Semester III [Second year]						Branch: Electrical Engineering				
Sr. No.	**Course code**	**Course Title**	**L**	**T**	**P**	**Hours/ Week**	**Internal Marks**	**External Marks**	**Total Marks**	**Credits**
1	BTEE-301C	Electrical Circuit Analysis	3	1	0	4	40	60	100	4
2	BTEE-302C	Analog Electronics	3	0	0	3	40	60	100	3
3	BTEE-303C	Magnetic Circuits &Transformers	3	0	0	3	40	60	100	3
4	BTEE-304C	Engineering Mechanics	3	1	0	4	40	60	100	4
5	BTEE-305C	DC Machines	3	0	0	3	40	60	100	3
6	BTEE-306C	Electrical Measurements & Measuring Instruments	3	0	0	3	40	60	100	3
7	BTEE-311C	Analog Electronics Laboratory	0	0	2	2	30	20	50	1
8	BTEE-312C	Electrical Machines–I Laboratory	0	0	2	2	30	20	50	1
9	BTEE-321C	Institutional Summer Vacation Training	-	-	-	35	60	40	100	2
		Total	**18**	**2**	**4**	**24**	**360**	**440**	**800**	**24**

BTEE-301C	Electrical Circuit Analysis	3L:1T:0P	4 credits

Internal Marks: 40 External Marks: 60 Total Marks: 100

Course Outcomes:

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

CO1	Apply network theorems for the analysis of electrical circuits.
CO2	Understand & memorize the concepts of transient and steady-state response of electrical circuits.
CO3	Analyze circuits in the sinusoidal steady-state (single-phase and three-phase), analyze two port circuit behavior.
CO4	Synthesize networks and filters.

Module 1: Basic Network Analysis (14Hours)

Superposition theorem, Thevenin's theorem, Norton's theorem, Maximum power transfer theorem, Reciprocity theorem, Compensation theorem. Analysis with dependent current and voltage sources. Node and Mesh Analysis. Concept of duality and dual 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 state response.

Module 2: Electrical circuit and steady state analysis (14Hours)

Representation of sine function as rotating phasor, phasor diagrams, impedances and admittances, AC circuit analysis, effective or RMS values, average power and complex power. Three-phase circuits. Mutual coupled circuits, Dot convention in coupled circuits,Ideal Transformer. Analysis of electrical circuits using Laplace Transform for standard inputs, transformed network with initial conditions. Frequency response (magnitude and phase plots), series and parallel resonances.

Module 3: Network functions and two port network (10Hours)

Driving point impedance and admittance, natural response of a network, transfer impedance and admittance, concept of pole and zero sin a network function, Routh Hurwitz criterion of stability.

Two Port Networks: terminal pairs, relationship of two port variables, impedance parameters, admittance parameters, transmission parameters and hybrid parameters, inter connections of two port networks.

Module 4: Network Synthesis and Filters (10Hours)

Network synthesis techniques for 2-terminal network, Foster and Cauer forms.

Filters: Classification of filters, characteristics impedance and propagation constant of pure reactive network, ladder network, T-section, π-section, terminating half section, pass band s and stop bands, Design of constant-K, m-derived filters.

Text/References:

1. M.E.VanValkenburg,"NetworkAnalysis",PrenticeHall,2006.
2. D.Roy Choudhury,"NetworksandSystems",New Age International Publications,1998.
3. W.H.Hayt and J.E.Kemmerly,"Engineering Circuit Analysis",McGraw Hill Education, 2013.
4. C.K.Alexander and M.N.O.Sadiku,"Electric Circuits",McGraw Hill Education,2004.
5. K.V.V.Murthy and M.S.Kamath,"Basic Circuit Analysis",Jaico Publishers,1999.

BTEE-302C	Analog Electronics	3L:0T:0P	3 credits

Internal Marks: 40 External Marks: 60 Total Marks: 100

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

CO1	Understand the characteristics of transistors.
CO2	Design and analyse various rectifier and amplifier circuits.
CO3	Design sinusoidal and non-sinusoidal oscillators.
CO4	Understand the functioning of OP-AMP and design OP-AMP based circuits.

Module 1: Diode and BJT circuits (12Hours)
P-N junction diode, *V-I* characteristics of a diode; review of half-wave and full-wave rectifiers, Zener diodes, clamping and clipping circuits.
BJT circuits: Structure and *V-I* characteristics of a BJT; BJT as a switch. BJT as an amplifier: small-signal model, biasing circuits, current mirror; common-emitter, common-base and common-collector amplifiers.

Module 2: MOSFET circuits (10Hours)
MOSFET structure and *V-I* characteristics. MOSFET as a switch. MOSFET as an amplifier: small-signal model and biasing circuits, common-source, common-gate and common-drain amplifiers; small signal equivalent circuits-gain, input and output impedances, trans-conductance, high frequency equivalent circuit.

Module 3: Differential, multi-stage and operational amplifiers (10Hours)
Differential amplifier; power amplifier; direct coupled multi-stage amplifier ;internal structure of an operational amplifier, ideal op-amp, non-idealities in an op-amp (Output offset voltage, input bias current, input offset current, slew rate, gain bandwidth product)

Module 4: Linear applications of op-amp (10Hours)
Idealized analysis of op-amp circuits. Specifications. Inverting and non-inverting amplifier, differential amplifier, instrumentation amplifier, integrator, active filter, voltage regulator.

Text/References:

1. A.S.Sedra & K.C.Smith,"Microelectronic Circuits", New York, Oxford University Press, 1998.
2. J.V.Wait,L.P.Huelsmanand G.A.Korn,"Introduction to Operational Amplifier theory and applications", McGraw Hill U.S., 1992.
3. J.Millman and A.Grabel,"Microelectronics",McGraw Hill Education,1988.
4. P.Horowitz and W.Hill, "The Art of Electronics",Cambridge University Press, 1989.
5. P.R.Gray, R.G.Meyer and S.Lewis,"Analysis and Design of Analog Integrated Circuits", John Wiley & Sons, 2001.

BTEE-303C	Magnetic Circuits & Transformers	3L:0T:0P	3 credits

Internal Marks: 40 External Marks: 60 Total Marks: 100

Course Outcomes:

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

CO1	Understand & memorize the concepts of Magnetic circuits and Transformers.
CO2	Apply the knowledge acquired to solve the numerical problems.
CO3	Understand the effects of connections, operation, testing and saturation in transformers.
CO4	Analyse the concepts and problems related to magnetic circuits and transformers-single phase & three phase.

Module 1: Electromagnetism and Magnetic Circuits (8 hours)

Review of electromagnetism, Magnetic field strength, Magnetic force. Magneto motive force, reluctance, laws of magnetic circuits , determination of ampere-turns for series and parallel magnetic circuits, magnetic leakage and fringing, hysteresis and eddy current losses.

Module 2: Electromagnetic Induction (4 hours)

Faraday's laws, Lenz's law, statically and dynamically induced E.M.F., Energy stored in magnetic field.

Module 3: Transformers (16 hours)

Introduction, Principle of working, construction of single phase transformer, EMF equation, phasor diagram on no-load, leakage reactance, transformer on load, equivalent circuit, voltage regulation, power and energy efficiency, open circuit and short circuit tests, equivalent circuit parameters estimation. Effect of saturation on exciting current, in-rush current phenomenon. Parallel operation of single phase transformer. Auto Transformer: Principle of operation, comparison with two winding transformers.

