. Vopat, “Power Station Engineering and Economy”, 2nd Edition, Tata McGraw Hill Publication.

REFERENCE BOOKS:

1. Arora &Domkundwar, “A Course in Power Plant Engineering”, Dhanpat Rai and sons.
2. R. K. Rajput, “A Text Book of Power Plant Engineering”, 3rd Edition, Laxmi Publishing.

DIGITAL LEARNING RESOURCES:

Course Name	Energy Resources and Technology
Course Link	NPTEL visit http://nptel.iitm.ac.in.
Course Instructor	Prof.S.Banerjee,Department of Electrical Engineering, IIT Kharagpur.

Subject Code: 19EEE5PE02T	**Subject Name:** Sensors and Transducers	**L-T-P** 3- 0- 0	**Credit** :3

COURSE OBJECTIVES:

1. The students will understand the concepts of measurement technology.
2. They learn the various sensors used to measure various physical parameters.
3. They will learn the fundamentals of signal conditioning, data acquisition and communication systems used in mechatronics system development.

SYLLABUS

Module -1 **(9 Hours)**

Elements of a general 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.

(Bentley: Chapters 1-4)

Module-2 **(8 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.

(Bentley: Sections 8.1 to 8.6)

Module-3 **(8 Hours)**

Thermoelectric sensing elements: laws, thermocouple characteristics, installation problems, cold junction compensation. IC temperature sensor Elastic sensing elements: Bourdon tube, bellows, and diaphragms for pressure sensing, force and torque measurement.

(Ghosh: Section 10.3 to 10.4)

Module-4 **(8 Hours)**

Signal Conditioning Elements: Deflection bridges: design of resistive and reactive bridges, push-pull configuration for improvement of linearity and sensitivity. Amplifiers: Operational amplifiers-ideal and non-ideal performances, inverting, non-inverting and differential amplifiers, instrumentation amplifier, filters. A.C. carrier systems, phase sensitive demodulators and its applications in instrumentation

(Bentley: Sections 9.1 to 9.3; Ghosh: Sections 15.1 and 15.2)

Module-5 (Additional Module) **(8 Hours)**

Digital and Semiconductor Sensors: Position Encoders, Resonant Sensors, SAW Sensors, Sensors Based On Semiconductor Junctions, Sensors Based On MOSFET Transistors, Charge-Coupled and CMOS Image Sensors, Fiber-Optic Sensors, Ultrasonic-Based Sensors. Sensors for Robotics: Proximity Sensors: Typical Sensor Characteristics, Technologies for Proximity Sensing, Electro-Optical Sensors, Capacitive Sensors, Magnetic Sensors.

COURSE OUTCOMES:

At the end of the course, a student will be able to:

1. Use concepts in common methods for converting a physical parameter into an electrical quantity.

2. Classify and explain with examples of transducers, including those for measurement of temperature, strain, motion, position and light.
3. Choose proper sensor comparing different standards and guidelines to make sensitive measurements of physical parameters like pressure, flow, acceleration, etc
4. Predict correctly the expected performance of various sensors

TEXT BOOKS:

1. Principles of Measurement Systems- J.P. Bentley (3/e), Pearson Education, New Delhi,2007.
2. Introduction to Measurement and Instrumentation- A.K. Ghosh (3/e), PHI Learning, New Delhi, 2009.

REFERENCE BOOKS:

1. Measurement Systems Application and Design- E.O. Doeblin (4/e), McGraw-Hill, International, NY.
2. Electronic Measurements and Instrumentation, Instrumentation for Engineering Measurements- J.W. Dally, W.F. Riley and K.G. McConnel (2/e), John Wiley, NY, 2003.
3. Industrial Instrumentation- T.R. Padmanabhan, Springer, London, 2000.
4. Patranabis D, Sensors and Transducers, 2nd Edition, PHI, New Delhi, 2010

DIGITAL LEARNING RESOURCES:

Course Name	Sensor and Transducer
Course Link	https://nptel.ac.in/courses/108/108/108108147/ https://nptel.ac.in/courses/108/105/108105064/
Course Instructor	Dr. Hardik Jeetendra Pandya, Department of Electronic Systems Engineering, IISc Bangalore Prof. Alok Barua, Department of Electrical Engineering, IIT Kharagpur.

