

SemesterIII[Secondyear]					Branch:ElectricalEngineering					
Sr. No.	Course code	CourseTitle	L	T	P	Hours/ Week	Internal Marks	External Marks	Total Marks	Credits
1	BTEE-301C	Electrical CircuitAnalysis	3	1	0	4	40	60	100	4
2	BTEE-302C	AnalogElectronics	3	0	0	3	40	60	100	3
3	BTEE-303C	MagneticCircuits &Transformers	3	0	0	3	40	60	100	3
4	BTEE-304C	EngineeringMechanics	3	1	0	4	40	60	100	4
5	BTEE-305C	DCMachines	3	0	0	3	40	60	100	3
6	BTEE-306C	ElectricalMeasurements & Measuring Instruments	3	0	0	3	40	60	100	3
7	BTEE-307C	AnalogElectronics Laboratory	0	0	2	2	30	20	50	1
8	BTEE-308C	ElectricalMachines–I Laboratory	0	0	2	2	30	20	50	1
9	BTEE-309C	InstitutionalSummer Vacation Training	-	-	-	35	60	40	100	2
		Total	18	2	4	24	360	440	800	24

BTEE-301C	ElectricalCircuitAnalysis	3L:1T:0P	4credits
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InternalMarks:40ExternalMarks: 60TotalMarks:100

CourseOutcomes:

Attheend ofthiscourse,studentswilldemonstratethe abilityto:

CO1	Applynetworktheoremsfortheanalysisofelectricalcircuits.
CO2	Understand &memorizetheconceptsoftransientandsteady-stateresponseof electrical circuits.
CO3	Analyzecircuitsinthesinusoidalsteady-state(single-phaseandthree-phase),analyzetwoportcircuitbehavior.
CO4	Synthesizenetworksandfilters.

Module1:BasicNetworkAnalysis (14Hours)

Superposition theorem, Thevenin's theorem, Norton's theorem, Maximum power transfer theorem, Reciprocitytheorem, Compensationtheorem. Analysiswithdependent current and voltage sources. Node and Mesh Analysis. Concept of duality and dual networks. Solutionof 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.

Module2:Electricalcircuit andsteadystateanalysis(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.

Module3:Networkfunctionsandtwoport network(10Hours)

Driving point impedance and admittance, natural response of a network, transferimpedanceandadmittance, conceptofpoleandzerosinanetworkfunction, RouthHurwitz 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.

Module4:NetworkSynthesisandFilters(10Hours)

Networksynthesistechniquesfor 2-terminalnetwork, FosterandCauer 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.RoyChoudhury, "NetworksandSystems",NewAgeInternationalPublications,1998.
3. W.H.HaytandJ.E.Kemmerly, "EngineeringCircuitAnalysis",McGrawHill Education, 2013.
4. C.K.AlexanderandM.N.O.Sadiku, "ElectricCircuits",McGrawHillEducation,2004.
5. K.V.V.MurthyandM.S.Kamath, "BasicCircuit Analysis",JaicoPublishers,1999.

BTEE-302C	Analog Electronics	3L:0T:0P	3credits
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InternalMarks:40 ExternalMarks:60 TotalMarks: 100

CourseOutcomes:

Attheend ofthistcourse,studentswilldemonstratethe abilityto:

CO1	Understand thecharacteristicsoftransistors.
CO2	Designandanalysevariousrectifier andamplifiercircuits.
CO3	Designsinusoidalandnon-sinusoidaloscillators.
CO4	UnderstandthefunctioningofOP-AMPanddesignOP-AMPbased circuits.

Module1:DiodeandBJTcircuits(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.

Module2:MOSFETcircuits(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.

Module3:Differential,multi-stageandoperationalamplifiers(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)

Module4:Linearapplicationsofop-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,“MicroelectronicCircuits”,NewYork,OxfordUniversity Press, 1998.
2. J.V.Wait,L.P.HuelsmanandG.A.Korn,“IntroductiontoOperationalAmplifiertheory and applications”, McGraw Hill U.S., 1992.
3. J.MillmanandA.Grabel,“Microelectronics”,McGrawHillEducation,1988.
4. P.HorowitzandW.Hill,“TheArtofElectronics”,CambridgeUniversityPress,1989.
5. P.R.Gray,R.G.MeyerandS.Lewis,“AnalysisandDesignofAnalogIntegrated Circuits”, John Wiley & Sons, 2001.

BTEE-303C	Magnetic Circuits & Transformers	3L:0T:0P	3 credits
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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	Analyze 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. Magnetomotive 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 parameter 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	4credits
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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; Indicical notation; Symmetric and anti-symmetric tensors; Eigenvalues 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: Definition 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: Definition and computation, Principal moments and axes of inertia, Parallel and perpendicular axes theorems; Mass moment of inertia of symmetrical bodies, cylinder, sphere, cone etc., Area moment of inertia and Polar moment of inertia, Forces and moments; Newton-Euler's laws of rigid body motion.

Module 5: Free Body Diagram (2 hours)

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.

Module9:Friction(4hours)

ConceptofFriction;LawsofCoulombfriction; AngleofRepose;Coefficientoffriction.

Text/References:

1. J.L.MeriamandL.G.Kraige,“EngineeringMechanics:Dynamics”,Wiley,2011.
2. M.F.Beatty,“PrinciplesofEngineeringMechanics”,SpringerScience& BusinessMedia, 1986.

BTEE-305C	D.C. Machines	3L:0T:0P	3credits
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InternalMarks:40 ExternalMarks:60 TotalMarks: 100

CourseOutcomes:

Attheend ofthiscourse,studentswilldemonstratethe abilityto:

CO1	Understand &memorizetheconceptsofElectro-MechanicalEnergyconversionin Electrical Machines and D.C. Machines.
CO2	Applytheknowledgeacquiredtosolvethenumericalproblems.
CO3	AnalyzetheconceptsandproblemsrelatedtoD.C.Machines.
CO4	DrawtheoperatingcharacteristicsofdifferenttypesofDCmachines,their applications, find losses & efficiency.

Module1. Electro-MechanicalEnergyConversion(6hours)

Energystoredinelectricand magnetic fields,energyconversioninsinglyand multipleexcited systems, reluctance torque, reluctance and hysteresis motors.

Module2.GeneralDescription of ElectricalMachines(8hours)

Descriptionofelectriccircuits incylindricalrotorandsalient pole machines, MMFofSingleand multiple coils, Effect of slots, winding factors, Torque in terms of flux and mmf.

Module3.D.C.Machines(16hours)

Armaturewindings,singleanddouble layers,windings&windingdiagrams,E.M.F.andtorque equations,interactionoffieldsproducedbyexcitationcircuit andarmature,effectofbrushshift, 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,startingofshunt andseriesmotor,starters,speedcontrolmethods-field and armature control, Ward Leonard method,

Braking:plugging,dynamicandregenerativebraking, Testing:

Swinburn's test, Hopkinson test, Field test.

Estimationoflossesand efficiency.

Module4. Cross-FieldMachines(6hours)

Principleofworking, analysisofcross-fieldgenerator,typicalcharacteristicswithdifferent compensations and Applications.

RecommendedBooks:

1. ElectricMachineryFitzgeraldKingsley&Kusko
2. PrinciplesofD.C. machinesLangsdorff
3. ElectricalMachinesNagrath&Kothari
4. ElectricalMachineryP.S.Bhimbhra

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

Module 1. Units, Dimensions and Standards (6 hours)

Introduction to MKS & Rationalised MKS A 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 d.c. & a.c. 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, multiplier 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 (8 hours)

Fluxmeter, B-H Curve, Hysteresis loop, Permeameters, A.C. Testing of Magnetic materials, Separation of iron losses, iron loss measurement by Wattmeter and Bridge methods.

Module 6. 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
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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 of electronic circuits and working small projects employing semiconductor devices.

Note: A student to perform many 8-10 experiments 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 types 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
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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 many 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 characteristics 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.

