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-307C	Analog Electronics Laboratory	0	0	2	2	30	20	50	1
8	BTEE-308C	Electrical Machines–I Laboratory	0	0	2	2	30	20	50	1
9	BTEE-309C	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	4credits

InternalMarks: 40 External Marks: 60 TotalMarks: 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	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 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-307C	**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-308C	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-406C	Measurements and Instrumentation Lab.	0	0	2	2	30	20	50	1
7	BTEE-407C	Digital Electronics Laboratory	0	0	2	2	30	20	50	1
8	BTEE-408C	Power Electronics Laboratory	0	0	2	2	30	20	50	1
9	XXXX-XXXC	Open Elective-I	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 ExternalMarks: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-406C	**Measurements and Instrumentation 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	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.

.

BTEE-407C	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-408C	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.

SemesterV[Third Year]				**Branch:ElectricalEngineering**						
Sr. No.	**CourseCode**	**Course Title**	**L**	**T**	**P**	**Hours/ Week**	**Internal Marks**	**External Marks**	**Total Marks**	**Credits**
1	BTEE-501C	Power System-I (Transmissionand Distribution)	3	1	0	4	40	60	100	4
2	BTEE-502C	ControlSystems	3	1	0	4	40	60	100	4
3	BTEE-503C	Synchronous Machines	3	1	0	4	40	60	100	4
4	BTEE-51XC	DepartmentElectives-1	3	0	0	3	40	60	100	3
5	BTEE-504C	Electrical:Estimation &Costing Lab	0	0	2	2	30	20	50	1
6	BTEE-505C	ControlSystem Laboratory	0	0	2	2	30	20	50	1
7	BTEE-506C	ElectricalMachines-II Laboratory	0	0	2	2	30	20	50	1
8	XXXX-XXXC	OpenElectives-2	3	0	0	3	40	60	100	3
9	BTEE-507C	Industrial Training	-	-	-	-	60	40	100	-
		Total	**15**	**3**	**6**	**24**	**350**	**400**	**750**	**21**

BTEE-501C	PowerSystem-I(Transmissionand Distribution)	3L:1T:0P	4 credits

InternalMarks:40ExternalMarks:60TotalMarks:100

Course Outcomes:

Attheendofthiscourse,studentswilldemonstrate theabilityto:

CO1	UnderstandthedifferenttypesofDC&ACsupplysystemandhaveknowledge abouttransmissionlineconductors& insulators.
CO2	UnderstandTransmissionlineparametersandanalyzeperformanceof transmissionlines.
CO3	Learnthe conceptofcirclediagramandlinecompensation.
CO4	SolveproblemsrelatedwithdifferentconceptsofpowersystemI

Module1: **SupplySystem(8 Hours)**

IntroductiontoTransmissionandDistributionsystems,ComparisonbetweenDCandACsystemsfor 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 distribution networks, Voltage regulation.

Module2:Conductors andTransmissionLineConstruction(8Hours)

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.

Module3:TransmissionLineParameters(8 Hours)

Introduction to lineparameters,Resistanceof transmission line,inductanceofsinglephasetwowire 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.

Module4:Performance ofTransmissionLines(8Hours)

Representation of short transmission line, medium length line (nominal T & II circuits). long length line by hyperbolic equations and equivalent T & II circuits. Power flow through transmission lines, ABCD constants, Voltage regulation.

Module5: CircleDiagramandLineCompensation(8Hours)

Receiving end circle diagram for long transmission lines based on ABCD constants, equivalent T circuits,powerloci,surgeimpedanceloading,reactivepowerrequirementofsystemseriesandshunt compensation, Synchronous phase modifiers, rating of phase modifiers.

Module6: UndergroundCables (8 Hours)

Classification of cables based upon voltage and dielectric material, insulation resistance and capacitance of 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.

Text/References:

1. ElgerdO.L.,ElectricalEnergySystemTheory-Anintroduction,TataMcGraw-Hill Publication
2. GuptaB.R.,PowerSystemAnalysis&Design,WheelerPublishing.
3. NagrathI.J. and Kothari D.P., Power SystemAnalysis Tata McGraw-HillPublication
4. StevensonJr.W.D., ElementsofPower SystemAnalysis, TataMcGraw-HillPublication
5. WadhwaC.L.,CourseinElectricalPower,NewAgeInternational(P)Ltd.

BTEE-502C	Control Systems	3L:1T:0P	4 credits

InternalMarks:40 ExternalMarks:60 TotalMarks:100

Course Outcomes:

Attheendofthiscourse,studentswilldemonstrate theabilityto:

CO1	Understandtheconceptsoflinear-time-variantandinvariantsystems,modellingof varioustypesofsystemsandanalysisoflinearsystems.usingtransferfunctionand state-spacerepresentations.
CO2	Understand theconceptofpotentiometers,servomotorsandtachogeneratorsasanerror detector.
CO3	Analyzetheconceptsofstabilityfromvariousmethodslike RouthHurwtitz,Bodeplot, RootLocusand Polarplots, andNyquistcriterion.

Module1.Introductory Concepts(5 Hours)

Plant,Systems,Servomechanism,regulatingsystems,disturbances,Openloopcontrolsystem,closed loop control systems, linear and non-linear systems, time variant and invariant, continuous and sampled-data control systems, Block diagrams, some illustrative examples.

Module 2.Modelling(6 Hours)

Formulation of equations of linear electrical, mechanical, thermal, pneumatic and hydraulic system, electrical,mechanicalanalogies.Transferfunction,Blockdiagramrepresentation,signalflowgraphs and associated algebra, characteristics equation.

Module 3.Time DomainAnalysis (7Hours)

Typical test - input signals, Transient response of the first and second order systems. Time domain specifications, Dominant closed loop poles of higher order systems. Steady state error and coefficients, pole-zero location and stability, Routh-Hurwitz Criterion.

Module 4.Root LocusTechnique (4 Hours)

RootLocus Technique:Theextreme points ofthe root loci forpositive gain. Asymptotes totheloci, Breakaway points, intersection with imaginary axis, location of roots with given gain and sketch of the root locus plot.

Module 5:FrequencyDomainAnalysis(7 Hours)

Closedloopfrequencyresponse,Bodeplots,stabilityandlooptransferfunction.Frequencyresponse specifications, Relative stability, Relation between time and frequency response for second order systems. Log. Magnitude versus Phase angle plot, Nyquist criterion for stability.

Module 6:Compensation (7**Hours)**

Necessity of compensation, series and parallel compensation, compensating networks, applications of lag and lead-compensation.

ControlComponents:Errordetectors-potentiometersandsynchros,servomotors,a.c.andd.c.techno generators, Magnetic amplifiers.

Text/References:

1. M.Gopal,Control Systems:PrinciplesandDesign,McGrawHillEducation,1997.
2. A.Ambikapathy, ControlSystem,FirstEdition,2019.
3. K.Ogata,ModernControlEngineering, PrenticeHall, 1991.
4. I.J.NagrathandM.Gopal,ControlSystemsEngineering, NewAgeInternational,2009.

BTEE-503C	Synchronous machines	3L:1T:0P	4 credits

InternalMarks:40 ExternalMarks:60 TotalMarks:100

Course Outcomes:

Attheendofthiscoursestudentswilldemonstratetheability to:

CO1	Understandaboutthegeneralaspectsandwindingterminologyusedin3-ϕsynchronous machinesand1-ϕsynchronousmachines.
CO2	Understandtheoperationofsynchronous machines
CO3	AnalyzethevariousmethodsofvoltageregulationsandEMFequationsofalternators.
CO4	Analyzepoweranglecharacteristicsandtheoperatingcharacteristicsofsynchronousmachines.
CO5	Understandtheconceptsaboutparalleloperationand transientconditionsofalternators.

Module1: General Aspects(8 Hours)

Construction and working principle of synchronous machines, Excitation systems, production of sinusoidalelectromotiveforce(EMF),fluxandmagnetomotiveforce(MMF)phasorsinsynchronous. machines; cylindrical and salient pole rotors.

WINDINGS:Classification of windings, pitch factor, distribution factor. Electromagnetic Force equation.

Module2: Alternators (10 Hours)

Construction, Phasor diagram of cylindrical rotor alternator, ratings, nature of armature reaction, determination of synchronous reactance; open-circuit characteristics, short- circuit characteristics, short-circuitratio,short-circuitloss.Effectofvariationofpowerfactoronvoltage. Determinationof voltage regulation: EMF method,MMF. method. Zeropower factor(Z. P. F). method.Alternatoron infinite bus bar, operation at constant load and variable excitation, power flow through inductive impedance.Power-anglecharacteristicsofsynchronousmachines:-cylindricalandsalientpole.Two reaction theory of salient pole machines, power factor control.

Module 3: SynchronousMotors (10 Hours)

Operatingcharacteristics,power-anglecharacteristics,conditionsformaximumpowerdeveloped.V-curves and inverted V-curves, methods of starting, synchronous motors applications, synchronous condensers. Hunting and damper windings.

Module4:ParallelOperationofAlternators(6Hours)

Conditions for proper synchronizing for single phase and three phase alternators, conditions for parallel operation, synchronizing power, current and torque, effect of increasing excitation of one of the alternators, effect of change of speed of one of the alternators, effect of unequal voltages, load sharing.

Module 5:Transients(6Hours)

Transientreactanceandtimeconstantsfromequivalentcircuits,synchronousmachinereactanceand their determination, short circuit. Oscillogram, Synchronization with the grid system, Qualitative introduction to the transient stability of the synchronous machines.

Module6:SinglePhaseSynchronousMotors(3Hours) Reluctance and Hysteresis motors.

Text/References:

1. A.E.Fitzgerald andC.Kingsley,ElectricMachinery,McGrawHillEducation, 2013.
2. P.S.Bimbhra,ElectricalMachinery,KhannaPublishers, 2ndEdition,2022.

