PUNJAB TECHNICAL UNIVERSITY

Scheme& Syllabus of
B. Tech. Electrical Engineering [EE]

Batch 2011

By
Board of Studies Electrical Engineering

Punjab Technical University

B.Tech Electrical Engineering (EE) Batch 2011

Note: There will be 04 weeks BTEE309 Institutional training after 2nd semester.
"S" for Satisfactory and US for unsatisfactory

Semester –III								
Course Code	**Course Title**	**L**	**T**	**P**	**Marks Distribution**		**Total Marks**	**Credits**
					Internal	External		
BTAM-301	Engineering Mathematics-III	4	1	-	40	60	100	5
BTEE-301	Circuit Theory	4	1	-	40	60	100	5
BTEE-302	Transformers & Direct Current Machines	4	1	-	40	60	100	5
BTEE-303	Electrical Measurements & Instrumentation	4	1	-	40	60	100	5
BTEE-304	Electronic Devices and Circuits	4	1	-	40	60	100	5
BTEE-305	Laboratory-I (Semiconductor Devices and Circuit Theory)	-	-	2	30	20	50	1
BTEE-306	Laboratory-II (Electrical Machines -I)	-	-	2	30	20	50	1
BTEE-307	Laboratory-III (Electrical Measurements)	-	-	2	30	20	50	1
BTEE-309	Institutional Training (Undertaken after 2nd semester)				60	40	100	S/US
	Total	**20**	**5**	**6**	**350**	**400**	**750**	**28**

Semester –IV								
Course Code	**Course Title**	**L**	**T**	**P**	**Marks Distribution**		**Total Marks**	**Credits**
					Internal	External		
BTEE-401	Asynchronous Machines	3	1	-	40	60	100	4
BTEE-402	Linear Control Systems	4	1	-	40	60	100	5
BTEE-403	Electromagnetic Fields	3	1	-	40	60	100	4
BTEC-404	Digital Electronics	3	1	-	40	60	100	4
BTEE-405	Power System-I (Transmission & Distribution)	3	1	-	40	60	100	4
BTEE-406	Power Plant Engineering	3	1	-	40	60	100	4
BTEE-407	Laboratory-IV (Instrumentation & Measuring Devices)	-	-	2	30	20	50	1
BTEE-408	Laboratory-V (Control System)	-	-	2	30	20	50	1
BTEC-409	Laboratory-VI (Electronic Circuits)	-	-	2	30	20	50	1
General Fitness					100	-	100	S/US
	Total	**19**	**6**	**6**	**430**	**420**	**850**	**28**

Note: There will be 04 weeks BTEE509 Institutional training after 4th semester.
"S" for Satisfactory and US for unsatisfactory

Semester –V								
Course Code	**Course Title**	**L**	**T**	**P**	**Marks Distribution**		**Total Marks**	**Credits**
					Internal	**External**		
BTEE-501	Synchronous Machines	4	1	-	40	60	100	5
BTEE-502	Electric Generation & Economics	4	1	-	40	60	100	5
BTEE-503	Microprocessors	4	1	-	40	60	100	5
BTEE-504	Power Electronics	4	1	-	40	60	100	5
BTEE-505	Numerical & Statistical Methods	4	1	-	40	60	100	5
BTEE-506	Laboratory-VII (Electrical Machines-II)	-	-	2	30	20	50	1
BTEE-507	Laboratory-VIII (Numerical Analysis)	-	-	2	30	20	50	1
BTEE-508	Laboratory-IX (Electrical: Estimation & Costing)	-	-	2	30	20	50	1
BTEE-509	Industrial Training (Undertaken after 4th semester)				60	40	100	S/US
	Total	**20**	**5**	**6**	**350**	**400**	**750**	**28**

Semester –VI								
Course Code	**Course Title**	**L**	**T**	**P**	**Marks Distribution**		**Total Marks**	**Credits**
					Internal	**External**		
BTEE-601	Electric Power Utilization	3	1	-	40	60	100	4
BTEE-602	Power System-II (Switch Gear & Protection)	3	1	-	40	60	100	4
BTEE-603	Non-Linear & Digital Control Systems	4	1	-	40	60	100	5
BTEE-604	Microcontroller and PLC	3	1	-	40	60	100	4
BTEE-OPX	Open Elective	3	1	-	40	60	100	4
BTEE-605X	Elective-I	3	1	-	40	60	100	4
BTEE-606	Laboratory-X (Power Electronics & Drives)	-	-	2	30	20	50	1
BTEE-607	Laboratory-XI (Power System-II)	-	-	2	30	20	50	1
BTEE-608	Laboratory-XII (Micro controller & PLC)	-	-	2	30	20	50	1
General Fitness					100	-	100	S/US
	Total	**19**	**6**	**6**	**430**	**420**	**850**	**28**

Semester –VII/VIII					
Course Code	**Course Title**	**Marks Distribution**		**Total Marks**	**Credits**
		Internal	**External**		
Industrial Training (One semester)					
BTEE-701	Software Training	150	100	250	8
BTEE-702	Industrial oriented Project Training	300	200	500	10
	Total	**450**	**300**	**750**	**18**

Semester –VII/VIII								
Course Code	**Course Title**	**L**	**T**	**P**	**Marks Distribution**		**Total Marks**	**Credits**
					Internal	**External**		
BTEE-801	Power System Analysis	3	1	-	40	60	100	4
BTEE-802	High Voltage Engineering	4	1	-	40	60	100	5
BTEE-803	Non-conventional Energy Sources	3	1	-	40	60	100	4
BTEE-804Y	Elective-II	3	1	-	40	60	100	4
BTEE-805Z	Elective-III	3	1	-	40	60	100	4
BTEE-806	Lab-XIII (Power System Analysis)	-	-	2	30	20	50	1
BTEE-807	Project Work	-	-	6	60	40	100	4
BTEE-808	Seminar	-	-	2	100	-	100	2
General Fitness					100	-	100	S/US
	Total	**16**	**5**	**10**	**490**	**360**	**850**	**28**

Elective	**Electrical Power Systems**	
Elective-I **(BTEE-605X)**	BTEE-605A	Computer Aided Electrical Machine Design
	BTEE-605B	Flexible AC Transmission Systems
Elective-II **(BTEE-804Y)**	BTEE-804A	Power System Operation and Control
	BTEE-804B	Energy Auditing and Management
Elective-III **(BTEE-805Z)**	BTEE-805A	Power Quality Monitoring and Conditioning
	BTEE-805B	HVDC Transmission
Elective	**Instrumentation and Control**	
Elective-I **(BTEE-605X)**	BTEE-605C	Instrumentation in Power System
	BTEE-605D	Biomedical instrumentation
Elective-II **(BTEE-804Y)**	BTEE-804C	Digital Signal Processing
	BTEE-804D	Industrial Process Control
Elective-III **(BTEE-805Z)**	BTEE-805C	Virtual Instrumentation
	BTEE-805D	Energy Efficient Machines
Elective	**Electronics and Computers**	
Elective-I **(BTEE-605X)**	BTEE-605E	Principles of Communication Systems
	BTEE-605F	Microelectronics Technology
Elective-II **(BTEE-804Y)**	BTEE-804E	Networks and Data Communication
	BTEE-804F	Data Mining and Pattern Recognition
Elective-III **(BTEE-805Z)**	BTEE-805E	Embedded Systems
	BTEE-805F	Visual Programming

OPEN ELECTIVES – offered to other department	
BTEE-OP1	Fundamentals of Electrical Machines
BTEE-OP2	Energy Auditing & Management
BTEE-OP3	Non-Conventional Energy Sources
BTEE- OP4	Electrical Measurements

OPEN ELECTIVES – to be offered by other department	
BTCE-3XX	Fluid Mechanics
BTHU-3XX	Entrepreneurships
BTME-3XX	Business Process and Re-engineering
BTHU-3XX	Human Resource Management
BTAM-3XX	Optimization Techniques
BTCS-3XX	Introduction to Business Systems
BTME-3XX	Total Quality Management

Third Semester

BTAM301 Engineering Mathematics-III

Unit I Fourier Series: Periodic functions, Euler's formula. Even and odd functions, half range expansions, Fourier series of different wave forms.

Unit II Laplace Transforms: Laplace transforms of various standard functions, properties of Laplace transforms, inverse Laplace transforms, transform of derivatives and integrals, Laplace transform of unit step function, impulse function, periodic functions, applications to solution of ordinary linear differential equations with constant coefficients, and simultaneous differential equations.

Unit III Special Functions: Power series solution of differential equations, Frobenius method, Legendre's equation, Legendre polynomial, Bessel's equation, Bessel functions of the first and second kind. Recurrence relations, equations reducible to Bessel's equation.

Unit IV Partial Differential Equations: Formation of partial differential equations, Linear partial differential equations, homogeneous partial differential equations with constant coefficients.

Unit V

Applications of PDEs: Wave equation and Heat conduction equation in one dimension. Two dimensional Laplace equation in Cartesian Coordinates, solution by the method of separation of variables.

Unit VI Functions of Complex Variable: Limits, continuity and derivative of the function of complex variable, Analytic function, Cauchy-Riemann equations, conjugate functions, harmonic functions; Conformal Mapping: Definition, standard transformations, translation, rotation, inversion, bilinear. Complex Integration: Line integrals in the complex plane, Cauchy's theorem, Cauchy's integral formula and derivatives of analytic function. Taylor's and Laurent's expansions (without proofs), singular points, poles, residue, Integration of function of complex variables using the method of residues.

Suggested Readings/ Books:

- Kreyszing, E., Advanced Engineering Mathematics, Eighth edition, John Wiley, New Delhi.
- Grewal, B. S., Higher Engineering Mathematics, Khanna Publishers, New Delhi.
- Ian N. Sneedon, Elements of Partial Differential Equations, McGraw- Hill, Singapore, 1957.
- Peter. V. O'Nil, Advanced Engineering Mathematics, Wadsworth Publishing Company.
- Taneja, H. C., Engineering Mathematics, Volume-I & Volume-II, I. K.Publisher.
- Babu Ram, Advance Engineering Mathematics, Pearson Education.
- Bindra, J. S., Applied Mathematics, Volume-III, Kataria Publications.

BTEE301 Circuit Theory

Unit I Circuit Concepts: Independent and dependent sources, Signals and wave forms: Periodic and singularity voltages, step, ramp, impulse, doublet, loop currents and loop equations, node voltage and node equations, Network Theorems: Superposition, Thevenin's, Norton's, Maximum Power Transfer, and Reciprocity.