Subject Code: 19EEE5PE03T	Subject Name: Renewable Power Generation Systems	L-T-P 3-0-0	Credit : 3

COURSE OBJECTIVES:

The program is expected to enable the students to

1. Design and develop innovative products and services in the field of Renewable Energy.
2. Keeps abreast with the latest technology and toolset.
3. Communicate effectively to propagate ideas and promote teamwork
4. Attain intellectual leadership skills to cater to the changing needs of power industry, academia, society and environment

SYLLABUS

Module-1 **(7 Hours)**

Introduction: Conventional energy Sources and its Impacts, Non-conventional energy– seasonal variations and availability, Renewable energy – sources and features, Distributed energy systems and dispersed generation (DG). Solar Energy: Solar processes and spectral composition of solar radiation. Solar Thermal system-Solar collectors, Types and performance characteristics, Applications-Solar water heating systems(active & passive) , Solar space heating & cooling systems , Solar desalination systems, Solar cooker.

Module-2 **(7 Hours)**

Solar photovoltaic system-Operating principle, Photovoltaic cell concepts, Cell, module, array, Losses in Solar Cell, Effects of Shadowing-Partial and Complete Shadowing, Series and parallel connections, Cell mismatching, Maximum power point tracking, Applications-Battery charging, Pumping, Lighting, Peltier cooling, Modelling of PV cell.

Module-3 **(10 Hours)**

Wind Energy: Wind energy, Wind energy conversion; Wind power density, efficiency limit for wind energy conversion, types of converters, aerodynamics of wind rotors, power ~ speed and torque speed characteristics of wind turbines, wind turbine control systems; conversion to electrical power: induction and synchronous generators, grid connected and self-excited induction generator operation, constant voltage and constant frequency generation with power electronic control single and double output systems, reactive power compensation, Characteristics of wind power plant, Concept of DFIG.

Module-4 **(9 Hours)**

Biomass Power: Principles of biomass conversion, Combustion and fermentation, Anaerobic digestion, Types of biogas digester, Wood gassifier, Pyrolysis, Applications. Bio gas, Wood stoves, Bio diesel, Combustion engine, Application.

Module-5 **(6 Hours)**

Hybrid Systems: Need for Hybrid Systems, Range and type of Hybrid systems, Case studies of Diesel-PV, Wind-PV, Micro hydel-PV, Biomass-Diesel systems, electric and hybrid electric vehicles.

COURSE OUTCOMES:

1. Appraise the need and possibility of extracting solar energy and converting into electrical energy using PV cell.
2. Design and analyze stand-alone and grid connected PV system.
3. Describe the dynamics of wind turbine and electrical generator.

4. Select and design suitable configuration of the wind energy conversion system based on application.
5. Suggest, design and analyze hybrid energy systems.

TEXT BOOKS:

1. Godfrey Boyle, "Renewable Energy- Power for a Sustainable Future",Oxford University Press.
2. B.H.Khan, "Non-Conventional Energy Resources",Tata McGrawHill, 2009.
3. S. N. Bhadra, D. Kastha, S. Banerjee, "Wind Electrical Systems",Oxford University Press, 2005.
4. S. A. Abbasi, N. Abbasi, "Renewable Energy Sources and Their Environmental Impact", Prentice Hall of India, New Delhi, 2006.

REFERENCE BOOKS:

1. S. Borlase, "Smart Grids, Infrastructure, Technology and Solutions", CRC Press, 1st Edition, 2013.
2. N. D. Hatziargyriou, "Microgrids Architecture and control", IEEE Press Series, John Wiley & Sons Inc, 1st Edition, 2013.