SemesterIV[Secondyear]					Branch:ElectricalEngineering					
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	AsynchronousMachines	3	1	0	4	40	60	100	4
3	BTEE-403C	PowerElectronics	3	1	0	4	40	60	100	4
4	BTEE-404C	SignalsandSystems	3	0	0	3	40	60	100	3
5	BTEE-405C	ElectromagneticFields	3	1	0	4	40	60	100	4
6	BTEE-406C	Measurements and InstrumentationLab.	0	0	2	2	30	20	50	1
7	BTEE-407C	DigitalElectronics Laboratory	0	0	2	2	30	20	50	1
8	BTEE-408C	PowerElectronics Laboratory	0	0	2	2	30	20	50	1
9	XXXX-XXXC	OpenElective-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
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InternalMarks:40

ExternalMarks:60

TotalMarks:100

CourseOutcomes:

Attheend ofthiscourse,studentswilldemonstratetheabilityto:

CO1	Understandworkingoflogic familiesand logicgates.
CO2	Designand implement CombinationalandSequentiallogiccircuits.
CO3	UnderstandtheprocessofAnalogtoDigitalconversionandDigitalto Analog conversion.
CO4	Beabletounderstandmemories.

Module1:FundamentalsofDigitalSystemsandlogicfamilies(10Hours)

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 ICs, digitallogic families, TTL, SchottkyTTLand CMOS logic, interfacingCMOSandTTL, Tri-state logic.

Module2:CombinationalDigitalCircuits(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:Sequentialcircuitsandsystems(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 designusing flip flops, special counter IC's, asynchronous sequential counters, applications of counters.

Module4:A/DandD/AConverters(10Hours)

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, specificationsof A/D converters, example of A/D converter ICs, concept of memories.

Text/References:

1. R.P.Jain,"ModernDigitalElectronics",McGrawHillEducation, 2009.
2. M.M.Mano,"DigitallogicandComputerdesign",PearsonEducationIndia,2016.
3. A.Kumar,"FundamentalsofDigitalCircuits",PrenticeHallIndia, 2016.

BTEE-402C	Asynchronous machines	3L:1T:0P	4credits
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Internal Marks:40 External Marks:60 Total Marks:100

Course Outcomes:

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

CO1	Understand and memorize the concept of polyphase induction motors, their starting and speed control methods.
CO2	Apply the knowledge acquired for solving numerical problems on Induction machines and analyze 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 application of induction generator, special purpose motors and single-phase motors.

Module 1. Basic Concepts (10 hours)

Field distribution of spaced 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 its 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.

Phasesplitting, 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	PowerElectronics	3L:1T:0P	4credits
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InternalMarks:40 ExternalMarks:60 TotalMarks: 100

CourseOutcomes:

Atthe endofthiscourse students willdemonstratethe abilityto:

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CO1	Understandthedifferencesbetween signal levelandpower leveldevices.
CO2	Analysecontrolledrectifiercircuits.
CO3	Analyse theoperationofDC-DCchoppers.
CO4	Analyse theoperationofvoltage sourceinverters.

Module 1: Powerswitching devices(10Hours)

Diode,Thyristor,MOSFET,IGBT: V - I characteristics;Firing circuit forthyristor;Voltageandcurrent commutation of a thyristor; Gate drive circuits for MOSFET and IGBT.

Module2: 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.

Module3: DC-DC buck converter(12Hours)

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.

Module4: 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
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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. Schaffer, "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	4credits
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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 analyze 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 it 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, ∇ , gradient, divergence and curl; integral theorems of vectors. Conversion of a vector from one coordinate system to another.

Module 2: Static Electric Field (12 Hours)

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, Ohm's 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 homogeneous 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, "ElementsofElectromagnetics", OxfordUniversityPublication, 2014.
2. A.Pramanik, "Electromagnetism-Theoryandapplications", PHI Learning Pvt.Ltd, New Delhi, 2009.
3. A.Pramanik, "Electromagnetism-Problemswithsolution", PrenticeHallIndia, 2012.
4. G.W.Carter, "Theelectromagneticfield initsengineeringaspects", Longmans, 1954.
5. W.J.Duffin, "ElectricityandMagnetism", McGrawHillPublication, 1980.
6. W.J.Duffin, "AdvancedElectricityandMagnetism", McGrawHill, 1968.
7. E.G.Cullwick, "TheFundamentals ofElectromagnetism", CambridgeUniversityPress, 1966.
8. B.D.Popovic, "IntroductoryEngineeringElectromagnetics", Addison-Wesley Educational Publishers, International Edition, 1971.
9. W.Hayt, "EngineeringElectromagnetics", McGrawHillEducation, 2012.

BTEE-406C	Measurements and Instrumentation Laboratory	0L:0T:2P	1 credit
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Internal Marks:30 External Marks:20 Total Marks:50

Course Outcomes:

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

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

Experiments

1. Measurement of a batch of resistors and estimating statistical parameters.
2. Measurement of L using a bridge technique as well as LCR meter.
3. Measurement of C using a bridge technique as well as LCR meter.
4. Measurement of Low Resistance using Kelvin's double bridge.
5. Measurement of High resistance and Insulation resistance using Megger.
6. Usage of DSO for steady state periodic waveforms produced by a function generator. Selection of trigger source and trigger level, selection of time-scale and voltage scale. Bandwidth of measurement and sampling rate.
7. Download of one-cycled 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 many 8-10 Experiments and make one minor working model project.

BTEE-407C	Digital Electronics Laboratory	0L:0T:2P	1Credit
Internal Marks:30	External Marks:20	Total Marks:50	

Course Outcomes:

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

CO1	To understand of basic electronic components and circuits
CO2	Understanding and 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 electronic circuits

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

Suggested List of Experiments:

- Design a delay circuit using 555 timer and study the monostable, bistable and astable operations using 555.
- Verification of the truth tables of TTL gates viz; 7400, 7402, 7404, 7408, 7432, 7486.
 - Design and fabrication and realization of all gates using NAND/NOR gates.
- Verification of truth table of Multiplexer (74150)/Demultiplexer (74154)
- Design and verification of truth tables of half-adder, full-adder and subtractor circuits using gates 7483 and 7486 (controlled inverter).
- To study the operation of Arithmetic Logic Unit IC 74181.
- Design fabrication and testing of
 - Monostable multivibrator of $\tau = 0.1\text{ms}$ approx. using 74121/123. testing for both positive and negative edge triggering, variation in pulse width and retriggering.
 - Free running multivibrator at 1KHz and 1Hz using 555 with 50% duty cycle. Verify the timing from theoretical calculations.
- Design and test S-R flip-flop using NOR/NAND gates.
- Design, fabricate and test a switch debouncer using 7400.
- Verify the truth table of a JK flip flop using IC 7476,
- Verify the truth table of a D flip flop using IC 7474 and study its operation in the toggle and asynchronous mode.
- 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.
- Verify the truth table of decoder driver 7447/7448. 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
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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 waveform 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 choppers, and inverter.

Note: A student to perform many 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 of SCR.
2. To study the effect of free-wheeling diode on power factor for single phase half-wave rectifier with R-L load.
3. To plot waveforms for output voltage and current, for single phase full-wave, fully controlled 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 output voltage, 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[ThirdYear]				Branch:ElectricalEngineering						
Sr. No.	CourseCode	CourseTitle	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	SynchronousMachines	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 &CostingLab	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	IndustrialTraining	-	-	-	-	60	40	100	-
		Total	15	3	6	24	350	400	750	21

BTEE-501C	PowerSystem-I(Transmissionand Distribution)	3L:1T:0P	4 credits
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InternalMarks:40ExternalMarks:60TotalMarks:100

Course Outcomes:

Attheendofthiscourse,studentswilldemonstratetheabilityto:

CO1	UnderstandthedifferenttypesofDC&ACsuppliesystemandhaveknowledge abouttransmissionlineconductors& insulators.
CO2	UnderstandTransmissionlineparametersandanalyzeperformanceoftransmissionlines.
CO3	Learntheconceptofcirclediagramandlinecompensation.
CO4	SolveproblemsrelatedwithdifferentconceptsofpowersystemI

Module1: SupplySystem(8 Hours)

IntroductiontoTransmissionandDistributionsystems,ComparisonbetweenDCandACsystemsfor TransmissionandDistribution,comparisonofcostofconductors,choiceofworkingvoltagefor transmissionanddistribution,economicsizeofconductors-Kelvin'slaw,Radialandmesh distributionnetworks,Voltageregulation.