3. M.G.Say,Performanceanddesignof ACmachines,CBSPublishers, 2002.
4. I.J.NagrathandD.P.Kothari,ElectricMachines,McGrawHillEducation, 2010.
5. A.S.Langsdorf,Alternatingcurrentmachines,McGraw HillEducation,1984.
6. P.C.Sen,PrinciplesofElectricMachinesandPowerElectronics,JohnWiley &Sons,2007.

BTEE-504C	Electrical:EstimationandCostinglab	0L:0T:2P	1 credit

InternalMarks:30 ExternalMarks:20 TotalMarks:50

Course Outcomes:

Attheendofthiscoursestudentswilldemonstratetheabilityto:

CO1	InterpretthesalientfeaturesofNationalElectricalCodeandotherrelevantnationalstandards applicableforelectricalinstallationsinIndia.
CO2	Developdetailed wiringdiagramforhousebuildingelectrification.
CO3	Developproposals/singlelinediagramsforelectricalinstallationsinspecifiedpremises.

Note:Any8-10experimentsaretobeperformedinasemester. List

of Experiments:

1. TostudyIndianelectricityrules
2. Tocarryoutwiringdiagramofresidentialbuilding,educationalinstituteandIndustry.Giving selection of
3. appropriatewiring,listmaterialsandaccessoriesforgivenproject.
4. Tostudythedesign considerationofPanelBoards.
5. Tostudythedesignconsiderationofvariouselectrical systems:
   a. 3phasefourwiredistributionsystems b. Earthing
6. To estimate the cost of a domestic installation (Residential building, laboratory room or Drawing Hall etc.) with concept of illumination design. TERI (The Energy Research Institute) recommendations on lighting schemes
7. Toestimatethecost ofindustrialinstallation(Workshop,agriculture,flour mill etc.).
8. Toestimatethecost ofoverheadserviceconnection(Singlephaseandthree phase).
9. Toestimatethecostofundergroundserviceconnection(singlephaseandthree phase).
10. Toestimatethecostofoverhead,440V, 3-phase,4wireor 3wiredistribution line.
11. Toestimatethecost oftheundergrounddistribution line.
12. Toestimatethecostofanyoneelectricalappliance.
13. Toestimatethecostofrepairsandmaintenanceofanyonedomestic appliance.
14. To make wiring diagrams of motor control circuits for starting of a. 3 phase induction motor b. Wound Motor c. Synchronous motor

BTEE-505C	Control System Laboratory	0L:0T:2P	1credit

InternalMarks:30 ExternalMarks:20 TotalMarks:50

Course Outcomes:

Attheendofthiscoursestudentswilldemonstratetheability to:

CO1	Interprettheroleofvariouscomponentsincontrol system
CO2	Computeortopredictthecharacteristicsofasystembyvisualizingexperimentaldataandits graphicalrepresentation.
CO3	Analyzetheresponseofcontrolsystemby measuringrelevantparameters

Note:Any8-10experimentsaretobeperformedinasemester. List of

Experiments:

1. TostudythecharacteristicsofpotentiometersandtousePotentiometersasanerrordetector in a control system.
2. TostudythesynchroTransmitter-Receiversetand touseitasanerror detector.
3. TostudytheSpeed–TorquecharacteristicsofanACServoMotorandtoexploreits applications.
4. TostudytheSpeed–TorquecharacteristicsofanDCServoMotorandexploreitsapplications.
5. Tostudythevariationsoftimelagbychangingthetimeconstantusingcontrolengineering trainer.
6. To simulate third order differential equations using an analog computer and calculate time responsespecifications.
7. ToobtainthetransferfunctionofaD.C.motor–D.C.GeneratorsetusingTransferFunction Trainer
8. To study the speed control of an A.C. Servo Motor using a closed loop and an open loopsystem:
9. Tostudytheoperationofapositionsensorandstudytheconversionofpositioninto corresponding voltage
10. To study a PI control action and show its usefulness for minimizing steady state error oftime response.
11. TomeasureForce/Displacementusing StrainGaugeinawheatstonebridge.
12. TodesignaLag compensatorandtestitsperformance characteristics.
13. TodesignaLead-compensatorandtestitsperformancecharacteristics.
14. TodesignaLead-Lagcompensatorand testitsperformancecharacteristics.

BTEE-506C	ElectricalMachines-IILaboratory	0L:0T:2P	1 credit

InternalMarks:30 ExternalMarks:20 TotalMarks:50

Course Outcomes:

Attheendofthiscoursestudentswilldemonstratetheability to:

CO1	Constructequivalentcircuitsinduction motorsbyroutinetests.
CO2	Comprehendtherequirementofstartingandspeedcontrolmethodsofinductionmotorsin thevariousapplicationsof industry.
CO3	Constructequivalentcircuitsofsynchronousgeneratorandmotor.
CO4	Constructcharacteristiccurvesfor inductionandsynchronous machines
CO5	Understandtheconceptofparalleloperationofthreephase alternators.

Note:8–10experimentsaretobeperformedinasemester.listofexperimentsisgivenbelow:

ListofExperiments:

1. Toperformload-testonthree-phaseInductionmotorandtoplottorqueversusspeed characteristics.
2. Toperformno-loadandblocked–rotortestsonthree-phaseInductionmotortoobtainequivalent circuit
3. Tostudythespeed controlofthree-phaseInductionmotorbyKramer’s Concept.
4. Tostudythespeedcontrolofthree-phaseInductionmotorbycascadingoftwoinductionmotors, i.e.byfeeding the slippowerof onemotor intotheother motor.
5. Tostudystar-deltastartersphysicallyanda)todrawelectricalconnectiondiagramb)tostartthe three-phase Induction motor using it. c) to reverse the direction of three-phase Induction motor
6. Tostartathree-phaseslip–ringinductionmotorbyinsertingdifferentlevelsofresistanceinthe rotor circuit. And to plot torque –speed characteristics.
7. Toperformno-loadandblocked–rotortestonsingle-phaseInductionmotorandtodeterminethe parameters of equivalent circuit.
8. Toperformload –testonsingle-phase. Inductionmotorandplottorque –speed characteristics.
9. To perform no load and short circuit. Test on three-phase alternator and draw open and shortcircuit characteristics.
10. Tofindvoltage regulationofan alternatorbyzero powerfactor(ZPF) method.
11. To study the effect of variation of field current upon the stator current and power factor with synchronous motor running at no load and draw Voltage and inverted Voltage curves of motor.
12. TomeasurenegativesequenceandzerosequencereactanceofSynchronousMachines.
13. Parallel operation of three phase alternators using • Dark lamp method • Two-Bright and one dark lamp method
14. Tostudysynchroscopephysicallyandparalleloperationofthree-phasealternatorsusing synchroscope.
15. Startingofsynchronousmotorsusing•Auxiliarymotor• UsingDamper windings

BTEE-507C	**Industrial Training**	**0L:0T:0P**	**- credit**

InternalMarks: 60 ExternalMarks:40 TotalMarks:100

Department Electives

V (Odd)	DE-1	BTEE-511C	ElectricalEngineeringMaterials
V (Odd)	DE-1	BTEE-512C	PowerPlant Engineering
V (Odd)	DE-1	BTEE-513C	OptimizationTechniques
V (Odd)	DE-1	BTEE-514C	RenewableEnergy Sources

BTEE-511C	ElectricalEngineeringMaterials	3L:0T:0P	3 credits

InternalMarks:40ExternalMarks: 60TotalMarks:100

Course Outcomes:

Attheendofthiscoursestudentswilldemonstratetheability to:

CO1	Understandthebasicconceptsofmaterials
CO2	Usesimplifiedmaterialsselectionconceptsfordesignpurposes
CO3	UnderstandthepropertiesofMaterials

Module1:DielectricMaterials (8Hours)

Static dielectric constant, Polarization, atomic interpretation of the dielectric constant of mono-atomic and poly atomic gases, internal fields in the solids and liquids, static dielectric constants of solids, ferroelectric materials and spontaneous polarization, piezo- electricity. frequency dependence of electronics, ionic and orientational polarization, complex dielectric constant and dielectric losses.

Module2:ConductivityofMetals(4Hours)

Ohm'sLawandrelaxationtimeofelectrons,collisiontimeandmeanfreepath.Electronscattering and resistivity of metals. Heat developed in current carrying conductor, thermal conductivity of metals, superconductivity.

Module3: MagneticMaterials (4 Hours)

Magnetization from microscopic viewpoint, orbital magnetic dipole movement and angular momentum materials, diamagnetism, origin of permanent magnetic dipoles in material, paramagnetic spin systems.

Module4:PropertiesofFerromagnetic Materials(6Hours)

Spontaneousmagnetizationandthecurie-Weiss Law. FerromagneticDomains and coerciveforce, antiferromagnetic and ferromagnetic materials. magnetic materials for electrical devices, introduction to permanent magnets.

Text/References:

1. AdrianusJDekker,ElectricalEngineeringMaterialsPHILearningPublishers.
2. S.P.SethandP.V.Gupta,ElectricalEngineeringmaterials,DhanpatRaiPublishingCoPvtLtd
3. G.P.Chalotra,ElectricalEngineeringMaterials

BTEE-512C	**PowerPlant Engineering**	**3L:0T:0P**	**3 credits**

InternalMarks:40ExternalMarks:60Total Marks:100

Course Outcomes:
Attheendofthiscoursestudentswilldemonstratetheability to:

CO1	Memorizethebasicconceptrelatedtopollutionandworkingofsteam,hydro,diesel,nuclear and gas power plant and their accessories.
CO2	Constructthelayoutof differenttypeof power plants
CO3	Understandthecombinedoperationofdifferentpowerplantsandcomparisonbetween various types of plants
CO4	Evaluatethenumericalproblems relatedtodifferenttypesofpower plants

Module1:Steam Generators,Condensers andTurbines(12Hours)
Classification of steam generators, selection, operation of locomotive, Babcock Wilcox, Cochran boilers, Types of condensers, effect of air in condensers, Dalton's law of partial pressure, cooling watercalculations,steamnozzles,typesofsteamturbineefficiencies,compounding,governingand control.