Unit II Time and Frequency Domain Analysis: Representation of basic circuits in terms of generalized frequency and their response, Laplace transform of shifted functions, transient and steady response, Time domain behaviors from poles and zeros, Convolution Theorem.

Unit III Network Synthesis: Network functions, Impedance and admittance function, Transfer functions, Relationship between transfer and impulse response, poles and zeros and restrictions, Network function for two terminal pair network, Sinusoidal network in terms of poles and zeros, Real liability condition for impedance synthesis of RL and RC circuits, Network synthesis techniques for 2-terminal network, Foster and Cauer forms.

Unit IV: Classification of filters, characteristics impedance and propagation constant of pure reactive network, Ladder network, T-section, π-section, terminating half section, Pass bands and stop bands, Design of constant-K, m-derived filters, Composite filters.

Suggested Readings/ Books:

- Bird John, *Electrical Circuit Theory and Technology*, 2nd Ed., Newnes.
- Chakraborty, Abhijit, *Circuit Theory*, 2nd Edition, Dhanpat Rai, 2001.
- Chaudhury D. Roy, *Networks and Synthesis*, New Age International.
- Edminister J.A., *Electric Circuits*, 4th Edition, Tata McGraw Hill, 2002.
- Iyer T.S.K.V., *Circuit Theory*, Tata McGraw Hill, 2006.
- Mohan, Sudhakar Sham, *Circuits and Networks Analysis and Synthesis*, 2nd Edition, Tata Mc Graw Hill, 2005.
- Van Valkenberg, M.E., *Network Analysis and Synthesis*, PHI learning, 2009.

BTEE302 Transformers and Direct Current Machines

Unit I Transformers: Working principle, construction of single phase transformer, EMF equation, phasor diagrams on no-load and on loaded conditions, open circuit and short circuit tests, equivalent circuit parameters estimation, voltage regulation and efficiency, back to back test. Effect of saturation on exciting current and in-rush current phenomenon. Parallel operation of single phase transformers.

Unit II Auto Transformers: Principle of operation, equivalent circuit and phasor diagrams, comparison with two winding transformer.

Unit III Three-Phase Transformers: Different types of winding connections, Voltage and current ratios, Parallel operation of three phase transformers. Three winding transformer's equivalent circuit, off-load and on-load tap changing transformer, Scott connections. Testing of transformers.

Unit IV DC Generator: Working principle, construction of DC Machines, Armature windings, single and double layer winding diagrams, EMF. and torque equations, armature reaction, effect of brush shift, compensating winding, commutation, causes of bad commutation, methods of improving commutation, methods of excitation of DC generators and their characteristics.

Unit V DC Motor: Working principle characteristics, starting of shunt and series motor, starters, speed control methods: field and armature control. Braking: plugging, dynamic and regenerative braking, Testing: Swinburn's test, Hopkinson test, Field test. Estimation of losses and efficiency.

Suggested Readings/ Books:

- Bimbhra P.S., *Electrical Machinery, Khanna Publishers*
- Fitzgerald A.E., Kingsley C. and Umans S.D., *Electric Machinery*, 6th Edition, McGraw Hill
- Langsdorff E.H., *Principles of D.C. machines*, McGraw Hill
- Nagrath I.J. and Kothari D.P., *Electrical Machines*, 4th Edition, Tata McGraw Hill,
- Say M G, *Alternating Current Machines*, 5th edition, Sir Isaac Pitman and Sons Ltd.

BTEE303 Electrical Measurements and Measuring Instruments

Unit I Units, Dimensions and Standards: Introduction to MKS and Rationalized MKS System, SI Units, Standards of EMF, Resistance, Capacitance and Inductance, Systematic errors

Unit II General Theory of Analog Measuring Instruments: Operating torque, damping and controlling torque, T/W ratio, Pointers and Scales. Principles of operation of various types of electro mechanical indicating / registering instruments viz. PMMC, dynamometer, induction, thermal, etc. for dc and ac measurement of voltage, current, power, frequency, phase and power factor etc., energy meter: their sources of error and compensation, shunts and multipliers, multi-meter.

Unit III Potentiometers: Basic direct current (DC) potentiometer circuit, Modern form of DC potentiometer, measurement of voltage, current, Resistance and calibration of voltmeter and ammeter using DC potentiometer, volt ratio box, Self balancing potentiometer, Alternating current (AC) potentiometers and their applications.

Unit IV Bridges: Sources and Detectors, General equation for bridge balance, Wheatstone bridge and its sensitivity analysis, Kelvin double bridge, AC bridges: applications and conditions for balance, Maxwell's bridge, Hay's bridge, Schering bridge, Wien bridge, DeSauty's bridge, Insulation testing, Sources of errors in bridge circuits, Shielding of bridge elements, Wagner Earthling Device.

Unit V Magnetic Measurements: Flux meter, B-H Curve, Hysteresis loop, Permeameters, AC Testing of Magnetic materials, Separation of iron losses, iron loss measurement by Wattmeter and Bridge methods.

Unit VI Instrument Transformers: Theory and construction of current and potential transformers, ratio and phase angle errors and their minimization, Characteristics of current transformers (CT).and potential transformers (PT) and their Testing.

Suggested Readings/ Books:

- Bell David A., *Electronics Instrumentation and Measurements,* Prentice Hall, India
- Golding Edward William and Widdis Frederick Charles, *Electrical Measurements and Measuring instruments,* Wheelers India
- Helfrick A.D. and Cooper W.D., Modern *Electronic Instrumentation. and Measurement Techniques*, Prentice Hall
- Murthy D. V. S., Transducers and Instrumentation, Prentice-Hall, India
- Sawhney A. K., *A Course in Electrical and Electronics Measurement and Inst*rumentation, Dhanpat Rai and Sons.

BTEE-304 Electronic Devices and Circuits

Unit I Basic Semiconductor and Diodes: Intrinsic and extrinsic semiconductors, diffusion and drift currents, p-n junction under open-circuit, reverse bias and forward-bias conditions, p-n junction in the breakdown region, Ideal diode, terminal characteristics of junction diode, Load-line analysis of diode circuits, half wave rectifier and full wave rectifiers, Clippers and Clampers, capacitive filters, RC and LC filter, voltage multipliers. Principles, construction and characteristics of Zener diodes, Light Emitting Diodes, Schottky Diode, Varactors

Unit II Bipolar and Unipolar Transistors: Bipolar junction transistor (BJT)- physical structure and modes of operation, Transistor characteristic and parameters, Common Base, Common Emitter and Common Collector Configurations, Transistor biasing, Transistor as a switch, Basics characteristics of an amplifier, Simple transistor model (r_e model), Common Emitter, Common Collector and Common base amplifiers, hybrid equivalent circuit, H-parameters, circuit analysis using h-parameters. Junction field effect transistor (JFET): Characteristics, parameters and biasing. Metal oxide field effect transistor (MOSFET): Characteristics, parameters and biasing. Class a power amplifier, Class B, Class AB Push-pull and Class C-power amplifiers.

Unit III Integrated Circuit and Operational-Amplifiers: Introduction to IC's, Op-Amps, Op-Amp Characteristics, Feedback, Different feedback configurations, Current– to–voltage converter and voltage-to-current converters, voltage and current amplifiers, mathematical operations using Op-Amp: summing, differentiation and integration, Comparators and Schmitt trigger

Unit IV Oscillators and Active Filters: Oscillations, Feedback oscillator Principles,, RC phase shift oscillator, Wien bridge oscillator, Hartley oscillator, Colpitts oscillator, Crystal oscillators, frequency stability, Active Filters (1^{st} order) with low pass, high pass, band pass, band stop and all pass. Pin configuration of 555 timer, 555 timer as Oscillator: monostable, bistable and astable multivibrator.

Unit V Regulated Power Supplies: Unregulated power supplies, line and load regulations, Zener diode voltage regulators, transistor series and shunt regulators, current limiting, Op-Amp voltage regulators, integrated circuit (LM-3XX) voltage regulators. Introduction to switching regulators. Working of Switched Mode Power Supply (SMPS).

Suggested Readings/ Books:

- Boylestad, Robert.L. *Electronic Devices and Circuit Theory,* Pearson Education
- Cathey Jimmie J., *Theory and Problems of Electronic Devices and Circuit*s, McGraw-Hill
- Floyd Thomas L., *Electronic Devices*, Pearson Education
- Gayakwad, Ramakant A. *OP-AMPS and Linear Integrated Circuits*, Prentice Hall of India

- Malvino Albert Paul and Bates David, *Electronic Principles*, edition 7th, Tata McGraw Hill
- Millman Jacob, *Integrated Electronic Devices and Circuits*, Tata McGraw Hill.

BTEE-305 Laboratory-I (Semi-conductor Devices and Circuit Theory)

List of Experiments:

1. Measurement of resistance of elements
2. Phasor analysis of RL, RC and RLC circuits in series and in parallel
3. Frequency response of resonant circuits
4. Transients in RL, RC, and RLC Circuits
5. To verify Superposition theorem.
6. To verify Norton's theorem.
7. To verify Thevenin's theorem.
8. To verify maximum power transfer theorem.
9. To study the response of low pass and high pass filters.
10. To study the response of constant K-filters.
11. To study the response of m-derived filters
12. Two-port networks; network parameters and equivalent circuit
13. To draw V-I characteristics of PN junction diode (Ge, Si, switching and signal).
14. To design half wave rectifier.
15. To design full wave and bridge rectifiers.
16. Diode clippers and clampers.
17. To study transistor characteristics in common base and common emitter configurations.
18. To study the FET characteristics.
19. To design, study and compare various transistor biasing techniques.
20. To design regulated power supply using Zener diode/ voltage regulator IC.
21. To study of an emitter follower circuit.

BTEE-306 Laboratory-II (Electrical Machines-I)

List of Experiments:

1. To Load test on a single phase transformer.
2. To perform Open circuit and short circuit tests on a single phase transformer and hence find equivalent circuit, voltage regulation and efficiency.
3. To find the efficiency and voltage regulation of single phase transformer under different loading conditions.
4. To perform parallel operation of two single phase transformers.
5. To study the various connections of three phase transformer.
6. To perform Scott connections on three phase transformer to get two phase supply.
7. To study the constructional details of direct current (DC) machine and to draw sketches of different components.
8. To measure armature and field resistance of direct current (DC) shunt generator and to obtain its open circuit characteristics.
9. To obtain load characteristics of direct current (DC) shunt/series /compound generator.
10. To draw speed-torque characteristics of direct current (DC) shunt/series /compound generator.
11. To study direct current (DC) motor starters.
12. To perform Swinburne's test (no load test) to determine losses of direct current (DC) shunt motor.