Module2: ConductorsandTransmissionLineConstruction(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(8Hours)

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: PerformanceofTransmissionLines(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 Tcircuits,powerloci,surgeimpedanceloading,reactivepowerrequirementofsystemseriesandshunt compensation, Synchronous phase modifiers, rating of phase modifiers.

Module6: UndergroundCables(8Hours)

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-HillPublication
2. GuptaB.R.,PowerSystemAnalysis&Design,WheelerPublishing.
3. NagrathI.J.andKothariD.P.,PowerSystemAnalysisTataMcGraw-HillPublication
4. StevensonJr.W.D.,ElementsofPowerSystemAnalysis,TataMcGraw-HillPublication
5. WadhwaC.L.,CourseinElectricalPower,NewAgeInternational(P)Ltd.

BTEE-502C	Control Systems	3L:1T:0P	4 credits
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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 linear-time-variant and invariant systems, modelling of various types of systems and analysis of linear systems using transfer function and state-space representations.
CO2	Understand the concept of potentiometers, servomotors and tachogenerators as an error detector.
CO3	Analyze the concepts of stability from various methods like Routh-Hurwitz, Bode plot, Root Locus and Polar plots, and Nyquist criterion.

Module 1. Introductory Concepts (5 Hours)

Plant, Systems, Servomechanism, regulating systems, disturbances, Open loop control system, 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, mechanical analogies. Transfer function, Block diagram representation, signal flow graphs and associated algebra, characteristics equation.

Module 3. Time Domain Analysis (7 Hours)

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 Locus Technique (4 Hours)

Root Locus Technique: The extreme points of the root loci for positive gain. Asymptotes to the loci, Breakaway points, intersection with imaginary axis, location of roots with given gain and sketch of the root locus plot.

Module 5: Frequency Domain Analysis (7 Hours)

Closed loop frequency response, Bode plots, stability and loop transfer function. Frequency response 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.

Control Components: Error detectors-potentiometers and synchros, servomotors, a.c. and d.c. technology generators, Magnetic amplifiers.

Text/References:

1. M. Gopal, Control Systems: Principles and Design, McGraw Hill Education, 1997.
2. A. Ambikopathy, Control System, First Edition, 2019.
3. K. Ogata, Modern Control Engineering, Prentice Hall, 1991.
4. I.J. Nagrath and M. Gopal, Control Systems Engineering, New Age International, 2009.

BTEE-503C	Synchronous machines	3L:1T:0P	4 credits
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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 about the general aspects and winding terminology used in 3- ϕ synchronous machines and 1- ϕ synchronous machines.
CO2	Understand the operation of synchronous machines
CO3	Analyze the various methods of voltage regulations and EMF equations of alternators.
CO4	Analyze power angle characteristics and the operating characteristics of synchronous machines.
CO5	Understand the concepts about parallel operation and transient conditions of alternators.

Module 1: General Aspects (8 Hours)

Construction and working principle of synchronous machines, Excitation systems, production of sinusoidal electromotive force (EMF), flux and magnetomotive force (MMF) phasors in synchronous machines; cylindrical and salient pole rotors.

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

Module 2: 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-circuit ratio, short-circuit loss. Effect of variation of power factor on voltage. Determination of voltage regulation: EMF method, MMF method. Zero power factor (Z.P.F.) method. Alternator on infinite busbar, operation at constant load and variable excitation, power flow through inductive impedance. Power-angle characteristics of synchronous machines: -cylindrical and salient pole. Two reaction theory of salient pole machines, power factor control.

Module 3: Synchronous Motors (10 Hours)

Operating characteristics, power-angle characteristics, conditions for maximum power developed. V-curves and inverted V-curves, methods of starting, synchronous motors applications, synchronous condensers. Hunting and damper windings.

Module 4: Parallel Operation of Alternators (6 Hours)

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 (6 Hours)

Transient reactance and time constants from equivalent circuits, synchronous machine reactance and their determination, short circuit. Oscillogram, Synchronization with the grid system, Qualitative introduction to the transient stability of the synchronous machines.

Module 6: Single Phase Synchronous Motors (3 Hours)

Reluctance and Hysteresis motors.

Text/References:

1. A.E. Fitzgerald and C. Kingsley, Electric Machinery, McGraw Hill Education, 2013.
2. P.S. Bimbhra, Electrical Machinery, Khanna Publishers, 2nd Edition, 2022.

3. M.G.Say, Performance and design of AC machines, CBS Publishers, 2002.
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-504C	Electrical: Estimation and Costing lab	0L:0T:2P	1 credit
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Internal Marks:30 External Marks:20 Total Marks:50

Course Outcomes:

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

CO1	Interpret the salient features of National Electrical Code and other relevant national standards applicable for electrical installations in India.
CO2	Develop detailed wiring diagram for house building electrification.
CO3	Develop proposals/single line diagrams for electrical installations in specified premises.

Note: Any 8-10 experiments are to be performed in a semester. List

of Experiments:

1. To study Indian electricity rules
2. To carry out wiring diagram of residential building, educational institute and Industry. Giving selection of appropriate wiring, list materials and accessories for given project.
3. To study the design consideration of Panel Boards.
4. To study the design consideration of various electrical systems:
 - a. 3 phase four wire distribution systems
 - b. Earthing
5. 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
6. To estimate the cost of industrial installation (Workshop, agriculture, flour mill etc.).
7. To estimate the cost of overhead service connection (Single phase and three phase).
8. To estimate the cost of underground service connection (single phase and three phase).
9. To estimate the cost of overhead, 440V, 3-phase, 4 wire or 3 wire distribution line.
10. To estimate the cost of the underground distribution line.
11. To estimate the cost of any one electrical appliance.
12. To estimate the cost of repairs and maintenance of any one domestic appliance.
13. 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
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InternalMarks:30 ExternalMarks:20 TotalMarks:50

Course Outcomes:

Attheendofthiscoursestudentswilldemonstratetheabilityto:

CO1	Interprettheroleofvariouscomponentsincontrolsystem
CO2	Computeortopredictthecharacteristicsofasystembyvisualizingexperimentaldataandits graphicalrepresentation.
CO3	Analyzetheresponseofcontrolsystembymeasuringrelevantparameters

Note: Any 8-10 experiments are to be performed in a semester. List of Experiments:

1. TostudythecharacteristicsofpotentiometersandtousePotentiometersasanerrordetectorina control system.
2. TostudythesynchroTransmitter-Receiver setandtouseitasanerrordetector.
3. TostudytheSpeed–TorquecharacteristicsofanACServoMotorandtoexploreitsapplications.
4. TostudytheSpeed–TorquecharacteristicsofanDCServoMotorandexploreitsapplications.
5. Tostudythevariationsoftimelagbychangingthetimeconstantusingcontrolengineeringtrainer.
6. Tosimulatethirdorderdifferentialequationsusinganalogcomputerandcalculatetimet responsespecifications.
7. ToobtainthetransferfunctionofaD.C.motor–D.C.GeneratorsetusingTransferFunction Trainer
8. TostudythespeedcontrolofanA.C.ServoMotorusingaclosedloopand anopen loopsystem:
9. Tostudytheoperationofapositionsensorandstudytheconversionofpositionintocorresponding voltage
10. Tostudy a PI control action and show its usefulness for minimizing steady state error of time response.
11. Tomeasure Force/Displacement using Strain Gauge in a wheatstone bridge.
12. Todesign a Lag compensator and test its performance characteristics.
13. Todesign a Lead-compensator and test its performance characteristics.
14. Todesign a Lead-Lag compensator and test its performance characteristics.

BTEE-506C	Electrical Machines-III Laboratory	0L:0T:2P	1 credit
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Internal Marks:30 External Marks:20 Total Marks:50

Course Outcomes:

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

CO1	Construct equivalent circuits in induction motors by routine tests.
CO2	Comprehend the requirement of starting and speed control methods of induction motors in the various applications of industry.
CO3	Construct equivalent circuits of synchronous generator and motor.
CO4	Construct characteristic curves for induction and synchronous machines
CO5	Understand the concept of parallel operation of three phase alternators.