Module 4: Three-Phase Transformers (8 hours)

Different winding connections, Voltage and current ratios, comparative features, effect of connections on exciting current, Parallel operation. Three winding transformer- equivalent circuit, off-load and on-load tap changing transformer, Scott connections.

Recommended Books:

1. Electric Machinery Fitzgerald, Kingsley & Kusko (Mcgraw Hill)
2. Transformer Engineering -L.F.Blume
3. Performance design & Testing of A.C. Machines - M.G. Say (CBS, Delhi)
4. Magnetic Circuits and Transformers MIT staff
5. Electrical Machines- Nagrath & Kothari (TMH)
6. Theory of Alternating Current Machines- A.S. Langsdorf (TMH)

BTEE-304C	Engineering Mechanics	3L:1T:0P	4 credits

Internal Marks: 40 External Marks: 60 Total Marks: 100

Course Outcomes:

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

CO1	Understand the concepts of co-ordinate systems.
CO2	Analyse the three-dimensional motion.
CO3	Understand the concepts of rigid bodies.
CO4	Analyse the free-body diagrams of different arrangements.
CO5	Analyse torsional motion and bending moment.

Module 1: Introduction to vectors and tensors and co-ordinate systems (6 hours)

Introduction to vectors and tensors and coordinate systems; Vector and tensor algebra; Indicial notation; Symmetric and anti-symmetric tensors; Eigen values and Principal axes.

Module 2: Three-dimensional Rotation (6 hours)

Three-dimensional rotation: Euler's theorem, Axis-angle formulation and Euler angles; Coordinate transformation of vectors and tensors.

Module 3: Kinematics of Rigid Body (7 hours)

Kinematics of rigid bodies: Dentition and motion of a rigid body; Rigid bodies as coordinate systems; Angular velocity of a rigid body, and its rate of change; Distinction between two and three-dimensional rotational motion; Integration of angular velocity to find orientation; Motion relative to a rotating rigid body: Five term acceleration formula.

Module 4: Kinetics of Rigid Bodies (5 hours)

Kinetics of rigid bodies: Angular momentum about a point; Inertia tensor: Dentition and computation, Principal moments and axes of inertia, Parallel and perpendicular axes theorems; Mass moment of inertia of symmetrical bodies, cylinder, sphere, cone etc., Are amoment of inertia and Polar moment of inertia, Forces and moments; Newton-Euler's laws of rigid body motion.

Module 5: Free Body Diagram (2 hour)

Free body diagrams; Examples on modelling of typical supports and joints and discussion on the kinematic and kinetic constraints that they impose.

Module 6: General Motion (9 hours)

Examples and problems. General planar motions. General 3-D motions. Free precession, Gyroscopes, Rolling coin.

Module 7: Bending Moment (5 hours)

Transverse loading on beams, shear force and bending moment in beams, analysis of cantilevers, simply supported beams and overhanging beams, relationships between loading, shear force and bending moment, shear force and bending moment diagrams.

Module 8: Torsional Motion (4 hours)

Torsion of circular shafts, derivation of torsion equation, stress and deformation in circular and hollow shafts.

Module 9: Friction (4 hours)
Concept of Friction; Laws of Coulomb friction; Angle of Repose; Coefficient of friction.

Text/References:

1. J.L.Meriamand L.G. Kraige,“EngineeringMechanics:Dynamics”,Wiley,2011.
2. M. F. Beatty, “Principles of Engineering Mechanics”, Springer Science & BusinessMedia, 1986.

BTEE-305C	D.C. Machines	3L:0T:0P	3 credits

Internal Marks: 40 External Marks: 60 Total Marks: 100

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

CO1	Understand & memorize the concepts of Electro-Mechanical Energy conversion in Electrical Machines and D.C. Machines.
CO2	Apply the knowledge acquired to solve the numerical problems.
CO3	Analyze the concepts and problems related to D.C. Machines.
CO4	Draw the operating characteristics of different types of DC machines, their applications, find losses & efficiency.

Module 1. Electro-Mechanical Energy Conversion (6 hours)
Energy stored in electric and magnetic fields, energy conversion in singly and multiple excited systems, reluctance torque, reluctance and hystersis motors.

Module 2. General Description of Electrical Machines (8 hours)
Description of electric circuits in cylindrical rotor and salient pole machines, MMF of Single and multiple coils, Effect of slots, winding factors, Torque in terms of flux and mmf.

Module 3. D.C. Machines (16 hours)
Armature windings, single and double layers, windings & winding diagrams, E.M.F. and torque equations, interaction of fields produced by excitation circuit and armature, effect of brush shift, compensating winding, commutation, causes of bad commutation, methods of improving commutation, methods of excitation of d.c. generators and their characteristics.
D.C. motors: characteristics, starting of shunt and series motor, starters, speed control methods-field and armature control, Ward Leonard method,
Braking: plugging, dynamic and regenerative braking,
Testing: Swinburn's test, Hopkinson test, Field test.
Estimation of losses and efficiency.

Module 4. Cross-Field Machines (6 hours)
Principle of working, analysis of cross-field generator, typical characteristics with different compensations and Applications.

Recommended Books :

1. Electric Machinery Fitzgerald Kingsley &Kusko
2. Principles of D.C. machines Langsdorff
3. Electrical Machines Nagrath& Kothari
4. Electrical Machinery P.S. Bhimbhra

BTEE-306C	**Electrical measurements & measuring instruments**	**3L:0T:0P**	**3credits**

Internal Marks: 40 External Marks: 60 Total Marks: 100

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

CO1	Understand the basic units, dimensions and dimensional formulas.
CO2	Memorize the basic concept of potentiometers, bridges and instrument transformers and Magnetic measurement.
CO3	Be familiar with the working principles of various measuring instruments.
CO4	Apply the acquired knowledge while solving the problems related with potentiometers, bridges, instrument T/F and magnetic measurements

Module1.Units, Dimensions and Standards(6 hours)
Introduction to MKS & Rationalised MKSA System, SI Units, Standards of EMF, Resistance, Capacitance and Inductance, Systematic errors

Module 2.General Theory of Analog Measuring Instruments(10 hours)
Operating torque, damping & controlling torque, T/W ratio, Pointers & Scales. Principles of operation of various types of electro mechanical indicating / registering instruments viz. PMMC, dynamometer, induction, thermal, etc. for dc & ac measurement of V,I, W, frequency, phase & power factor etc., energy meter, their sources of error & compensation, shunts & multipliers, multi- meter.

Module 3.Potentiometers(8 hours)
Basic Potentiometer circuit, multiple range potentiometers, constructional details of potentiometers, applications of d-c potentiometers; self balancing potentiometers.
A-C potentiometers, polar and co- ordinate types.

Module 4.Bridges(8 hours)
Sources and Detectors, General equation for bridge balance, Measurement of R,L,C,M, F etc by Wheatstone, Kelvin, Maxwell, Hay's, Anderson, Owen, Heaviside, Campbell, schering, Wien bridges. Bridge sensitivity. Errors, , Wagner Earthing Device.

Module 5.Magnetic Measurements(8hours)
Flux meter, B-H Curve, Hystersis loop, Permeameters, AC Testing of Magnetic materials, Separation of iron losses, iron loss measurement by Wattmeter and Bridge methods.

Module6.Instrument Transformers(8 hours)
Theory and construction of current and potential transformers, ratio and phase angle errors and their minimization, Characteristics of CTs. & PTs., Testing of CTS & PTS.