BTEE-307 Laboratory-II (Measurements)

List of Experiments:

1. Study of principle of operation of various types of electromechanical measuring instruments.
2. a) To measure High value of DC current by a Low Range DC Ammeter and Shunt.
   b) To measure High value of DC voltage by a Low Range DC Voltmeter and Multiplier
3. a) To measure High value of AC Current by a Low Range AC Ammeter and Current Transformer.
   b) To measure High value of AC Voltage by Low Range Voltmeter and Potential Transformer
4. Measurement of resistance using Wheatstone Bridge.
5. To measure active and reactive power in 3 phase balanced load by one wattmeter method.
6. To measure the active power in three phase balanced and unbalanced load by two wattmeter method and observe the effect of power factor variation on wattmeter reading.
7. To calibrate and use the Induction Energy Meter.
8. Measurement of resistance using Kelvin's Bridge.
9. Measurement of self inductance using Anderson's Bridge.
10. Measurement of capacitance using Schering Bridge.
11. Plotting of Hysteresis loop for a magnetic material using flux meter.
12. Measurement of frequency using Wien’s Bridge.
13. To study the connections and use of Current and potential transformers and to find out ratio error.
14. Determination of frequency and phase angle using CRO.
15. Measurement of unknown voltage using potentiometer.
16. To find 'Q' of an inductance coil and verify its value using Q- meter.

Fourth Semester

BTEE-401 ASYNCHRONOUS MACHINES

Internal Marks:	**40**	**L**	**T**	**P**
External Marks:	**60**	**3**	**1**	**0**
Total Marks:	**100**			

POLYPHASE INDUCTION MACHINES: Analogy between induction motor and transformer, production of rotating field in space distributed three-phase winding, constructional features, concept of slip and operation, rotor frequency, current and power, equivalent circuit, phasor diagram, torque-slip characteristics, effect of rotor circuit resistance, starting torque, crawling and cogging, cage motors(double cage and deep bar motor).

STARTING METHODS AND SPEED CONTROL: Starting methods, speed control: (i) control of speed of rotating field, (ii) control of slip speed. Effect of voltage injection in rotor circuit of slip ring induction motor. Motor tests for estimation of equivalent circuit parameters.

INDUCTION GENERATOR: Isolated and Grid mode operation, method of excitation, performance characteristics of three-phase self-excited induction generator.

SPECIAL PURPOSE MOTORS: Stepper Motors: construction, principle of operation and applications. Linear Induction Machines: construction, principle of operation and applications. Universal Motor: construction, principle of operation and applications.

SINGLE –PHASE MOTORS: Double revolving field theory, types of single phase motors, characteristics and equivalent circuit. Shaded pole motor: working principle and characteristics.

BOOKS RECOMMENDED:

1. Fitzgerald A.E., Kingsley C. and Umans S.D., *Electric Machinery*, 6th Edition, McGraw Hill
2. Langsdorff E.H., *Principles of A.C. Machines*, McGraw Hill
3. Nagrath I.J. and Kothari D.P., *Electrical Machines*, 4th Edition, Tata McGraw Hill,
4. Bimbhra P.S., *Electrical Machinery*, *Khanna Publishers*
5. Say M G, *Alternating Current Machines*, 5th edition, Sir Isaac pitman & Sons Ltd.

EE-402 LINEAR CONTROL SYSTEMS

Internal Marks:	**40**	**L**	**T**	**P**
External Marks:	**60**	**4**	**1**	**0**
Total Marks:	**100**			

INTRODUCTORY CONCEPTS: 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.

MODELING: Formulation of equation of linear electrical, mechanical, thermal, pneumatic and hydraulic system, electrical, mechanical analogies. Use of Laplace transforms, Transfer function, concepts of state variable modeling. Block diagram representation, signal flow graphs and associated algebra, characteristics equation.

TIME DOMAIN ANALYSIS: 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.

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.

FREQUENCY DOMAIN ANALYSIS: 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.

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

CONTROL COMPONENTS: Error detectors – potentiometers and synchros, servo motors, a.c. and d.c. techno generators, Magnetic amplifiers.

BOOKS RECOMMENDED

1. Dorf Richard C. and Bishop Robert H., *Modern Control System*, Addison –Wesley, Pearson New Delhi
2. Ogata K., *Modern Control Engineering*", Prentice Hall,
3. Kuo B. C., *Automatic Control System*", Prentice Hall
4. Nagrath I.J. and Gopal M., *Control System Engineering*, Wiley Eastern Ltd.

BTEE-403, ELECTROMAGNETIC FIELDS

Internal Marks:	**40**	**L**	**T**	**P**
External Marks:	**60**	**3**	**1**	**0**
Total Marks:	**100**			

REVIEW OF VECTOR ANALYSIS: Vector analysis, Physical interpretation of gradient, divergence and curl; vector relations in other coordinate systems, integral theorems: divergence theorem, stoke's theorem, green's theorem and Helmholtz theorem.

ELECTROSTATICS: Introduction to fundamental relations of electrostatic field; Gauss's law and its applications; potential function; Field due to continuous distribution of charges; Equipotential surfaces; Divergence theorem; Poisson's equation and Laplace's equation, capacitance, electrostatic energy, Conditions at Boundary between dielectrics, Uniqueness theorem.

STEADY MAGNETIC FIELD: Magnetic induction and Faraday's laws; magnetic Flux Density; magnetic field strength and magnetomotive force; Ampere's work Law in the differential vector form; permeability; energy stored in a magnetic field ; ampere's force law; magnetic vector potential, Analogies between electric and magnetic fields.

MAXWELL'S EQUATIONS AND POYNTING VECTOR: Equation of continuity for time varying fields, Inconsistency of ampere's law, Maxwell's equations in integral and differential form for static and time varying fields, conditions at a Boundary surface, Concept of Poynting vector, Poynting Theorem, Interpretation of ExH

ELECTROMAGNETIC WAVES: Solutions for free-space conditions; Uniform plane Wave Propagation; Wave equations for a conducting medium; Sinusoidal time variations; Polarization; Conductors and Dielectrics; Direction Cosines; Reflection by Perfect Conductor -normal and oblique incidence, Perfect Dielectric-normal incidence, Perfect Insulator –Oblique incidence; Brewster angle, Reflection at a surface of Conductive medium, Surface impedance.

BOOKS RECOMMENDED

1. Edward C. Jordan and Keith G Balmain, *Electromagnetic Waves and Radiating Systems*, Prentice-Hall Inc.
2. Kraus John D. *Electromagnetics, McGraw-Hill Publishers*
3. Edminister Joseph A., *Schaum's Theory and Problems of Electromagnetics, McGraw-Hill*
4. Rao N. Narayana, *Elements of Engineering Electromagnetics, Pearson Education*

BTEC- 404, DIGITAL ELECTRONICS

Internal Marks:	**40**	**L**	**T**	**P**
External Marks:	**60**	**3**	**1**	**0**
Total Marks:	**100**			

NUMBER SYSTEM & CODES: Binary number system, octal number system, hexadecimal number system, BCD Code, Gray code, signed & unsigned binary numbers, 1's & 2's complement of a number, different types of codes, Binary operations- addition, subtraction, multiplication, division, Parity for error detection, Check sum and Hamming Code for error detection and correction.

COMBINATIONAL CIRCUITS: Concept of positive and negative logic, Introduction to Boolean variables, Boolean theorems and DeMorgan Theorem, Sum of product and Product of sum form of Logic expressions, Duality, Logical functions using Karnaugh map and Quine-McClusky methods, multiplexers, demultiplexers, encoders, decoders, adders, subtractors, parity generators, parity checkers, code converters.

SEQUENTIAL LOGIC CIRCUITS: Flip-flops, JK flip-flops, D flip-flops, T flip- flops, SR flip- flops, edge triggered and clocked flip-flops. Registers and Counters: Series and Parallel registers; Synchronous & Asynchronous counters, Up and Down counters, Ring counters & Mod- Counters.

INTRODUCTION TO VHDL: Overview of digital design with very-high-speed integrated circuits (VHSIC) hardware description language (VHDL), HDL format and Syntax, entity, Data representation in VHDL, Truth table using VHDL, Decision Control structure and Sequential Circuit using VHDL.

DIGITAL LOGIC FAMILIES: Introduction, characteristics of digital ICs, resistor-transistor logic, integrated-injection logic, direct-coupled transistor logic, diode-transistor logic & transistor-transistor logic, emitter-coupled logic and MOS logic

DIGITAL TO ANALOG (D/A) AND ANALOG TO DIGITAL (A/D) CONVERTERS: Introduction, weighted register *D/A* converter, binary ladder, *D/A* converter, specifications for *D/A* converters, parallel *A/D* converter, successive approximation *A/D* converter single & dual slope *A/D* converter, *AID* converter using voltage to frequency conversion, *A/D* converter using voltage to time conversion, countertype *AID* converters.

SEMICONDUCTOR MEMORIES: Introduction, memory organization, classification & characteristics of memories, sequential memories, read only memories, read & write memories, content addressable memories, Programmable array Logic, programmable logic arrays and Programmable Logic Device, Field Array Programmable Gate array

RECOMMENDED BOOKS:

1. Floyd Thomas S. *Digital Fundamentals*, Pearson Education
2. Jain R.P., *Modern digital Electronics*, Tata McGraw Hill
3. Kumar Anand, *Fundamentals of Digital Circuits*, Prentice Hall of india
4. Malvino Albert Paul, *Principles of Digital Electronics*, Tata McGraw Hill

5. Mano Morris, *Digital Logic and Computer Design*, Prentice Hall of India
6. Tocci Ronald J. Widmer Neal S. and Moss Gregory L., *Digital Systems: Principles and Applications*, Prentice Hall of India

BTEE-405, POWER SYSTEMS – I (Transmission and Distribution)

Internal Marks:	**40**	**L**	**T**	**P**
External Marks:	**60**	**3**	**1**	**0**
Total Marks:	**100**			

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

CONDUCTORS AND TRANSMISSION LINE CONSTRUCTION: 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.

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

PERFORMANCE OF TRANSMISSION LINES: 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.

