Detailed Syllabus for

4-Years B.Tech.
in
Electrical and Electronics Engineering
(3rd Semester to 8th Semester)

Effective from 2018-2019 Academic Session
For 2017-21 Batch onwards

Department of Electrical and Electronics Engineering
National Institute of Technology Sikkim
South Sikkim - 737 139

3RD SEMESTER

EE13101 CIRCUITS AND SYSTEMS

Pre-requisite: None

L	T	P	C
3	0	0	3

Total Hours: 42 Hours

Module 1: Networks and Systems **(10Hours)**
IntroductoryConcepts on signals and systems - Signals, Transformation of the independent variable, Basic continuous time signal, Basic-discrete time signals, Systems, Properties of systems, Fourier series, Fourier Transforms.

Module 2: Modeling of Electrical Circuits **(08 Hours)**
Element of the electric circuits, types of sources, types of passive network elements C,R, L, M their V-I characteristics, source transformation including special cases, examples of formulation of network equations based on loop/node basis, concept of graph of a network, incidence matrix, formulation of network equations on Cut-set and Tie-set basis.

Module 3: Network Theorems **(04 Hours)**
Thevenin's theorem, Norton' theorem, Superposition theorem, Maximum power transfer theorem, Miller's and Tellegen's theorem.

Module 4: Time-Domain Analysis of Electrical Network **(10 Hours)**
Concept of initial conditions in various circuit elements, Formulation of the circuit differential equations of RL, RC and RLC circuits with and without sources and their solutions using classical method. Concept of zero input response, zero state response steady state response, transient response and complete response of circuits, Sinusoidal steady state response of circuits with and without mutual coupling.

Module 5: Frequency-Domain Representation & Analysis of Electrical Network
(10 Hours)
Concept of complex frequency variable, transformed impedances, Laplace transform of complex waveforms, solution of the electrical network using Laplace transforms, concept of network functions, poles and zeros, driving point functions and transfer functions of one port and two-port networks.

References:

1. M.E. Van Valkenburg, Network Analysis,
2. Franklin Fa-Kun. Kuo, Network Analysis & Synthesis, John Wiley & Sons.
3. Decarlo& Lin, Linear Circuit Analysis.
4. C. K. Alexander, Mattew N.O. Sadiku, Fundamentals of Electric Circuits.
5. B.P. Lathi, Signal and Systems. Oxford Publication.

EE13102 ANALOG ELECTRONIC CIRCUITS & SYSTEMS

Pre-requisite: EC12101 Electronics Devices and Circuits

L	T	P	C
3	0	0	3

Total Hours: 42 Hours

Module 1: Feedback Amplifiers, Stability and Oscillators (10 Hours)

Concept of Feedback - Negative and Positive Feedback, Loop Gain, Closed Loop Gain. Advantages of Negative Feedback in a Single Time Constant Voltage to Voltage Amplifier. Gain, Input and Output Resistances, Rise Time, Bandwidth, Nonlinearity etc- Stability and Positive Feedback in the above Amplifier. Types of Feedback Amplifiers.

Barkhausen's Criterion for Stability of Feedback Amplifiers. Gain Margin and Phase Margin. Oscillators- Transistor Phase Shift Oscillator and Wein's Bridge Oscillator.

Module 2: IC Operation of Amplifiers and LinearOPAMP Applications (12 Hours)

Different stages in an OPAMP – differential amplifiers, CMRR. Current Sources for Biasing inside an IC. Practical Operational Amplifier (LM741, LM358, and OP07).

Ideal OPAMP Model and Properties- Concept of Virtual Short. Offset Model of a Practical OPAMP. Slew Rate and Gain Bandwidth Product. Non-Inverting and Inverting Amplifier. Offset Analysis of Non-Inverting and Inverting Amplifiers. Summing Amplifier, Voltage Follower, Subtracting Circuit, Instrumentation Amplifier, OPAMP Integrator, and Differentiator.

Module 3: Waveform Generators and Nonlinear IC Applications (10 Hours)

Square, Triangular and Ramp Generator Circuits using OPAMPS. Study of Function Generator IC ICL803. OPAMP Based Astable and Monostable Circuits, Sweep circuits, Timer ICs – 555 and Its Applications. Principles of VCO circuits. Comparator IC LM311 and Its Applications - Effect of Slew Rate on Waveform Generation. Precision Half-Wave and Full-Wave Rectification using OPAMPS - Log and Antilog OPAMPS and Applications.

Module 4: Signal Conditioning and Signal Conversion using IC OPAMP (10 Hours)

Analog Passive Filters – Low Pass, High Pass, Band Pass, Band Reject and All Pass. Active Filter - Butterworth Low Pass Filter, Sallen-Key Second Order LPF HPF BPF BRF APF. Multiple Feedback Second Order Single OPAMP LPF HPF & BPF.

Data Conversion Fundamentals. D/A Conversion - Weighted Resistor DAC, R/2R Ladder DAC, A/D conversion - Single Slope and Dual Slope ADCs.

<u>Text/Reference Books:</u>

1. A. S. Sedra and K.C. Smith, 'Microelectronic Circuits,' Oxford University Press, 5th Edition, 2009.
2. J. Millman, 'Microelectronic,' 2nd Edition, McGraw-Hill, New Delhi, 2005.
3. Schilling &Belove, 'Electronic Circuits–Discrete and Integrated', 3rd Edition, McGraw-Hill, New Delhi, 2006.
4. National Semiconductor, 'Linear Applications Handbook,' 1994.
5. B. Razavi, Fundamentals of Microelectronics, Wiley, 2nd Edition, 2013.
6. Sergio Franco, Design with Operational Amplifiers and Analog Integrated Circuits, Tata Magrawhills.

EE13103 ELECTRICAL AND ELECTRONICS MEASUREMENTS

Pre-requisite: None

L	T	P	C
3	0	0	3

Total Hours: 42 Hours

Module 1: Basic Measuring Instruments (8 Hours)

General principles of measurements, units, dimensions, standards and calibration of meters.
Characteristics of instruments - qualities and errors of measurements and analysis. Direct deflecting instruments - moving coil, moving iron, dynamo meter; induction, thermal, electrostatic and rectifier type meters; extension of instrument ranges using shunts, multipliers and instrument transformers; various types of Galvanometers (principle, construction, operation, torque equation and comparison).

Module 2: Measurement of Resistance, Inductance and Capacitance (10 Hours)

Measurement of current, voltage and resistance, Wheatstone bridge, Kelvin double bridge, Carey Foster slide wire bridge, bridge current limitations, insulation resistance, earth resistance, localization of cable fault by Murray and Varley loop tests.
Various A.C. bridges and measurement of inductance, capacitance and frequency.