Steam Power Plant: Classification, Operation, Description of Rankin cycle, Regenerative cycle, Reheat-Regenerative Cycle, Binary Vapour Cycle, Selection of plant site and its layout, coal handling system, combustion system, Fluidized bed combustion, Ash handling, Feed pumps, Heat exchangers, Economizers, Super heaters, Reheaters, Air preheaters, Feed water heaters, Evaporators.

Module2:Hydro-ElectricPower Plants(8 Hours)
Hydrological Cycle, Hydrograph, Flow duration curve, Selection of site, Essential features, Classification of hydro plants, Selection of water turbines for hydro power plant, Automatic and remote control of hydro-station, layout of hydro power plant.

Module 3: NuclearPowerPlants(8Hours)
Nuclear physics, Binding energy, Radioactive decay. Fertile material, Mass defect, Nuclear reactions type and application, Generation of nuclear energy by fission, Nuclear reactors. Site selections, safety measures, plant layout, Fusion reaction, Future of nuclear power.

Module 4:GasTurbine (6Hours)
Elements of gas turbines, Open and closed cycles for gas turbines, Performance terms, Thermal refinement to gas turbines cycle, Plant layout, applications, gas turbines Cycle calculations.

Module5:Diesel Power Plants(5 Hours)
Classifications of IC Engines and their performance, Four stroke and two stroke diesel engines, combustion phenomenon; Essential components, Celane number, knocking, super charging, operation and layout of diesel power plant.

Module6:CombinedOperation ofDifferent Power Plants(4 Hours)
Advantagesofcombinedoperationofplants,loaddivisionbetweenpowerstations,coordinationof different types of Power Plants.

Module 7:PollutionControl (3 Hours)

Pollutionfromthermal&nuclearplants,Particulateemissionandcontrol,electrostaticprecipitator, solid waste disposal.

Text/References:

1. ChakrabartiA.,Soni,M.L.GuptaP.V.andBhatanagarU.S.,ATextbookonPowerSystem Engineering, Dhanpat Rai & Co.
2. EI-WakitM.M.,PowerPlantEngineering,McGrawHill,USA
3. RajputR.K.,PowerPlantEngineering,Luxmi Publications
4. SharmaP.C.,PowerPlantEngineering, Kataria&Sons

BTEE-513C	OptimizationTechniques	3L:0T:0P	3 credits

InternalMarks:40 ExternalMarks:60 TotalMarks:100

Course Outcomes:

Attheendofthiscoursestudentswilldemonstratetheability to:

CO1	Understandtheideaofoptimization problems
CO2	Solvetransportationmodels
CO3	Solvevarioustypesofoptimizationproblems

Module1: Introduction(6Hours)

OriginofORanditsroleinsolvingindustrialproblems:GeneralapproachforsolvingORproblems. Classification of mathematical models: various decision-making environments.

Module2:LinearProgramming(6Hours)

Formulationoflinearmathematicalmodels:Graphicalandsimplextechniquesforsolutionoflinear programming problems, Big M method and two -phase method, Introduction to duality theory and sensitivity analysis.

Module 3:Transportation and AssignmentModels(6Hours)

Various initial basic feasible solutions methods, Optimization of transportation and assignment using different methods considering the concept of time and cost function.

Module 4:DynamicProgramming(4Hours)

Introductiontodeterministicandprobabilisticdynamicprogramming.

Module5:NetworkModels (8Hours)

Shortest route and traveling sales – man problems, PERT &CPM introduction, analysis of time bound project situations, construction of networks, identification of critical path, slack and float, crashing of network for cost reduction.

Module 6:Non-Linear ProgrammingModels(3 Hours)

Introductiontonon-linearprogrammingmodels,GenericAlgorithmandproblemsrelatedtotopic.

Text/References:

1. K.Deb.OptimizationforEngineeringDesign:AlgorithmsandExamples,2nd Edition,Jan2012.
2. H.MWagner,PrinciplesofOperationsResearch,PrenticeHall.
3. P.K.Guptaand D.S.Hira, OperationsResearch,S. Chand &Co.
4. F.S.HillerandG.I.Libermann,IntroductiontoOperationResearch,HoldenRay.
5. AManagementGuidetoPERT/CPMWiest&LevyPrenticeHall

BTEE-514C	**RenewableEnergy Sources**	**3L:0T:0P**	**3 credits**

InternalMarks:40 ExternalMarks:60 TotalMarks:100

CourseOutcomes:
Attheendofthiscoursestudentswilldemonstratetheability to:

CO1	UnderstandtheNeed,importanceandscopeofnon-conventionalandalternateenergyresources
CO2	UnderstandroleofMHDgeneration,thermo-electric effectandphoto-voltaic effect
CO3	Understandtheroleoffuelcell
CO4	Gettheutilizationof miscellaneous sources.

Module1: Introduction(6Hours)
Limitation ofconventional energysources, need andgrowth of alternativeenergy source, basic scheme and application of direct energy conservation.

Module 2: MHDGenerators(6 Hours)
Basicprinciples,gaseous,conductionandhalleffect,generatorandmotoreffect,differenttypesof Magneto-Hydro-Dynamic (MHD) generator, types of MHD material, conversion effectiveness, analysis of constant area MHD generator, practical MHD generator, application and economic aspects.

Module3:Thermo-ElectricGenerators(8 Hours)
Thermoelectric effects, Seeback effect, Peltier effect, Thomson effect, thermoelectric converters, figures of merit, properties of thermoelectric material, brief description of the construction of thermoelectric generators, application and economic aspect.

Module4:PhotovoltaicEffect andSolarEnergy (10 Hours)
Photovoltaic effect, different types of photovoltaic cells, cell fabrication, characteristics of photovoltaiccells,conversionefficiency,solarbatteries,application,solarradiationanalysis,solar energy in India, solar collectors, solar furnaces and applications.

Module 5: FuelCells(6Hours)
Principle of action, Gibb's free energy, general description of fuel cells, types, construction, operational characteristics and application.

Module6:MiscellaneousSources(6Hours)
Geothermalsystem, hydro-electricplants,windpower,tidalenergy,Bio-massenergy

Text/References:
1. Renewableenergyresources:Tiwari and Ghosal, Narosa publication.
2. Non-conventionalEnergySources,KhannaPublication
3. RenewableEnergySources:Twidell&Weir,CRC Press.
4. SolarEnergy/S.P.Sukhatme,Tata McGraw-Hill.
5. Non-ConventionalEnergySystems:KM.Mittal,AH WheelerPublishingCo Ltd.
6. RenewableEnergyTechnologies:Ramesh&Kumar,Narosapublication.
7. BiomassEnergy,Oxford&IBHPublicationCo.

Semester VI [Third year]						Branch: Electrical Engineering				
Sr. No.	**Course code**	**Course Title**	**L**	**T**	**P**	**Hours/ Week**	**Internal Marks**	**External Marks**	**Total Marks**	**Credits**
1	BTEE-601C	Power System-II (Switchgear and Protection)	3	1	0	4	40	60	100	4
2	BTEE-602C	Power Generation and Economics	3	1	0	4	40	60	100	4
3	BTEE-603C	Electric Drives & Utilization	3	0	0	3	40	60	100	3
4	BTEE-61 XC	Department Elective-2	3	0	0	3	40	60	100	3
5	XXXX-XXXC	Open Elective-3	3	0	0	3	40	60	100	3
6	BTHU-901C	Personality Development	3	0	0	3	40	60	100	3
7	BTEE-604C	Power Systems-II Laboratory	0	0	2	2	30	20	50	1
Total			**18**	**2**	**2**	**22**	**270**	**380**	**650**	**21**

BTEE-601C	PowerSystem–II(Switchgear&Protection)	3L:1T:0P	4credits

InternalMarks: 40 *ExternalMarks:60* *TotalMarks: 100*

CourseOutcomes:

Attheend ofthiscourse,studentswilldemonstratetheabilityto:

CO1Understandtheconceptsofpowersystems.
CO2Understandthevarious power systemcomponents
CO3Understandthegenerationofover-voltages
CO4Understandbasicprotectionschemes.
CO5Understandthebasicsofcircuitbreakersandprotectiverelays.

Module1:Sub-Station(4Hours)

Types,MainequipmentinSubstation, substationlayout,Busbar-arrangements.

Module2:Isolators&Fuses(4Hours)

Isolatingswitchesfunctions,Types,Ratingandoperation.Fuse-types,Rating,Selection, theory and characteristics, applications.

Module3:CircuitBreakers(7Hours)

Need for Circuit Breakers, Arc phenomenon, Theory of Arc Interruption, Recovery Voltageand Restriking Voltage, Various Types of Circuit Breakers. Principles and Constructional Details of AirBlast, Minimum Oil, SF_6, Vacuum Circuit Breakers etc.

Module4:Protective Relays(8Hours)

Introduction, classification, constructional features; and Characteristics of Electromagnetic, Induction,Thermal, Overcurrent relays, Directionalrelays, Distancerelays, Differential, Translay, Negative sequence relay, introduction to static and up-based relays.

Module5:Protection ofFeeders(7Hours)

Time graded protection, Differential and Distance protection of feeders, choice between Impedance,ReactanceandMhorelays, Elementaryideaaboutcarriercurrentprotectionoflines.

Module6:ProtectionofGenerators&Transformers(6Hours)

Types of faults on alternator, Stator and rotor protection, Negative sequence protection, Loss of excitation and overload protection. Types of fault on transformers, percentage differential protection, Gas relays.

Module7:Protectionagainst overvoltageand earthing(6Hours)

Ground wires, Rod gap, Impulse gap, Valve type and MetalOxide Arresters, Line Arrester/Surge Absorber. Ungrounded neutral system, Grounded neutral system and Selection of Neutral Grounding.