DIGITAL LEARNING RESOURCES:

Course Name	Solar, Wind and Biomass Energy Systems
Course Link	https://nptel.ac.in/courses/103/103/103103206/
Course Instructor	Prof. R. Anandalakshmi Prof. Vaibhav Vasant Goud, Department of Chemical Engineering, IIT Guwahati
Course Name	Solar & Wind Energy
Course Link	https://nptel.ac.in/courses/103/107/103107157/
Course Instructor	Prof. P. Mondal, Department of Chemical Engineering, IIT Roorkee
Course Name	Energy Resources
Course Link	https://www.youtube.com/watch?v=cZSYukWvpsE
Course Instructor	Prof. Rangan Benarjee, Department of Energy Science & Technology, IIT Bombay
Course Name	Design of Photovoltaic system
Course Link	https://www.youtube.com/watch?v=hr2sId412zU&list=PLuv3GM6-gsE2KyXoBTQ6lbrwn22Z3SiVm&index=2
Course Instructor	Prof. L. Umanand, Department of Electronic System Engineering, IISC Bangalore

Subject Code: 19EEE5PE04T	Subject Name: Electrical Properties of Materials	L-T-P 3-0-0	Credit : 3

COURSE OBJECTIVES:

1. To understand the conducting properties of metal.
2. To give knowledge about semiconductor materials.
3. To give knowledge about the insulating materials and their applications.
4. To acquire the knowledge about the dielectric materials.
5. To have knowledge about magnetic materials.
6. To have knowledge about special purpose materials.

SYLLABUS

Module-1 **(8 Hours)**

Conductivity of Metal: Introduction, factors affecting the resistivity of electrical materials, motion of an electron in an electric field, Equation of motion of an electron, current carried by electrons, mobility, energy levels of a molecule, emission of electrons from metals, thermionic emission, photo electric emission, field emission.

Module-2 **(8 Hours)**

Effect of temperature on electrical conductivity of metals, electrical conducting materials, thermal properties, thermal conductivity of metals, thermoelectric effects. Dielectric Properties: Introduction, effect of a dielectric on the behaviour of a capacitor, polarization, the dielectric constant of monatomic gases, frequency dependence of permittivity.

Module-3 **(9 Hours)**

Dielectric losses, significance of the loss tangent, dipolar relaxation, frequency and temperature dependence of the dielectric constant. Dielectric properties of polymeric system, ionic conductivity in insulators, insulating materials, Ferro-electricity, piezoelectricity.

Module-4 **(8 Hours)**

Magnetic properties of Materials: Introduction, Classification of magnetic materials, diamagnetism, para-magnetism, ferromagnetism, magnetization curve, the hysteresis loop, factors affecting permeability and hysteresis loss, common magnetic materials, magnetic resonance.

Module-5 **(8 Hours)**

Semiconductors: energy band in solids, conductors, semiconductors and insulators, types of semiconductors, Intrinsic semiconductors, impurity type semiconductor, diffusion, the Einstein relation, hall effect, thermal conductivity of semiconductors, electrical conductivity of doped materials.

TEXT BOOKS:

1. C. S. Indulkar and S. Thiruvengadam, S., “An Introduction to Electrical Engineering
2. Kenneth G. Budinski, “Engineering Materials: Prentice Hall of India, New Delhi
3. ELECTRICAL PROPERTIES OF MATERIALS, 9th Edition (L. Solymer, Donald Walsh,R. R .A. Syms)
4. Electrical and Electronic Engineering Materials by SK Bhattacharya, Khanna Publishers, New Delhi.

REFERENCE BOOKS:

1. Electrical Engineering Materials Adrianus J Dekker, Phi Learning Publishers.
2. Introduction to Electrical Engineering Materials 4th Edn. 2004 Edition by Indulkar C, S. Chand & Company Ltd-New Delhi.

COURSE OUTCOMES:

After the completion of the course, the students will be able to

1. Understand the various kinds of materials and their applications in ac and dc fields.
2. Understand the conductivity of superconductivity of materials.
3. Explain the electrical properties of different materials and metallic behavior of materials on the basis of band theory.
4. Explain the properties and applications of all kind of magnetic materials.
5. Explain the properties of electrical conducting and insulating materials.
6. Assess a variety of approaches in developing new materials with enhanced performance to replace existing materials.

DIGITAL LEARNING RESOURCES:

Course Name	Processing of Semiconducting Materials
Course Link	http://nptel.ac.in
Course Instructor	Dr. Pallab Banerji,Department of Metallurgy and Material Science,IIT Kharagpur.