Module 3: Measurement of Current, Voltage and Power (12 Hours)

DC potentiometer – Crompton potentiometer - Vernier potentiometer- Diessel-horst potentiometer, method of use - use of potentiometer for measurement of resistance, current and voltage and power.
Applications of D.C. potentiometers and A.C. potentiometers.
Measurement of power and energy – dynamometer type wattmeter, error and compensation, Ampere-hour meter, single and three phase energy meters (induction type), calibration, phantom loading.
Current transformer and potential transformer – construction, theory operation, phasor diagram, characteristics – error elimination and its application, trivector meter, frequency meter, power factor meters.

Module 4: Sensors and Advance Measuring Instruments (12 Hours)

Classification of transducers – Selection of transducers – Resistive, capacitive & inductive Transducers – Piezoelectric, Hall effect, optical and digital transducers – Elements of data acquisition system – Smart sensors – Thermal Imagers.
Digital multimeters – Recorders, digital plotters and printers, CRT display, digital CRO, LED, LCD & Dot matrix display – Data Loggers.

<u>Text/Reference Books:</u>

1. E.W.Golding,Electrical Measurements & Measuring Instruments, Reem Publications.
2. W.D.Cooper, Modern Electronics Instrumentation, Prentice Hall of India.
3. M.B.Stout, Basic Electrical Measurements, Prentice Hall.
4. Oliver & Cage, Electronic Measurements & Instrumentation, McGraw Hill.
5. A. K.Sawhney, Electrical and Electronic Measurements and Instrumentation, DhanpathRai& Co.

EE13104 DIGITAL ELECTRONICS

Pre-requisite: None

L	T	P	C
3	0	0	3

Total Hours: 42 Hours

Module 1 **(10 Hours)**

Introductory Concepts - Number Systems, Operations, and Codes, - Logic Gates - Boolean Algebra and Logic Simplification - Combinational Logic Analysis, Functions of Combinational Logic – ROM, PAL, PLA.

Module 2 **(12 Hours)**

Introduction to Sequential circuits: Latches, Flip-flops and Timers- Registers – Counters: Ripple Counters – Synchronous counters - Shift registers - Shift Register counters - Random Sequence Generators – Programmable Logic.

Module 3 **(6 Hours)**

Signal conversion and processing: Analog-to-Digital Conversion - Methods of Analog-to-Digital Conversion - Methods of Digital-to-Analog Conversion - Practical design aspects: Timing and triggering considerations in the design of synchronous circuits - Set up time - Hold time - Clock skew.

Module 4 **(8 Hours)**

Integrated Circuit Technologies: Basic Operational Characteristics and Parameters - CMOS Circuits - TTL (Bipolar) Circuits - Comparison of CMOS and TTL Performance - Emitter-Coupled Logic (ECL) Circuits - PMOS, NMOS, and E2CMOS.

Module 5 **(6 Hours)**

Introduction to HDL based Digital Design: - Basic VHDL terminology, Basic language elements, Data objects and types, Behavioral modeling.

Text/Reference Books:

1. C. H. Roth, Fundamentals of Logic Design, Jaico Publishers. V Ed., 2009
2. Taub& Schilling: Digital Integrated Electronics, MGH, 1998.
3. W. I. Fletcher, An Engineering Approach to Digital Design, Prentice-Hall, Inc., Englewood Cliffs, NJ, 1980.
4. R. J. Tocci, and N. S. Widner,Digital Systems - Principles and Applications, Prentice Hall, 10th Ed., 2007.
5. J. F. Wakerly, Digital Design: Principles and Practices, Prentice-Hall, 2nd Ed., 2002.
6. M. M. Mano, Computer System Architecture, Prentice Hall, 1993.
7. R. Katz, Contemporary Logic Design, Addison Wesley, 1993.
8. Lewin D. &D. Protheroe, Design of Logic Systems, Chapman & Hall, University and Professional Division, 1992, II Ed.
9. T. L. Floyd, Digital Fundamentals, Prentice Hall, June 2005.
10. J. Bhasker, A VHDL Synthesis Primer, B.S Publications, 2001.
11. C. H.Roth Jr, Digital System Design using VHDL. Thomson Education, 2005.

EE13105 ELECTRICAL MACHINES I

Pre-requisite: None

L	T	P	C
3	0	0	3

Total Hours: 42 Hours

Module 1: DC Machines **(9 Hours)**
Construction - Armature windings- Lap and Wave winding, Flux distribution, Commutation, Armature reaction - Demagnetizing and Cross magnetizing effect, Mitigation of armature reaction - Methods of excitation - Generators and Motors.

Module 2: DC Generators **(9 Hours)**
Principle of operation, EMF equation, Classification, Process of voltage build up, Losses and power flow, Magnetization Characteristics and Terminal Characteristics - Parallel operation – applications, Load test and Voltage regulation.

Module 3: DC Motors **(8 Hours)**
Principle of operation, Back EMF, EMF equation, Classification, Power flow diagram - Circuit model - Torque and Speed equations, Performance and Characteristics – applications, Starting methods of dc motor, Methods of speed control - Testing - Swinburne's test - Hopkinton’s test - Separation of losses - Retardation test.

Module 4: Transformers **(16 Hours)**
Types and construction - Principle of operation – Magnetizing current and flux -EMF equation, - Ideal transformer, Transformation ratio, Real transformer - Equivalent circuit - phasor diagram - Cu-loss- Core loss (hysteresis and eddy current loss) - OC and SC tests-Efficiency and Regulation - All day efficiency - Sumpner's test – Polarity test-parallel operation, - Auto transformers and its applications - Different connections of three phase transformers - Notations - Scott connection – Open delta connection.

Text/Reference Books:

12. Clayton & Hancock, Performance & Design Of DC Machines, CBS, 3rd edition, 2001
13. A.S.Langsdorf, Principles of DC Machines, McGraw Hill.6th edition, 1959.
14. M. G.Say, Performance & Design of AC Machines, Pitman, ELBS.3rd edition, 1983.
15. A.S.Langsdorf, Theory of AC Machinery, McGraw Hill., 2nd edition, 2002.
16. V.D.Toro, Electrical Machines & Power Systems, Prentice Hall, 2nd edition, 2003.
17. S.J.Chapman, Electric Machinery Fundamentals, McGraw Hill, 2nd edition, 1991.
18. I.J. Nagarath&D.P. Kothari, Electric Machines, Tata McGraw Hill, 3rd edition, 2004.

EE13201 BASIC ELECTRICAL ENGINEERING LABORATORY

Pre-requisite-

L	T	P	C
0	0	2	1

Objective:

This laboratory will help the students to form a strong foundation on the basics of Electrical Engineering. Each experiment has been curated to show the practical aspect of theories learnt in earlier semesters. By performing the experiments, the students will learn the applications of different network theorems, different types of loads and their voltage-current characteristics, power measurements of balanced and unbalanced loads, designing DC power supplies and sources, and also safety issues such as fuse rating for circuits. The students will be able to apply the knowledge gained from this laboratory to all other areas of Electrical Engineering.