Text/References:
1.A Course in Electrical & Electronics Measurement & Inst. By. A. K. Sawhney, Dhanpat Rai & sons.
2.Electronic Inst. & Measurement techniques. By W.D. Cooper.

BTEE-311C	Analog Electronics Laboratory	0L:0T:2P	1 Credit

Internal Marks: 30 External Marks: 20 Total Marks: 50

Course Outcomes:

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

CO1	Understand the use and importance of various types of equipments used in the laboratory.
CO2	Ability to make circuits on bread-board.
CO3	Analyze, take measurements to understand circuit behavior and performance under different conditions.
CO4	Troubleshoot, design and create electronic circuits meant for different applications.
CO5	Evaluate the performance electronic circuits and working small projects employing semiconductor devices.

Note: A student to perform any 8-10experiments and make one minor working model project.

Suggested List of Experiments:

1. To draw *V-I* characteristics of a PN junction diode (Ge, Si, switching and signal).
2. To design half wave rectifier.
3. To design full wave and bridge rectifiers.
4. To study the transistor characteristics in common base, common collector, and common emitter configurations.
5. To study the *V-I* characteristics of a MOSFET.
6. To design a voltage regulator IC using zener diode and also see the effect of line and load regulation
7. To design various clippers and clampers using diodes.
8. To obtain the frequency response of an amplifier and calculate the gain bandwidth of the amplifier.
9. To investigate the emitter follower(Buffer) amplifier and determine A_V, R_i, and R_O
10. To design and study various type of oscillators, and determine frequency of oscillations.
11. To design a transistor series voltage regulator with current limits and observe its current feedback characteristics.
12. To study the characteristics of a complementary symmetry amplifier.
13. To study the application of an Op-Amp (741) as inverting and non-inverting amplifier.
14. To use the OP-AMP as summing, scaling and averaging amplifier.
15. Design differentiator and integrator using OP-AMP and also determine the time constant and cut-off frequency.

BTEE-312C	Electrical Machines-I Laboratory	0L:0T:2P	1 Credit

Internal Marks: 30 External Marks: 20 Total Marks: 50

Course Outcomes:

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

CO1	Analyze three-phase transformer/system connections.
CO2	Evaluation of equivalent circuit parameters, efficiency and voltage regulation by performing various tests on transformer.
CO3	Analyze parallel operation of transformers.
CO4	Analyze performance characteristics of DC generators.

Note: A student is required to perform any 7-9 experiments.

Suggested List of Experiments:

1. To perform Open circuit and short circuit tests on a single phase transformer and find the equivalent circuit.
2. To find the efficiency and voltage regulation of single phase transformer under different loading conditions.
3. To perform parallel operation of two single phase transformers.
4. To study the star & delta connections of three phase transformer.
5. To identify different components of D.C. machine and draw detailed sketches.
6. To measure armature and field resistance of d.c.shunt generator and to obtain its open circuit characteristics.
7. To obtain load characteristics of d.c. shunt/series /compound generator.
8. To draw speed-torque characterisitcs of d.c. shunt/series/compound generator.
9. To study electrical & mechanical components and their arrangement in d.c.motor starters.
10. To perform Swinburne's test (no load test) to determine losses of d.c. machines.

Semester IV [Second year]						Branch: Electrical Engineering				
Sr. No.	**Course code**	**CourseTitle**	**L**	**T**	**P**	**Hours/ Week**	**Internal Marks**	**External Marks**	**Total Marks**	**Credits**
1	BTEE-401C	Digital Electronics	3	0	0	3	40	60	100	3
2	BTEE-402C	Asynchronous Machines	3	1	0	4	40	60	100	4
3	BTEE-403C	Power Electronics	3	1	0	4	40	60	100	4
4	BTEE-404C	Signals and Systems	3	0	0	3	40	60	100	3
5	BTEE-405C	Electromagnetic Fields	3	1	0	4	40	60	100	4
6	BTEE-411C	Measurements and Instrumentation Lab.	0	0	2	2	30	20	50	1
7	BTEE-412C	Digital Electronics Laboratory	0	0	2	2	30	20	50	1
8	BTEE-413C	Power Electronics Laboratory	0	0	2	2	30	20	50	1
9	XXXX-XXXC	Open Elective-1	3	0	0	3	40	60	100	3
		Total	**18**	**3**	**6**	**27**	**330**	**420**	**750**	**24**

BTEE-401C	Digital Electronics	3L:0T:0P	3credits

InternalMarks: 40 ExternalMarks: 60 Total Marks: 100

Course Outcomes:

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

CO1	Understand working of logic families and logic gates.
CO2	Design and implement Combinational and Sequential logic circuits.
CO3	Understand the process of Analog to Digital conversion and Digital to Analog conversion.
CO4	Be able to understand memories.

Module1: Fundamentals of Digital Systems and logic families (10 Hours)

Digital signals, digital circuits,AND,OR,NOT,NAND,NOR and Exclusive-OR operations, Boolean algebra, examples of IC gates, number systems-binary, signed binary, octal hexadecimal number, binary arithmetic, one's and two's complements arithmetic, codes, error detecting and correcting codes, characteristics of digital lCs, digital logic families, TTL, Schottky TTL and CMOS logic, interfacing CMOS and TTL, Tri-state logic.

Module2:Combinational Digital Circuits(10Hours)

Standard representation for logic functions, K-map representation, and simplification of logic functions using K-map, minimization of logical functions. Don't care conditions, Multiplexer, De-Multiplexer/Decoders, Adders, Subtractors, BCD arithmetic, carry look ahead adder, serial adder, ALU, elementary ALU design, popular MSI chips, digital comparator, parity checker/generator, code converters, priority encoders, decoders/drivers for display devices, Q-M method of function realization.

Module3:Sequential circuits and systems(12Hours)

A1-bit memory, the circuit properties of Bi-stable latch, the clocked SR flipflop, J-K-T and D- types flip flops, applications of flip flops, shift registers, applications of shift registers, serial o parallel converter, parallel to serial converter, ring counter, sequence generator, ripple (Asynchronous) counters, synchronous counters, counters design using flip flops, special counter IC's, asynchronous sequential counters, applications of counters.

Module4:A/D and D/A Converters(10 Hours)

Digital to analog converters: weighted resistor/converter, R-2R Ladder D/A converter, specifications for D/A converters, examples of D/A converter ICs, sample and hold circuit, analog to digital converters: quantization and encoding, parallel comparator A/D converter, successive approximation A/D converter, counting A/D converter, dual slope A/D converter, A/D converter using Voltage to frequency and voltage to time conversion, specifications of A/D converters, example of A/D converter ICs, concept of memories.

Text/References:

1. R. P. Jain, "Modern Digital Electronics", McGraw Hill Education, 2009.
2. M. M. Mano, "Digital logic and Computer design", Pearson Education India, 2016.
3. A. Kumar, "Fundamentals of Digital Circuits", Prentice Hall India, 2016.

BTEE-402C	Asynchronous machines	3L:1T:0P	4credits

Internal Marks: 40 External Marks: 60 Total Marks: 100

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

CO1	Understand and memorize the concept of polyphase induction motors, their starting and speed control methods.
CO2	Apply the knowledge acquired for solving numerical problems on Induction machines and analyse the results.
CO3	Appraise the performance of the Induction machines-single phase and three phase and select appropriate ac machines considering its significance.
CO4	Understand working and applications of induction generator, special purpose motors and single-phase motors.

Module 1.Basic Concepts(10 hours)

Field distribution of space distributed three-phase winding, concept of rotating field, production and concept of asynchronous and synchronous torques.