CIRCLE DIAGRAM AND LINE COMPENSATION: Receiving end circle diagram for long transmission lines based on ABCD constants, equivalent T circuits, power loci, surge impedance loading, reactive power requirement of system series and shunt compensation, Synchronous phase modifiers , rating of phase modifiers.

UNDERGROUND CABLES: 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.

RECOMMENDED BOOKS

1. Elgerd O.L., *Electrical Energy System Theory - An introduction*, Tata McGraw-Hill Publication
2. Gupta B.R., Power System Analysis & Design, Wheeler Publishing.
3. Nagrath I.J. and Kothari D.P., Power System Analysis Tata McGraw-Hill Publication
4. Stevenson Jr. W.D., *Elements of Power System Analysis*, Tata McGraw-Hill Publication
5. Wadhwa C.L., *Course in Electrical Power*, New Age International (P)Ltd.

BTEE-406, POWER PLANT ENGINEERING

Internal Marks:	**40**	**L**	**T**	**P**
External Marks:	**60**	**3**	**1**	**0**
Total Marks:	**100**			

STEAM GENERATORS, CONDENSERS AND TURBINES: 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, Fluidised bed combustion, Ash handling, Feed pumps, Heat exchangers, Economizers, Super heaters, Reheaters, Air preheaters, Feed water heaters, Evaporators.

HYDRO-ELECTRIC POWER PLANTS: 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.

NUCLEAR POWER PLANTS: 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.

GAS TURBINE: 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.

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

COMBINED OPERATION OF DIFFERENT POWER PLANTS: Advantages of combined operation of plants, load division between power stations, coordination of different types of Power Plants.

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

RECOMMENDED BOOKS:

1. Chakrabarti A., Soni, M.L. Gupta P.V. and Bhatanagar 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
5. Skrotzki B.G.A. and Vapot W.A., *Power Station Engineering and Economy*, Tata McGraw-Hill

BTEE-407 Laboratory-IV (Instrumentation & Measuring Devices)

		L	T	P
Internal Marks:	**30**			
External Marks:	**20**	**0**	**0**	**2**
Total Marks:	**50**			

List of Experiments:

1. **To study the input-output characteristics of a potentiometer and to use a potentiometer as an error detector.**
2. **To measure Insulation Resistance by Megger.**
3. **To measure earth resistance by Earth Tester.**
4. **To observe phase sequence of three phase circuit using Rotating type Phase Sequence Indicator.**
5. **To measure frequency of A.C. supply using Weston Frequency Meter.**
6. **To measure power factor of single phase and three phase load by PF Meter and verifying through current, voltage and power measurement.**
7. **To measure circuit parameters and three phase load by PF Meter by LCR Meter.**
8. **Measurement of displacement using LVDT.**
9. **Temperature measurement using temperature sensor (RTD).**
10. **Light measurement using LDR and photo cell censor.**
11. **Water level measurement using capacitance transducer of a Liquid in a Tank**
12. **Velocity measurement using air flow transducer.**
13. **RPM measurement using electromagnetic transducers.**
14. **Study of the characteristics of a Piezoresistive Sensor for Pressure Measurement of a Liquid in a Tank**
15. **Study of the characteristics of Resistance Temperature Detector(RTD)**
16. **Study of the characteristics of a Thermistor**
17. **Study of the characteristics of a Thermocouple**
18. **Study of the characteristics of an Electromagnetic Flowmeter**
19. **Study of the characteristics of a Tachometer**
20. **Study of the characteristics of a Photo reflective sensor for Speed Measurement**

BTEE-408 Laboratory-V (Control System)

		L	T	P
Internal Marks:	**30**			
External Marks:	**20**	**0**	**0**	**2**
Total Marks:	**50**			

List of Experiments:

1. To study the characteristics of potentiometers and to use 2- potentiometers as an error detector in a control system.
2. To study the synchro Transmitter-Receiver set and to use it as an error detector
3. To study the Speed – Torque characteristics of an AC Servo Motor and to explore its applications.
4. To study the Speed – Torque characteristics of an DC Servo Motor and explore its applications.
5. To study various electro-mechanical transducers i.e. resistive, capacitive and inductive transducers
6. To study a LVDT (AC-AC, DC-DC) as a transducer and its processing circuits
7. To study the characteristics of a thermocouple, a thermistor and a RTD
8. To study photo-conductive cell, semi-conductor photodiode and a silicon photo voltaic cell
9. To study a silicon phototransistor and obtain response of photo conductive cell
10. To study the variations of time lag by changing the time constant using control engineering trainer
11. To simulate a third order differential equations using an analog computer and calculate time response specifications
12. To obtain the transfer function of a D.C. motor – D.C. Generator set using Transfer Function Trainer
13. To study the speed control of an A.C. Servo Motor using a closed loop and an open loop systems
14. (i) To study the operation of a position sensor and study the conversion of position in to corresponding voltage
    (ii) To study an PI control action and show its usefulness for minimizing steady state error of time response.
15. To measure Force / Displacement using Strain Gauge in a wheat stone bridge
16. To design a Lag compensator and test its performance characteristics.
17. To design a Lead-compensator and test its performance characteristics.
18. To design a Lead-Lag compensator and test its performance characteristics.

Note: At least 10 Experiments, out of above list of experiments are to be performed in the semester.

BTEC-409 Laboratory-VI (Electronic Circuits)

Internal Marks:	**30**	**L**	**T**	**P**
External Marks:	**20**	**0**	**0**	**2**
Total Marks:	**50**			

List of Experiments:

1. To design a voltage regulator using zener diode and also see the effect of line and load regulation
2. To design various clippers and clampers using diodes.
3. To obtain the frequency response of an amplifier and calculate the gain bandwidth of the amplifier.
4. To investigate the emitter follower (Buffer) amplifier and determine A_V,R_i,R_O
5. To study the characteristics of a class B amplifier and also calculate the overall efficiency.
6. To study the characteristics of a class AB amplifier.
7. To study the characteristics symmetry amplifier.
8. To design and study various type of oscillators and to determine the frequency of oscillations.
9. To design a transistor series voltage regulator with current limits and observes current feedback characteristics.
10. To study the characteristics of a complementary symmetry amplifier.
11. Application of Op-Amp(741) as inverting and non-inverting amplifier.
12. To use the OP-AMP as summing, scaling and averaging amplifier.
13. Design differentiator and integrator using OP-AMP and also determine the time constant and cut-off frequency.
14. Application of OP-AMP as Schmitt Trigger.
15. Design a delay circuit using 555 timer and study the monostable, bistable and astable operations using 555.
16. a) Verification of the truth tables of TTL gates viz; 7400,7402, 7404, 7408,7432,7486.
    b) Design and fabrication and realization of all gates using NAND/NOR gates.
17. Verification of truth table of Mutiplexer(74150)/Demultiplexer(74154)
18. Design and verification of truth tables of half-adder, full-adder and subtractor circuits using gates 7483 and 7486(controlled inverter).
19. To study the operation of Arithmetic Logic Unit IC 74181.
20. Design fabrication and testing of
    a) Monostable multivibrator of t = 0.1ms approx. using 74121/123.testing for both positive and negative edge triggering, variation in pulse width and retriggering.
    b) Free running mutivibrator at 1KHz and 1Hz using 555 with 50% duty cycle. Verify the timing from theoretical calculations.
21. Design and test S-R flip-flop using NOR/NAND gates.
22. Design, fabricate and test a switch debouncer using 7400.
23. Verify the truth table of a JK flip flop using IC 7476,
24. Verify the truth table of a D flip flop using IC 7474 and study its operation in the toggle and asynchronous mode.
25. 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.
26. Verify the truth table of decoder driver7447/7448. Hence operate a 7 segment LED display through a counter using a low frequency clock. Repeat the above with the BCD to Decimal decoder 7442.

BTEE-501 SYNCHRONOUS MACHINES

Internal Marks:	**40**	**L**	**T**	**P**
External Marks:	**60**	**4**	**1**	**0**
Total Marks:	**100**			

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

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

ALTERNATORS: 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 bus bar, 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.

SYNCHRONOUS MOTORS: 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.

PARALLEL OPERATION OF ALTERNATORS: 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.

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

SINGLE PHASE SYNCHRONOUS MOTORS: Reluctance and Hysteresis motors.

BOOKS RECOMMENDED:

1. Bimbhra P.S., *Electrical Machinery, Khanna Publishers*
2. Fitzgerald A.E., Kingsley C. and Umans S.D., *Electric Machinery*, 6th Edition, McGraw Hill
3. Langsdorff E.H., *Principles of D.C. machines*, McGraw Hill
4. Nagrath I.J. and Kothari D.P., *Electrical Machines*, 4th Edition, Tata McGraw Hill,
5. Say M G, *Alternating Current Machines*, 5th edition, Sir Isaac Pitman and Sons Ltd.

Note: *External question paper shall be set following guidelines to paper setter given at Page 44.*

BTEE-502 ELECTRIC GENERATION AND ECONOMICS

Internal Marks:	**40**	**L**	**T**	**P**
External Marks:	**60**	**4**	**1**	**0**
Total Marks:	**100**			

Introduction: 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

Loads and Load curves: 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.

Power Plant Economics: Capital cost of plants, annual fixed cost, operating costs and effect of load factor on cost of energy, depreciation.

Tariffs and power factor improvement: Objectives of tariff making, different types of tariff (domestic, commercial, agricultural and industrial loads). Need for power factor (p.f.) improvement, power factor improvement using capacitors, determination of economic power factor.

Selection of plant: 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.

Economic operation of steam plants: 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.

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

Pollution and environmental problems: Energy and environment, Air pollution, Aquatic impacts, nuclear plant and hydro plant impacts.

Cogeneration: Definition and scope, Topping and Bottoming Cycles, Benefits, cogeneration technologies.

BOOKS RECOMMENDED:

1. Deshpande M.V., *Power Plant Engineering,* Tata McGraw Hill (2004).
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 and Sons
5. Skrotzki B.G.A. and Vapot W.A., *Power Station Engineering and Economy*, Tata McGraw-Hill
6. Arora S.C. and Dom Kundwar S., A course in *Power Plant Engineering*, Dhanpat Rai.
7. Nag, P.K., *Power Plant Engineering*, Tata McGraw Hill
8. Gupta B.R., *Generation of Electrical Energy,* S. Chand (1998).
9. Nagrath I.J. and Kothari D.P., Power System Analysis Tata McGraw-Hill Publication

10. Chakrabarti A., Soni, M.L. Gupta P.V. and Bhatanagar U.S., *A Textbook on Power System Engineering*, Dhanpat Rai and Co.