Text/ReferenceBooks

1) SwitchgearandProtection — SunilS. Rao(Khanna Publishers)
2) PowerSystemEngg. — SoniGupta&Bhatnager(DhanpatRai&Sons)
3) A Course in Electrical Power — C.L.Wadhawa(NewAgeinternationalPvt. Ltd)
4) PowersystemProtection&Switchgear — Badriram&D.V.Vishwakarma (TMH)
5) Switchgears&Protection — M.V.Deshpande(THM)

BTEE-602C	PowerGenerationand Economics	3L:1T:0P	4credits

InternalMarks:40 *ExternalMarks:60* *TotalMarks: 100*

CourseOutcomes:

Atthe end ofthe course,studentswilldemonstratetheabilityto

CO1Understandtheloadcurves,load-durationCurve.
CO2Understandthepowerplanteconomicsandtariff
CO3Explorethe significance ofeconomicoperationofsteamplants
CO4Understandthehydro-thermalcoordination

.

Module1:LoadsandLoadcurves(8 hours)

Electrical energy sources, organization of power sector in India, single line diagram of thermal, hydroandnuclearpowerstations.Classificationofpowerplantsinbaseloadandpeakloadplants.

Typesofload(fixedvoltageloads,resistiveloads,Inductivemotorloads,Mechanicalload),effect ofload onsupplyvoltage,Maximumdemand,Group diversityfactor,Peakdiversityfactor,Types ofload,chronologicalloadcurves, load-durationCurve,mass curves, load factor,capacityfactor, utilization factor, base load and peak load plants, load forecasting.

Module2:PowerPlant Economicsand Tariff(10 hours)

Capitalcostofplants,annualfixedcost,operatingcosts andeffectofloadfactoroncostofenergy, depreciation. Objectives of tariff making, different types of tariff (domestic, commercial, agriculturaland industrialloads).Needforpowerfactorimprovement,power factor improvement using capacitors, determination of economic power factor.

Module3:Selectionofplant,Cogeneration (8hours)

Plant location, plantsize, number and sizeofunits in plants, economiccomparison ofalternatives based on annual cost, rate of return, present worth and capitalized cost methods. Definition and scope of cogeneration, Topping and Bottoming Cycles, Benefits, cogeneration technologies.

Module4:EconomicsofSteamplants(8hours)

Methods of loading turbo-generators, input- output curve, heat rate, incremental cost, method of Lagrangian multiplier, effect of transmission losses, co- ordination equations, and iterative procedure to solve co-ordination equations.

Module5:Hydro-thermalco-ordination (8hours)

Advantagesofcombinedworking ofRun-offRiverplantandsteamplant,reservoir hydroplants and thermal plants, long-term operational aspects, scheduling methods.

Text/ReferenceBooks

1. M.V.Deshpande,PowerPlantEngineering,TataMcGrawHill(2004).
2. M.M.EI-Wakit,PowerPlantEngineering,McGrawHill,USA8.RajputR.K.,Power Plant Engineering, Luxmi Publications
3. P.C.Sharma,PowerPlantEngineering,KatariaandSons
4. B.G.A.SkrotzkiandW.A.Vapot,PowerStationEngineeringandEconomy,Tata McGraw-Hill
5. S.C.AroraandS.DomKundwar,AcourseinPowerPlantEngineering,DhanpatRai.
6. P.K.Nag,PowerPlantEngineering, TataMcGrawHill
7. B.R. Gupta,GenerationofElectricalEnergy, S.Chand(1998).
8. I.J.NagrathandD.P.Kothari,ModernPowerSystemAnalysisTataMcGraw-HillPublication

BTEE-603C	ElectricDrivesAndUtilization	3L:0T:0P	3credits

InternalMarks: 40 *ExternalMarks:60* *TotalMarks:100*

CourseOutcomes:

Attheend ofthe course,studentswilldemonstratetheabilityto

CO1:ToimparttheknowledgeofElectricTraction,Electricheating,ElectricweldingandIllumination.
CO2:Enablethestudentstodesignofinterior andexterior lightingsystems-illuminationlevelsfor various
purposeslightfittings-factorylighting-floodlighting-streetlighting.
CO3:Tomakestudentscapableofanalyzingandsolvingthevarietiesofproblemsandissuesinelectricpower
utilization.
CO4:Toimparttheknowledgeofairconditioningandrefrigeration.

Module1:ElectricDrives(6Hours)
Basic features of industrial drives, review of operating and starting characteristics of different types ofelectric motors for various drives. Estimation of rating, Load equalization (Fly wheel effect), Drives for particular services.

Module2:ElectricTraction(5Hours)
Various types of Traction system, 25KV, 50Hz, single phase feeding arrangement prevalent in India. Substation arrangements, Different Types of Catenary construction and line insulation, Span and dropper design Calculations.

Module3: ElectricHeatingandWelding(5Hours)
Methodsofelectricheating,constructionaldetails&performanceofresistanceheating furnace.Dielectric heating, A.C.& D.C. Welding, Resistance and Arc Welding. Electric Beam Welding, Laser Welding.

Module4: Illumination(6Hours)
Production of light by different methods, terms used, laws of illumination, Different Artificial light sources, their construction and operating principles, Design of lighting schemes and equipment used for indoor, industrial and flood lighting.

Module5:RefrigerationandAirconditioning(5Hours)
Refrigeration system, Domestic refrigeration, Air conditioner, Comfort Air conditioning, Effective temperature.

Module6: Electrolysis(4Hours)
LawsofElectrolysis,Processvoltage,current, energy,efficiency,Applicationsofelectrolysis.

Text/ReferenceBooks

1. ElectricTraction — H.Partab
2. ElectricDrives &Utilization — H.Partab
3. ElectricDrives — De&Sen(PHI publication)
4. ElectricMotor Drives — M.S.Berde(KhannaPublishers)
5. UtilizationofElectric Power — J.B.Gupta(S.K.Kataria&Sons)
6. Electric Energy Utilization Mc Graw. Hill)& Conservation — Tripathi(Tata
7. ElectricEnergyUtilization — E.O.Taylor

BTEE-604C	*PowerSystems Laboratory*	0L:0T:2P	1credit

InternalMarks:30 *ExternalMarks:20* *TotalMarks: 50*

CourseOutcomes:

Atthe endofthiscourse students willdemonstratethe abilityto:

CO1	Acquiretheknowledgeofvariousabnormalconditionsthatcouldoccurinpower system.
CO2	Abilitytodesignvariousprotectivedevicesinpowersystemfor protecting equipment andpersonnel.
CO3	Knowledgeofvarioustypesofexistingcircuitbreakers,their designandconstructional details.
CO4	Knowledgeofvariousconventionalrelays,their designandlatestdevelopments.

SuggestedList ofExperiments:

1. *Tostudytheperformanceofa transmissionline.Also computeitsABCDparameters.*
2. *StudyofCharacteristicsofovercurrentandearthfaultprotection.*
3. *Tostudytheoperating characteristicsof fuse.(HRCoropen type)*
4. *Tofindtheearth resistanceusing threespikes*
5. *Tostudyovercurrentstatic relay.*
6. *Tostudythedifferent typesoffaultsontransmission linedemostration panel/model.*
7. *To study the radialfeederperformance when*
   (a) Fedatoneend.(b).Fed atbothends
8. *To studythe performanceof undervoltageandovervoltage relay.*
9. *Tostudythecharacteristicsofbimetalmini circuitbreakers.*
10. *TostudythecharacteristicsofDistance Relay.*
11. *Tofindthe breakdown strength of transformeroil.*

Department Electives

VI (even)	DE-2	BTEE-611C	ElectricalEnergyConservation& Auditing	3L:0T:0P	3
VI (even)	DE-2	BTEE-612C	Non-linearandDigitalControl Systems	3L:0T:0P	3
VI (even)	DE-2	BTEE-613C	Microprocessors	3L:0T:0P	3
VI (even)	DE-2	BTEE-614C	WindandSolarEnergySystems	3L:0T:0P	3

BTEE-611C	ElectricalEnergyConservationand Auditing	3L:0T:0P	3credits

InternalMarks: 40 *ExternalMarks:60* *TotalMarks: 100*

CourseOutcomes:

Attheendofthiscourse, studentswilldemonstratetheabilityto:

CO1	Understandthecurrentenergyscenarioandimportanceofenergy conservation.Understandtheconceptsofenergymanagement.
CO2	Understandthemethodsofimprovingenergyefficiencyindifferent electrical systems.
CO3	Understandtheconceptsofdifferentenergyefficient devices.

Module1:EnergyScenario(6Hours)

Commercial and non-commercial energy, primary energy resources, commercial energy production, final energy consumption, energy needs of growing economy, long term energy scenario, energypricing, energysector reforms, energy and environment, energysecurity, energy conservationandits importance, restructuringof the energysupplysector, energystrategyfor the future, air pollution, climate change. Energy Conservation Act-2001 and its features.

Module2:EnergyManagement&Audit(6Hours)

Definition, energy audit, need, types of energy audit. Energy management (audit) approach-understanding energy costs, bench marking, energy performance, matching energy use to requirement, maximizing system efficiencies, optimizing the input energy requirements, fuel energy substitution, energy audit instruments. Material and energy balance: Facility as an energy system, methods for preparing process flow, material and energy balance diagrams.

Module3:EnergyEfficiencyinElectricalSystems(7 Hours)

Electrical system: Electricity billing, electrical load management and maximum demand control, power factor improvement and its benefit, selection and location of capacitors, performance assessment ofPF capacitors, distributionandtransformer losses. Electric motors:Types, lossesin induction motors, motor efficiency, factors affecting motor performance, rewinding and motor replacement issues, energy saving opportunities with energy efficient motors.

Module4:EnergyEfficiencyinIndustrialSystems(8 Hours)

Compressed Air System: Types of air compressors, compressor efficiency, efficient compressor operation,Compressedairsystemcomponents,capacityassessment,leakagetest,factorsaffecting theperformance and savings opportunities in HVAC, Fans and blowers: Types, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities. Pumps and Pumping System: Types, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities. Cooling Tower: Types andperformanceevaluation, efficient systemoperation, flowcontrolstrategies and energysaving opportunities, assessment of cooling towers.

Module5:EnergyEfficientTechnologiesinElectricalSystems(8Hours)

Maximum demand controllers, automatic power factor controllers, energy efficient motors, soft starterswith energy saver, variable speed drives, energy efficient transformers, electronic ballast, occupancy sensors, energy efficient lighting controls, energy saving potential of each technology.