Module 2.Polyphase Induction Machines(16 hours)
Constructional features, operation, equivalent circuit, phasor diagram , leakage reactance and it's importance on machine performance, effect of rotor circuit resistance, starting torque, cage motors, double cage and deep bar motor. Generator action, methods of excitation, space harmonics and their effect on motor performance, starting methods, speed control: (i) control of speed of rotating field, (ii) control of slip speed. Estimation of equivalent circuit parameters Effect of voltage injection in rotor circuit of slip ring induction motor, action of commutator, scherbius and Kramer schemes of speed and P.F. control of induction motors.

Module 3. Stepper motors And Linear Induction Machines(10 hours)
Stepper Motors: construction, principle of operation and applications.
Linear Induction Machines: construction, principle of operation and applications.

Module 4. Single-Phase Motors (12 hours)

Single phase induction motor, double revolving field theory, equivalent circuit, characteristics.
Phase splitting, shaded pole motor, single phase series and repulsion motor: working and characteristics.

Text/References:

1. A. E. Fitzgerald and C. Kingsley, "Electric Machinery", McGraw Hill Education, 2013.
2. M. G. Say, "Performance and design of AC machines", CBS Publishers, 2002.
3. P. S. Bimbhra, "Electrical Machinery", Khanna Publishers, 2011.
4. I. J. Nagrath and D. P. Kothari, "Electric Machines", McGraw Hill Education, 2010.
5. A. S. Langsdorf, "Alternating current machines", McGraw Hill Education, 1984.
6. P. C. Sen, "Principles of Electric Machines and Power Electronics", John Wiley & Sons, 2007.

BTEE-403C	Power Electronics	3L:1T:0P	4credits

Internal Marks: 40 External Marks: 60 Total Marks: 100

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

CO1	Understand the differences between signal level and power level devices.
CO2	Analyse controlled rectifier circuits.
CO3	Analyse the operation of DC-DC choppers.
CO4	Analyse the operation of voltage source inverters.

Module 1: Power switching devices (10 Hours)
Diode, Thyristor, MOSFET, IGBT: *V-I* characteristics; Firing circuit for thyristor; Voltage and current commutation of a thyristor; Gate drive circuits for MOSFET and IGBT.

Module 2: Thyristor rectifiers (12 Hours)
Single-phase half-wave and full-wave rectifiers, Single-phase full-bridge thyristor rectifier with R-load and highly inductive load; Three-phase full-bridge thyristor rectifier with R- load and highly inductive load; Input current wave shape and power factor.

Module 3: DC-DC buck converter (12 Hours)
Elementary chopper with an active switch and diode, concepts of duty ratio and average voltage, power circuit of a buck converter, analysis and waveforms at steady state, duty ratio control of output voltage. DC-DC boost converter: Power circuit of a boost converter, analysis and waveforms at steady state, relation between duty ratio and average output voltage.

Module 4: Single-phase voltage source inverter (14 Hours)
Power circuit of single-phase voltage source inverter, switch states and instantaneous output voltage, square wave operation of the inverter, concept of average voltage over a switching cycle, bipolar sinusoidal modulation and unipolar sinusoidal modulation, modulation index and output voltage. Three-phase voltage source inverter: Power circuit of a three-phase voltage source inverter, switch states, instantaneous output voltages, average output voltages over a sub-cycle, three-phase sinusoidal modulation

Text/References:
1. M. H. Rashid, “Power electronics: circuits, devices, and applications”, Pearson Education India, 2009.
2.N. Mohan and T. M. Undeland, “Power Electronics: Converters, Applications and Design”, John Wiley & Sons, 2007.
3.R. W. Erickson and D. Maksimovic, “Fundamentals of Power Electronics”, Springer Science & Business Media, 2007.
4.L. Umanand, “Power Electronics: Essentials and Applications”, Wiley India, 2009.
5.P. S. Bimbhra, Power Electronics”, Khanna Publishers

BTEE-404C	Signals and Systems	3L:0T:0P	3 credits

Internal Marks: 40 External Marks: 60 Total Marks: 100

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

CO1	Understand the concepts of continuous time and discrete time systems.
CO2	Analyse systems in complex frequency domain.
CO3	Understand sampling theorem and its implications.
CO4	Understand mathematical tools to be able to apply in state variable modeling

Module 1: Introduction to Signals and Systems (12 hours):
Signals and systems as seen in everyday life, and in various branches of engineering and science. Signal properties: periodicity, absolute integrability, determinism and stochastic character. Some special signals of importance: the unit step, the unit impulse, the sinusoid, the complex exponential, some special time-limited signals; continuous and discrete time signals, continuous and discrete amplitude signals. System properties: linearity: additivity and homogeneity, shift- invariance, causality, stability, realizability. Examples.

Module 2: Behavior of continuous and discrete-time LTI systems (12 hours)
Impulse response and step response, convolution, input-output behavior with aperiodic convergent inputs, cascade interconnections. Characterization of causality and stability of LTI systems. System representation through differential equations and difference equations. State- space Representation of systems. State-Space Analysis, Multi-input, multi-output representation. State Transition Matrix and its Role. Periodic inputs to an LTI system, the notion of a frequency response and its relation to the impulse response.

Module 3: Fourier, Laplace and z- Transforms (10 hours)
Fourier series representation of periodic signals, Waveform Symmetries, Calculation of Fourier Coefficients. Fourier Transform, convolution/multiplication and their effect in the frequency domain, magnitude and phase response, Fourier domain duality. The Discrete-Time Fourier Transform (DTFT) and the Discrete Fourier Transform (DFT). Parseval's Theorem. Review of the Laplace Transform for continuous time signals and systems, system functions, poles and zeros of system functions and signals, Laplace domain analysis, solution to differential equations and system behavior. The z-Transform for discrete time signals and systems, system functions, poles and zeros of systems and sequences, z-domain analysis.

Module 4: Sampling and Reconstruction (8 hours)
The Sampling Theorem and its implications. Spectra of sampled signals. Reconstruction: ideal interpolator, zero-order hold, first-order hold. Aliasing and its effects. Relation between continuous and discrete time systems. Introduction to the applications of signal and system theory: modulation for communication, filtering, feedback control systems.

Text/References:

1. V. Oppenheim, A.S. Willsky & S.H. Nawab, “Signals and systems”, Prentice Hall, 1997.
2. G. Proakis and D. G. Manolakis, “Digital Signal Processing: Principles, Algorithms, and Applications”, Pearson, 2006.
3. P. Hsu, “Signals and systems”, Schaum’s series, McGraw Hill Education, 2010.
4. S. Haykin and B. V. Veen, “Signals and Systems”, John Wiley and Sons, 2007.
5. A. V. Oppenheim and R. W. Schafer, “Discrete-Time Signal Processing”, Prentice Hall,2009.
6. M. J. Robert “Fundamentals of Signals and Systems”, McGraw Hill Education, 2007.
7. P. Lathi, “Linear Systems and Signals”, Oxford University Press, 2009.

BTEE-405C	**Electromagnetic Fields**	**3L:1T:0P**	**4 credits**

Internal Marks: 40 External Marks: 60 Total Marks: 100

Course Outcomes:

At the end of the course, students will demonstrate the ability:

CO1	To understand the basic laws of electromagnetism.
CO2	To obtain the electric and magnetic fields for simple configurations under static conditions.
CO3	To analyse time varying electric and magnetic fields.
CO4	To understand Maxwell's equation in different forms and different media.
CO5	To understand the propagation of EM waves.