Note: 8–10 experiments are to be performed in a semester. List of experiments is given below:

List of Experiments:

1. To perform load-test on three-phase Induction motor and to plot torque versus speed characteristics.
2. To perform no-load and blocked-rotor tests on three-phase Induction motor to obtain equivalent circuit
3. To study the speed control of three-phase Induction motor by Kramer's Concept.
4. To study the speed control of three-phase Induction motor by cascading of two induction motors, i.e. by feeding the slip power of one motor into the other motor.
5. To study star-delta starters physically and a) to draw electrical connection diagram b) to start the three-phase Induction motor using it. c) to reverse the direction of three-phase Induction motor
6. To start a three-phase slip-ring induction motor by inserting different levels of resistance in the rotor circuit. And to plot torque –speed characteristics.
7. To perform no-load and blocked-rotor tests on single-phase Induction motor and to determine the parameters of equivalent circuit.
8. To perform load-test on single-phase Induction motor and plot torque –speed characteristics.
9. To perform no-load and short circuit. Test on three-phase alternator and draw open and short circuit characteristics.
10. To find voltage regulation of an alternator by zero power factor (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. To measure negative sequence and zero sequence reactance of Synchronous Machines.
13. Parallel operation of three phase alternators using • Dark lamp method • Two-Bright and one dark lamp method
14. To study synchroscope physically and parallel operation of three-phase alternators using synchroscope.
15. Starting of synchronous motors using • Auxiliary motor • Using Damper windings

BTEE-507C	Industrial Training	0L:0T:0P	-credit
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InternalMarks:60

ExternalMarks:40

TotalMarks:100

Department Electives

V (Odd)	DE-1	BTEE-511C	ElectricalEngineeringMaterials
V (Odd)	DE-1	BTEE-512C	PowerPlantEngineering
V (Odd)	DE-1	BTEE-513C	OptimizationTechniques
V (Odd)	DE-1	BTEE-514C	RenewableEnergySources

BTEE-511C	ElectricalEngineeringMaterials	3L:0T:0P	3 credits
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InternalMarks:40ExternalMarks:60TotalMarks:100

Course Outcomes:

Attheendofthiscoursestudentswilldemonstratetheabilityto:

CO1	Understandthebasicconceptsofmaterials
CO2	Usesimplifiedmaterialsselectionconceptsfordesignpurposes
CO3	UnderstandthepropertiesofMaterials

Module1:DielectricMaterials(8Hours)

Static dielectric constant, Polarization, atomic interpretation of the dielectric constant of mono-atomic and polyatomic 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. Electrons scattering and resistivityofmetals. Heatdevelopedincurrentcarryingconductor, thermalconductivityofmetals, superconductivity.

Module3:MagneticMaterials(4Hours)

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

Module4:PropertiesofFerromagneticMaterials(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	PowerPlantEngineering	3L:0T:0P	3 credits
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InternalMarks:40ExternalMarks:60TotalMarks:100

Course Outcomes:

Attheendofthiscoursestudentswilldemonstratetheabilityto:

CO1	Memorizethebasicconceptrelatedtopollutionandworkingofsteam,hydro,diesel,nuclearand gaspowerplant andtheir accessories.
CO2	Constructthelayoutofdifferents typesofpowerplants
CO3	Understandthecombinedoperationofdifferents powerplantsandcomparisonbetweenvarious typesof plants
CO4	Evaluatethenumericalproblemsrelatedtodifferents typesofpower plants

Module1:SteamGenerators,CondensersandTurbines(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 water calculations, steam nozzles, types of steam turbine efficiencies, compounding, governing and 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-ElectricPowerPlants(8Hours)

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.

Module3: 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.

Module4: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:DieselPowerPlants(5Hours)

Classifications of IC Engines and their performance, Four stroke and two stroke diesel engines, combustion phenomenon; Essential components, Cetane number, knocking, super charging, operation and layout of diesel power plant.

Module6:CombinedOperation ofDifferent Power Plants(4 Hours)

Advantages of combined operation of plants, load division between power stations, coordination of different types of Power Plants.

Module7:PollutionControl(3Hours)

Pollution from thermal & nuclear plants, Particulate emission and control, electrostatic precipitator, solid waste disposal.

Text/References:

1. Chakrabarti A., Soni, M.L. Gupta P. V. and Bhatnagar U.S., A Textbook on Power System Engineering, Dhanpat Rai & Co.
2. EI-Wakit M.M., Power Plant Engineering, McGraw Hill, USA
3. Rajput R.K., Power Plant Engineering, Luxmi Publications
4. Sharma P.C., Power Plant Engineering, Kataria & Sons

BTEE-513C	Optimization Techniques	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 idea of optimization problems
CO2	Solve transportation models
CO3	Solve various types of optimization problems

Module1: Introduction(6Hours)

Origin of OR and its role in solving industrial problems: General approach for solving OR problems. Classification of mathematical models: various decision-making environments.

Module2: Linear Programming(6Hours)

Formulation of linear mathematical models: Graphical and simplex techniques for solution of linear programming problems, Big M method and two -phase method, Introduction to duality theory and sensitivity analysis.

Module3: Transportation and Assignment Models(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: Dynamic Programming(4Hours)

Introduction to deterministic and probabilistic dynamic programming.

Module5: Network Models(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.

Module6: Non-Linear Programming Models(3Hours)

Introduction to non-linear programming models, Generic Algorithm and problems related to topic.

Text/References:

1. K. Deb. Optimization for Engineering Design: Algorithms and Examples, 2nd Edition, Jan 2012.
2. H. M. Wagner, Principles of Operations Research, Prentice Hall.
3. P. K. Gupta and D. S. Hira, Operations Research, S. Chand & Co.
4. F. S. Hiller and G. I. Libermann, Introduction to Operation Research, Holden Ray.
5. A Management Guide to PERT/CPM Wiest & Levy Prentice Hall

BTEE-514C	RenewableEnergySources	3L:0T:0P	3 credits
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InternalMarks:40 ExternalMarks:60 TotalMarks:100

CourseOutcomes:

Attheendofthiscoursestudentswilldemonstratetheabilityto:

CO1	UnderstandtheNeed,importanceandscopeofnon-conventionalandalternateenergyresources
CO2	UnderstandroleofMHDgeneration,thermo-electriceffectandphoto-voltaiceffect
CO3	Understandtheroleoffuelcell
CO4	Gettheutilizationofmiscellaneousources.

Module1:Introduction(6Hours)

Limitationofconventionalenergysources,needandgrowthofalternativeenergysource,basicscheme and application of direct energy conservation.

Module 2: MHDGenerators(6 Hours)

Basicprinciples,gaseous,conductionandhalleffect,generatorandmotoreffect,differenttypesofMagneto-Hydro-Dynamic(MHD)generator,typesofMHDmaterial,conversioneffectiveness, analysisofconstantareaMHDgenerator,practicalMHDgenerator,applicationandeconomic aspects.

Module3:Thermo-ElectricGenerators(8Hours)

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:PhotovoltaicEffectandSolarEnergy(10Hours)

Photovoltaiceffect,differenttypesofphotovoltaiccells,cellfabrication,characteristicsof photovoltaiccells,conversionefficiency,solarbatteries,application,solarradiationanalysis,solarenergy in India, solar collectors, solar furnaces and applications.

Module5: FuelCells(6Hours)

Principleofaction,Gibb'sfreeenergy,generaldescriptionoffuelcells,types,construction, operational characteristics and application.

Module6:MiscellaneousSources(6Hours)

Geothermalsystem,hydro-electricplants,windpower,tidalenergy,Bio-massenergy

Text/References:

1. Renewableenergyresources:TiwariandGhosal,Narosa publication.
2. Non-conventionalEnergySources,KhannaPublication
3. RenewableEnergySources:Twidell&Weir,CRCPress.
4. SolarEnergy/S.P.Sukhatme,TataMcGraw-Hill.
5. Non-ConventionalEnergySystems:KM.Mittal,AH WheelerPublishingCoLtd.
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-XXXX	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
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InternalMarks:40

ExternalMarks:60

TotalMarks:100

CourseOutcomes:

Attheendofthiscourse,studentswilldemonstratetheabilityto:

CO1Understandtheconceptsofpowersystems.
CO2Understandthevariouspowersystemcomponents
CO3Understandthegenerationofover-voltages
CO4Understandbasicprotectionschemes.
CO5Understandthebasicsofcircuitbreakersandprotectiverelays.