EE13202 ELECTRONICS LABORATORY

Pre-requisite-

L	T	P	C
0	0	2	1

Objective:

On the successful completion of the laboratory experiments, the students will be able to (1) Design and experiment with various signal and power amplifier circuits using BJTs and FETs, (2) Design and test various basic linear application circuits using Op-amps, (3) Design and test various waveform generation circuits using Op-amps, Comparators and IC packages, (4) Design and test various Op-amp based Active Filter Circuits.

The students will apply the knowledge for different analog controller circuits in power electronics and power systems.

EE13203 MEASUREMENTS LABORATORY

Pre-requisite-

L	T	P	C
0	0	2	1

Objective:

The Measurement laboratory in Electrical and Electronics Engineering (EEE) Department has the objective to familiarize the student with the operation of basic laboratory instrumentation such as Energy meter, multi meter, voltmeter, Ammeter etc. Another goal is to re-enforce theoretical knowledge with practice and analytical, and also to learn correct laboratory procedures and techniques. This is accomplished by building, testing, and taking measurements on simple circuits. In the execution of the experiment, highest benefit is gained by students of Electrical and Electronics Engineering (EEE) if they can distinguish between performing the experiment by following step-by-step instructions, and actually understanding the reasons and the methodology behind the various parts.

EE13204 ELECTRICAL MACHINES LABORATORY I

Pre-requisite-

L	T	P	C
0	1	2	2

Objective:

To give Electrical and Electronics engineering students a basic understanding of the principles of operation and construction of direct current machines and transformers. To understand the theory and concept of DC Machines and transformers. Deriving equivalent circuit of electrical machines. Studying performance and characteristics of machines.

4TH SEMESTER

EE14101 NUMERICAL ANALYSIS AND PROGRAMMING

Pre-requisite: None

L	T	P	C
3	0	0	3

Total Hours: 42

Module 1: Error Analysis (10 Hours)

Representation of numbers in computers and their accuracy, floating point arithmetic, concept of zero, errors in computations, types of errors, propagation of errors, computational methods for error estimation, general error formulae, approximations of functions and series.

Module 2: Interpolation and Numerical Differentiation and Integration (10 Hours)

Interpolation (Finite difference operators, difference tables, Newton's Forward/Backward difference); Divided differences, Lagrange interpolation and Newton's divided difference interpolation); Numerical Differentiation (Using Forward/ Backward/central difference formula), Integration (Trapezoidal and Simpson's rules for integration)

Module 3: Solution of Simultaneous Linear Algebraic & Differential Equations (12 Hours)

Numerical Solution of first order and second order Ordinary Differential Equations (ODEs) Initial Value Problems: Mathematical Theory of ODE; existence and uniqueness; Single-step, explicit methods: Taylor Series Methods; (Euler method, Euler modified method, Runge-Kutta methods (4^{th} order); Solution of system of linear Equations (direct methods, Iterative methods, Ill-conditioned systems).

Module 4: Solution of Simultaneous Nonlinear Algebraic & Differential Equations (10 Hours)

Solution of Nonlinear equations (one variable: f(x) = 0) Mathematical preliminaries Bisection Method; error analysis; convergence criteria; Stopping criteria; Newton-Raphson Method; error analysis; order of the method; Secant Method, examples; Regula- Falsi Method;

References/Textbook:

1. B. S.Grewal, Numerical Methods in Engineering and Science, Khanna Publishers.
2. S. S. Sastry, Introductory Methods of Numerical Analysis, Prentice Hall of India.
3. M.K. Jain, S.R.K. Iyengar and R.K. Jain, Numerical Methods for Scientific and Engineering Computation, Wiley Eastern Limited.

EE14102 NETWORK ANALYSIS AND SYNTHESIS

Pre-requisite: EE13101 Circuits and Systems

L	T	P	C
3	0	0	3

Total Hours: 42 Hours

Module 1: Two-port networks (08 Hours)

Concept of two-port and n-port networks, various representations of a two-ports in terms of [z], [y], [h], [g], [T] and inverse transmission parameters, interrelationship between various representations, their interconnections and applications in simplification and solutions of electrical networks, concepts of positive impedance converters and impedance inverters, gyrators.

Module 2: Network Functions and Elements of Realizability (06 Hours)

Review of Network Functions - Network functions for one port and two port networks – Poles and Zeros of network functions – Restrictions on pole and zero locations for driving–point functions – Restrictions on pole and zero locations for transfer functions – Concept of stability, Hurwitz polynomials – properties - Brune's positive real functions – Properties of positive real functions - Necessary and sufficient conditions for positive real functions – Sturm's test for positive real functions.

Module 3: Driving Point Immittance Synthesis (10 Hours)

Basic synthesis methodology, concept of removal of poles and zeros from driving point functions, properties of LC, RC, and RL driving point immittances, reactance magnitude versus frequency diagrams for LC driving point functions, impedance versus frequency diagrams for RC and RL driving point functions, Foster and Cauer forms of realization of driving point immittance functions of two-elements (LC, RC and LC) kind of networks, RLC one terminal-pair network synthesis – Minimum positive real functions – Brune's method and Bott and Duffin's method of RLC network synthesis.

Module 4: Transfer Function Synthesis (06 Hours)

Properties of transfer functions, concept of zeros of transmission, synthesis of Y_{12} and Z_{12} with 1-Ω termination, synthesis of constant resistance networks.

Module 5: Active Network Synthesis (12 Hours)

Concept of simulated immittances- negative impedance converters, positive impedance converters and impedance inverters, simulation of lossless and lossy inductances using operational amplifiers, capacitance multipliers, frequency dependent negative resistances, realization of bi-linear and bi-quadratic voltage transfer functions using operational amplifiers.

Text/Reference Books:

1. M. E. Van Valkenburg, Introduction to Modern Network Synthesis, John Wiley & Sons.
2. Franklin F. Kuo, Network Analysis and Synthesis, John Wiley.
3. D. Roy Choudhury, Networks and Systems, New Age International Publications, 2005.
4. A. S. Sedra and K.C. Smith, Microelectronic Circuits, Oxford University Press, 5th Edition, 2009.
5. L. T. Bruton, RC-Active Circuits: Theory and Design, Prentice-Hall, 1980.

EE14103 ENGINEERING MATERIALS

Pre-requisite: None

L	T	P	C
3	0	0	3

Total Hours: 42 Hours

Module 1: Introduction (10 Hours)

Conducting materials, materials used in brushes of electrical machines, fuses and solder. semiconductors -mechanism of conduction in semiconductors, intrinsic semiconductors, energy gap, types of semiconductors. Hall effect, compound semiconductors, magnetic materials - classification of magnetic materials, hysteresis curve, magneto-striction, magnetic materials used in electrical machines, instruments and relays.

Module 2: Photovoltaic Solar Energy Materials (10 Hours)

Solar cell principles and its characterization, absorption and minority carrier life time, single crystalline and polycrystalline silicon solar cells, amorphous silicon solar cells, Cadmium Telluride thin film solar cells, transparent conductive oxide materials, chalcopyrite based solar cells, organic and dye sensitized solar cells.