This course shall have Lectures and Tutorials. Most of the students find difficult to visualize electric and magnetic fields. Instructors may demonstrate various simulation tools to visualize electric and magnetic fields in practical devices like transformers, transmission lines and machines.

Module 1: Review of Vector Calculus (6 hours)

Vector algebra-addition, subtraction, components of vectors, scalar and vector multiplications, triple products, three orthogonal coordinate systems (rectangular, cylindrical and spherical).Vector calculus-differentiation, partial differentiation, integration, vector operator, del, gradient, divergence and curl; integral theorems of vectors. Conversion of a vector from one coordinate system to another.

Module 2: Static Electric Field (12Hours)

Coulomb's law, Electric field intensity, Electrical field due to point charges. Line, Surface and Volume charge distributions. Gauss law and its applications. Absolute Electric potential, Potential difference, Calculation of potential differences for different configurations. Electric dipole, Electrostatic Energy and Energy density.

Current and current density, Ohms Law in Point form, Continuity of current, Boundary conditions of perfect dielectric materials. Permittivity of dielectric materials, Capacitance, Capacitance of a two wire line, Poisson's equation, Laplace's equation, Solution of Laplace and Poisson's equation, Application of Laplace's and Poisson's equations.

Module 3: Magnetic Forces and Inductance (6 Hours)

Biot-Savart's law, Ampere's law of force, Ampere's circuital law, Faraday's law, Force on a moving charge, Force on a differential current element, Force between differential current elements, Magnetic boundary conditions, Magnetic circuits, calculations of inductances and mutual inductances for a solenoid and toroid.

Module 4: Maxwell's Equations in Time Varying Fields and Wave theory (12 Hours)

Concept of displacement current and conduction current, Maxwell's equation-differential and integral form, Poynting's theorem, its significance and Poynting's vector, Boundary Conditions.

Wave theory: Derivation of wave equation, uniform plane waves, Maxwell's equation in Phasor form, Wave equation in Phasor form, Plane waves in free space and in a homogenous material. Attenuation, phase and propagation constant, intrinsic impedance, Relation between E&H, wave equation for a conducting medium, Plane waves in lossy dielectrics, Propagation in good conductors, Skin effect.

Text/References:

1. M.N.O.Sadiku,“Elements of Electromagnetics”,Oxford University Publication, 2014.
2. A. Pramanik, “Electromagnetism - Theory and applications”, PHI Learning Pvt. Ltd, New Delhi, 2009.
3. A.Pramanik,“Electromagnetism-Problems with solution”,Prentice Hall India,2012.
4. G.W.Carter, “The electromagnetic field in its engineering aspects”,Longmans, 1954.
5. W.J.Duffin,“Electricity andMagnetism”,McGraw Hill Publication, 1980.
6. W.J.Duffin,“Advanced Electricity and Magnetism”,McGraw Hill, 1968.
7. E.G.Cullwick,“The Fundamentals of Electromagnetism”,Cambridge University Press, 1966.
8. B. D. Popovic, “Introductory Engineering Electromagnetics”, Addison-Wesley Educational Publishers, International Edition, 1971.
9. W.Hayt,“Engineering Electromagnetics”,McGraw Hill Education, 2012.

BTEE-411C	**Measurements and Instrumentation Laboratory**	**0L:0T:2P**	**1credit**

Internal Marks: 30 External Marks: 20 Total Marks: 50

Course Outcomes:

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

CO1	Design and validate DC and AC bridges.
CO2	Analyze the dynamic response and the calibration of few instruments.
CO3	Understand various measurement devices, their characteristics, their operation and their limitations.
CO4	Understand statistical data analysis.
CO5	Understand computerized data acquisition.

Experiments

1. Measurement of a batch of resistors and estimating statistical parameters.
2. Measurement of L using a bridge technique as well as LCR meter.
3. Measurement of C using a bridge technique as well as LCR meter.
4. Measurement of Low Resistance using Kelvin's double bridge.
5. Measurement of High resistance and Insulation resistance using Megger.
6. Usage of DSO for steady state periodic waveforms produced by a function generator. Selection of trigger source and trigger level, selection of time-scale and voltage scale. Bandwidth of measurement and sampling rate.
7. Download of one-cycle data of a periodic waveform from a DSO and use values to compute the RMS values using a C program.
8. Usage of DSO to capture transients like a step change in R-L-C circuit.
9. Current Measurement using Shunt, CT, and Hall Sensor.
10. Measurement of frequency using Wein's Bridge.
11. To find 'Q' of an inductance coil and verify its value using Q- meter.
12. Plotting of Hysteresis loop for a magnetic material using flux meter.

Note: A student to perform any 8-10 Experiments and make one minor working model project.

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BTEE-412C	Digital Electronics Laboratory	0L:0T:2P	1Credit

Internal Marks: 30 ExternalMarks: 20 Total Marks: 50

Course Outcomes:

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

CO1	To understand of basic electronic components and circuits
CO2	Understanding verify truth tables of TTL gates
CO3	Design and fabrication and realization of all gates and basic circuits
CO4	Design the truth tables and basic circuits
CO5	Testing of basic electronics circuits

Note: A student to perform any 8-10 Experiments and make one working minor project.

Suggested List of Experiments:

1. Design a delay circuit using 555 timer and study the monostable, bistable and astable operations using 555.
2. a) Verification of the truth tables of TTL gates viz; 7400,7402, 7404, 7408,7432,7486.
   b) Design and fabrication and realization of all gates using NAND/NOR gates.
3. Verification of truth table of Mutiplexer(74150)/Demultiplexer(74154)
4. Design and verification of truth tables of half-adder, full-adder and subtractor circuits using gates 7483 and 7486(controlled inverter).
5. To study the operation of Arithmetic Logic Unit IC 74181.
6. Design fabrication and testing of
   a) Monostable multivibrator of t = 0.1ms approx. using 74121/123.testing for both positive and negative edge triggering, variation in pulse width and retriggering.
   b) Free running mutivibrator at 1KHz and 1Hz using 555 with 50% duty cycle. Verify the timing from theoretical calculations.
7. Design and test S-R flip-flop using NOR/NAND gates.
8. Design, fabricate and test a switch debouncer using 7400.
9. Verify the truth table of a JK flip flop using IC 7476,
10. Verify the truth table of a D flip flop using IC 7474 and study its operation in the toggle and asynchronous mode.
11. Operate the counters 7490, 7493 and 74193(Up/Down counting mode). Verify the frequency division at each stage. Using a frequency clock (say 1 Hz) display the count of LED’s.
12. Verify the truth table of decoder driver7447/7448. Hence operate a 7 segment LED display through a counter using a low frequency clock. Repeat the above with the BCD to Decimal decoder 7442.

BTEE-413C	Power Electronics Laboratory	0L:0T:2P	1 Credit

Internal Marks: 30 External Marks: 20 Total Marks: 50

Course Outcomes:

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

CO1	Understand the properties and characteristics of thyristors.
CO2	Understand the different types of waveforms of inverter and chopper circuits.
CO3	Analyze speed and direction control of single phase and three phase electric motors using ac and dc drive.
CO4	Understand the effect of free-wheeling diode on pf with RL load.
CO5	Check the performance of a choppers, and inverter.

Note: A student to perform any 8-10 Experiments and make one hardware/software based minor project.