Note: *External question paper shall be set following guidelines to paper setter given at Page 44.*

BTEE-503 MICROPROCESSORS

Internal Marks:	**40**	**L**	**T**	**P**
External Marks:	**60**	**4**	**1**	**0**
Total Marks:	**100**			

Introduction to Microprocessors: Types of computers, Microprocessor evolution and types, Central Processing Unit (CPU) operation and terminology, idea of 8- bit, 16-bit, 32-bit and 64- bit Microprocessors from Intel, Motorola and Zilog and their comparisons.

Introduction to 8-bit Microprocessor: 8085 Microprocessor architecture, classification of instructions, Instruction format, and overview of the 8085 instruction set.

Introduction to 16-bit Microprocessor: 8086 Internal Architecture, Addressing modes, program development steps, 8086 instruction set, Assembler directives, Assembly language, program development tools.

Programming of 8086: Simple sequence programs, jumps, flags, conditional Jumps, IF-THEN, IF-THEN-ELSE, Multiple IF-THEN-ELSE, WHILE-DO, REPEAT-UNTIL, Instruction Timing and delay loops, strings, procedures, Macros.

8086 System Connections, Timing, Troubleshooting: Pin-diagram, maximum/minimum. modes, timing diagrams, use of logic analyzer to observe Bus signals, troubleshooting a simple 8086 based system

8086 Interrupts and Applications: 8086 Interrupts, responses and applications, 8254 software-programmable timer/counter, 8259 a priority Interrupt Controller

Interfacing of 8086: Programmable parallel ports and handshake, Interfacing a Microprocessor to Keyboards and alphanumeric displays, Digital to Analog (D/A) converter operation, interfacing and applications, Analog-to Digital (*A/D)* converter specifications and Interfacing.

BOOKS RECOMMENDED:

1. Gaonkar, Ramesh S. *Microprocessor Architecture, Programming and Applications with the 8085*, Penram International
2. Ram B, *Fundamentals of Microprocessors and Microcomputers*, Dhanpat Rai and Sons,
3. Hall, Douglas V. *Microprocessors and interfacing: Programming and Hardware*, Tata McGraw Hill
4. Brey, Barry B.Bray, *The INTEL Microprocessors 8086/88, 80186, 286, 386, 486, Pentium Pro Processors, Architecture, Programming and Interfacing*, 4th Edition, Prentice Hall (India)
5. Ray A.K. and Bhurchandi K.M., *Advanced Microprocessors and Peripherals*, Tata McGraw Hill.

Note: *External question paper shall be set following guidelines to paper setter given at Page 44.*

BTEE-504 POWER ELECTRONICS

Internal Marks:	**40**	**L**	**T**	**P**
External Marks:	**60**	**4**	**1**	**0**
Total Marks:	**100**			

Thyrlstors and their characteristics: Introduction to Thyristor family, V-I characteristics of silicon-controlled rectifier (SCR), gate turn-off thyristor (GTO), Bidirectional diode for alternating current (DIAC) and Bidirectional, Triode for Alternating Current (TRIAC). Principle of operation of silicon-controlled rectifier (SCR). Two transistor analogy. Turn on methods of a thyristor Switching characteristics of thyristors during tum-on and turn-off. Gate characteristics. Firing of thyristors. Gate triggering circuits. Series and parallel operation of silicon-controlled rectifiers (SCR) and their triggering circuits. Thyristor specifications; such as latching current and holding current, critical rate of rise of off-state voltage (dv/dt) and critical rate of rise of on-state current (di/dt) etc. Protection of SCR from over voltage and over current. Snubber circuits. Power dissipation.

Thyristor commutation techniques: Self commutation by resonating the load (Class A), Self commutation by LC circuit (class B), Complementary commutation (class C), Auxiliary commutation (class D), External pulse commutation (class E), AC Line commutation (class F).

Phase controlled techniques: Introduction to phase angle control. Single phase half wave controlled rectifiers. Single phase half controlled and full controlled bridge rectifiers. Three phase full controlled bridge rectifiers. Effect of resistive, inductive and resistive cum inductive loads. Basic circuit and principle of operation of Dual Converter, circulating current mode and non-circulating current mode of operation. Applications of rectifiers and dual converters to speed control of DC motor drives.

Choppers: Introduction of chopper, Basic chopper classification, Basic chopper operations. Control strategies, Chopper configuration, voltage commutated chopper, Current commutated chopper, Load commutated chopper.

Cycloconverters: Basic principle of operation, Single phase to. single phase cycloconverter. Three phase half wave cycloconverter. Advantages disadvantages of cycloconverters.

Inverters: Introduction & Classification of inverter. Operating principle, Single phase half bridge voltage source inverters, Single phase full bridge inverter. Modified McMurray half-bridge and full-bridge inverter. Three-phase bridge inverter. Voltage control (Pulse-width modulation (PWM) control etc.) and reduction of harmonics in the inverter output voltage. Series inverter.

Symbols and V-I characteristics of Silicon Unilateral Switch (SUS), Silicon Controlled Switch (SCS), Silicon Bilateral Switch (SBS), Unijunction Transistor (UJT), Programmable Unijunction Transistor (PUT), Light-activated silicon-controlled rectifier (LASCR), Reverse conducting Thyristors (RCT), Static Induction Thyristor (SITH), N- Metal Oxide Semiconductor Controlled Thyristor (N-MCT), Field Controlled Thyristors (FCT).

BOOKS RECOMMENDED:

1. Bimbhra, P.S., *Power Electronics*, Khanna Publishers.
2. Singh M.D. and Khanchandani K.B., *Power Electronics*, Tata Mc Graw Hill Publishing company limited.
3. Rashid M.H., *Power Electronics*, Circuits Devices and Applications, Prentice Hall (India)
4. Sen, P.C., *Power Electronics*, Tata McGraw Hill Publishing Company limited.
5. Bhattacharya S.K. and Chatterji, S. *Industrial Electronics and Control*, by New Age international Publications(P) Ltd, New Delhi.

Note: *External question paper shall be set following guidelines to paper setter given at Page 44.*

BTEE-505 NUMERICAL AND STATISTICAL METHOD

Internal Marks:	**40**	**L**	**T**	**P**
External Marks:	**60**	**4**	**1**	**0**
Total Marks:	**100**			

Floating-Point Numbers: Floating-point representation, Rounding, Chopping, Error analysis, Condition and instability.

Non-Linear Equations: Bisection, Fixed-point iteration and Newton-Raphson methods, Order of convergence.

Linear Systems and Eigen-Values: Gauss-elimination method (using Pivoting strategies) and Gauss-Seidel Iteration method. Rayleigh's power method for Eigen-values and Eigen-vectors

Interpolation: Lagrange's formula with error, divided difference, Newton's divided difference formula

Numerical Integration: Newton-Cote's quadrature formula (with error) and Gauss-Legendre quadrature formula.

Differential Equations: Solution of initial value problem using Taylor Series, Euler's and Runge-Kutta (up to fourth order) methods Statistical Methods

Random Variables: Definition, Probability distribution, Distribution functions, probability distribution function (pdf) and cumulative distribution function (cdf), Expectation and Variance.

Special Probability Distributions: Binomial, Poisson, Geometric, Uniform, Normal and Exponential distributions.

Sampling Distributions: Population and samples, Concept of sampling distributions, Sampling distribution of mean, Chi-square, t and F distributions (pdf only). Tests of Hypotheses: Basic ideas, Important tests based on normal, Chi-square, t and F distribution.

Curve Fitting: Method of least squares, Fitting of simple curves using this method, Regression and Correlation: (Two variables case only)

BOOKS RECOMMENDED:

1. Jain M.K., Iyengar, S.R.K., and Jain R.K., *Numerical Methods for Scientific and Engineering Computation,* New Age International (2008) 5th ed.
2. Conte, S.D and Carl D. Boor, *Elementry Numerical Analysis: An Algorithmic approach,* Tata McGraw Hill, New York (2005).
3. Johnson, R., Miller, I. and Freunds, J., *Probability and Statistics for Engineers*, Pearson Education(2005) 7th ed.
4. Gerald C.F and Wheatley P.O., *Applied Numerical Analysis*, Pearson Education (2008) 7th ed.
5. Mathew, J.H., *Numerical Methods for Mathematics, Science and Engineering,* Prentice Hall Inc.J (2002).
6. Meyer, P.L., *Introductory Probability and Statistical Applications,* Oxford (1970) 2nd ed.
7. Walpole, Ronald E., Myers, Raymond H., Myers, Sharon L. and, Keying Ye, *Probability and Statistics for Engineers and Scientists,* Pearson Education (2007) 8th ed
8. Sastry S.S., *Introductory Methods of Numerical Analysis*, Prentice Hall (India), (2002), 3rd ed.