Module 3: Electrochemical Energy Materials (10 Hours)

Fundamentals of electrochemical energy conversions, primary batteries - Zn-MnO_2 system, carbon-zinc andcarbon-zinc chlorides and zinc-silver oxide. Secondary batteries – lead acid, nickel cadmium, nickel metalhydride, silver oxide zinc system, lithium ion, lithium polymer, super capacitors, fuel cells.

Module 4: Applications (12 Hours)

Dielectrics - dielectric polarization under static fields, behaviour of dielectrics in alternating fields, capacitormaterials - ferro and piezo electricity, insulating materials, super conductors, introduction to nanomaterials,sensors - gas sensors and biosensors, smart materials, fuel and solar cells, drug delivery systems andoptoelectronic devices.

Text/Reference Books:

1.C. S. Indulkar&S. Thiruvengadam, An Introduction to Electrical Engineering Materials, S. Chand Co.
2. P.K. Palanisamy, Solid State Physics, SCITECH Publications, Hyderabad.
3. A.J. Dekker, Electrical Engineering Materials, Prentice Hall of India.
4. Yu Koritsky, Electrical Engineering Materials, MIR.
5. M. Arumugam, Materials Science, Anuradha Publishers.
6. P.L.Kapoor, Electrical Engineering Materials, Khanna Publications.
7. T.S. Hutchison & D.C.Baird, The Physics of Engineering Solids, John Wiley Publications.
8. Tom Markvart and Luis Castaner, Solar Cells-Materials, Manufacture and Operation, Elsevier.
9. M. Graziani and P. Fornasiero, Renewable resources and renewable energy- A global challenge, CRCTaylorand Francis.
10. Online resources e.g. NPTEL https://nptel.ac.in/, MOOC http://mooc.org/, SWAYAMhttps://swayam.gov.in/

EE14104 MICROPROCESSOR AND MICROCONTROLLER

Pre-requisite: None

L	T	P	C
3	0	0	3

Total Hours: 42 Hours

Module 1: **(08 Hours)**

Introduction to Microprocessor, Microcontroller, Microcomputer; 8085 Microprocessor Architecture, Pin Description, Bus concept and organization, Multiplexing and Demultiplexing of Buses; Static and Dynamic RAM, ROM, Memory map; Signals and Timings, Classification of Instructions, Instruction Format, Instruction Set, Addressing Modes.

Module 2: **(10 Hours)**

Assembly Language Programming and Debugging – Simple Assembly Programming, Directives used in Assembly Language, Counter and Time delay, Stack organization and implementation, Macros and Subroutines; Debug and Testing of Assembly Language Programs. Interrupts - Types, Applications and Handling; 8259 Programmable Interrupt Controller.

Module 3: **(10 Hours)**

Interfacing with 8085 Microprocessor – Interfacing of Simple input/output devices (Switches, LEDs); 8255 Programmable Peripheral Interface; 8254 Programmable Interval Timer; 8279 Keyboard/Display Controller; 8251 USART; Memory Interfacing. Serial Interface - RS232C and RS422A; Parallel Interface.

Module 4: **(14 Hours)**

8051 Microcontroller – Introduction of 8051 family; Block diagram description of AT89C51; Internal Architecture - System Clock and Oscillator Circuits, CPU Registers, SFRs, Memory Map, I/O Ports. Simple program and application development.

Text book(s)

1. Ramesh S. Gaonkar, "Microprocessor Architecture, Programming and Applications with the 8085", Penram Publishers
2. Aditya P. Mathur, "Introduction to Microprocessors", Tata McGraw Hill
3. Muhammad Ali Mazidi, D. MacKinlay, "The 8051 Microcontroller & Embedded Systems usingAssembly and C", Pearson Education.

Reference book(s)

1. Douglas V. Hall, "Microprocessors and Interfacing", Tata McGraw Hill
2. Kenneth J. Ayala, "The 8051 Microcontroller – Architecture, Programming and Applications",Penram Publishers
3. John Uffenbeck, "Microcomputers and Microprocessors – The 8080, 8085 and Z80 Programming, Interfacing and Troubleshooting", Tata McGraw Hill, 3rd Edition

EE14105 POWER TRANSMISSION AND DISTRIBUTION

Pre-requisite: None

L	T	P	C
3	0	0	3

Total Hours: 42 Hours

Module 1: **(16 Hours)**

Overhead transmission systems - Calculation of transmission line parameters: inductance and capacitance- GMD and GMR- bundled conductors- transposition of conductors- ABCD constants- Classification of Transmission lines- Performance of transmission lines - nominal T and pi methods of calculations Voltage regulation and efficiency calculation- underground cables – Capacitance of single core and three core cables - grading of cables, Mechanical Design of Overhead Transmission line- line insulators - String Efficiency - Sag calculation

Module 2: Distribution systems **(16 Hours)**

Classification and arrangement of distribution systems - distribution substation Component, layout and arrangement - economic loading of distribution transformers - Kelvin's law- considerations in primary and secondary distribution system design - current distribution and voltage drop calculation-design of feeders and distributors.

Module 3: **(10 Hours)**

Representation of power systems - per unit quantities - Y-bus and Z-bus matrices - load flow studies:-Gauss-Seidal- Newton Raphson and fast decoupled methods - line loss computation.

Text/Reference Books:

1. Soni, Gupta, Bhatnagar, A course in Electric Power, DhanpatRai& Sons, New Delhi, latest edition.
2. Turan, Goren, Electric Power Transmission System Engineering, John Wiley, 1988
3. S.L. Uppal, “Electric Power”, Khanna Publishers, 1992.
4. A.S. Pabla, “Electric Power Distribution System”, Tata McGraw Hill, 1992.
5. M. N.Bandyopadhyay, “Electrical Power Systems- Theory and Practice”, Prentice Hall of India, 2006.
6. B. M.Weedy andB. J.Cory, “Electric Power Systems,” John Wiley Publication, 4 ed., 1998.

EE14106 ELECTRICAL MACHINES II

Pre-requisite: EE13105 Electrical Machines I

L	T	P	C
3	0	0	3

Total Hours: 42 Hours

Module 1: Induction Machines (12 Hours)

Three phase induction motors - construction - principle of operation - rotor MMF and production of torque – slip and frequency of rotor current - phasor diagram - equivalent circuit - mechanical power developed – maximum torque - torque slip characteristics - losses and power flow - no-load and blocked rotor tests - effect of deep bar and double cage rotors - cogging and crawling, Single phase induction motors – double field revolving theory – classification - applications of all types of induction motors, Induction Generator.

Module 2: Starting and Speed Control of 3-Φ Induction Motor (8 Hours)

Starting methods of three phase induction motors - direct on line starting - auto transformer starting - star delta starting - rotor resistance starting - basic methods for speed control of three phase induction motors - voltage control - frequency control - rotor resistance control - pole changing etc.