Suggested List of Experiments:

1. To plot V-I characteristics and study the effect of gate triggering on turning on ofSCR.
2. To study the effect of free-wheeling diode on power factor for single phase half-waverectifier with R-L load.
3. To plot waveforms for output voltage and current, for single phase full-wave, fullycontrolled bridge rectifier, for resistive and resistive cum inductive loads.
4. Study of the microprocessor-based firing control of a bridge converter.
5. To study three phase fully controlled bridge converter and plot waveforms of outputvoltage, for different firing angles.
6. To study Jones chopper or any chopper circuit to check the performance.
7. Thyristorised speed control of a D.C. Motor.
8. Speed Control of induction motor using thyristors.
9. Study of series inverter circuit and to check its performance.
10. Study of a single-phase cycloconverter.
11. To check the performance of a McMurray half-bridge inverter.

LIST OF OPEN ELECTIVE COURSES FOR STUDENTS OF OTHER PROGRAMMS OFFERED BY ELECTRICAL ENGINEERING

Prerequisite: To have passed Basic Electrical Engineering/Basic Electronics Engineering Course

Sr. No.	Course Code	Course Title	L	T	P	Hours/ Week	Credits
1.	BTEE-901C	Control Systems	3	0	0	3	3
2.	BTEE-902C	Power Electronics	3	0	0	3	3
3.	BTEE-903C	Electrical Energy Conservation & Auditing	3	0	0	3	3
4.	BTEE-904C	Renewable Energy Sources	3	0	0	3	3
5.	BTEE-905C	Electric Machines	3	0	0	3	3
6.	BTEE-906C	Industrial Electrical Systems	3	0	0	3	3
7.	BTEE-907C	Wind and Solar Energy Systems	3	0	0	3	3
8.	BTEE-908C	Power Systems	3	0	0	3	3

BTEE-901C	Control Systems	3L:0T:0P	3 credits

Internal Marks: 40   *External Marks: 60*   *Total Marks: 100*

Course Outcomes:

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

(i) Understanding the model of linear-time-invariant systems using transfer function
(ii) Understanding state-space representations.
(iii) Knowledge of the concept of stability
(iv) Assessment for linear-time invariant systems.
(v) Knowledge of non-linear systems

Module 1: Introduction to control problem (6 hours)

Industrial Control examples. Mathematical models of physical systems. Control hardware and their models. Transfer function models of linear time-invariant systems.
Feedback Control: Open-Loop and Closed-loop systems. Benefits of Feedback.

Module 2: Time and Frequency Response Analysis (12 hours)

Standard test signals. Time response of first and second order systems for standard test inputs. Application of initial and final value theorem. Design specifications for second-order systems based on the time-response. Concept of Stability. Routh-Hurwitz Criteria.

Module 3: Frequency-response analysis (8 hours)

Relationship between time and frequency response, Polar plots, Bode plots. Nyquist stability criterion.

Module 4: State variable Analysis (8 hours)

Concepts of state variables. State space model. Diagonalization of State Matrix. Solution of state equations. Eigenvalues and Stability Analysis. Concept of controllability and observability.
Pole-placement by state feedback.

Module 5: Introduction to Optimal Control and Nonlinear Control (8 hours)

Performance Indices. Regulator problem, Tracking Problem. Nonlinear system–Basic concepts and analysis.

Text/References:

1. M. Gopal, Control Systems: Principles and Design, McGraw Hill Education, 1997.
2. B. C. Kuo, Automatic Control System, Prentice Hall, 1995.
3. K. Ogata, Modern Control Engineering, Prentice Hall, 1991.
4. I. J. Nagrath and M. Gopal, Control Systems Engineering, New Age International, 2009.

BTEE-902C	Power Electronics	3L:0T:0P	3 credits

Internal Marks: 40 External Marks: 60 Total Marks: 100

Course Outcomes:
At the end of this course, students will demonstrate the ability to
(i) Knowledge of power semiconductor switches
(ii) Understand the working of various types of converters
(iii) Apply the ac-dc and dc-dc converter in field

Module 1: Semiconductor Devices Construction and Characteristics (8 hours)
Introduction to Thyristor family: SCR, DIACs, TRIACs Power Transistors, Power MOSFET, Insulated Gate Bipolar transistors (IGBTs), Light Activated SCRs (LASCRs), Reverse Conducting Thyristor, (RCT), Asymmetrical SCR (ASCR), Gate turn-off Thyristors (GTOs), Integrated Gate- Commutated Thyristors (IGCTs), MOS controlled Thyristors (MCTs) Power Integrated circuits (PICs), Intelligent Modules

Module 2: Thyristor Fundamentals (10 hours)
Construction of SCR, Operating modes, Two transistor analogy, Static & dynamic characteristics, Gate characteristics, Turn on & turn off methods (Commutation methods), Series and Parallel operations of SCRs : Need, String efficiency, Issues, Static and Dynamic Equalizing circuit and Means to minimize the effect of mis-match Isolation of gate and base drive using pulse transformer and Optocouplers Gate Drive/Triggering circuits: R trigger, RC trigger, Cosine Triggering, UJT and Programmable UJT as an oscillator and triggering circuit based on them Ratings, Cooling and Heat sinks, Thermal Modeling, di/dt and dv/dt protection,

Module 3: Phase Controlled (AC to DC) Converters (8 hours)
Review of half-wave and full-wave diode rectifier (with RL load); Principle of phase-controlled converter operation; Operation of 1-phase half wave converter with R, RL and RLE load; 1- phase full wave converter: Center-tapped and Bridge Configuration; Gating Requirements.

Module 4: Operation and analysis of 1-phase Semi-converter/Half controlled converter (8 hours)
Operation of half wave converter; Full wave fully controlled converters: Semi-controlled converter; Dual Converter: Principle and operation; 1-phase and 3-phase configurations.

Module 5: DC to DC Converters (8 hours)
The chopper, Basic principle of DC chopper, Classification of DC choppers, Principle, operation, and analysis for Step-down (Buck), Step-up (Boost), Step up/down (Buck-Boost), Application of DC-to-DC converters.

Text/References:
1. M. D. Singh and K. B. Khanchandani, Power electronics, TMH, New Delhi, 2nd ed., 2007.
2. M. H. Rashid, Power Electronics - Circuits, Devices and Applications, Prentice Hall of India, 3rd ed., 2003.
3. V. Subramanyam, Power Electronics – Devices, Converters and Applications, New Age International Publishers Pvt. Ltd., Bangalore, 2nd ed. 2006.
4. P. S. Bimbhra, Power Electronics, Khanna Publishers, New Delhi, 2012.
5. N. Mohan, Undeland and Robbins, Power Electronics – Converters, Applications and Design, John Willey & sons, Inc., 3rd ed., 2003.
6. V. R. Moorthi, Power Electronics, Oxford University press, 2005.
7. G. K. Dubey, S.R. Doradla, A. Joshi, and R.M.K. Sinha, Thyristorised Power Controllers, New Age International Ltd. Publishers, 1986 (Reprint 2008).
8. P.T. Krein, Elements of Power Electronics, Oxford University Press, 1998.
9. G. K. Dubey, Fundamentals of Electrical Drives, Narosa Publishing House, New Delhi, 2nd ed. 2001.

BTEE-903C	Electrical Energy Conservation & Auditing	3L:0T:0P	3 credits

Internal Marks: 40 *External Marks: 60* *Total Marks: 100*

Course Outcome: After learning the course the students should be able to,

(i) Knowledge of the energy conservation/saving opportunities in different electric system
(ii) Knowledge of energy conservation opportunities in thermal system
(iii) Understand the Demonstrate skills required for energy audit and management.
(iv) Understand the Suggest cost-effective measures towards improving energy efficient and energy conservation.