Note: *External question paper shall be set following guidelines to paper setter given at Page 44.*

BTEE-506 Laboratory-VII (ELECTRICAL MACHINES-II)

		L	T	P
Internal Marks:	**30**			
External Marks:	**20**	**0**	**0**	**2**
Total Marks:	**50**			

Note: Atleast TEN 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. Parameters and to draw circle diagram.
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 ckt. And to plot torque –speed characteristics.
7. To perform no-load and blocked–rotor test on single-phase Induction motor and to determine the parameters of equivalent ckt. Drawn on the basis of double revolving field theory.
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 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-507 Laboratory-VIII (NUMERICAL ANALYSIS)

Internal Marks:	**30**	**L**	**T**	**P**
External Marks:	**20**	**0**	**0**	**2**
Total Marks:	**50**			

Note: Atleast TEN experiments are to be performed in a semester. list of experiments is given below:

List of Experiments:

To Develop algorithms/programs in C or C++ or FORTRAN-77/90/95 or MatLab language for the following methods

1. Lagrange's formula with error, divided difference for interpolation,
2. Newton's divided difference method for interpolation and extrapolation.
3. Bisection method for finding a real root of an equation.
4. Newton Raphson method for finding a real root of an equation.
5. Iteration method for finding a real root of an equation.
6. Gauss elimination method for solving simultaneous linear algebraic equations.
7. Gauss Jordan method for solving simultaneous linear algebraic equations.
8. Simpson's 1/3rd rule for numerical integration.
9. Newton's forward interpolation formula.
10. Lagrange's method for interpolation.
11. Euler's method for solving ordinary differential equations.
12. Runge-Kutta (up to fourth order) method for solving ordinary differential equations.
13. Curve fitting (linear and polynomial)

BTEE-508 Laboratory-IX (ELECTRICAL: ESTIMATION AND COSTING)

		L	T	P
Internal Marks:	**30**			
External Marks:	**20**	**0**	**0**	**2**
Total Marks:	**50**			

Note: Atleast TEN experiments are to be performed in a semester. list of experiments is given below:

List of Experiments:

1. To study Indian electricity rules
2. To carryout 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 (Work shop, 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, 440 V, 3-phase, 4 wire or 3 wire distribution line.
10. To estimate the cost of 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 study various types of light sources and lighting schemes.
14. To make wiring diagrams of motor control circuits for starting of
    a. 3 phase induction motor
    b. Wound Motor
    c. Synchronous motor

RECOMMENDED BOOKS

1. Raina K.B. and Bhattacharya S.K., *Electrical Design, Estimating and Costing,* Tata McGraw Hill, New Delhi
2. Gupta J.B., *A course in Electrical Installation, Estimating and Costing*, SK Kataria and Sons, N.Delhi
3. Sharma B.R. and Rai H.M., *Electrical Estimating and Costing*
4. Uppal S.L., *Electrical Wiring, Estimating and Costing*
5. Singh Surjeet, *Estimating and Costing,* Dhanpat Rai and Co., New Delhi

BTEE-601 ELECTRIC POWER AND UTILIZATION

Internal Marks:	**40**	**L**	**T**	**P**
External Marks:	**60**	**3**	**1**	**0**
Total Marks:	**100**			

Electric Drives: Electrical drives & Mechanical drives, Concept of electrical drives, Basic features of industrial drives, review of operating and starting characteristics of different types of electric motors for various drives (AC and DC motors). Estimation of rating and heating of motors, Load equalization (Fly wheel effect), Drives for particular services.

Electric Traction: Introduction to Indian railways system , Electric Locomotive Classes, Various types of Traction system, single phase feeding arrangement prevalent in India. Substation. arrangements, Different Types of Catenary construction and line insulation, Span and dropper design Calculations.

Electric Heating and Welding: Methods of electric heating, types of electric heating, constructional details and performance of resistance heating furnace. Dielectric heating, Alternating current (AC).and Direct current (DC) Welding, Resistance and Arc Welding. Electric Beam Welding, Laser Welding. Typical construction of electrical welding AC and DC set.

Illumination: 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.

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

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

BOOKS RECOMMENDED:

1. Partab H., *Modern Electric Traction,* Dhanpat Rai
2. De N.K. and Sen P.K., *Electric Drives*, PHI publication
3. Berde M.S., *Electric Motor Drives*, Khanna Publishers
4 Gupta J.B., *Utilization of Electric Power and Electric Traction*, S.K. Kataria and Sons
5. Tripathy S. C., *Electric Energy Utilization and Conservation*, Tata McGraw Hill
6. Taylor E.O., *Utilization of Electric Energy,* Orient Blackswan
7. Hughes Austin, *Electric Motors and Drives: Fundamentals, Types and Applications,* Newnes, (2005)

Note: *External question paper shall be set following guidelines to paper setter given at Page 44.*

BTEE-602 POWER SYSTEM-II (SWITCH GEAR AND PROTECTION)

Internal Marks:	**40**	**L**	**T**	**P**
External Marks:	**60**	**3**	**1**	**0**
Total Marks:	**100**			

Sub-Station: Types, Main equipment in Substation, substation layout, Busbar-arrangements.

Isolators and Fuses: Isolating switches functions, Types, Rating and operation. Fuse-types, Rating, Selection, theory and characteristics, applications.

Circuit Breakers: Need for Circuit Breakers, Arc phenomenon, Theory of Arc Interruption, Recovery Voltage and Restriking Voltage, Various Types of Circuit Breakers. Principles and Constructional Details of Air Blast, Minimum Oil, SF6, Vacuum Circuit Breakers etc.

Protective Relays: Introduction, classification, constructional features; and Characteristics of Electromagnetic, Induction, Thermal, Overcurrent relays, Directional relays, Distance relays, Differential, Translay, Negative sequence relay, introduction to static and up-based relays.

Protection of Feeders: Time graded protection, Differential and Distance protection of feeders, choice between Impedance, Reactance and Mho relays, Elementary idea about carrier current protection of lines.

Protection of Generators and Transformers: 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.

Protection against over voltage and earthing: Ground wires, Rod gap, Impulse gap, Valve type and Metal Oxide Arresters, Line Arrester/Surge Absorber. Ungrounded neutral system, Grounded neutral system and Selection of Neutral Grounding.

BOOKS RECOMMENDED

1. Rao S., *Switchgear and Protection*, Khanna Publishers
2. Chakrabarti A., Soni, M.L. Gupta P.V. and Bhatanagar U.S., *A Textbook on Power System Engineering*, Dhanpat Rai and Co.
3. Wadhawa C.L. , *A Course in Electrical Power*, New Age international Pvt. Ltd
4. Badri Ram and Vishwakarma D.N., *Power system Protection and Switchgear*, Tata McGraw Hill
5. Deshpande M.V., *Switchgears and Protection*, Tata McGraw Hill

Note: *External question paper shall be set following guidelines to paper setter given at Page 44.*

BTEE-603 NON-LINEAR AND DIGITAL CONTROL SYSTEM

Internal Marks:	**40**	**L**	**T**	**P**
External Marks:	**60**	**4**	**1**	**0**
Total Marks:	**100**			

STATE VARIABLE TECHNIQUES: State variable representation of systems by various methods, solution of state variable model. Controllability and observability.

PHASE PLANE ANALYSIS: Singular points, Method of isoclines, delta method , phase portrait of second order nonlinear systems, limit cycle.

DESCRIBING FUNCTION ANALYSIS: Definition, limitations, use of describing function for stability analysis, describing function of ideal relay, relay with hystersis, dead zone, saturation, coulomb friction and backlash.

LYAPUNOV'S STABILITY METHOD: Lyapunov's direct method, generation of Lyapunov's function by Krasovskii's and Variable Gradient methods

SAMPLED DATA SYSTEMS: Sampling process, mathematical analysis of sampling process, application of Laplace transform. Reconstruction of sampled signal, zero order, first order hold. Z-transform definition, evaluation of Z-transform, inverse Z-transform, pulse transfer function, limitations of Z-transform, State variable formulation of discrete time systems, solution of discrete time state equations. Stability definition, Jury's test of stability, extension of Routh-Hurwitz criterion to discrete time systems.

BOOKS RECOMMENDED:

1. Ogata K., *Modern control engineering.* Prentice Hall (India)
2. Nagrath I.J., Gopal M., *Control system engineering*, New Age Publications
3. Hsu J.C. and Meyer A.U., *Modern control principles and application*
4. Gopal M., *Digital Control and State Variable Methods*, Tata McGraw Hill
5. Kuo B.C. and Golnaraghi F., *Automatic Control System, Wiley* Publications
6. Dorf R.V. and Bishop R.H., *Modern Control Systems*, Adison Wesley

Note: *External question paper shall be set following guidelines to paper setter given at Page 44.*

BTEE-604 MICROCONTROLLER AND PLC

Internal Marks:	**40**	**L**	**T**	**P**
External Marks:	**60**	**3**	**1**	**0**
Total Marks:	**100**			

Introduction: Microprocessor, 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

8051 Assembly Language Programming: The mechanics of programming, assembly language programming process, programming tools and techniques, instruction set (data moving, logical operations, arithmetic operations, jump and call instructions)

8051 Microcontroller Design: Micro-controller 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

Microcontroller Applications: 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.

Programmable Logic Controllers (PLC): 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.

RECOMMENDED BOOKS:

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. Udayashankara V. and Mallikarjunaswamy M.S., *8051 Microcontroller Hardware, Software and Applications*, TataMcGraw Hill Education Pvt. Ltd., (2010)
6. Surekha Bhanot, *Process Control*, Oxford Higher Education.
7. Otter, Job Dan, *Programmable Logic Controlle*r, P.H. International, Inc, USA
8. Dunning Gary, *Introduction to PLCs,* Tata McGraw Hill
9. Kumar Rajesh, *Module on PLCs and their Applications*, NITTTR Chandigarh

Note: *External question paper shall be set following guidelines to paper setter given at Page 44.*

BTEE-OP1 FUNDAMENTALS OF ELECTRICAL MACHINES

Internal Marks:	**40**	**L**	**T**	**P**
External Marks:	**60**	**3**	**1**	**0**
Total Marks:	**100**			

Introduction: Basic Principle, Types and constructional features of electrical machines, torque, torque angle, basic electromagnetic laws, Induced EMF.

Transformers: Basic principle, turns ratio, types and parts of a transformer, ideal transformer, transformer on no-load and on-load, phasor diagram, transformer reactance and equivalent circuit, losses, efficiency, all day efficiency, regulation, basic concept of three-phase transformer and auto transformer (excluding analysis).

Direct Current (DC) Machines: Principle, Constructional features, Types of direct current (DC) machines, Electromotive force (EMF) and torque equations, circuit model, armature reaction, commutation, Types of armature winding(no detailed diagram), characteristics of dc motors, characteristics of dc generators, starting (three point and four point starters), speed control methods, efficiency and applications.

Three-phase Induction Machines: Concept of rotating magnetic field in three phase, Construction and principle of operation. slip frequency, rotor currents, rotor Magnetomotive force (MMF) and torque production, equivalent circuit; torque slip characteristics, power output, starting;

Single-phase Induction Motors: Principle of single phase induction motors, double field revolving theory, types of single phase induction motors.

Synchronous Machines: Construction and types, Electromotive force (EMF) equation, synchronous reactance.

Principle of Special Motors: Alternating current (AC) series motor, universal motor, reluctance motor, hysteresis motor, stepper motor, Brushless Motors, Switched reluctance motor and their applications.