Text/ReferenceBooks

1. GuidebooksforNationalCertificationExaminationfor EnergyManager/EnergyAuditors Book-1,General Aspects (available online).
2. GuidebooksforNationalCertificationExaminationfor EnergyManager/EnergyAuditors Book-3, Electrical Utilities (available online).
3. S.C.Tripathy, “UtilizationofElectricalEnergyandConservation”, McGrawHill,1991.
4. SuccessstoriesofEnergyConservationbyBEE,NewDelhi(www.bee-india.org).

BTEE-612C	NonLinearAndDigitalControlSystems	3L:0T:0P	3credits

InternalMarks: 40 *ExternalMarks:60* *TotalMarks: 100*

CourseOutcomes:

Attheendofthiscourse,studentswilldemonstratethe abilityto

CO1Understandthegeneralconceptofstatevariable,statespace,nonlinearsystem,nonlinear characteristicsandsampleddatasystem.
CO2Analyzethesystemresponseandstability ofsystems representedinstatespaceform
CO3Analyseandevaluatestabilityofnonlinear systemsbydescribingfunction method, Lyapunov'smethodandphaseplanetechnique.
CO4Assesssampleddatasystemandjudgetheissues facedinsampling, digitaldataand discretetimesystems.

Module 1:StateVariableTechniques(6Hours)

Statevariablerepresentationofsystems byvarious methods, solutionofstatevariable model, Controllability and observability.

Module2:PhasePlaneAnalysis(4Hours)

Singular points,Methodofisoclines,deltamethod,phaseportraitofsecondorder nonlinear systems,limitcycle.

Module3:DescribingFunctionAnalysis(8Hours)

Definition, limitations,useofdescribingfunctionforstabilityanalysis,describingfunction of idealrelay,relaywithhysteresis, dead zone, saturation,coulomb friction and backlash.

Module4:Lyapunov'sStabilityMethod(5Hours)

Lyapunov'sdirect method,generationofLyapunov'sfunctionbyKrasovskii'sandVariable Gradient methods

Module5:SampledDataSystems(10Hours)

Sampling process, mathematical analysis of sampling process, application of Laplace transform.Reconstruction of sampled signal, zero order, first order hold. Z-transform definition, evaluation ofZ-transform, inverse Z-transform, pulse transfer function, limitations ofZ-transformState variable formulation of discretetime systems, solutionofdiscrete time stateequations. Stability definition, Jury's test of stability, extension of Routh-Hurwitz criterion to discrete time systems.

Text/ReferenceBooks

1Moderncontrolengineering.	K.Ogata
2. Controlsystemengineering	I.J.Nagrath,M.Gopal
3. Moderncontrolprinciplesand application	J.C.HsuandA.U.Meyer
4. DigitalControlandStateVariableMethods	M.Gopal
5. AutomaticControlSystem.	B.C.KUO

BTEE-613C	Microprocessors	3L:0T:0P	3credits

InternalMarks: 40 *ExternalMarks:60* *TotalMarks: 100*

CourseOutcomes:

At theendofthiscourse,studentswilldemonstratethe abilityto:

CO1Studyof8085and8086Microprocessors.
CO2Doassemblylanguage programming.
CO3Dointerfacing designofperipheralslike 8255,8253,8279,8251 etc.
CO4Developsystemsusingdifferentmicroprocessors.

Module1:FundamentalsofMicroprocessors:(3 Hours)

Digital Computers: General architecture and brief description of elements, programming system, Buses and CPU Timings. Microprocessor and Microprocessor Development Systems: Evolution of Microprocessor, memory, data transfer schemes, architecture advancements of microprocessors, typical microprocessor development system, higherlever languages.

M**odule2:The8085Architecture(10 Hours)**

Microprocessor architecture and its operations, Pin configuration, internal architecture. Timing& Signals: control and status, interrupt: ALU, machine cycles, Instruction format, op-codes, mnemonics, number. of bytes, Instruction Set of 8085: Addressing Modes: Register addressing,direct addressing; register indirect addressing, immediate addressing, and implicit addressing.RTL, variants, number. of machine cycles and T states, addressing modes. Instruction Classification: Data transfer, arithmetic operations, logical operations, branching operation, machine control; Writing assembly Language programs, Assembler directives.

M**odule3:The8086Architecture(9Hours)**

8086 Microprocessors: Architecture: Architecture of INTEL 8086 (Bus Interface Unit, Execution unit), register organization, memory addressing, memory segmentation, Operating Modes Instruction Set of 8086 Addressing Modes: Instruction format:Discussion on instructionSet: Groups: datatransfer, arithmetic, logic string, branchcontrol transfer, processor control. Interrupts: Hardware and software interrupts, responses and types.

Module4:FundamentalofProgramming(9Hours)

Development of algorithms, flowcharts in terms of structures ,(series, parallel, if-then-else etc.) Assembler Level Programming: memory space allocation (mother board and user program) Assembler level programs (ASMs) .

Module5:Peripheralmemory and I/O **Interfacing(8Hours)**

Interfacing devices, Interfacing of Memory, Programmed I/O, Interrupt Driven I/O,memory I/O, 8255- Programmable peripheral interface, 8253/8254 Programmable timer/counter. 8259programmable Interrupt Controller, 8251- USART

Text/References:

1. Gaonkar, Ramesh S, “Microprocessor Architecture, programming and applications withthe 8085” Pen ram International Publishing 5th Ed.
2. Uffenbeck,John,“MicrocomputersandMicroprocessors”PHI/3rdEdition.
3. Ray,A.K.&Burchandi,K.M.,“AdvancedMicroprocessorsandPeripherals: Architecture,Programaming and Interfacing” Tata Mc. Graw Hil

BTEE-614C	Wind andSolarEnergy Systems	3L:0T:0P	3credits

CourseOutcomes:

Attheendofthiscourse,studentswilldemonstratethe abilityto

CO1Understand theglobalenergyscenarioand theconsequentgrowthofthepower generationfromrenewableenergysources.
CO2Understand thebasicphysicsofwindand solar powergeneration.
CO3Applytheknowledge ofelectrical machinestogenerateelectricalpowerfromwind
CO4Understandthepowerelectronicinterfacesforwindandsolargeneration.
CO5Understandtheissuesrelatedtothegrid-integrationofsolar andwind energysystems.

Module1:PhysicsofWindPower:(5 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.

Module2:Windgeneratortopologies:(12 Hours)

Reviewofmodernwindturbinetechnologies,FixedandVariablespeedwindturbines,Induction Generators, Doubly-Fed Induction Generators and their characteristics, Permanent-Magnet Synchronous Generators, Power electronics converters. Generator-Converter configurations, Converter Control.

Module3:TheSolarResource:(6 Hours)

Introduction,solarradiationspectra,solargeometry,EarthSunangles,observerSunangles,solar day length, Estimation of solar energy availability.

Module4:Solarenergy Technologies(12 Hours)

Solar photovoltaic 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. Converter Control.

Solarthermalpowergeneration:Technologies,Parabolic trough,centralreceivers,parabolic dish, Fresnel, solar pond, elementary analysis.

Module5:NetworkIntegration Issues: (7Hours)

Overview of grid code technical requirements. Fault ride-through for wind farms - real and reactive power regulation, voltage and frequency operating limits, solar PV and wind farm behavior during grid disturbances. Power quality issues. Power system interconnection experiences in the world. Hybrid and isolated operations of solar PV and wind systems.

Text/References:

1. T.Ackermann,WindPowerinPowerSystems,JohnWileyandSonsLtd., 2005.
2. G.M.Masters,RenewableandEfficientElectricPowerSystems,JohnWileyandSons,2004.
3. S. P. Sukhatme,SolarEnergy:Principles of Thermal Collection& Storage, McGrawHill, 1984.
4. H. Siegfried and R. Waddington, Grid integration of wind energy conversion systems, John Wiley and Sons Ltd., 2006.
5. G.N.TiwariandM.K.Ghosal, RenewableEnergyApplications, NarosaPublications, 2004.
6. J.A.DuffieandW.A.Beckman,SolarEngineeringofThermalProcesses,JohnWiley&Sons,1991.

SemesterVII[Fourth Year]				Branch:ElectricalEngineering						
Sr. No.	**CourseCode**	**Course Title**	**L**	**T**	**P**	**Hours/ Week**	**Internal Marks**	**External Marks**	**Total Marks**	**Credits**
1	BTEE-701C	ComputerAidedPower System Analysis	3	1	0	4	40	60	100	4
2	BTEE-702C	Microcontroller &ProgrammableLogic Controllers	3	0	0	3	40	60	100	3
3	BTEE-71XC	DepartmentElective-3	3	0	0	3	40	60	100	3
4	XXXX-XXXC	Open Elective-4	3	0	0	3	40	60	100	3
5	BTHU-902C	HumanResource Management	3	0	0	3	40	60	100	3
6	BTEE-703C	ComputerAidedPower System Analysis Lab	0	0	2	2	30	20	50	1
7	BTEE-704C	Project	0	0	8	8	120	80	200	4
8	SBS101C	Introduction to Shaheed Bhagat Singh and his Co-patriotes (For LEET students)	1	0	0	Satisfactory/Non Satisfactory				0
		Total	**15**	**1**	**10**	**26**	**350**	**400**	**750**	**21**

BTEE-701C	ComputerAidedPowerSystem Analysis	3L:1T:0P	4 credits

InternalMarks:40 ExternalMarks:60 TotalMarks:100

Course Outcomes:

Attheendofthiscourse,studentswilldemonstrate theabilityto:

CO1	Understandthebasic conceptofPowerSystemandperunit.
CO2	Understandthesolutionmethodsandtechniquesusedinpowersystem studies
CO3	Createcomputationalmodelsforanalysisofbothsymmetricalandunsymmetrical conditions in Power System.

Module1:Modelling(8Hours)

System modelling of synchronous machines, transformers, loads etc, per unit system, single line diagram of electrical networks, single phase impedance diagrams. Ybus and Zbus formulation through graphical concepts. Bus building algorithm for Zbus formation.