Module 1: Energy Conservation in Power Generation, Transmission and Distribution (6 hours)
Performance improvement of existing power plant: co-generation, small hydro, DG Set, Demand side management, Load response programmes, Types of tariff and restructuring of electric tariff.

Module 2: Energy Audit Methodology and recent trends (10 hours)
General Philosophy need of Energy Audit and Management, EC Act, Definition and Objective of Energy Management, General Principles of Energy Management. Energy Management Skills, Energy Management Strategy. Economics of implementation of energy optimization projects, it's constraints, barriers and limitations, Report-writing, preparations and presentations of energy audit reports, Post monitoring of energy conservation projects, MIS, Case-studies / Report studies of Energy Audits. Impact of renewable energy on energy audit recommendations.

Module 3: Thermal Systems (10 hours)
Boilers- performance evaluation, Loss analysis, Water treatment and its impact on boiler losses, integration of different systems in boiler operation. Furnaces- Types and classifications, applications, economics and quality aspects, heat distributions, draft controls, waste heat recovering options, Furnaces refractory- types and sections. Thermic Fluid heaters need and applications, Heat recovery and its limitations.

Module 4: Energy Audit (8 hours)
Energy audit and its benefits, Energy flow diagram, Preliminary, Detailed energy audit., Methodology of preliminary energy audit and Detailed energy audit – Phase I, Pre audit, Phase II- Audit and Phase III- Post audit, Energy audit report., Electrical Measuring Instruments - Power Analyser, Combustion analyser, fuel efficiency monitor, thermometer-contact, infrared, pitot tube and manometer, water flowmeter, leak detector, tachometer and luxmeter, IE rules and regulations for energy audit, Electricity act.

Module 5: Energy Conservation Approaches in Industries (8 hours)
Energy saving opportunities in electric motors, Benefits of Power factor improvement and its techniques-Shunt capacitor, Synchronous Condenser etc., Effects of harmonics on – Motors, and remedies leading to energy conservation, Area Sealing, Insulating the Heating / cooling fluid pipes, automatic door closing- Air curtain, Thermostat / Control., Lighting techniques – Natural, CFL, LED lighting sources and fittings. Introduction to green buildings

Textbooks:
1. Energy Audit and Management, Volume-I, IECC Press
2. Energy Efficiency in Electrical Systems, Volume-II, IECC Press
3. W. R. Murphy, G. Mckay, Energy Management: Butterworths Scientific
4. C. B. Smith, Energy Management Principles, Pergamon Press
5. D.A. Reay, Industrial Energy Conservation, Pergammon Press
6. W.C. Turner, Energy Management Handbook, John Wiley and Sons, A Wiley Interscience
7. L.C. Witte, P.S. Schmidt, D.R. Brown, Industrial Energy Management and Utilization, Hemisphere Publication, Washington, 1988.
8. Handbook of Energy Audits, Albert Thumann, P.E., C.E.M. William J. Younger, C.E.M., CRC Press.

BTEE-904C	Renewable Energy Sources	3L:0T:0P	3 credits

Internal Marks: 40   *External Marks: 60*   *Total Marks: 100*

Course Outcomes:

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

(i) Knowledge of the basic properties of different renewable sources of energy and technologies
(ii) Knowledge of the main elements of technical systems designed for utilization of renewable sources of energy
(iii) Understand the advantages and disadvantages of different renewable sources of energy
(iv) Understand the energy potential of renewable sources of energy,

Module 1: Solar Radiation and Solar Energy Collection (12 hours)

Role and potential of new and renewable source, the solar energy option, Environmental impact of solar power, physics of the sun, the solar constant, extraterrestrial and terrestrial solar radiation, solar radiation on titled surface, instruments for measuring solar radiation and sun shine, solar radiation data.

Flat plate and concentrating collectors, classification of concentrating collectors, orientation and thermal analysis, advanced collectors. Solar Applications- solar heating/cooling technique, solar distillation and drying, photovoltaic energy conversion.

Module 2: Wind Energy (8 hours)

Energy availability of wind, wind resources, principle of wind energy conservation. Wind turbine site and its site selection, classification of wind turbine, characteristics of wind turbine.

Module 3: Bio-Mass (8 hours)

Principles of Bio-Conversion, Anaerobic/aerobic digestion, types of Bio-gas digesters, gas yield, combustion characteristics of bio-gas, utilization for cooking.

Module 4: Geothermal Energy (6 hours)

Resources, types of wells, methods of harnessing the energy, potential in India.

Module 5: Ocean Energy (8 hours)

OTEC, Principles utilization, setting of OTEC plants, thermodynamic cycles. Tidal and wave energy: Potential and conversion techniques, mini-hydel power plants, and their economics.

Text/References:

1. Non-Conventional Energy Sources /G.D. Rai, Khanna Publishers
2. Renewable Energy Resources – Twidell &Wier, CRC Press (Taylor & Francis)
3. Renewable energy resources/ Tiwari and Ghosal/ Narosa.
4. Ramesh & Kumar, Renewable Energy Technologies / /Narosa
5. D. P. Kothari, K. C. Singhal, Renewable energy sources and emerging technologies, P.H.I.

BTEE-905C	Electric Machines	3L:0T:0P	3 credits

Internal Marks: 40 External Marks: 60 Total Marks: 100

Course Outcomes:

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

(i) Summarize the basics of Single-Phase Machines
(ii) Acquire knowledge about testing and applications of induction motors.
(iii) Understand the concepts of Steeper Motors, construction, modes of operation and characteristics
(iv) Understand the basic concept of DC Machines and its torque slip characteristics
(v) Explain the basic concepts of universal and repulsion motors, construction, application.

Module 1: Poly-phase AC Machines (9 hours)

Construction of three phase induction motors, types of three-phase induction motors, rotor induced emf, power flow in induction motor, equivalent circuit of induction motor, Torque -speed characteristics, condition of maximum torque, tests on induction motor: measurement of DC resistance, No-load test, blocked rotor test. Braking: Plugging, rheostatic braking and regenerative braking.

Module 2: Single phase Induction Motors (8 hours)

Pulsating magnetic field, double revolving field, starting methods of single-phase induction motor, Construction, starting characteristics and applications of split phase, capacitor start, capacitor run, capacitor-start capacitor-run and shaded pole motors. Servo motors: DC Sevomotor and AC servo motor,

Module 3: Stepper Motors (8 hours)

Principle of operation, variable reluctance, permanent magnet and hybrid stepper motors, characteristics, drive circuits and applications. Switched Reluctance Motors: Construction; principle of operation; torque production, modes of operation, drive circuits.

Module 4: Permanent Magnet Machines (9 hours)

Types of permanent magnets and their magnetization characteristics, demagnetizing effect, permanent magnet dc motors, sinusoidal PM ac motors, brushless dc motors and their important features and applications, PCB motors. Single phase synchronous motor; construction, operating principle and characteristics of reluctance and hysteresis motors; introduction to permanent magnet generators and applications

Module 5: Special Machines (8 hours)

Construction, principle of operation of: Single phase AC commutator motor, Switched Reluctance motor, brushless dc motor, hysteresis Motor, Synchronous reluctance motor, Linear induction motor.