Module 3: Synchronous Generator (14 Hours)

Construction - principle of operation – classification and constructional features of salient pole and cylindrical pole type rotor, generated EMF, winding coefficients, harmonics in generated emf, - armature reaction – two-reaction theory, power angle equation of salient pole and cylindrical pole type rotor, Slip test, Voltage regulation -predetermination of voltage regulation - phasor diagrams – parallel operation of alternator, synchronizing power and torque coefficient, transient and sub transient reactance - measurement of losses, effect of change in fuel supply and excitation - alternator connected to infinite bus, Excitation system.

Module 4: Synchronous Motor (8 Hours)

synchronous motor - principle of operation - different starting methods, equivalent circuit - effect of load changes on synchronous motor - V curves - inverted V curves – phasor diagram - torque and power relations - Hunting - periodicity of hunting and its suppression.

Text/Reference Books:

1. M. G.Say, Performance & Design of AC Machines, Pitman, ELBS.3rd edition, 1983.
2. A.S.Langsdorf, Theory of AC Machinery, McGraw Hill., 2nd edition, 2002.
3. A.E.Fitzgerald. & Kingsley: Electrical Machinery, Tata McGraw Hill,6th edition, 2003.
4. S.J.Chapman, Electric Machinery Fundamentals, McGraw Hill., 2nd edition, 1991.
5. V.D.Toro, Electrical Machines & Power Systems, Prentice Hall, 2nd edition, 2003.
6. L. Puchestein&Cenrad,Alternating Current Machines, Asia Publishing House,1962.
7. I.J.Nagarath. &D.P.Kothari, Electric Machines, Tata McGraw Hill, 3rd edition, 2004.
8. P.S. Bimbra, Generalized Theory of Electrical Machines, Khanna Publishers, 2001.

EE14201 NUMERICAL ANALYSIS AND PROGRAMMING LABORATORY I

Pre-requisite-

L	T	P	C
0	0	2	1

Objective:

To analyze any complex systems, we need computational methods as mathematical models can be rarely solved algebraically. Numerical methods are based upon computational mathematics, and are the basic algorithms behind computer predictions. These include techniques for simple optimization, interpolation, linear algebra for systems of equations, ordinary differential equations, and stochastic simulation. In Numerical Analysis and Programming Lab I, the students will learn about the basics of interpolation and extrapolation, numerical differentiation and integration and their programming. This lab will be primarily focused on developing the programming skills of the students. After completion of the lab, the students will be able to articulate the tradeoffs between easy computation and accuracy.

EE14202 COMPUTER SYSTEM DESIGN LABORATORY

Pre-requisite-

L	T	P	C
0	0	2	1

Objective: After completion of the experiments the students will learn to write assembly label language on trainer kit of microprocessor and microcontroller. Different programs for different functions will be tested and verified with the theoretical results. Moreover, different devices can be connected to the microprocessor and microcontroller through ADC and DAC chips. Later on, the students can apply this knowledge for controller circuits of Power Electronics and Power Systems.

EE14203 POWER SYSTEMS LABORATORY I

Pre-requisite-EE14105

L	T	P	C
0	0	2	1

Objective:

By performing the different experiments during the laboratorial classes, the students have a clear concept on different aspects of power transmission and distribution like power flow problem and its solution techniques, distribution system analysis etc. This knowledge will help the students to design and analysis of power transmission and distribution systems.

EE14204 ELECTRICAL MACHINES LABORATORY II

Pre-requisite-

L	T	P	C
0	1	2	2

Objective:

To give Electrical and Electronics engineering students a basic understanding of the principles of operation and construction of alternating current machines and transformers. To understand the theory and concept of AC Machines and transformers. Deriving equivalent circuit of electrical machines. Studying performance and characteristics of machines.

5TH SEMESTER

EE15101 DIGITAL SIGNAL PROCESSING

Pre Requisite: EE13101 Circuit Theory

L	T	P	C
3	0	0	3

Total Hours: 38 Hours

Module 1: Discrete-Time Signals and Systems (8 Hours)
Classification and properties of signal and systems. Introduction to z transform, inverse z transform, solution of difference equations, Review of Fourier transform and its properties - sampling of continuous - time signals – Spectral characteristics.

Module 2: Transform Analysis of LTI Systems and Structures for DTS (12 Hours)
Frequency response for rational system functions- Geometric construction for computation of the frequency response function from pole-zero plots- All pass systems-minimum phase systems-Linear systems with generalized linear phase characteristics- basic structures for IIR and FIR systems- Direct forms- cascade forms- parallel forms.

Module 3: Digital Filter Design techniques and Finite Word-length Effects (12 Hours)
Design of IIR filters from analog filters – analog Butterworth function for various frequency selective filters- analog to digital transformation - backward - difference and forward - difference approximations - impulse invariant transformation - bilinear transformation - prewarping - design examples - properties of FIR filters - design of FIR filters using windows - comparison of IIR and FIR filters - finite word length effect in DSP- zero-input limit cycles in fixed point realizations of IIR digital filters-Limit cycles due to overflow.

Module 4: The Discrete Fourier Transform and FFT (10 Hours)
Representation of periodic sequences - properties of discrete Fourier series - discrete Fourier transforms - properties of DFT - linear convolution using DFT - overlap - add method - overlap - save method - FFT - Radix2 DIT FFT algorithm - Radix2 DIF FFT algorithm - butterfly structure - bit reversed order - in - place computations-Fourier analysis of signals using the DFT .

Text/Reference Books:

1. Alan V. Oppenheim, Ronald W. Schafer, .Discrete-Time Signal Processing., Prentice-Hall of India Pvt. Ltd., New Delhi, 1997.
2. Sanjit K Mitra, .Digital Signal Processing: A computer-based approach,Tata McGraw-Hill edition, 1998.
3. John G. Proakis, and Dimitris G. Manolakis, Digital Signal Processing.(Fourth Edition), Pearson Prentice Hall of India Pvt. Ltd, New Delhi, 2007
4. Emmanuel C. Ifeachor, Barrie W. Jervis, .Digital Signal Processing-A practical Approach, Addison Wesley Publishers Ltd.,1993

EE15102 POWER GENERATIONS AND ECONOMICS

Pre Requisite: None

L	T	P	C
3	0	0	3

Total Hours: 42 Hours

Module 1: Conventional Electrical Energy Sources (12 Hours)
Construction and operation of Thermal Power plant Hydro power plant, Nuclear Power plant.

Module 2: Renewable Electrical Energy Sources (8 Hours)
Basic Concept and Operation of Solar, Wind, Tidal, Geothermal sources of energy. Advantages and disadvantages of Solar and Wind Power Plants. Potential of Renewable energy sources in India.

Module 3: Power Plant Economics (10 Hours)
Load factor - demand factor - diversity factor – plant factor –, Unit Commitment and Economic dispatch of thermal plants. B-coefficient. Tariffs: classification and calculations

Module 4: Power System Deregulation & Restructuring (12 Hours)
Introduction- Transmission network, Power wheeling and Transmission costing. Power wheeling transactions and marginal costing. Framework and methods for the analysis of Bilateral and pool markets. Introduction of Market structure-Market Architecture-Spot market-forward markets and settlements. Review of Concepts- marginal cost of generation. Least cost operation. Energy Management System, SCADA.