Module2:LoadFlowStudies(14Hours)

Data for the load flow studies, Swing Bus, Formulation of simultaneous equations, Iterative solutions by Gauss- Seidel Iteration using YBUS, Newton-Raphson method, Fast Decoupled Load Flow (FDLF) DC load flow.

Module3:OptimalPowerFlow(6Hours)

Basics concepts, active/reactive power objectives (Economic dispatch, MW and MVAr loss minimization) applications -security constrained optimal power flow.

Module3: FaultAnalysis(6 Hours)

NetworkfaultcalculationsusingZBUSandYBUSTableoffactors,Algorithmforcalculating system conditions after fault -three phase short circuit, three - phase to ground, double line to ground, line to line and single line to ground fault.

Module4: PowerSystem Stability(6 Hours)

Steady statestability, Dynamics of a synchronous machine, Power angle equations, Transient stability,equalareacriterion,Numericalsolutionofswingequation,factorseffectingtransient stability.

Text/References:

1. DanielS.Kirschen,PowerSystems,JohnWiley&Sons,8Mar2024
2. Nagrath I.J., Kothari D.P., Modern Power System Analysis, Tata McGraw Hill,5th edition, 2022.
3. StevensonW.D.,ElementsofPowerSystemAnalysis,McGraw Hill
4. NagrathI.J.andKothariD.P.,Power SystemEngineering, TataMcGraw Hill
5. ArrillagaJ.andArnoldC.P.,Computer Analysis ofPowerSystems,JohnWiley &Sons
6. StaggGlennW.andEi-AbiadAhmedH.,ComputerMethodsinPowerSystemAnalysis, Tata McGraw Hill
7. KusicG.L.,ComputerAidedPowerSystemanalysis,PrenticeHall,India

BTEE-702C	MicrocontrollerandProgrammable Logic Controllers	3L:0T:0P	3 credits

InternalMarks:40 ExternalMarks:60 TotalMarks:100

CourseOutcomes:

Attheendofthiscourse,studentswilldemonstrate theabilityto:

CO1	Understandtheworkingofa microprocessor/controller
CO2	Learnconfiguringandusingdifferentperipheralsinadigitalsystem
CO3	Compileanddebuga Programin PLC

Module1:Introduction(8 Hours)

Microprocessors, Micro-controllers and their comparison. The 8051 Architecture: Introduction, 8051 micro-controller hardware, input/ output, pins, ports and circuits, external memory, counters and timers, serial data input/ output, interrupts.

Module2: 8051Assembly LanguageProgramming(8Hours)

Themechanicsofprogramming,assemblylanguageprogrammingprocess,programmingtools and techniques, instruction set (data moving, logical operations, arithmetic operations, jump and call instructions).

Module3:8051Microcontroller Design(8Hours)

Micro-controllerspecification, externalmemory andmemoryspacedecoding, resetandclock circuits, expanding input and output (I/O), memory mapped I/O, memory address decoding, memoryaccesstimes,testingthedesign,timingsubroutines,lookuptablesforthe8051,serial data transmission.

Module4:MicrocontrollerApplications(8Hours)

Interfacing keyboards, displays, Digital-to-Analog (D/A) and Analog-to-Digital (A/D), multiple interrupts, serial data communications, introduction to the use of assemblers and simulatorsEmbeddedSystems:IntroductiontoPLDsandFPGA-architecture,technologyand design issues, implementation of 8051 core.

Module5:ProgrammableLogicControllers(PLC)(8Hours)

Introduction, operation of PLC, difference between PLC and Hardwired system, difference between PLC and Computer, relay logic and ladder logic, ladder commands and examples of PLC ladder diagram realization, PLC timers, PLC counters, PLC classification.

Text/References:

1. KennethJAyola,The8051MicroController-Architecture,ProgrammingandApplication, Penram International Publication

2. JohnBPeatman,DesignwithMicroController, TataMcGrawHill

3. RayA.K.andBhurchandiK.M.,AdvancedMicroprocessorsandPeripherals;Architecture, Programming and Interfacing, Tata McGraw Hill

4. MazidiM.A.andMazidiJ.G.,The8051Micro-controllerandEmbeddedSystem,Pearson Education.

5. UdayashankaraV.andMallikarjunaswamyM.S.,8051MicrocontrollerHardware,Software and Applications, TataMcGraw Hill Education Pvt. Ltd., (2010)

6. NSenthilKumar,MSaravanan,SJeevananthan,MicroprocessorsandMicrocontrollers PAP/CDR Edition, Oxford Higher Education, 2022
7. Otter,JobDan,ProgrammableLogicController,P.H.International,Inc, USA
8. DunningGary,Introductionto PLCs,TataMcGraw Hill
9. KumarRajesh,ModuleonPLCsandtheirApplications,NITTTRChandigarh

Department Electives

VII (Odd)	DE-3	BTEE-711C	HighVoltageEngineering
VII (Odd)	DE-3	BTEE-712C	PowerSystem Reliability
VII (Odd)	DE-3	BTEE-713C	ElectromagneticWaves
VII (Odd)	DE-3	BTEE-714C	EnergyEfficientMachines

BTEE-711C	HighVoltageEngineering	3L:0T:0P	3 credits

InternalMarks:40 ExternalMarks:60 TotalMarks:100

Course Outcomes:

Attheendofthiscourse,studentswilldemonstrate theabilityto:

CO1	Understandthebasicphysicsrelatedtovariousbreakdownprocessesinsolid,liquid,and gaseous insulating materials
CO2	HaveknowledgeofgenerationandmeasurementofD.C.,A.C.,&Impulsevoltages
CO3	HaveknowledgeoftestsonH.V.equipmentandoninsulatingmaterials,asperthestandard
CO4	Haveknowledgeofhowover-voltagesariseinapowersystem,andprotectionagainstthese over-voltages

Module1:BreakdowninInsulatingmaterials(8Hours)

Ionization processes and de-ionization processes, Types of Discharge, Gases as insulating materials, Breakdown in Uniform gap, non-uniform gaps, Townsend’s theory, Streamer mechanism, Corona discharge.

Module2:Breakdowninliquidandsolid(9 Hours)

Breakdown in pure and commercial liquids, Solid dielectrics and composite dielectrics, intrinsicbreakdown,electromechanicalbreakdownandthermalbreakdown,Partialdischarge, applications of insulating materials.

Module3:GenerationofHighVoltages(9Hours)

Generation of high voltages, generation of high D C and AC voltages, generation of impulse voltages, generation of impulse currents, tripping and control of impulse generators.

Module4:MeasurementsofHighVoltagesandCurrents(8Hours)

Peak voltage, impulse voltage and high direct current measurement method, cathode ray oscillographsforimpulsevoltageandcurrentmeasurement,measurementofdielectricconstant and loss factor, partial discharge measurements.

Module5:LightningandSwitchingOver-voltages(8 Hours)

Charge formation in clouds, stepped leader, Dart leader, Lightning Surges. Switching over-voltages, Protection against over-voltages, Surge diverters, Surge modifiers.

Text/References:

1. M.S.NaiduandV.Kamaraju,HighVoltageEngineering,McGrawHillEducation, 6th Edition, 2020.
2. C.L.Wadhwa,HighVoltageEngineering,NewAgeInternationalPublishers,2012.
3. D.V.Razevig(TranslatedbyDr.M.P.Chourasia),HighVoltageEngineering Fundamentals, Khanna Publishers, 1993.
4. Kuffel,W.S.ZaenglandJ.Kuffel,HighVoltageEngineeringFundamentals,Newnes Publication, 2000.
5. R.AroraandW.MoschHighVoltageandElectricalInsulationEngineering,JohnWiley& Sons, 2011.
6. VariousISstandardsforHVLaboratoryTechniquesandTesting

BTEE-712C	PowerSystem Reliability	3L:0T:0P	3 credits

InternalMarks:40 ExternalMarks:60 TotalMarks:100

Course Outcomes:

Attheendofthiscourse,studentswilldemonstrate theabilityto:

CO1	Understandthebasicquantitativereliability analysis
CO2	Understandthereliability modelling andanalysisofelectricpowersystems
CO3	Haveknowledgeofreliabilityassessmentfor elementsoftransmission system
CO4	Understandtheriskanalysisinpowersystem planning

Module1:Generalreliabilitymodellingandevaluation(8Hours)

Introductiontoprobabilityandstochasticprocesses;systemmodellingforreliability;methods ofreliability assessment:statespace, cut-setandtie-setanalysis,decomposition;MonteCarlo simulation:non-sequentialandsequential;synchronousandasynchronoustiming,Analysisof risk in power systems; understanding of causes and remedial measures.

Module2:Reliabilitymodellingandanalysisofelectricpowersystems(10 Hours)

Bulk power systems, distribution systems, and industrial systems. Component modelling: generator modelling, transmission line modelling, load modelling; capacity outage table; probability and frequency distributions; unit addition algorithm; load modelling algorithm. Generation adequacy assessment using discrete convolution: discrete convolution of generation and load models; generation reserve model.

Module3:PowerSystemReliability(8Hours)

Basic Notions of Power System Reliability- sub systems, reliability indices, outage classification, value of reliability tools, Concepts and methodologies, power system structure, Reliability based planning in power systems, Effect of failures on power system, Planning criteria, Risk analysis in power system planning, multi-state systems.

Module4:ReliabilityofGenerationSystems(8Hours)

Capacityoutagecalculations,reliabilityindicesusingthelossofloadprobabilitymethod,unit commitment and operating constraints, optimal reserve management, single and multi-stage expansion.

Module 5: Reliability Assessment for Elements of Transmission and Transformation Systems (8 Hours)

Reliability indices of substations based on the overload capability of the transformers, evaluation and analysis of substation configurations.

Text/References:

1. G.F.KovalevandL.M.Lebedeva,ReliabilityofPowerSystem,SpringerPublishers,2019.

2. C. Singh, P. Jirutitijaroen and J. Mitra, Electric Power Grid Reliability Evaluation: Models and Methods. Wiley-IEEE Press, Hoboken, NJ: 2019. ISBN: 9781119486275.