Text / Reference Books:

1. P.S. Bimbhra, Generalized Theory of Electrical Machines, Khanna Publishers.
2. P.C. Sen, Principles of Electrical Machines and Power Electronics, John willey & Sons, 2001
3. G. K. Dubey, Fundamentals of Electric Drives, Narosa Publishing House, 2001.
4. C. G. Veinott, Fractional and Sub-fractional horsepower electric motors, McGraw Hill International, 1987
5. M.G. Say, Alternating current Machines, Pitman & Sons.

BTEE-906C	Industrial Electrical Systems	3L:0T:0P	3 credits

Internal Marks: 40   External Marks: 60   Total Marks: 100

Course Outcomes:

(i) At the end of this course, students will demonstrate the ability to
(ii) Understand the electrical wiring systems for residential, commercial, and industrial consumers, representing the systems with standard symbols and drawings, SLD.
(iii) Understand various components of industrial electrical systems.
(iv) Analyze and select the proper size of various electrical system components.

Module 1: Electrical System Components (10 Hours)
LT system wiring components, selection of cables, wires, switches, distribution box, metering system, Tariff structure, protection components- Fuse, MCB, MCCB, ELCB, inverse current characteristics, symbols, single line diagram (SLD) of a wiring system, Contactor.,

Module 2: Residential and Commercial Electrical Systems (9 Hours)
Types of residential and commercial wiring systems, general rules and guidelines for installation, load calculation and sizing of wire, rating of main switch, distribution board and protection devices, earthing system calculations, requirements of commercial installation, deciding lighting scheme and number of lamps, earthing of commercial installation, selection and sizing of components.

Module 3: Illumination Systems (9 Hours)
Understanding various terms regarding light, lumen, intensity, candle power, lamp efficiency, specific consumption, glare, space to height ratio, waste light factor, depreciation factor, various illumination schemes, Incandescent lamps and modern luminaries like CFL, LED and their operation, energy saving in illumination systems, design of a lighting scheme for a residential and commercial premise, flood lighting.

Module 4: Industrial Electrical Systems I (9 Hours)
HT connection, industrial substation, Transformer selection, Industrial loads, motors, starting of motors, Cable and Switchgear selection, Power factor correction – kVAR calculations, type of compensation, Introduction to PCC, MCC panels. Specifications of LT Breakers, MCB and other LT panel components.

Module 5: Electrical Protection (5 Hours)
Lightning protection, Earthing, circuit breakers, isolators.

Text/Reference Books

6. S. L. Uppal and G. C. Garg, Electrical Wiring, Estimating & Costing, Khanna publishers, 2008.
7. K. B. Raina, Electrical Design, Estimating & Costing, New age International, 2007.
8. S. Singh and R. D. Singh, Electrical estimating, and costing, Dhanat Rai and Co., 1997.
9. Web site for IS Standards.
10. H. Joshi, Residential Commercial and Industrial Systems, McGraw Hill Education, 2008.

BTEE-907C	Wind and Solar Energy Systems	3L:0T:0P	3 credits

Internal Marks: 40 *External Marks: 60* *Total Marks: 100*

Course Outcomes:

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

(i) Understand the energy scenario and the consequent growth of the power generation from renewable energy sources.

(ii) Understand the basic physics of wind and solar power generation.

(iii) Understand the power electronic interfaces for wind and solar generation.

(iv) Understand the issues related to the solar technologies and wind topologies.

Module 1: Physics of Wind Power (8 Hours)

History of wind power, Indian and Global statistics, Wind physics, Betz limit, Tip speed ratio, stall and pitch control, Wind speed statistics-probability distributions, Wind speed and power-cumulative distribution functions.

Module 2: Wind generator topologies (14 Hours)

Review of modern wind turbine technologies Fixed and Variable speed wind turbines, Induction Generators, Doubly-Fed Induction Generators and their characteristics, Permanent-Magnet Synchronous Generators, Power electronics converters. Generator-Converter configurations, Converter Control.

Module 3: The Solar Resource (6 Hours)

Introduction, solar radiation spectra, solar geometry, Earth Sun angles, observer Sun angles, solar day length, Estimation of solar energy availability.

Module 4: Solar photovoltaic (8 Hours)

Technologies-Amorphous, monocrystalline, polycrystalline; V-I characteristics of a PV cell, PV module, array, Power Electronic Converters for Solar Systems, Maximum Power Point Tracking (MPPT) algorithms.

Module 5: Solar thermal power generation (4 Hours)

Technologies, Parabolic trough, central receivers, parabolic dish, Fresnel, solar pond, elementary analysis.

Text / References:

1. T. Ackermann, Wind Power in Power Systems, John Wiley and Sons Ltd., 2005.
2. G. M. Masters, Renewable and Efficient Electric Power Systems, John Wiley and Sons, 2004.
3. S. P. Sukhatme, Solar Energy: Principles of Thermal Collection and Storage, McGraw Hill, 1984.
4. H. Siegfried and R. Waddington, Grid integration of wind energy conversion systems, John Wiley and Sons Ltd., 2006.
5. G. N. Tiwari and M. K. Ghosal, Renewable Energy Applications, Narosa Publications, 2004.
6. J. A. Duffie and W. A. Beckman, Solar Engineering of Thermal Processes, John Wiley & Sons, 1991.

BTEE-908C	Power Systems	3L:0T:0P	3 credits

Internal Marks: 40 External Marks: 60 Total Marks: 100

Course Outcomes:

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

(i) Awareness of supply system
(ii) Understanding of the material used and construction of transmission lines
(iii) Enable the students to do analysis of power transmission line parameters.
(iv) Understand the cables used in power system
(v) Knowledge of neutral grounding.

Module 1: Supply System (8 hours)

Introduction to Transmission and Distribution systems, Comparison between DC and AC systems for Transmission and Distribution, comparison of cost of conductors, choice of working voltage for transmission and distribution, economic size of conductors - Kelvin's law, Radial and mesh distributionnetworks, Voltage regulation.

Module 2: Conductors and Transmission Line Construction (8 hours)

Conductor materials; solid, stranded, ACSR, hollow and bundle conductors. Different types of supporting structures for overhead lines. Elementary ideas about transmission line construction and erection. Stringing of conductors, spacing, sag and clearance from ground, overhead line insulators, concept of string efficiency.

Module 3: Transmission Line Parameters (10 hours)

Introduction to line parameters, Resistance of transmission line, inductance of single phase two wire line, concept of G.M.D., Inductance of three phase line, Use of bundled conductor, transposition of power lines, capacitance of 1-phase and 3-phase lines. effect of earth on capacitance of conductors.

Module 4: Underground Cables (8 hours)

Classification of cables based upon voltage and dielectric material, insulation resistance and capacitanceof single core cable, dielectric stress, Capacitance of 3 core cables, methods of laying, heating effect, Maximum current carrying capacity, cause of failure, comparison with overhead transmission lines.

Module 5: Neutral grounding (8 hours)

Necessity of neutral grounding, various methods of neutral grounding, earthing transformer, grounding practices

Text/Reference Books:

11. W. D. Stevenson, Element of Power System Analysis, McGraw Hill.
12. C. L. Wadhwa, Electrical Power Systems, New age international Ltd. Third Edition
13. Asfaq Hussain, 'Power System, CBS Publishers and Distributors.
14. B. R. Gupta, Power System Analysis and Design, Third Edition, S. Chand & Co.
15. M. V. Deshpande, Electrical Power System Design, Tata Mc Graw Hill. Reference Books.
16. S.N. Singh, “Electric Power Generation, Transmission& distribution.” PHI Learning