Module1:Sub-Station(4Hours)

Types,MainequipmentinSubstation,substationlayout,Busbar-arrangements.

Module2:Isolators&Fuses(4Hours)

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

Module3:CircuitBreakers(7Hours)

Need for Circuit Breakers, Arc phenomenon, TheoryofArc Interruption, RecoveryVoltageand RestrikingVoltage, VariousTypesofCircuit Breakers.PrinciplesandConstructionalDetailsof AirBlast, Minimum Oil, SF₆, Vacuum Circuit Breakers etc.

Module4:ProtectiveRelays(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:ProtectionofFeeders(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:Protectionagainstovervoltageand 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(KhannaPublishers) |
| 2) | PowerSystemEngg. | SoniGupta&Bhatnager(DhanpatRai&Sons) |
| 3) | ACourseinElectricalPower | C.L.Wadhawa(NewAgeinternationalPvt.Ltd) |
| 4) | PowersystemProtection&Switchgear | Badriram&D.V.Vishwakarma(TMh) |
| 5) | Switchgears&Protection | M.V.Deshpande(THM) |

BTEE-602C	Power Generation and Economics	3L:1T:0P	4credits
<i>Internal Marks:40</i>	<i>External Marks:60</i>	<i>Total Marks:100</i>	

Course Outcomes:

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

CO1 Understand the load curves, load-duration Curve.
CO2 Understand the power plant economics and tariff
CO3 Explore the significance of economic operation of steam plants
CO4 Understand the hydro-thermal coordination

Module 1: Loads and Load curves (8 hours)

Electrical energy sources, organization of power sector in India, single line diagram of thermal, hydro and nuclear power stations. Classification of power plants in base load and peak load plants.

Types of load (fixed voltage loads, resistive loads, Inductive motor loads, Mechanical load), effect of load on supply voltage, Maximum demand, Group diversity factor, Peak diversity factor, Types of load, chronological load curves, load-duration Curve, mass curves, load factor, capacity factor, utilization factor, base load and peak load plants, load forecasting.

Module 2: Power Plant Economics and Tariff (10 hours)

Capital cost of plants, annual fixed cost, operating costs and effect of load factor on cost of energy, depreciation. Objectives of tariff making, different types of tariff (domestic, commercial, agricultural and industrial loads). Need for power factor improvement, power factor improvement using capacitors, determination of economic power factor.

Module 3: Selection of plant, Cogeneration (8 hours)

Plant location, plant size, number and size of units in plants, economic comparison of alternatives 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.

Module 4: Economics of Steam plants (8 hours)

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.

Module 5: Hydro-thermal co-ordination (8 hours)

Advantages of combined working of Run-off River plant and steam plant, reservoir hydro plants and thermal plants, long-term operational aspects, scheduling methods.

Text/Reference Books

1. M.V. Deshpande, Power Plant Engineering, Tata McGraw Hill (2004).
2. M.M. El-Wakil, Power Plant Engineering, McGraw Hill, USA 8. Rajput R.K., Power Plant Engineering, Luxmi Publications
3. P.C. Sharma, Power Plant Engineering, Kataria and Sons
4. B.G.A. Skrotzki and W.A. Vaport, Power Station Engineering and Economy, Tata McGraw-Hill
5. S.C. Arora and S. Domkundwar, A course in Power Plant Engineering, Dhanpat Rai.
6. P.K. Nag, Power Plant Engineering, Tata McGraw Hill
7. B.R. Gupta, Generation of Electrical Energy, S. Chand (1998).
8. I.J. Nagrath and D.P. Kothari, Modern Power System Analysis Tata McGraw-Hill Publication

BTEE-603C	Electric Drives And Utilization	3L:0T:0P	3 credits
<i>Internal Marks: 40</i>	<i>External Marks: 60</i>	<i>Total Marks: 100</i>	

Course Outcomes:

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

CO1: To impart the knowledge of Electric Traction, Electric heating, Electric welding and Illumination.
CO2: Enable the students to design of interior and exterior lighting systems - illumination levels for various purposes light fittings - factory lighting - flood lighting - street lighting.
CO3: To make students capable of analyzing and solving the varieties of problems and issues in electric power utilization.
CO4: To impart the knowledge of air conditioning and refrigeration.

Module 1: Electric Drives (6 Hours)

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

Module 2: Electric Traction (5 Hours)

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.

Module 3: Electric Heating and Welding (5 Hours)

Methods of electric heating, constructional details & performance of resistance heating furnace. Dielectric heating, A.C. & D.C. Welding, Resistance and Arc Welding. Electric Beam Welding, Laser Welding.

Module 4: Illumination (6 Hours)

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.

Module 5: Refrigeration and Air Conditioning (5 Hours)

Refrigeration system, Domestic refrigeration, Air conditioner, Comfort Air conditioning, Effective temperature.

Module 6: Electrolysis (4 Hours)

Laws of Electrolysis, Process voltage, current, energy, efficiency, Applications of electrolysis.

Text/Reference Books

- | | |
|---|------------------------------------|
| 1. Electric Traction | H. Partab |
| 2. Electric Drives & Utilization | H. Partab |
| 3. Electric Drives | De & Sen (PHI publication) |
| 4. Electric Motor Drives | M. S. Berde (Khanna Publishers) |
| 5. Utilization of Electric Power | J. B. Gupta (S. K. Kataria & Sons) |
| 6. Electric Energy Utilization
Mc Graw. Hill) & Conservation | Tripathi (Tata) |
| 7. Electric Energy Utilization | E. O. Taylor |

BTEE-604C	Power Systems Laboratory	0L:0T:2P	1 credit
<i>Internal Marks:30</i>	<i>External Marks:20</i>	<i>Total Marks:50</i>	

Course Outcomes:

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

CO1 Acquire the knowledge of various abnormal conditions that could occur in power system.
CO2 Ability to design various protective devices in power system for protecting equipment and personnel.
CO3 Knowledge of various types of existing circuit breakers, their design and constructional details.
CO4 Knowledge of various conventional relays, their design and latest developments.

Suggested List of Experiments:

1. To study the performance of a transmission line. Also compute its ABCD parameters.
2. Study of Characteristics of overcurrent and earth fault protection.
3. To study the operating characteristics of fuse. (HRC or open type)
4. To find the earth resistance using three spikes
5. To study overcurrent static relay.
6. To study the different types of faults on transmission line demonstration panel/model.
7. To study the radial feeder performance when
(a) Fed at one end. (b). Fed at both ends
8. To study the performance of under voltage and over voltage relay.
9. To study the characteristics of bimetallic circuit breakers.
10. To study the characteristics of Distance Relay.
11. To find the breakdown strength of transformer oil.

Department Electives

VI (even)	DE-2	BTEE-611C	ElectricalEnergyConservation& Auditing	3L:0T:0P	3
VI (even)	DE-2	BTEE-612C	Non-linearandDigitalControlSystems	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	Electrical Energy Conservation and Auditing	3L:0T:0P	3 credits
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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 current energy scenario and importance of energy conservation. Understand the concepts of energy management.
CO2	Understand the methods of improving energy efficiency in different electrical systems.
CO3	Understand the concepts of different energy efficient devices.

Module 1: Energy Scenario (6 Hours)

Commercial and non-commercial energy, primary energy resources, commercial energy production, final energy consumption, energy needs of growing economy, long term energy scenario, energy pricing, energy sector reforms, energy and environment, energy security, energy conservation and its importance, restructuring of the energy supply sector, energy strategy for the future, air pollution, climate change. Energy Conservation Act-2001 and its features.

Module 2: Energy Management & Audit (6 Hours)

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.

Module 3: Energy Efficiency in Electrical Systems (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 of PF capacitors, distribution and transformer losses. Electric motors: Types, losses in induction motors, motor efficiency, factors affecting motor performance, rewinding and motor replacement issues, energy saving opportunities with energy efficient motors.