Subject Code: 19EEE5OE02T	Subject Name: Introduction to Electrical Properties of Materials	L-T-P 3-0-0	Credit : 3

COURSE OBJECTIVES:

1. To understand the conducting properties of metal.
2. To give knowledge about semiconductor materials.
3. To give knowledge about the insulating materials and their applications.
4. To acquire the knowledge about the dielectric materials.
5. To have knowledge about magnetic materials.
6. To have knowledge about special purpose materials.

SYLLABUS

Module-1 **(8 Hours)**

Conductivity of Metal: Introduction, factors affecting the resistivity of electrical materials, motion of an electron in an electric field, Equation of motion of an electron, current carried by electrons, mobility, energy levels of a molecule, emission of electrons from metals, thermionic emission, photo electric emission, field emission.

Module-2 **(6 Hours)**

Dielectric Properties: Introduction, effect of a dielectric on the behaviour of a capacitor, polarization, the dielectric constant of monatomic gases, frequency dependence of permittivity.

Module-3 **(9 Hours)**

Dielectric losses, significance of the loss tangent, dipolar relaxation, frequency and temperature dependence of the dielectric constant. Dielectric properties of polymeric system, ionic conductivity in insulators, insulating materials, Ferro-electricity, piezoelectricity.

Module-4 **(8 Hours)**

Magnetic properties of Materials: Introduction, Classification of magnetic materials, diamagnetism, para-magnetism, ferromagnetism, magnetization curve, the hysteresis loop, factors affecting permeability and hysteresis loss, common magnetic materials, magnetic resonance. Superconductivity and its origin, Zero resistance and Meissner Effect, critical current density.

Module-5 **(8 Hours)**

Semiconductors: energy band in solids, conductors, semiconductors and insulators, types of semiconductors, Intrinsic semiconductors, impurity type semiconductor, diffusion, the Einstein relation, hall effect, thermal conductivity of semiconductors, electrical conductivity of doped materials.

COURSE OUTCOMES:

After the completion of the course, the students will be able to

1. Understand the various kinds of materials and their applications in ac and dc fields.
2. Understand the conductivity of superconductivity of materials.
3. Explain the electrical properties of different materials and metallic behavior of materials on the basis of band theory.
4. Explain the properties and applications of all kind of magnetic materials.
5. Explain the properties of electrical conducting and insulating materials.
6. Assess a variety of approaches in developing new materials with enhanced performance to replace existing materials.

TEXT BOOKS:

1. C. S. Indulkar and S. Thiruvengadam, S., “An Introduction to Electrical Engineering
2. Kenneth G. Budinski, “Engineering Materials: Prentice Hall of India, New Delhi

3. ELECTRICAL PROPERTIES OF MATERIALS, 9th Edition (L. Solymer, Donald Walsh,R. R .A. Syms)
4. Electrical and Electronic Engineering Materials by SK Bhattacharya, Khanna Publishers, New Delhi.

REFERENCE BOOKS:

1. Electrical Engineering Materials Adrianus J Dekker, Phi Learning Publishers.
2. Introduction to Electrical Engineering Materials 4th Edn. 2004 Edition by Indulkar C, S. Chand & Company Ltd-New Delhi.

DIGITAL LEARNING RESOURCES:

Course Name	Processing of Semiconducting Materials
Course Link	http://nptel.ac.in
Course Instructor	Dr. Pallab Banerji,Department of Metallurgy and Material Science,IIT Kharagpur.

Subject Code: 19EEE5OE01T	**Subject Name: Sensor and Instrumentation**	**L-T-P: 3-0-0**	**Credit: 3**

COURSE OBJECTIVES:

The students will

1. Understand the concepts of measurement technology.
2. They learn the various sensors used to measure various physical parameters.
3. They will learn the fundamentals of signal conditioning and data acquisition.
4. Learn how to use virtual instrumentation for measurement.