BOOKS RECOMMENDED:

1. Thareja B.L., *Electrical Machines, VOL II*, S.Chand.
2. Fitzgerald A.E., Kingsley C. and Umans S.D., *Electric Machinery*, 6th Edition, McGraw Hill
3. Nagrath I.J. and Kothari D.P., *Electrical Machines*, Tata McGraw Hill
4. Bimbhra P.S., *Electrical Machinery, Khanna Publishers*

Note: *External question paper shall be set following guidelines to paper setter given at Page 44.*

BTEE-OP2 ENERGY AUDITING AND MANAGEMENT

Internal Marks:	**40**	**L**	**T**	**P**
External Marks:	**60**	**3**	**1**	**0**
Total Marks:	**100**			

Energy Scenario: Energy needs of growing economy, Long term energy scenario, Energy pricing, Energy sector reforms, Energy and environment: Air pollution, Climate change, Energy security, Energy conservation and its importance, Energy strategy for the future, Energy conservation Act-2001 and its features.

Energy Management and Audit: 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 and energy substitution, Energy audit instruments

Material and Energy balance: Facility as an energy system, Methods for preparing process flow, Material and energy balance diagrams.

Financial Management: Investment-need, Appraisal and criteria, Financial analysis techniques-Simple payback period, Return on investment, Net present value, Internal rate of return, Cash flows, Risk and sensitivity analysis, Financing options, Energy performance contracts and role of energy savings companies (ESCOs).

Electrical system: Electricity tariff, Load management and maximum demand control, Power factor improvement, Distribution and transformer losses. Losses in induction motors, Motor efficiency, Factors affecting motor performance, Rewinding and motor replacement issues, energy efficient motors. Light source, Choice of lighting, Luminance requirements, and Energy conservation avenues

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 efficiency

High Voltage Alternating Current and Refrigeration System: Vapor compression refrigeration cycle, Refrigerants, Coefficient of performance, Capacity, Factors affecting refrigeration and air conditioning system performance and savings opportunities, Vapor absorption refrigeration system: Working principle, Types and comparison with vapor compression system, Saving potential, Fans, Blowers and pumps- Types, Performance evaluation, Efficient system operation, Flow control strategies and energy conservation opportunities.

BOOKS RECOMMENDED:

1. Abbi, Y.P. and Jain, S., *Handbook on Energy Audit and Environment Management*, Teri Bookstore
2. Diwan, P., *Energy Conservation*, Pentagon Press (2008).
3. Younger, W., *Handbook of Energy Audits*, CRC Press (2008)
4. Sawhney and Maheshwari, *Solar Energy and Energy Conservation*, Prentice Hall (India)
5. Rao S. and B. B. Parulkar, *Energy Technology*, Khanna Publishers
6. Sukhatme S. P., *Solar Energy*, Tata McGraw Hill
7. David S., *Hand Book of Industrial Energy Conservation*, Van Nostrand Reinhold Publishing Company.

Note: *External question paper shall be set following guidelines to paper setter given at Page 44.*

BTEE-OP3 NON-CONVENTIONAL ENERGY SOURCES

Internal Marks:	**40**	**L**	**T**	**P**
External Marks:	**60**	**3**	**1**	**0**
Total Marks:	**100**			

INTRODUCTION: Limitation of conventional energy sources, need and growth of alternative energy source, basic scheme and application of direct energy conservation.

MHD GENERATORS: Basic principles, gaseous, conduction and hall effect, generator and motor effect, different types of Magneto-Hydro-Dynamic (MHD) generator, types of MHD material, conversion effectiveness, analysis of constant area MHD generator, practical MHD generator, application and economic aspects.

THERMO-ELECTRIC GENERATORS: 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.

PHOTOVOLTAIC EFFECT AND SOLAR ENERGY: Photovoltaic effect, different types of photovoltaic cells, cell fabrication, characteristics of photovoltaic cells, conversion efficiency, solar batteries, application, solar radiation analysis, solar energy in India, solar collectors, solar furnaces and applications.

FUEL CELLS: Principle of action, Gibb's free energy, general description of fuel cells,types, construction, operational characteristics and application.

MISCELLANEOUS SOURCES: Geothermal system, hydro-electric plants, wind power, tidal energy, Bio-mass energy

BOOKS RECOMMENDED:

1. Gupta B. R., *Generation of Electrical Energy*, S. Chand.
2. Rai, G.D., *Non Conventional Energy Sources,* Khanna Publishers (2005).
3. Rao, S. and Parulekar, *B.B., Energy Technology: Non Conventional, Renewable and Conventional,* Khanna Publishers (2005).
4. Wadhwa, C.L., *Generation, Distribution and Utilization of Electric Energy,* New Age International (P) Limited, Publishers (2007).
5. *Simon , Christopher A., Alternate Source of Energy,* Rowman and LittleField Publishers Inc.(2007).
6. *Venikov, V.A. and Putyain, E.V., Introduction to Energy Technology,* Mir Publishers (1990).
7. Chakrabarti A., Soni M. L., Gupta P. V. and Bhatnagar U. S., *Power System Engineering*, Dhanpat Rai and Co.
8. Kothari D.P., Singal K.C. and Ranjan R., Renewable Energy Sources and Emerging Technologies, Prentice Hall (India)

Note: *External question paper shall be set following guidelines to paper setter given at Page 44.*

BTEE-OP4 ELECTRICAL MEASUREMENTS

Internal Marks:	**40**	**L**	**T**	**P**
External Marks:	**60**	**3**	**1**	**0**
Total Marks:	**100**			

UNITS, DIMENSIONS AND STANDARDS: Introduction to MKS (**(**Meter-Kilogram-Second) and Rationalized MKSA **(**Meter-Kilogram-Second-Ampere) System, SI Units (International System of Units), Standards of electromotive force (EMF), Resistance, Capacitance and Inductance, Systematic errors

GENERAL THEORY OF ANALOG MEASURING INSTRUMENTS: Operating torque, damping and controlling torque, Torque-weight ratio, Pointers and Scales. Principles of operation of various types of electro mechanical indicating / registering instruments viz. Permanent Magnet Moving Coil (PMMC), dynamometer, induction, thermal, etc. for direct current and alternating current measurement of voltage, current, power, frequency, phase and power factor etc., energy meter: their sources of error and compensation, shunts and multipliers, multi-meter.

POTENTIOMETERS: Basic direct current (DC) potentiometer circuit, Modern form of DC potentiometer, measurement of voltage, current, Resistance and calibration of voltmeter and ammeter using DC potentiometer, volt ratio box, Self balancing potentiometer, Alternating current (AC) potentiometers and their applications.

BRIDGES: Sources and Detectors, General equation for bridge balance, Wheatstone bridge and its sensitivity analysis, Kelvin double bridge, AC bridges: applications and conditions for balance, Maxwell's bridge, Hay's bridge, Schering bridge, Wien bridge, DeSauty's bridge, Insulation testing, Sources of errors in bridge circuits, Shielding of bridge elements, Wagner Earthling Device.

MAGNETIC MEASUREMENTS: Flux meter, B-H Curve, Hysteresis loop, Permeameters, AC Testing of Magnetic materials, Separation of iron losses, iron loss measurement by Wattmeter and Bridge methods.

INSTRUMENT TRANSFORMERS: Theory and construction of current and potential transformers, ratio and phase angle errors and their minimization, Characteristics of current transformers (CT) and potential transformers (PT) and their Testing.

BOOKS RECOMMENDED:

1. Bell David A., *Electronics Instrumentation and Measurements,* Prentice Hall, India
2. Golding Edward William and Widdis Frederick Charles, *Electrical Measurements and Measuring instruments,* Wheelers India
3. Helfrick A.D. and Cooper W.D., Modern *Electronic Instrumentation. and Measurement Techniques*, Prentice Hall
4. Murthy D. V. S., Transducers and Instrumentation, Prentice-Hall, India
5. Sawhney A. K., *A Course in Electrical and Electronics Measurement and Ins*trumentation., Dhanpat Rai and Sons.

Note: *External question paper shall be set following guidelines to paper setter given at Page 44.*

BTEE-605A COMPUTER AIDED ELECTRICAL MACHINE DESIGN

		L	T	P
Internal Marks:	**40**			
External Marks:	**60**	**3**	**1**	**0**
Total Marks:	**100**			

Review of Magnetic and insulating materials.

Principles of design of Machines: Factors and limitations in design, specific magnetic and electric loadings, output, real and apparent flux densities, separation of main dimensions for D.C., induction and synchronous machines.

Heating, Cooling and Ventilation: Temperature rise calculation, continuous, short time and intermittent ratings, types of ventilation, hydrogen cooling and its advantages.

Design of Transformers: General considerations, output equation, main dimensions, leakage reactance, winding design, tank and cooling tubes, calculation of magnetizing current, losses, efficiency and regulation.

Design Three-phase induction motors: General considerations, output equation, choice of specific electric and magnetic loadings, No. of slots in stator and rotor, elimination of harmonic torques, design of stator and rotor windings, leakage reactance, equivalent resistance of squirrel cage rotor, magnetizing current, temperature rise and efficiency.

Introduction to computer aided electrical machine design.

BOOKS RECOMMENDED:

1. Sawhney A.K., *A Course in Electrical Machine Design,* Dhanpat Rai.
2. Aggarwal R.K., *Principles of Electrical Machine Design*, S. K. Kataria and Sons.
3. Deshpande M.V., *Design And Testing of Electrical Machines*- PHI Learning Pvt. Ltd.
4. Upadhyay K.G., *Design of Electrical Machine,* New Age International.
5. Hamdi Essam S., *Design of small electrical machines*,Wiley publications

Note: *External question paper shall be set following guidelines to paper setter given at Page 44.*

BTEE-605B FLEXIBLE AC TRANSMISSION SYSTEMS

Internal Marks:	**40**	**L**	**T**	**P**
External Marks:	**60**	**3**	**1**	**0**
Total Marks:	**100**			

Power Transmission control: Fundamental of alternating current (AC) power transmission, transmission problems and needs, the emergence of Flexible Alternating Current Transmission Systems (FACTS), FACTS controller and consideration. Uncompensated transmission lines and compensated transmission lines.

Shunt Compensation: Principle, configuration, control and applications of Shunt Static Var Compensator (SVC) and Static Synchronous compensator (STATCOM).

Series Compensation: Fundamental of series compensation, principle of operation, Application of Thyristor Controlled Series Capacitor (TCSC) for different problems of power system, TCSC layout, Static Synchronous Series Compensator (SSSC): principle of operation.

Phase Shifter: Principle of operation, steady state model of static phase shifter (SPS), operating characteristics of SPS, power current configuration of SPS application.

Unified Power Flow Controllers (UPFC): Basic operating principles and characteristics, control UPFC installation applications, UPFC model for power flow studies.