Module 4: Energy Efficiency in Industrial Systems (8 Hours)

Compressed Air System: Types of air compressors, compressor efficiency, efficient compressor operation, Compressed air system components, capacity assessment, leakage test, factors affecting the performance 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 and performance evaluation, efficient system operation, flow control strategies and energy saving opportunities, assessment of cooling towers.

Module 5: Energy Efficient Technologies in Electrical Systems (8 Hours)

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

Text/Reference Books

1. Guidebooks for National Certification Examination for Energy Manager/Energy Auditors Book-1, General Aspects (available online).
2. Guidebooks for National Certification Examination for Energy Manager/Energy Auditors Book-3, Electrical Utilities (available online).
3. S.C. Tripathy, "Utilization of Electrical Energy and Conservation", McGraw Hill, 1991.
4. Success stories of Energy Conservation by BEE, New Delhi (www.bee-india.org).

BTEE-612C	NonLinearAndDigitalControlSystems	3L:0T:0P	3credits
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InternalMarks:40

ExternalMarks:60

TotalMarks:100

CourseOutcomes:

Attheendofthiscourse,studentswilldemonstratetheabilityto

CO1Understandtheconceptofstatevariable,statespace,nonlinearsystem,nonlinear characteristicsandsampleddatasystem.
CO2Analyzethesystemresponseandstabilityofsystemsrepresentedinstatespaceform
CO3Analyseandevaluatemethodofnonlinearsystemsbydescribingfunctionmethod, Lyapunov'smethodandphaseplane technique.
CO4Assesssampleddatasystemandjudgetheissuesfacedinsampling,digitaldataand discretetimesystems.

Module1:StateVariableTechniques(6Hours)

Statevariablerepresentationofsystemsbyvariousmethods,solutionofstatevariablemodel, Controllability and observability.

Module2:PhasePlaneAnalysis(4Hours)

Singularpoints,Methodofisoclines,deltamethod,phaseportraitofsecondordernonlinear systems,limitcycle.

Module3:DescribingFunctionAnalysis(8Hours)

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

Module4:Lyapunov'sStabilityMethod(5Hours)

Lyapunov'sdirectmethod,generationofLyapunov'sfunctionbyKrasovskii'sandVariableGradient 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-Hurwitzcriterion to discrete time systems.

Text/ReferenceBooks

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

BTEE-613C	Microprocessors	3L:0T:0P	3credits
<i>InternalMarks:40</i>	<i>ExternalMarks:60</i>	<i>TotalMarks:100</i>	

CourseOutcomes:

Attheendofthiscourse,studentswilldemonstratetheabilityto:

CO1Studyof8085and8086Microprocessors.
CO2Doassemblylanguageprogramming.
CO3Dointerfacingdesignofperipheralslike8255,8253,8279,8251etc.
CO4Developsystemsusingdifferentmicroprocessors.

Module1:FundamentalsofMicroprocessors:(3Hours)

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 advancementsofmicroprocessors,typicalmicroprocessor development system, higherlever languages.

Module2:The8085Architecture(10Hours)

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.

Module3:The8086Architecture(9Hours)

8086 Microprocessors: Architecture: Architecture of INTEL 8086 (Bus Interface Unit, Execution unit), register organization, memory addressing, memory segmentation, Operating Modes InstructionSet of8086 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:PeripheralmemoryandI/OInterfacing(8Hours)

Interfacingdevices, InterfacingofMemory, ProgrammedI/O, Interrupt DrivenI/O,memory I/O, 8255- Programmable peripheral interface, 8253/8254 Programmable timer/counter. 8259programmable Interrupt Controller, 8251- USART

Text/References:

1. Gaonkar,RameshS,“MicroprocessorArchitecture,programmingandapplications 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 and Solar Energy Systems	3L:0T:0P	3 credits
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Course Outcomes:

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

CO1 Understand the global energy scenario and the consequent growth of the power generation from renewable energy sources.
CO2 Understand the basic physics of wind and solar power generation.
CO3 Apply the knowledge of electrical machines to generate electrical power from wind
CO4 Understand the power electronic interfaces for wind and solar generation.
CO5 Understand the issues related to the grid-integration of solar and wind energy systems.

Module 1: Physics of Wind Power: (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.

Module 2: Wind generator topologies: (12 Hours)

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

Module 3: The Solar Resource: (6 Hours)

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

Module 4: Solar energy 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. Solar thermal power generation: Technologies, Parabolic trough, central receivers, parabolic dish, Fresnel, solar pond, elementary analysis.

Module 5: Network Integration Issues: (7 Hours)

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

SemesterVII[FourthYear]				Branch:ElectricalEngineering						
Sr. No.	CourseCode	CourseTitle	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-XXXX	OpenElective-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 BhagatSinghandhisCo-patriotes (For LEET students)	1	0	0	Satisfactory/NonSatisfactory				0
		Total	15	1	10	26	350	400	750	21

BTEE-701C	ComputerAidedPowerSystem Analysis	3L:1T:0P	4credits
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InternalMarks:40 ExternalMarks:60 TotalMarks:100

CourseOutcomes:

Attheendofthiscourse,studentswilldemonstratetheabilityto:

CO1	UnderstandthebasicconceptofPowerSystemandperunit.
CO2	Understandthesolutionmethodsandtechniquesusedinpowersystemstudies
CO3	Createcomputationalmodelsforanalysisofbothsymmetricalandunsymmetricalconditionsin 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)

Basicsconcepts,active/reactivepowerobjectives(Economicdispatch,MWandMVAr loss minimization) applications -security constrained optimal power flow.

Module3: FaultAnalysis(6 Hours)

NetworkfaultcalculationsusingZBUSandYBUSTableoffactors,Algorithmforcalculatingsystemconditionsafter fault -three phase short circuit,three - phase to ground, double line to ground, line to line and single line to ground fault.

Module4:PowerSystemStability(6Hours)

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. NagrathI.J., KothariD.P., ModernPowerSystemAnalysis, TataMcGrawHill,5thedition, 2022.
3. StevensonW.D.,ElementsofPowerSystemAnalysis,McGrawHill
4. NagrathI.J.andKothariD.P.,PowerSystemEngineering,TataMcGrawHill
5. ArrillagaJ.andArnoldC.P.,ComputerAnalysisofPowerSystems,JohnWiley&Sons
6. StaggGlennW.andEi-AbiadAhmedH.,ComputerMethodsInPowerSystemAnalysis,Tata McGraw Hill
7. KusicG.L.,ComputerAidedPowerSystemanalysis,PrenticeHall,India

BTEE-702C	Microcontroller and Programmable Logic Controllers	3L:0T:0P	3 credits
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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 working of a microprocessor/controller
CO2	Learn configuring and using different peripherals in a digital system
CO3	Compile and debug a Program in PLC

Module1: Introduction(8Hours)

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: 8051 Assembly Language Programming(8Hours)

The mechanics of programming, assembly language programming process, programming tools and techniques, instruction set (data moving, logical operations, arithmetic operations, jump and call instructions).

Module3: 8051 Microcontroller Design(8Hours)

Micro-controllers specification, external memory and memory space decoding, reset and clock circuits, expanding input and output (I/O), memory mapped I/O, memory address decoding, memory access times, testing the design, timing subroutines, lookup tables for the 8051, serial data transmission.

Module4: Microcontroller Applications(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 simulators Embedded Systems: Introduction to PLDs and FPGA-architecture, technology and design issues, implementation of 8051 core.