SYLLABUS

Module-1 **(8 Hours)**

Sensors & Transducer: Definition, Classification & selection of sensors, Elements of a general 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 **(8 Hours)**

Measurement of displacement using Potentiometer, LVDT & Optical Encoder, Measurement of force using strain gauge, Measurement of pressure using LVDT based diaphragm & piezoelectric sensor

Module-3 **(8 Hours)**

Signal Conditioning Elements: Deflection bridges: design of resistive and reactive bridges,push-pull configuration for improvement of linearity and sensitivity. Amplifiers:Operational amplifiers-ideal and non-ideal performances, inverting, non-inverting anddifferential amplifiers, instrumentation amplifier, filters. A.C. carrier systems, phasesensitive demodulators and its applications in instrumentation

Module-4 **(10 Hours)**

Virtual Instrumentation: Graphical programming techniques, Data types, Advantage of Virtual Instrumentation techniques, Concept of WHILE & FOR loops, Arrays, Clusters & graphs,Structures: Case, Sequence & Formula nodes, need of software based instruments for industrial automation.

Module – 5 **(4 Hours)**

Data Acquisition Methods: Basic block diagram, Analog and Digital IO, Counters, Timers, Types of ADC: successive approximation and sigma-delta, Types of DAC: Weighted Resistor and R-2R Ladder type, Use of Data Sockets for Networked Communication

COURSE OUTCOMES:

After completion of the course, the student will be able to

1. Apply the use of sensors for measurement of displacement, force and pressure.
2. Employ commonly used sensors in industry for measurement of temperature, position, accelerometer, vibration sensor, flow and level.
3. Demonstrate the use of virtual instrumentation in automation industries.
4. Identify and use data acquisition methods.
5. Comprehend intelligent instrumentation in industrial automation.

TEXT BOOKS:

1. J.P. Bentley, Principles of Measurement Systems- 3rd edition, Pearson Education, New Delhi,2007.

2. Jovitha Jerome,Virtual Instrumentation Using LabVIEW,PHI Learning Pvt. Ltd., New Delhi-1100012010

REFERENCE BOOKS:

1. Introduction to Measurement and Instrumentation- A.K. Ghosh (3/e), PHI Learning,New Delhi, 2009.
2. Patranabis D, Sensors and Transducers, 2nd Edition, PHI, New Delhi, 2010

Digital Learning Resources:

Course Name	Sensor and Transducer
Course Link	https://nptel.ac.in/courses/108/108/108108147/ https://nptel.ac.in/courses/108/105/108105064/
Course Instructor	Dr. Hardik Jeetendra Pandya, Department of Electronic Systems Engineering, IISc Bangalore Prof. Alok Barua, Department of Electrical Engineering, IIT Kharagpur.

Subject Code: 19EEE5PC01L	**Subject Name: Power Electronics Lab**	**L-T-P 0- 0- 1**	Credit 1

COURSE OBJECTIVES:

1. To expose students to operation and characteristics of power semiconductor devices and passive components, their practical application in power electronics.
2. To provide a practical exposure to operating principles, design and synthesis of different power electronic converters.
3. To introduce students to industrial control of power electronic circuits as well as safe electrical connection and measurement practices.

COURSE OUTCOMES:

At the end of the course, a student will be able to:

1. Identify relevant information to supplement to the Power Electronics course.
2. Set up testing strategies and select proper instruments to evaluate performance characteristics of power devices and power electronics circuits and analyze their operation under different loading conditions.
3. Practice different types of wiring and devices connections keeping in mind technical, economical, safety issues.

Syllabus

1. Study of the V-I characteristics of SCR and measurement of its latching and holding current.
2. Study of the V-I characteristics of TRIAC.
3. Study of the cosine controlled triggering circuit.
4. Study of the single phase half wave controlled rectifier and semi converter circuit with R and R-L Load.
5. Study of single phase full wave controlled rectifier circuits (Mid point and Bridge type) with R and R-L Load.
6. Study of three phase full wave controlled rectifier circuits (Full and Semi converter) with R and R-L Load.
7. Study of the single phase PWM voltage source inverter.
8. Study the performance of three phase VSI with PWM control.
9. Study of single phase ac voltage controller with R and R-L load.
10. Study of the forward converter and flyback converter.