3. R. Ramakumar, Engineering Reliability: Fundamentals and Applications. Prentice Hall. J. Endrenyi, Reliability Modelling in Electric Power Systems. Wiley.

4. ShahidehpourM,YaminH,Liz,Markeyoperationsinelectricpowersystems Forecasting, Scheduling, and Risk Management, John Wiley & sons

5. R. Billinton, R. Allan, Reliability evaluation of power systems, Plenum Press New York, 1996.

6. ComputationalMethodsinPowersystemReliability,D.Elmakias,Springer-Verlag

BTEE-713C	ElectromagneticWaves	3L:0T:0P	3 credits

InternalMarks:40 ExternalMarks:60 TotalMarks:100

Course Outcomes:

Attheendofthiscourse,studentswilldemonstrate theabilityto:

CO1	Analysetransmissionlinesandestimatevoltageandcurrentatanypointontransmission line for different load conditions
CO2	Providesolutiontoreallifeplanewaveproblemsforvariousboundary conditions
CO3	Analysethefieldequationsforwavepropagationinspecialcasessuchaslossyandlowloss dielectricmedia
CO4	VisualizeTEandTMmodepatternsoffielddistributionsina rectangularwaveguide
CO5	Understandandanalyseradiationbyantennas

Module1:TransmissionLines(8Hours)

Introduction, Concept of distributed elements, Equations of voltage and current, standing wavesandimpedancetransformation,Losslessandlow-losstransmissionlines,Powertransfer onatransmissionline,Analysisoftransmissionlineintermsofadmittances,Transmissionline calculations with the help of Smith chart, Applications of transmission line, Impedance matching using transmission lines.

Module2:Maxwell’sEquations(9 Hours)

BasicquantitiesofElectromagnetics,BasiclawsofElectromagnetics:Gauss’slaw,Ampere’s Circuital law, Faraday’s law of Electromagnetic induction. Maxwell’s equations, Surface charge and surface current, Boundary conditions at media interface.

Module3:Uniform PlaneWave(9 Hours)

Homogeneousunboundmedium,Waveequationfortimeharmonicfields,Solutionofthewave equation, Uniform plane wave, Wave polarization, Wave propagation in conducting medium, Phase velocity of a wave, Power flow and Poynting vector.

Module 4:PlaneWaves atMediaInterface(7 Hours)

Plane wave in arbitrary direction, Plane wave at dielectric interface, Reflection and refraction ofwavesatdielectricinterface,Totalinternalreflection,Wavepolarizationatmediainterface, Brewster angle, Fields and power flow at media interface, Lossy media interface, Reflection from conducting boundary.

Module5:Waveguides(8 Hours)

Parallel plane waveguide: Transverse Electric (TE) mode, Transverse Magnetic (TM) mode, Cut-off frequency, Phase velocity and dispersion. Transverse Electromagnetic (TEM) mode, Analysis of waveguide-general approach, rectangular waveguides. Introduction to antennas.

Text/References:

1. R.L.Yadava,ElectromagneticFields&Waves,Khannapublishers,FirstEdition2021.
2. R.K.ShevGaonkar,ElectromagneticWaves,TataMcGrawHill, 2005.
3. D.K.Cheng,FieldandWaveElectromagnetics,Addison-Wesley, 1989.
4. M.N.O.Sadiku,ElementsofElectromagnetics,OxfordUniversityPress,2007.
5. C.A.Balanis,AdvancedEngineeringElectromagnetics,JohnWiley&Sons,2012

BTEE-714C	EnergyEfficient Machines	3L:0T:0P	3 credits

InternalMarks:40 ExternalMarks:60 TotalMarks:100

Course Outcomes:

Attheendofthiscourse,studentswilldemonstrate the abilityto:

CO1	Understandthemajorissuesrelatedtoenergymanagementsystemandenergyaudits
CO2	Evaluateefficiencyparametersof energyefficient motors
CO3	Understandtheconceptofpowerfactorandexecutedifferentmethodstoimprove power factor
CO4	Analyzetheappropriateinductionmotorforgivenapplicationsandreviewthe operatingcharacteristicsofinductionmotor

Module1:Introduction (8Hours)

Need for energy efficient machines, energy cost and two-part tariff, energy conservation in industriesandfarms-anecessity,introductiontoenergymanagementandenergyauditsystem.
Review of induction motor characteristics.

Module2:**EnergyEfficientMotors (8 Hours)**

Standard motor efficiency, why more efficient motors, An energy efficient motor, efficiency determination methods, Direct Measurement method, Loss segregation method, Comparison, motor efficiency labelling, energy efficient motor standards. Motor life cycle

Module3: PowerFactor (6 Hours)

The power factor in sinusoidal systems, power factor improvement, power factor with nonlinear loads, Harmonics and the power factor

Module4: InductionMotors andAdjustableDriveSystems(6 Hours)

Energy Conservation, adjustable speed systems, Application of adjustable speed systems to fans, pumps and constant torque loads.

Text/References:

1. AndreasJohnC.,Energyefficientelectricmotors,Marcel DekkerInc.1992.
2. ThumanAlbert,IntroductiontoEfficientElectricSystemDesign,TheFairmountPress Prentice Hall.
3. TripathiS.C.,ElectricEnergyUtilizationandConservation,TataMcGraw-Hill 1991.
4. BeloveCharles,HandbookofModemElectronicsandElectricalEngineering,JohnWiley & Sons.

BTEE-703C	ComputerAidedPowerSystem Analysis Lab	3L:1T:0P	4 credits

InternalMarks:40 ExternalMarks:60 TotalMarks:100

Course Outcomes:

Attheendofthiscourse,studentswilldemonstrate theabilityto:

CO1	Hands-onandcomputationalexperimentsrelatedtothecoursecontentsofBTEE-701C
CO2	Developprogramofnumericalmethodsforsolutionofthepowerflowproblemandstability analysis.

Note: Any8-10experimentsaretobeperformedinasemester. List of

experiments is given below:

1. Designoftransmissionsystemsforgivenpoweranddistance.
2. Shortcircuitcalculationsandcalculationsofcircuitbreakerratingsforapowersystem network.
3. Designofsubstations
4. Designofdistributionsystems
5. Y-bus formation
6. Z-busformulation
7. LoadflowanalysisbyGaussSeidalmethod
8. LoadflowanalysisbyNewtonRaphson method
9. Faultanalysisforline-to-line(L-L), Line-to-Ground(L-G)etc
10. Designofundergroundcablingsystemforsubstation.
11. ToobtainpowersystemstabilityonHighVoltageAlternatingcurrent(HVAC)system withthehelpofFlexibleAlternatingCurrentTransmissionSystems(FACTS)devices.
12. OptimalCapacitorplacementonasystemhavingvariablereactivepowerandlowvoltage profile.
13. Toobtainrelayco-ordinationonapower system.
14. Toobtainoptimalgeneratorpricingonhydro-thermaland renewableenergy systems.
15. Tofindsynchronousreactance(Transient,sub-transient)duringfaultanalysis.

BTEE-704C	Project	0L:0T:8P	4 credits

InternalMarks:120 ExternalMarks:80 TotalMarks:200

Course Outcomes:
At the end of this course, students will demonstrate the ability to apply, verify basic scientific principles and technologies. Students will be able to make and design a prototype which is preferably a working model

Content:

Design,Fabrication,Simulation,Evaluation,Testingetc.relatedtoElectricalEngineeringisto be carried out under the supervision of guide(s).

Institute/Department/Student maydecidefor Industryorientedcoursesinlieu ofOneSemester Trainingin 8th Semester (Subject to approval from Competent Authority).

SemesterVIII[Fourthyear]					**Branch:ElectricalEngineering**		
BTEE-801C OneSemesterTraining	**Marks**					**Total Marks**	**Credits**
	Internal				**External**		
	Mid-semester		End-semester				
Evaluationby	***Institute***	***Industry***	***Institute***	***Industry***	***External Examiner***		
SoftwareTraining&Project	25	25	50	25	200	450	14
IndustrialTraining&Project	25	25	50	25			
Total	**250**				**200**	**450**	**14**

or

SemesterVIII[Fourthyear]						**Branch:ElectricalEngineering**				
Sr. No.	**Course code**	**CourseTitle**	**L**	**T**	**P**	**Hours/ Week**	**Internal Marks**	**External Marks**	**Total Marks**	**Credits**
1	BTEE-811C	SmartGrids	3	0	0	3	40	60	100	3
2	BTEE-812C	IndianElectricityStandardsand Practices	3	1	0	4	40	60	100	4
3	BTEE-813C	ArtificialIntelligence Techniques	3	0	0	3	40	60	100	3
4	BTEE-814C	ModelingandSimulationLab	0	0	4	4	30	20	50	2
5	BTEE-815C	TechnicalReportWritingand Presentation	0	0	4	4	60	40	100	2
Total			**9**	**1**	**8**	**18**	**210**	**240**	**450**	**14**

Note:Incasea student goes for pre-placement training andsuchtrainingcouldbeonlysoftwarebasedor only hardware based or a combination of both, the report/evaluation in such a case to be made accordingly.

BTEE-811C	SmartGrids	3L:0T:0P	3credits

InternalMarks: 40 ExternalMarks: 60 TotalMarks:100

Course Outcomes:

Attheend ofthiscourse,studentswilldemonstratetheabilityto:

CO1	Understandtechnologiesforsmartgrid.
CO2	Appreciatethesmarttransmissionaswelldistributionsystems.
CO3	Realizethedistributiongenerationandsmartconsumption.
CO4	Knowtheregulationsandmarketmodelsforsmartgrid.

Module1:IntroductiontoSmartGrids(8Hours)

Definition, justification for smart grids, smart grid conceptual model, smart gridarchitectures, Interoperability, communication technologies, role of smart grids standards, intelli-grid initiative, national smart grid mission (NSGM) by Govt. of India.