Text/ Reference Books:

1. J. V. Stevenson, D. William, Elements of Power System Analysis, McGraw Hill, 1988.
2. D. P. Kothari & 1. J. Nagrath, Modern Power System Analysis, Tata McGraw Hill, 2007.
3. A.K. Mahalanabis, Computer Aided Power System Analysis & Control, Tata McGraw Hill, 1991.
4. Arthur R Bergen, Vijay Vittal, Power system Analysis, Pearson Education (Singapore) PTE, Ltd., 2004.
5. HadiSaadat, Power System Analysis, Tata McGraw Hill, 2003.
6. J Arrilaga, C P Arnold, B J Harker, Computer Modelling of Electric Power Systems.
7. ElgerdolleI, Electric Energy Sytems Theory - An Introduction, Tata McGraw Hill, 2ed. 1995.
8. C. L. Wadhwa, Electrical Power Systems, New Age Publication, 3ed., 2002.
9. Loi Lei Lai, Power system restructuring and deregulation, John Wiley & sons, 2002.
10. Antonio Gomez-Exposito, Antonio J. Conejo& Claudio Canizares, Electric Energy systems analysis and operation, CRP press, 2009.

EE15103 CONTROL SYSTEMS

Pre Requisite: None

L	T	P	C
3	0	0	3

Total Hours: 42 Hours

Module 1: System Modeling (08 Hours)
Mathematical model of physical systems: differential equation model of physical system, transfer function, block diagram algebra, signal flow graphs, Mason's gain formula; feedback characteristics of control systems - open loop system and closed loop system, reduction of parameter variation, control of the effect of signal by use of feedback, regeneration feedback.

Module 2: Time Domain Response (10 Hours)
Time response analysis: design specification and performance indices; standard test signals, time response of first and second order systems, steady state error and error constants, effect of adding a zero to a system, higher-order systems, introduction to P, PI, and PID compensators.

Module 3: Stability Studies of LTI System (12 Hours)
Stability concept, Routh-Hurwitz stability criteria, relative stability analysis, root loci technique: root loci's concept, construction for root loci, root contours, polar plots, Bode plots, all pass and minimum phase system, stability in frequency domain: Nyquist stability criteria, assessment of relative stability, realization of basic compensators, idea of compensation in frequency domain, feedback compensation.

Module 4: State Space Analysis (12 Hours)
State variable analysis and design: concept of state, state variables and state model, state model for linear continuous time systems, diagonalization, Eigen values and stability analysis, solution of state equations.

References:

1. Nagrath and Gopal, Control System Engineering, , New Age International Publications
2. B. C. Kuo, Automatic Control System, PHI
3. K. Ogata Modern Control Engineering, Pearson Education
4. M. Gopal, Modern Control System Theory, New Age International Publishers.
5. Stainslaw H. Zak, Systems and Control, Oxford Press.

EE15104 POWER ELECTRONICS

Pre Requisite: EE13101 Circuit Theory

L	T	P	C
3	0	0	3

Total Hrs: 42 Hours

Module 1: Power Semiconductor Devices (8 Hours)
Power diodes - Basic structure and V-I characteristics - various types -**Thyristors**- basic structure - static and dynamic characteristics - device specifications and ratings - turning on and turning off of SCR, Modern power semiconductor devices-MOSFET and IGBT, basic characteristics and controlling.

Module 2: AC-DC Converters (10 Hours)
Single Phase – Half wave and full wave controlled rectifier with R, RL and RLE types of loads – with continuous and discontinuous modes of operations, source side analysis with constant output currents - Input side harmonics and power factor - Effect of source inductance, PFC converter, PWM rectifiers **Three Phase** - Half wave rectifier with R and RL loads - Full wave fully controlled converters with continuous and constant currents.

Module 3: DC- DC Converter (8 Hours)
Switching regulators– Non-Isolated Converters- Isolated Converter, Switched mode power supply - principle of operation and analysis.

Module 4: DC- AC Converter (8 Hours)
Single phase voltage source inverters – Half and Full bridge inverters, 3-Φ inverter, 120^0 and 180^0modes of operation, Modulation techniques, Current Source Inverter, Concept of Multilevel Inverter.

Module 4: AC- AC Converter (4 Hours)
Single phase ac regulator with R and RL loads, 3-Φ AC regulators with R-load

Module 5: Power Electronics Application (4 Hours)
UPS, Electronic Ballasts, renewable energy sources, active power filter, HVDC transmission.

Text/Reference Books:

1. Ned Mohan, Power Electronics, John Wiley and Sons, 2nd edition, 1995.
2. M. H. Rashid, “Power Electronics, Circuits Devices and Applications”, Pearson Education, 3rd edition, 2004.
3. D. W. Hart, Power Electronics, IEEE Press
4. G.K.Dubey, Thyristorised Power Controllers, Wiley Eastern Ltd, 1993.
5. IssaBatarse, Power Electronic Circuits.
6. L. Umanand, Power Electronics-Essential & Applications, Wiley India Pvt.ltd.

EE15105 POWER SYSTEMS PROTECTION AND SWITCHGEAR

Pre Requisite: EE14105 Power Transmission and Distribution

L	T	P	C
3	0	0	3

Total Hours: 42 Hours

Module 1: **(10 Hours)**
Short circuit studies – Symmetrical and unsymmetrical faults - Symmetrical components. Sequence network. Methods of symmetrical and unsymmetrical fault analysis. Fault MVA, Fault limiting reactors.

Module 2: **(4 Hours)**
Insulation coordination. Basic concepts of insulation levels and their selection - BIL – Co-ordination of insulation. Insulation Class. NEC and importance of relevant IS/IEC specifications related to switchgear and protection.

Module 3: **(14 Hours)**
Circuit breakers-principles of operation–RRRV-Current chopping. Constructional features and Selection of LT breakers (MCB/MCCB/ELCB) and HT Breakers (ABCB - OCB – SF6CB– VCB); Circuit breaker ratings.

Module 4: **(14 Hours)**
Protective relays – Basic functional characteristics of protective relays, Protective zones – Types of electromagnetic relays. Time graded and current graded relays. Over current Relays and their characteristics- Directional relays- Differential relays- Distance relays and their characteristics. Static Comparator and Static Relay. Basic concepts of numerical relays.
Protection Scheme for Generators, Transformers, feeder and Transmission lines. Carrier current protection.