Module5: Programmable Logic Controllers (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. Kenneth J Ayola, The 8051 Micro Controller-Architecture, Programming and Application, Penram International Publication
2. John B Peatman, Design with Micro Controller, Tata McGraw Hill
3. Ray A.K. and Bhurchandi K.M., Advanced Microprocessors and Peripherals; Architecture, Programming and Interfacing, Tata McGraw Hill
4. Mazidi M.A. and Mazidi J.G., The 8051 Micro-controller and Embedded System, Pearson Education.
5. Udayashankar V. and Mallikarjunaswamy M.S., 8051 Microcontroller Hardware, Software and Applications, Tata McGraw 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,IntroductiontoPLCs,TataMcGraw Hill
9. KumarRajesh,ModuleonPLCsandtheirApplications,NITTTRChandigarh

Department Electives

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

BTEE-711C	High Voltage Engineering	3L:0T:0P	3 credits
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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 physics related to various breakdown processes in solid, liquid, and gaseous insulating materials
CO2	Have knowledge of generation and measurement of D.C., A.C., & Impulse voltages
CO3	Have knowledge of test on H.V. equipment and on insulating materials, as per the standard
CO4	Have knowledge of how over-voltages arise in a power system, and protection against these over-voltages

Module 1: Breakdown in Insulating materials (8 Hours)

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.

Module 2: Breakdown in liquid and solid (9 Hours)

Breakdown in pure and commercial liquids, Solid dielectrics and composite dielectrics, intrinsic breakdown, electromechanical breakdown and thermal breakdown, Partial discharge, applications of insulating materials.

Module 3: Generation of High Voltages (9 Hours)

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.

Module 4: Measurements of High Voltages and Currents (8 Hours)

Peak voltage, impulse voltage and high direct current measurement method, cathode ray oscillographs for impulse voltage and current measurement, measurement of dielectric constant and loss factor, partial discharge measurements.

Module 5: Lightning and Switching Over-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.Naidu and V.Kamaraju, High Voltage Engineering, McGraw Hill Education, 6th Edition, 2020.
2. C.L.Wadhwa, High Voltage Engineering, New Age International Publishers, 2012.
3. D.V.Razevig (Translated by Dr.M.P.Chourasia), High Voltage Engineering Fundamentals, Khanna Publishers, 1993.
4. Kuffel, W.S.Zaengland J.Kuffel, High Voltage Engineering Fundamentals, Newnes Publication, 2000.
5. R.Arora and W.Mosch High Voltage and Electrical Insulation Engineering, John Wiley & Sons, 2011.
6. Various IS standards for HV Laboratory Techniques and Testing

BTEE-712C	PowerSystemReliability	3L:0T:0P	3credits
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InternalMarks:40 ExternalMarks:60 TotalMarks:100

CourseOutcomes:

Attheendofthiscourse,studentswilldemonstratetheabilityto:

CO1	Understandthebasicquantitativeliabilityanalysis
CO2	Understandthereliabilitymodellingandanalysisofelectricpowersystems
CO3	Haveknowledgeofreliabilityassessmentforelements oftransmissionsystem
CO4	Understandtheriskanalysisinpowersystemplanning

Module1:Generalreliabilitymodellingandevaluation(8Hours)

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

Module2:Reliabilitymodellingandanalysisofelectricpowersystems(10Hours)

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 ofreliabilitytools, Concepts and methodologies, powersystemstructure, 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 ofTransmission and TransformationSystems (8 Hours)

Reliabilityindicesofsubstationsbasedontheoverloadcapabilityofthetransformers, evaluation and analysis of substation configurations.

Text/References:

1. G.F.KovalevandL.M.Lebedeva,ReliabilityofPowerSystem, SpringerPublishers,2019.
2. C.Singh,P.JirutitijaroenandJ. Mitra,ElectricPowerGridReliabilityEvaluation:Models and Methods. Wiley-IEEE Press, Hoboken, NJ: 2019. ISBN: 9781119486275.
3. R.Ramakumar,EngineeringReliability:FundamentalsandApplications.PrenticeHall.J. Endrenyi, Reliability Modelling in Electric Power Systems. Wiley.

4. Shahidehpour M, Yamin H, Li Z, Markay operations in electric power systems Forecasting, Scheduling, and Risk Management, John Wiley & sons
5. R. Billinton, R. Allan, Reliability evaluation of power systems, Plenum Press New York, 1996.
6. Computational Methods in Power System Reliability, D. Elmakias, Springer-Verlag

BTEE-713C	Electromagnetic Waves	3L:0T:0P	3credits
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Internal Marks:40 External Marks:60 Total Marks:100

Course Outcomes:

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

CO1	Analyse transmission lines and estimate voltage and current at any point on transmission line for different load conditions
CO2	Provide solution to real life plane wave problems for various boundary conditions
CO3	Analyse the field equations for wave propagation in special cases such as lossy and low loss dielectric media
CO4	Visualize TE and TM mode patterns of field distributions in a rectangular waveguide
CO5	Understand and analyse radiation by antennas

Module 1: Transmission Lines (8 Hours)

Introduction, Concept of distributed elements, Equations of voltage and current, standing waves and impedance transformation, Lossless and low-loss transmission lines, Power transfer on a transmission line, Analysis of transmission line in terms of admittances, Transmission line calculations with the help of Smith chart, Applications of transmission line, Impedance matching using transmission lines.

Module 2: Maxwell's Equations (9 Hours)

Basic quantities of Electromagnetics, Basic laws of Electromagnetics: Gauss's law, Ampere's Circuital law, Faraday's law of Electromagnetic induction. Maxwell's equations, Surface charge and surface current, Boundary conditions at media interface.

Module 3: Uniform Plane Wave (9 Hours)

Homogeneous unbounded medium, Wave equation for time harmonic fields, Solution of the wave equation, Uniform plane wave, Wave polarization, Wave propagation in conducting medium, Phase velocity of a wave, Power flow and Poynting vector.

Module 4: Plane Waves at Media Interface (7 Hours)

Plane wave in arbitrary direction, Plane wave at dielectric interface, Reflection and refraction of waves at dielectric interface, Total internal reflection, Wave polarization at media interface, Brewster angle, Fields and power flow at media interface, Lossy media interface, Reflection from conducting boundary.

Module 5: 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, Electromagnetic Fields & Waves, Khanna publishers, First Edition 2021.
2. R.K. Shevgaonkar, Electromagnetic Waves, Tata McGraw Hill, 2005.
3. D.K. Cheng, Field and Wave Electromagnetics, Addison-Wesley, 1989.
4. M.N.O. Sadiku, Elements of Electromagnetics, Oxford University Press, 2007.
5. C.A. Balanis, Advanced Engineering Electromagnetics, John Wiley & Sons, 2012

BTEE-714C	Energy Efficient Machines	3L:0T:0P	3credits
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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 major issues related to energy management system and energy audits
CO2	Evaluate efficiency parameters of energy efficient motors
CO3	Understand the concept of power factor and execute different methods to improve power factor
CO4	Analyze the appropriate induction motor for given applications and review the operating characteristics of induction motor

Module 1: Introduction (8 Hours)

Need for energy efficient machines, energy cost and two-part tariff, energy conservation in industries and farms - a necessity, introduction to energy management and energy audit system. Review of induction motor characteristics.

Module 2: Energy Efficient Motors (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

Module 3: Power Factor (6 Hours)

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

Module 4: Induction Motors and Adjustable Drive Systems (6 Hours)

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

Text/References:

1. Andreas John C., Energy efficient electric motors, Marcel Dekker Inc. 1992.
2. Thuman Albert, Introduction to Efficient Electric System Design, The Fairmount Press Prentice Hall.
3. Tripathi S. C., Electric Energy Utilization and Conservation, Tata McGraw-Hill 1991.
4. Belove Charles, Handbook of Modern Electronics and Electrical Engineering, John Wiley & Sons.

BTEE-703C	ComputerAidedPowerSystem Analysis Lab	3L:1T:0P	4credits
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InternalMarks:40 ExternalMarks:60 TotalMarks:100

CourseOutcomes:

Attheendofthiscourse,studentswilldemonstratetheabilityto:

CO1	Hands-onandcomputational experimentsrelatedtothecoursecontentsofBTEE-701C
CO2	Developprogramofnumericalmethodsfor solutionofthepowerflowproblem andstabilityanalysis.