Subject Code: 19EEE5PC02L	Subject Name: Control Systems Engineering Lab	L-T-P 0- 0- 3	Credit: 1

COURSE OBJECTIVES:

1. The students should able to learn time response analysis of a system and determine the time domain specifications.
2. The students able to understand the concept of PID controller in servomotor, temperature control system, etc.
3. The students able to understand compensators and its effect on stability of the given system
4. The students able to determine the time response, stability analysis using MATLAB

COURSE OUTCOMES:

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

1. Determine the time domain specifications of the given system
2. Understand the importance of PID controllers in position control system, temperature control system etc.
3. Design the Lead, Lag compensator for the given system.
4. Design MATLAB programming for the time response and stability analysis of the given system.

Syllabus

Select any 4 experiments from Control, 2 experiments form instrumentation and 2 from MATLAB from the list of 12 experiments

Control:

1. Study of a dc motor driven position control system
2. Study of speed torque characteristics of two phase ac servomotor and determination of its transfer function
3. Obtain the frequency response of a lag and lead compensator
4. To design, implement and tune P, PI and PID controllers for second order systems
5. To determine the transfer function of a system using transfer function analyzer.
6. To study use of Synchros pairs as error detector system.
7. To study and validate the controllers for a temperature control system
8. To study and implement a PID controller for a DC servo system.

Instrumentation:

1. To plot the displacement-voltage characteristics of the given LVDT
2. Measurement of temperature-voltage characteristics of J-type thermocouple
3. Use a strain gauge to plot the curve between strain applied to a beam and the output voltage
4. Study of resistance-voltage characteristics of Thermistors

MATLAB/Simulink: Using Control System Tool Box

1. Determine the time response of given system.
2. Determine the stability of a 2^{nd}order system by Routh Hurwitz Criterion.
3. Determine the stability of a given system by Bode-plot.
4. Determine the stability of a given system by Nyquist-plot.

Subject Code: 19EEE5PC03L	Subject Name: Digital Signal Processing Laboratory	L-T-P: 0-0-2	Credit: 1

COURSE OBJECTIVES:

The object of this course is to introduce students to

1. Learn the software simulation tool like MATLAB for digital signal processing.
2. Familiarize about the architecture of DSP Processor (TMS 320C6748) and its applications.
3. Implementation of FIR and IIR filters using both hardware and software.
4. Practical Implementation of various signal processing applications using Multi-rate Signal Processing and Adaptive filter theory.

LIST OF EXPERIMENTS
(AT LEAST 10 EXPERIMENTS SHOULD BE DONE)

1. Familiarization with the architecture of a standard DSP kit (Preferably TMS 320C6XXX DSP kit of Texas Instruments)
2. To find DFT / IDFT of given DT signal using MATLAB and DSK 6748 KIT.
3. Program to obtain Linear Convolution of Long duration sequences using Overlap Add and Overlap Save using MATLAB.
4. Implementation of FFT of given sequence using MATLAB.
5. Generation of Real time SIN, COS AND RAMP signals using DSK 6748 KIT.

6. Implementation of Low Pass FIR filters using different window for a given sequence using MATLAB and DSK 6748 KIT.
7. Implementation of High Pass FIR filters using different window for a given sequence using MATLAB and DSK 6748 KIT.
8. Implementation of Low Pass IIR filters for a given sequence using MATLAB and DSK 6748 KIT.
9. Implementation of High Pass IIR filters for a given sequence using MATLAB and DSK 6748 KIT.
10. Implementation of Decimation Process using MATLAB and DSK 6748 KIT.
11. Implementation of Interpolation Process using MATLAB and DSK 6748 KIT.
12. To Implement and analyze the sampling and reconstruction principle and the effect of sampling on the frequency-domain using MATLAB.
13. Implementation of LMS algorithm using MATLAB.
14. Design and implementation of Adaptive noise cancellation.
15. Design and implementation of adaptive channel equalization.

COURSE OUTCOMES:

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

1. Implements various signal processing applications using MATLAB (Signal Processing tool box).
2. Apply discrete-time transform techniques to analyze the discrete time signals and systems.
3. Design and analyze digital filters for processing of discrete time signals.
4. Employ digital signal processing techniques for multidisciplinary applications (such as System Identification, Adaptive Channel Equalization, Adaptive Line Enhancer, and Adaptive Noise Cancelation).