Text/Reference Books:

1. Sunil S Rao, Switch Gear Protections, Khanna Publications, Delhi 1999
2. Allen Greenwood, Electrical Transients in Power Systems, 1991.
3. Van. C. Warrington A.R., “Protective Relays” Vol. 1 & 2, Chapman & Hall, 1998.
4. T S Madhav Rao, “Power system protection static relays with microprocessor Applications”, Tata McGraw hill Publication,1998.
5. Badri Ram, D. N.Vishwakarma, Power System Protection and Switchgear, Tata McGraw Hill, 2005.
6. P. M.Anderson, Power System Protection, IEEE publication, 1999.
7. Walter -Marcel Dekker, “Protective relaying theory and applications”, 2nded, Elmore, 2004.

EE15201 NUMERICAL ANALYSIS AND PROGRAMMING LABORATORY II

Pre-requisite-

L	T	P	C
0	0	2	1

Objective:

This lab is an extension for Numerical Analysis and Programming Lab I. In this lab, the students will learn about different techniques employed for solving Simultaneous Linear Algebraic & Differential Equations. They will also learn about the different techniques applied towards the solution of Solution of Simultaneous Non-Linear Algebraic & Differential Equations. This lab will test their programming skills in implementing these methods to solve different problems. After completion of this lab, they will be able to execute basic commands and scripts in a mathematical programming language as well as demonstrate expertise in using different input/output commands. They will have the required knowledge to select appropriate numerical methods to apply to different types of problems in engineering considering the mathematical operations involved, accuracy requirements, and available computational resources.

EE15202 POWER SYSTEMS LABORATORY II

Pre-requisite-

L	T	P	C
0	0	2	1

Objective:

During the different laboratory experiments students will be able to understand the operation and control of electrical power plant. Students will also understand how to dispatch the electrical power generation economically. Mathematical models of the mechanical and electrical components involved in the operation of power systems associated with the voltage and frequency control of single area or interconnected multi area power systems will be realized.

EE15203 CONTROL SYSTEMS LABORATORY I

Pre-requisite-

L	T	P	C
0	0	2	1

Objective:

Students will develop the ability to apply knowledge of mathematics, science, and engineering in solving control and industrial automation related problems. They will learn to obtain response of a system, understand and interpret its stability. They will design a controller or a system related to control engineering for a definite task. They will also learn and be able to analyze and interpret the system response for corrective measure, if any.

EE15204 POWER ELECTRONICS LABORATORY

Pre-requisite-

L	T	P	C
0	0	2	1

Objective:

The different experiments during the laboratorial classes can be performed toexpose students to the operation and characteristics of power semiconductor devices and passive components, their practical application in power electronics, to provide a practical exposure to the operating principles, design and synthesis of different power electronic converters andto introduce students to industrial control of power electronic circuits as well as safe electrical connection and measurement practices.

6TH SEMESTER

EE16101 ELECTRICAL DRIVES

Pre-requisite: EE13105, EE14106 AND EE15104

L	T	P	C
3	0	0	3

Total Hours: 42 Hours

Module 1: Introduction to Electric Drives **(10 Hours)**

Concept of modern electric drive, Advantages of Electric drives, Parts of Electrical Drives, selection of drives and its power rating, sensing devices;

Dynamics of electrical drives- torque equation, speed-torque characteristics of loads, multi-quadrant operation, loads with rotational motion, loads with translational motion, measurement of moment of inertia, Steady state stability, dynamic stability, load equalization.

Module 2: DC Motor Drives **(8 Hours)**

Review of DC motor and its performance-starting, braking and Speed control, Phase controlled DC drive, supply harmonics, power factor and ripple in motor current, Chopper controlled DC-drive, closed loop control of DC motor Drive-inner current loop and outer speed loop.

Module 3:Induction Motor Drives **(14 Hours)**

Review of Induction Motor and its performance-starting and braking, static voltage control, variable frequency control based on VSI, CSI, Speed control of induction motor with *v/f* control, static rotor resistance control, slip power recovery scheme, vector control, direct torque control.

Module 4: Power Electronics Control of Special Electric Machines **(10 Hours)**

Permanent magnet synchronous motor drive, Brushless dc motor drive, Switched reluctance motor drive, Stepper motors and control.

References:

1. B.K. Bose, Modern Power Electronics & AC Drives, Pearson.
2. R. Krishnan, Electric Motor Drives: Modeling, Analysis and Control, Prentice Hall
3. G. K. Dubey, Fundamentals of Electrical Drives, Narosa Publishing House, New Delhi, 2001.
4. Bin Wu, High-Power Converters And Ac Drives, IEEE Press.
5. V. Subrahmanyam, Electric Drives: Concepts and Applications, New Age International, New Delhi, 2005.
6. NPTEL Lecture on Advanced Electric Drives.

EE16102 ADVANCED CONTROL SYSTEMS

L	T	P	C
3	0	0	3

Total Hours: 42 Hours

Module 1: State Space Analysis and Design (10 Hours)
Controllability, observability, state variable design, state feedback, pole placement, Ackermann's formula, design of full order observers, state feedback design problems in EE and allied fields.

Module 2: Introduction to Nonlinear Systems (10 Hours)
Nonlinear system characteristics: different types of nonlinearities and their occurrences, phase plane analysis, linearization and equilibrium points, limit cycles in phase plane.

Module 3: Stability of Nonlinear Systems (10 Hours)
Stability of equilibrium points and limit cycles, stability of nonlinear systems, Lyapunov methods for nonlinear systems, describing function for single valued and double valued nonlinear elements.

Module 4: Introduction to Digital Control Systems (12 Hours)
Solution of difference equation, mapping between s-domain and z-domain, time responses of discrete data systems, Jury's stability test, design of PID controller by using Bilinear transformation.

Text/Reference Books:

1. B. C.Kuo, Digital Control Systems, Oxford University Press, 1992.
2. H. K. Khalil, Nonlinear Systems, Prentice Hall International (UK), 1996.
3. Alberto Isidori, .Nonlinear Control Systems, Springer Verlag, 1995.
4. S. Wiggins, .Introduction to Applied Nonlinear Dynamical Systems and Chaos, Springer Verlag, 1990.
5. M. Gopal, Digital Control & State Variable Methods, Tata McGraw Hill, 1992.

EE16103 Power System Stability and Control

Pre-requisite: EE14105, EE14106

L	T	P	C
3	0	0	3

Total Hours: 42 Hours

Module 1: Automatic Generation Control **(15 Hours)**
Speed governing of turbo generator - load sharing and governor characteristics-load frequency control of single and multi-area systems - implementation of Economic Dispatch and Automatic Generation Control – automatic voltage regulation. Excitation Systems**.**

Module 2: **(15 Hours)**
Power system stability studies Classification- **Transient stability**, electrical stiffness - swing equation - inertia constant - equal area criterion - Transient Stability Enhancement Methods.

Module 3: **(12 Hours)**
Voltage Stability Problem. Real and Reactive Power Flow in Long Transmission Lines. Effect of ULTC and Load Characteristics on Voltage Stability. Voltage Stability Limit. Voltage Stability Assessment Using PV Curves. Voltage Collapse Proximity Indices. Voltage Stability Improvement Methods.