Note: Any8-10experimentsaretobeperformedinasemester.Listof experiments

is given below:

1. Designoftransmissionsystemsfor givenpoweranddistance.
2. Shortcircuitcalculationsandcalculationsofcircuitbreakerratingsforapowersystem network.
3. Designofsubstations
4. Designofdistributionsystems
5. Y-bus formation
6. Z-busformulation
7. LoadflowanalysisbyGaussSeidalmethod
8. LoadflowanalysisbyNewtonRaphsonmethod
9. Faultanalysisforline-to-line(L-L),Line-to-Ground(L-G)etc
10. Designofundergroundcablingsystemfor substation.
11. ToobtainpowersystemstabilityonHighVoltageAlternatingcurrent(HVAC)system withthehelpofFlexibleAlternatingCurrentTransmissionSystems(FACTS)devices.
12. OptimalCapacitorplacementonasystemhavingvariablereactivepowerandlowvoltage profile.
13. Toobtainrelayco-ordinationonapowersystem.
14. Toobtainoptimalgeneratorpricingonhydro-thermalandrenewableenergysystems.
15. To findsynchronousreactance(Transient,sub-transient)duringfaultanalysis.

BTEE-704C	Project	0L:0T:8P	4credits
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InternalMarks:120 ExternalMarks:80 TotalMarks:200

CourseOutcomes:

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, Testing etc. related to Electrical Engineering is to be carried out under the supervision of guide(s).

Institute/Department/Student may decide for Industry oriented courses in lieu of One Semester Training in 8th Semester (Subject to approval from Competent Authority).

Semester VIII [Fourth year]				Branch: Electrical Engineering			
One Semester Training	Marks					Total Marks	Credits
	Internal				External		
	Mid-semester		End-semester				
Evaluation by	Institute	Industry	Institute	Industry	External Examiner		
Software Training & Project (BTEE-801CS)	50	25	50	25	200	500	14
Industrial Training & Project (BTEE-801CI)	50	25	50	25			
Total	300				200	500	14

or

Semester VIII [Fourth year]				Branch: Electrical Engineering						
Sr. No.	Course code	Course Title	L	T	P	Hours/Week	Internal Marks	External Marks	Total Marks	Credits
1	BTEE-811C	Smart Grids	3	0	0	3	40	60	100	3
2	BTEE-812C	Indian Electricity Standards and Practices	3	1	0	4	40	60	100	4
3	BTEE-813C	Artificial Intelligence Techniques	3	0	0	3	40	60	100	3
4	BTEE-814C	Modeling and Simulation Lab	0	0	4	4	30	20	50	2
5	BTEE-815C	Technical Report Writing and Presentation	0	0	4	4	60	40	100	2
Total			9	1	8	18	210	240	450	14

Note: In case a student goes for pre-placement training and such training could be only software based or 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:

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

CO1	Understand technologies for smart grid.
CO2	Appreciate the smart transmission as well as distribution systems.
CO3	Realize the distribution generation and smart consumption.
CO4	Know the regulations and market models for smart grid.

Module1: Introduction to Smart Grids (8 Hours)

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

Module2: Smart Transmission Technologies (8 Hours)

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

Module3: Smart Distribution Technologies (10 Hours)

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

Module4: Distributed Generation and Smart Consumption (8 Hours)

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: Regulations and Market Models for Smart Grid (8 Hours)

Demand response, Tariff design, Time of the day pricing (TOD), Time of use 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 Computer Society Press, 2012.
3. E.J. Jenkins, N. Liyanage, K. Wu, and J. Yokoyama, "Smart Grid: Technology and applications", Wiley Publications.
4. J. Momoh, "Smart Grid: Fundamentals of design and analysis", John Wiley & Sons, 2012.
5. T. Flick, and J. Morehouse, "Securing the smart grid: Next generation power grid security", Elsevier, 2010.
6. India smart grid knowledge portal.

BTEE-812C	Indian Electricity Standards and Practices	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	To know various definitions used in Indian electricity rules
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 electricity charges, disconnection, reconnection and restoration of supply of electricity.
CO 3	Authority and responsibility associated with power inspectors.

Module1: Introduction (8 Hours)

Various definitions used in Indian electricity rule 1956 i.e., appointment and authority of Inspectors and officers 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, Earthed terminal on consumer's premises, Accessibility of bare conductors, Danger notices, Handling of electric supply lines and apparatus, Cables for portable or transportable apparatus, Cables protected by bituminous materials, Street boxes.

Module2: General conditions relating to supply and use of energy (9 Hours)

Testing of consumer's installation, Precautions against leakage before connection, Leakage on consumer's premises, Supply and use of energy, Provisions applicable to medium, high or extra-high voltage installations, Cost of inspection and test of consumer's installation, Declared voltage of supply to consumer, Declared frequency of supply to consumer, Sealing of meters, and cut-outs.

Module3: Electric supply lines, systems and apparatus for high and extra-high voltages (10 Hours)

Approval by Inspector, Use of energy at high and extra-high voltage, Testing, Operation and Maintenance, Metalsheathed electric supply lines, Connection with earth, General conditions as to transformation and control of energy, Supply to X-ray and high frequency installation.

Module4: Overhead lines, under-ground cables and generating stations (10 Hours)

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 on same supports, Erection of or 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(5Hours)

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

Text/References

1. Indian Electricity Rules, 1956, Manak Bhavan, New Delhi.
2. P.S. Satnam, "Substation Design and Practice", Dhanpat Rai and Sons, 2001.

BTEE-813C	Artificial Intelligence Techniques	3L:0T:0P	3credits
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Internal Marks:40

External Marks:60

Total Marks:100

Course Outcomes:

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

CO1	Demonstrate knowledge of the building blocks of AI as presented in terms of intelligent agents.
CO2	Develop intelligent algorithms for constraint satisfaction problems and also design intelligent systems for Game Playing
CO3	Attain the capability to represent various real life problem domains using logic based techniques and use this to perform inference or planning.

Module1: Overview of Biological Neurons (8 Hours)

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 –take all learning rule.

Module2: Single layer Perceptron Classifier (8 Hours)

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

Module3: Single layer Feedback Networks (6 Hours)

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-layer Feed Forward Networks (8 Hours)

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

Module5: Fuzzy Systems (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 defuzzification modules. Defuzzification, weighted average method, 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, "Fuzzy logic with Engineering Applications", John Wiley & Sons, 2008.
2. J. Y. R. Langari, "Fuzzy Logic: Intelligence, Control, and Information", Pearson Education, 1999.
3. S. Haykin, "Neural Networks - A Comprehensive Foundation", Macmillan Publishing Co., 2009.
4. Drinnkov, "Fuzzy Logic Control", Narosa Publishers, 2003.
5. P. D. Wasserman, "Neural computing: Theory & Practice", Auza Research Inc. Van Nostrand, 1993.
6. R. C. Berkan and S. Truebatch, "Fuzzy system design principles: building if then rule base", John Wiley, 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	Modeling and Simulation Lab	0L:0T:4P	2 credits
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Internal Marks:30

External Marks:20

Total Marks:50

Course Outcomes:

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

CO1	Design of primary and secondary transmission systems by analyzing power flows at various points of common coupling through simulations.
CO2	Distinguish power flows and conversion systems among HVAC and HVDC systems.

List of Experiments

1. To design a 5-bus transmission system having voltage level of 220kV by taking appropriate values of different buses.
2. To design a 5-bus transmission system having voltage level of 133kV by taking appropriate values of different buses.
3. To design a 5-bus transmission system having voltage level of 66kV by taking appropriate values of different buses.
4. To design a 5-bus transmission system having voltage level of 11kV by taking appropriate values of different buses.
5. Compute power (P and Q) flows in each line for experiment 1 and analyze the power flow.
6. Design a transmission system delivering a load of 500MW using HVAC system.
7. Design a transmission system delivering a load of 500MW using HVDC system.
8. A major project on designing of IEEE 14 bus system.

BTEE-815C	Technical Report Writing and Presentation	0L:0T:4P	2credits
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InternalMarks:40

ExternalMarks:60

TotalMarks:100

Guidelines:

1. The teaching load of the subject to be equally distributed among all the faculty members of the department.
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. Basic report structure
 - Title page.
 - Summary.
 - Table of contents.
 - Introduction.
 - Body of the report.
 - Conclusions and recommendations.
 - References and appendices.
 - Appendix: Slides of the presentation
5. The presentation of the report is to be made in the Department prior to the External Evaluation.
6. Effort to be made for the publication in Conference/ an article in a periodical.