Module2:SmartTransmissionTechnologies(8Hours)

Substation automation, Supervisory Control and Data Acquisition (SCADA), Energy Management system (EMS), Phasor Measurement Units (PMU), Wide Area Measurement Systems (WAMS).

Module3:SmartDistributionTechnologies(10Hours)

Distribution automation, outage management systems, Automated Meter Reading (AMR), AutomatedMetering Infrastructure (AMI), Fault Location Isolation and Service Restoration (FLISR), Outage Management Systems (OMS), Energy storage, Renewable integration.

Module4:DistributedGenerationandSmartConsumption(8Hours)

Distributed Energy Resources (DERs), smart appliances, Low Voltage DC (LVDC) distribution in homes/buildings, Home Energy Management System (HEMS), Net metering, Building to Grid B2G, Vehicle to grid V2G, Solar to grid, Microgrid.

Module5:RegulationsandMarketModelsforSmartGrid(8 Hours)

Demand response, Tariff design, Time ofthe day pricing (TOD), Time ofuse pricing (TOU), Consumer privacy and data protection, consumer engagement etc. Cost benefits analysis of smart grid projects.

Text/References:

1. C. W. Gellings, "The Smart Grid, Enabling Energy Efficiency and Demand Side Response", CRC Press, 2009.
2. J.Momoh, "Smart Grid: Fundamentals of Design and Analysis", IEEE ComputerSociety Press,2012.
3. E. J. Jenkins, N. Liyanage, K. Wu, and J. Yokoyama, "Smart Grid: Technology and applications", Wiley Publications.
4. J.Momoh,"SmartGrid:Fundamentalsofdesignandanalysis",JohnWiley&Sons,2012.
5. T.Flick,andJ.Morehouse,"Securingthesmartgrid:Nextgenerationpowergridsecurity",Elsevier, 2010.
6. Indiasmartgridknowledgeportal.

BTEE-812C	IndianElectricityStandardsandPractices	3L:1T:0P	4credits

InternalMarks: 40 ExternalMarks: 60 TotalMarks:100

Course Outcomes:

At theend ofthiscourse,studentswilldemonstratetheabilityto:

CO1	ToknowvariousdefinitionsusedinIndianelectricityrules
CO2	Students will now know how to get a new connection and enhancement or reduction of load, recovery of electricity charges and intervals for billing of electricitycharges,disconnection,reconnectionandrestorationofsupplyof electricity.
CO 3	Authorityandresponsibilityassociatedwithpowerinspectors.

Module1:Introduction(8 Hours)

Various definitions used in Indian electricity rule 1956 i.e., appointment and authority of Inspectors andofficers under government, license and contents of draft license. Service lines and apparatus on consumer's premises. Cut-out on consumer's premises, Identification of earthed and earthed neutral conductors and position of switches and cut-outs, Earthedterminalon consumer's premises, Accessibility ofbare conductors, Danger notices, Handling of electric supply lines and apparatus, Cables for portable or transportable apparatus, Cables protected by bituminous materials, Street boxes.

Module2:Generalconditionsrelatingtosupplyanduseofenergy(9Hours)

Testingofconsumer'sinstallation,Precautionsagainst leakagebeforeconnection,Leakageon consumer's premises, Supply and use of energy, Provisions applicable to medium, high or extra-highvoltageinstallations,Costofinspectionandtestofconsumer'sinstallation, Declared voltage of supply to consumer, Declared frequency of supply to consumer, Sealing of meters, and cut-outs.

Module3:Electricsupplylines,systemsandapparatusforhighandextra-highvoltages(10 Hours)

Approval by Inspector, Use of energy at high and extra-high voltage, Testing, Operation and Maintenance, Metalsheathed electric supplylines, Connectionwithearth, Generalconditions as to transformation and controlof energy, Supply to X-ray and high frequency installation.

Module4:Overheadlines,under-groundcablesandgeneratingstations(10Hours)

Material and strength, Maximum stresses, Clearance above ground of the lowest conductor, Clearance between conductors and trolley wires, Clearances from buildings of low and medium voltage lines and service lines, Clearances from buildings of high and extra-high voltage lines, Conductors at different voltages onsame supports, Erection ofor alternation to buildings, structures, flood banks and elevation of roads, Clearances, Routes, Maximum interval between supports, Conditions to apply where telecommunication lines and power lines are carried on same supports, Lines crossing or approaching each other, Service-lines from overhead lines.

Module5:Protection(5 Hours)

Earthing, Safety and protective devices, Protection against lightning, Unused overhead lines. Additionalrules for electric traction, Introduction to electric supply in mines and oil fields.

Text/References

1. IndianElectricityRules,1956, ManakBhavan, New Delhi.
2. P.S.Satnam, "SubstationDesignandPractice",DhanpatRaiandSons,2001.

BTEE-813C	ArtificialIntelligenceTechniques	3L:0T:0P	3credits

InternalMarks: 40 ExternalMarks: 60 TotalMarks: 100

Course Outcomes:

At theend ofthiscourse,studentswilldemonstratetheabilityto:

CO1	Demonstrate knowledge ofthe building blocks of AI as presented interms of intelligent agents.
CO2	Developintelligentalgorithmsforconstraintsatisfaction problems andalsodesignintelligentsystemsforGamePlaying
CO3	Attainthecapabilitytorepresentvariousreallifeproblemdomains using logic based techniquesand use this to perform inference or planning.

Module1:OverviewofBiologicalNeurons(8Hours)

Structure of biological neurons relevant to Artificial Neural Networks (ANN)s. Fundamental concepts of ANN: Models of ANNs; Feed forward & feedback networks; learning rules; Hebbian learning rule, perception learning rule, delta learning rule, Widrow-Hoff learning rule, correction learning rule, Winner –lake all learning rule.

Module2:SinglelayerPerceptronClassifier(8Hours)

Classification model, Features & decision regions, training & classification using discrete perceptron, algorithm, and single layer continuous perceptron networks for linearly separable classifications.

Module3:SinglelayerFeedbackNetworks(6Hours)

Basic Concepts, Hopfield networks, Training & examples. Self-organizing networks: unsupervised learning of clusters, winner-take-all learning, recall mode, Initialization of weights, separability limitations**.**

Module4:Multi-layerFeedForwardNetworks(8Hours)

Linearly non-separable pattern classification, Error back-propagation training, learning factors, Examples**.**

Module5:FuzzySystems(12)

Introduction, need and Advantages of fuzzy-logic based systems over conventional systems. Fuzzy sets,Triangular, trapezoidal, sigma, Zed-Type Gaussian type fuzzy sets/membership function. operations on fuzzy sets: t-norms, s-norms, inverting, Fuzzy relations.

Fuzzification, rule base, rule composition, rule implication, aggregation and defuzzificationmodules.Defuzzification,weightedaveragemethod,centroid/centre of gravity/centre of area method, centre of sums, centre of largest area, max-membership based method, middle (mean) of maxima, first (last) of maxima.

Text/References

1. J.Ross,“FuzzylogicwithEngineeringApplications”, JohnWiley&Sons,2008.
2. J.Y.R.Langari,“FuzzyLogic:Intelligence,Control,andInformation”,PearsonEducation,1999.
3. S.Haykin,“NeuralNetworks-AComprehensiveFoundation”,MacmillanPublishingCo.,2009.
4. Drinnkov,“FuzzyLogicControl”,NarosaPublishers,2003.
5. P.D.Wasserman,“Neuralcomputing:Theory&Practice”,AuzaResearchInc.VanNostrand,1993.
6. R. C Berkan and S. Truebatch, “Fuzzy system design principles: building if then rule base”, Johnwilley, 2000.
7. Michal Negnevitsky, Artificial Intelligence: A Guide to Intelligent Systems, second edition 2008,Pearson Education.
8. Referred journals/peer reviewed conferences IEEE/Elsevier/Springer).(IEEE/Elsevier/Springer).

BTEE-814C	ModelingandSimulationLab	0L:0T:4P	2credits

InternalMarks: 30 ExternalMarks: 20 TotalMarks: 50

Course Outcomes:

At theend ofthiscourse,studentswilldemonstratetheabilityto:

CO1	Design of primary and secondary transmission systems by analyzing power flows atvariouspointofcommoncouplingsthroughsimulations.
CO2	DistinguishpowerflowsandconversionsystemsamongHVACandHVDC systems.

Listof Experiments

1. Todesigna5-bustransmissionsystemhaving voltage levelsof220kVbytaking appropriate valuesof different buses.

2. Todesigna5-bustransmissionsystemhaving voltage levelsof133kVbytaking appropriate valuesof different buses.

3. To design a 5-bus transmission system having voltage levels of 66kV bytaking appropriate values of different buses.

4. To design a 5-bus transmission system having voltage levels of 11kV bytaking appropriate valuesof different buses.

5. Computepower(PandQ)flowsineachlinefor experiment1andanalyzethepowerflow.

6. Designatransmissionsystemdeliveringaload of500 MWusing HVAC system.

7. Designatransmissionsystemdeliveringaloadof500 MWusing HVDC system.

8. Amajorproject ondesigningofIEEE14bussystem.

BTEE-815C	Technical Report Writing and Presentation	0L:0T:4P	2credits

InternalMarks: 40 ExternalMarks: 60 TotalMarks:100

Guidelines:

1. The teaching load of the subject to be equally distributed among all the faculty members of thedepartment.
2. A team of maximum 3 students to write a technical report based on Case Study of an Industry / Industrial project/ Study or implementation of IEEE/IEC/Indian standard / Product design.
3. The report is to be written under the supervision of Faculty member of concerned department, a Co-supervisor from Industry can be taken, if needed. (it should be different from that of the Project-1/Minor project and project-2/major project report.
4. Basicreportstructure
   - Titlepage.
   - Summary.
   - Tableofcontents.
   - Introduction.
   - Bodyofthereport.
   - Conclusionsandrecommendations.
   - Referencesandappendices.
   - Appendix: Slidesofthepresentation
5. ThepresentationofthereportistobemadeintheDepartmentpriortotheExternal Evaluation.
6. EfforttobemadeforthepublicationinConference/anarticleina periodical.