Texts/ references:

1. A. J. Wood, B. F. Wollenberg, Power Generation, Operation and Control, John Wiley and Sons, 2nd Edition, 1996.
2. J. Arrilaga, C. P. Arnold, B. J. Harker, Computer Modeling Of Electrical Power Systems., Wiley, New York, 1983.
3. I.J. Nagrath, O.P. Kothari, Power System Engineering, Tata McGraw Hill Publishing Co. Ltd., New Delhi, 1994.
4. Yao-Nan-Yu, Electric Power System Dynamics.
5. P. Kundur, Power System Stability and Control, McGraw Hill, New York, 1994.

EE16105 Electric Power Utilization

Pre-requisite: Knowledge of Power Systems.

L	T	P	C
3	0	0	3

Total Hours: 42 Hours

Module 1: Electric Traction **(11 Hours)**

Electric Traction: Introduction- Features of an ideal traction system. Systems of railway electrification, mechanism of train movement- speed-time curve, System of current collection, Traction motors- characteristics, tractive effort, horse power, Speed control Schemes, Types of electric braking, Types of railway services

Module 2: Electric Heating **(11 Hours)**

Electric heating: advantages- classification - different methods of heat transfer- heating element- losses in oven and efficiency- resistance furnace- radiant heating- induction heating- high frequency eddy current heating- dielectric heating- arc furnace- heating of buildings-Electric welding:- methods and equipments- Electrolysis and Electroplating applications.

Module 3: Illumination **(8 Hours)**

Illumination: radiant energy-terms and definitions- laws of illumination- polar curves- photometry- MSCP-integrating sphere- luminous efficacy- electrical lamps- illumination levels for various purposes- light fittings- factory lighting- flood lighting-street lighting-energy conservation in lighting.

Module4: Air-Conditioning and Refrigeration **(12 Hours)**

Introduction, Principle of refrigerator, Vapour compression refrigeration cycle, Electrical circuit of refrigerator, Application of refrigeration. Air-conditioning- Control of temperature and humidity. Types of air conditioning system. Electrical circuit of Air-conditioners - heat load calculations. type of compressor motor. Cold storage - estimation of tonnage capacity.

Text/Reference Books:

1. T. E.Openshaw, Utilisation of Electric Energy", Orient Longman,1986.
2. J. B. Gupta, Utilization of electric power and electric traction,S K Kataria& Sons, 2002.
3. C.L.Wadhwa, Generation, Distribution and utilization of electrical energy, Wiley Eastern Limited,1993.
4. Soni, Gupta, Bhatnagar, A course in electric power, DhanapatRai& sons, 2001.
5. S.L.Uppal, "Electrical Power," Khanna pulishers,1988.
6. H. Partab, Art and Science of Utilisation of Electrical Energy,DhanpatRai and Sons, New Delhi. Second edition.
7. S.C.Tripathy, Electric Energy Utilization And Conservation, Tata McGraw Hill, 1993.
8. Web sites: bee-india.org, eia.doe.gov, www.irfca.org.
9. IEEE bronze book-IEEE press
10. William Edward Barrows, Light, Photometry and Illumination,BiblioBazaar, LLC, 2009.

EE16104 COMMUNICATION SYSTEMS

Pre-requisite:

L	T	P	C
3	0	0	3

Total Hours: 42 Hours

Module 1: Basics of Communication and Amplitude Modulation (12 Hours)

Introduction to Analog Communication: Elements of communication system - Transmitters, Transmission channels, and receivers. Concept of modulation, its requirements.

Amplitude modulation (AM) - Time domain representation of AM signal, modulation index, frequency domain (spectral) representations, transmission bandwidth of AM. Generation and detection of AM - SSB, DSB, VSB - applications and comparison.

Module 2: Angle Modulation (12 Hours)

Angle Modulation: Frequency Modulation (FM) and Phase Modulation (PM). Time and Frequency domain representations, Spectral representation of FM and PM. Narrow and Wideband angle modulation. Generation of FM - Basic block diagram representation, Concept of VCO. FM generation: Narrowband FM, Wideband FM. Demodulation of FM using Phase Locked Loop, Frequency Division Multiplexing (FDM).

Module 3: Basic Digital Communication (8 Hours)

Introduction to Digital Communication; System block diagram. Digital transmission of analog signals: Sampling, Quantization: uniform – non uniform, companding: μ-law & A-law, PCM, Delta modulation.

Module 4: Digital Modulation Techniques (10 Hours)

Signal space concepts: Geometric structure of the signal space, vector representation, distance, norm and inner product, orthogonality and orthonormality, signal constellation.

Digital band pass modulation schemes: ASK, FSK, PSK signal space representation. – Coherent & non-coherent detection – Differential modulation schemes.

References:

1. B. P. Lathi, Z. Ding and H.M. Gupta, Modern Digital and Analog Communication Systems, 4/e, Oxford University Press.
2. Simon Haykin, An Introduction to Analog & Digital Communications, Wiley
3. John G. Proakis and M. Salehi, Communication System Engineering, 2nd Edition, Pearson Education.
4. Taub and Schilling, Principles of Communication Systems, 2nd Edition, McGraw Hill
5. B. Sklar and P. K. Ray, Digital Communication: Fundamentals and Applications, Pearson Education.
6. S. Haykin, Digital Communications, Wiley India.
7. John G. Proakis, Digital Communications, McGraw Hill, 2001.

EE16201 DRIVES LABORATORY

Pre-requisite-

L	T	P	C
0	0	2	1

Objective:

The different experiments during the laboratorial classes can be performed to impart knowledge on Performance of the fundamental control practices associated with AC and DC machines (speed control, starting, reversing, braking, plugging etc.) using power electronics devices. These experiments can also be helpful to impart industry oriented learning to the students.

EE16202 POWER SYSTEMS LABORATORY III

Pre-requisite-

L	T	P	C
0	0	2	1

Objective:

By performing the different experiment, students will be able to acquire knowledge about the working of different types of relays and their coordination for developing schemes for secured power system operation. Students will also learn about different protecting schemes for the protection of power system apparatuses. After the experiments they will able to design the protecting schemes for small power systems.

EE16203 CONTROL SYSTEMS LABORATORY II

Pre-requisite-

L	T	P	C
0	0	2	1

Objective:

Students will develop the ability to apply knowledge of mathematics, science, and engineering in solving control and industrial automation related problems. They will learn to get responses from linear, nonlinear, continuous and digital systems and interpret stability. They will design a controller or a system related to control engineering for a definite task. They will also learn and be able to analyze and interpret the system response for corrective measure, if any.

EE16204 RENEWABLE ENERGY SYSTEMS LABORATORY

Pre-requisite-

L	T	P	C
0	0	2	1

Objective:

The objective of Renewable Energy Systems Laboratory (RESL) is to focus on designing, testing, and disseminating renewable and efficient energy system. The mission of RESL is to help these technologies to realize their full potential to contribute to environmentally sustainable development in industrial and developing countries.