Reactive Power Control: Introduction, reactive power requirements in steady state, sources of reactive power, static var systems, reactive power control during transients. Harmonics and filters: Introduction, generation of harmonics, design of AC filters, DC filters, carrier frequency and RI noise.

Transmission line steady State Operation: Lossless Transmission lines, Maximum Power Flow, Line loadability, reactive compensation techniques. Congestion management on transmission lines using FACT devices.

RECOMMENDED BOOKS:

1. Ghosh,A. and Ledwich,G., *Power Quality Enhancement Using Custom Power Devices*, Kluwer Academic Publishers (2005).
2. Hingorani, N.G. and Gyragyi,L., *Understanding FACTS :Concepts and Technology of Flexible AC Transmission System*, Standard Publishers and Distributors (2005).
3. Sang, Y.H. and John, A.T., *Flexible AC Transmission Systems*, IEEE Press (2006).
5. K.R. Padiyar, *FACTS Controllers in Power Transmission and Distribution*, New Age International Publisher, 2007.
6. Miller T.J.E., *Reactive Power Control in Electric Systems*, John Wiley.

Note: *External question paper shall be set following guidelines to paper setter given at Page 44.*

BTEE-605C INSTRUMENTATION IN POWER SYSTEM

Internal Marks:	**40**	**L**	**T**	**P**
External Marks:	**60**	**3**	**1**	**0**
Total Marks:	**100**			

Introduction: Measurement of electrical quantities, Active and reactive power in power plants, Energy meters, Instrument transformers and their transient response.

Instrumentation Techniques: Telemetry, Remote Control, remote signaling and supervisory control and data acquisition (SCADA), signal formation, conversion and transmission.

Signal Transmission Techniques: Analog pulse and digital modulation, Amplitude modulation(AM) and Frequency modulation (FM), AM and FM Transmitter and Receiver, Phase Modulation, Pulse modulation, Digital transmission techniques, error detection and correction.

Telemetry: Telemetry errors, DC, pulse and digital telemetry methods and systems.

Supervisory Control and Data Acquisition: Function of SCADA system remote terminal unit (RTU) details, Control center details, Communication between control centers, control center and remote terminal unit.

Power Plant Instrumentation: Hydroelectric power plant instrumentation, Thermal power plant instrumentation, Nuclear Power plant Instrumentation. Applications of SCADA system to Indian Power Systems.

RECOMMENDED BOOKS:

1. Cegrell,T., *Power System Control Technology,* Prentice-Hall of India Private Limited(2001).`
2. Lindsley, D.M. , *Power Plant Control and Instrumentation,* IEEE Press (2000).
3. Jarvis, E.W., *Modern Power Station Practice: Control and Instrumentation (Vol. F),* British Electricity International (1980).

Note: *External question paper shall be set following guidelines to paper setter given at Page 44.*

BTEE-605D BIOMEDICAL INSTRUMENTATION

Internal Marks:	**40**	**L**	**T**	**P**
External Marks:	**60**	**3**	**1**	**0**
Total Marks:	**100**			

Transducers: Strain gauge for respiratory flow transducer, piezo resistive transducer for intracardiac catheter, thermistor as temperature sensing elements - its characteristics and compensation for non-linearity.

Piezoelectric transducer: its equivalent circuits and impedance frequency characteristics. Its applications as intra cardiac microphone, heart assist device and ultrasonic instruments. Variable inductance transducer, different configuration and application for measurement of muscular tremor. linear variable differential transformer (LVDT) and its signal processing circuitry. Magnetostrictive and variable capacitance transducers, stretched diaphragm transducer and its

characteristics.

Measurement and recording of bioelectric signals: electrocardiogram (ECG), electromyogram (EMG), electroencephalogram (EEG) and instruments for picking up and reproducing bioelectric signals, specific design characteristics, sources of noise and its removal.

Measurement and recording of non-electric signal: Measurement and recording of pressure, temperature, respiration rate, pulse rate and blood flow. Electromagnetic blood flow meter, thermography, pH measurements, gas analysis, ESR (erythrocyte sedimentation rate) measurement, plethysmograph, X-Ray, tonometer and dialysis. Ultrasonics and echoencephalography radiography imaging isotopes and nuclear medicine.

Equipment for effecting the human body: Stimulator, defibrillator, pacemaker, diathermy.

Prosthetics: Upper and lower extremity prostheses, harness control, EMG-controlled externally powered prosthesis, basic concept of monofunctional and multifunctional devices.

Biotelemetry: Radio-telemetry of biological signal, signal source, antenna and frequency design considerations, example of single channel FM units.

RECOMMENDED BOOKS:

1. Walter Welkowitz and Sid Deutch, *Biomedical Instruments, theory and design*, Academic press 1976.
2. Guha S.K., *An Introduction to Medical Electronics*, Bharti Publishers, Patna.
3. Harry E. Thomas, *Handbook of Biomedical Instrumentation and Measurement*, Reston Publishing Company, 1974.
4. Marvin D. Weisis, *Biomedical Instrumentation*, Chilton Book Company, 1973.
5. Geddes L.A., Barker L.E., *Principles of Applied Medical Instrumentation*, John Willey and Sons, 1968.

Note: *External question paper shall be set following guidelines to paper setter given at Page 44.*

BTEE-605E PRINCIPLES OF COMMUNICATION SYSTEMS

Internal Marks:	**40**	**L**	**T**	**P**
External Marks:	**60**	**3**	**1**	**0**
Total Marks:	**100**			

Review of Communication Engineering: Introduction, amplitude modulation (AM), Frequency modulation (FM), their side bands, comparison, sampling theorem, different pulse modulation techniques- Pulse-amplitude modulation (PAM), Pulse width modulation (PWM), Pulse-position modulation (PPM) and Pulse-code modulation (PCM), frequency-division multiplexing (FDM), Time division multiplexing (TDM). Introduction to Fourier series and Fourier transform of periodic signals. Transfer functions and properties of practically realizable filters.

Radio Transmitters: Block diagram explanation of low and high level amplitude modulation (AM) transmitter, amplitude modulation broadcast transmitter, double sideband (DSB) transmitter, single sideband (SSB) transmitter and Independent sideband transmitter, block diagram and explanation of reactance tube and Armstrong Frequency modulation (FM) transmitters, Stereophonic FM broadcast transmitter.

Radio Receiver: Amplitude modulation diode detector, characteristics of radio receiver: sensitivity, selectivity, fidelity and image rejections, classification of radio receivers, Tuned radio frequency (TRF) receiver and super heterodyne receiver, block diagram explanation of amplitude modulation receiver, amplitude modulation receiver using Phase lock loop (PLL), double sideband and single sideband receiver, Independent sideband receiver, amplitude modulation broadcast receiver, noise in amplitude modulation systems, Frequency modulation detection, block diagram explanation of Frequency modulation receiver and stereophonic Frequency modulation broadcast receiver, noise in Frequency modulation systems.

Television Engineering: Principle of camera, introduction of picture tube, scanning, frame, field, sync video signal, vestigial sideband transmission, block diagram of Television (TV) receiver and working, Television (TV) transmitter.

RECOMMENDED BOOKS:

1. Mittal G. K., *Radio and TV Engineering*, Khanna Publishers
2. Kennedy, *Electronic communication system*, McGraw Hill
3. Gulati R. R., *Monochrome and colour TV*, Dhanpat Rai and Sons.
4. Taub and Schilling, *Principles of communications* , McGraw Hill

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BTEE-605F MICROELECTRONICS TECHNOLOGY

Internal Marks:	**40**	**L**	**T**	**P**
External Marks:	**60**	**3**	**1**	**0**
Total Marks:	**100**			

Introduction: Classification, Scale thick film, Thin film and hybrid integrated circuits, hybrid Integrated Circuit (IC) Fabrication and component design, resistor, capacitor, and inductor, Design and fabrication.

Monolithic Architecture: Process on silicon crystal, line growth, refining substrate slicing, Polishing, chemical vapour deposition, thermal oxidation, photolithography, diffusion, dopant impurities, diffusion system, ion implantation, metallization, isolation.

Monolithic Components: Bipolar IC process, Metal Oxide Silicon (MOS) IC process, Bipolar Junction Transistor (BJT) construction, diode instruction, Field Effect Transistor (FET) and MOS construction and resistor, capacitor, and inductor, op –amp and voltage regulator, design and fabrication.

Large Scale Integrated (LSI) Circuits: Brief introduction to LSI circuits, realizations of inter connection and realization of integrated elements.

Basic Very Large Scale Integrated (VLSI) Design: Basic MOS transistor and working, n-channel MOS and Complementary MOS (CMOS) fabrication, thermal aspects MOS and VLSI, some electric properties of MOS, design process, circuit component, system design and layout and scaling of MOS circuit, some application of VLSI circuit like Programmable Logic Array (PLA).

RECOMMENDED BOOKS:

1. Botkar K. R., *Integrated Circuits Interfacing Techniques in Digital design*, Khanna Publishers
2. Sze, *VLSI Design*, TMH
3. Gray Paul R., *Analog MOS IC Circuit Design*, IEEE Press.

Note: *External question paper shall be set following guidelines to paper setter given at Page 44.*

BTEE-606 Laboratory-X (Power Electronics and Drives)

		L	T	P
Internal Marks:	**30**			
External Marks:	**20**	**0**	**0**	**2**
Total Marks:	**50**			

Note: Atleast TEN experiments are to be performed in a semester. list of experiments is given below:

List of Experiments:

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

BTEE-607 Laboratory-XI (Power System-II)

		L	T	P
Internal Marks:	**30**			
External Marks:	**20**	**0**	**0**	**2**
Total Marks:	**50**			

Note: Atleast TEN experiments are to be performed in a semester. list of experiments is given below:

List of Experiments:

1. To study the performance of a transmission line. Also compute its ABCD parameters.
2. Study of Characteristics of over current 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 over current static relay.
6. To study the different types of faults on transmission line demostration 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 bimetal mini circuit breakers.
10. To study the characteristics of Distance Relay.
11. To find the breakdown strength of transformer oil.

BTEC-608 Laboratory-XII (Micro controller and PLC)

Internal Marks:	**30**	**L**	**T**	**P**
External Marks:	**20**	**0**	**0**	**2**
Total Marks:	**50**			

Note: Atleast TEN experiments are to be performed in a semester. list of experiments is given below:

List of Experiments:

1. Study of 8051/8031 Micro-controller kits.
2. Write a program to add two numbers lying at two memory locations and display the result.
3. Write a program for multiplication of two numbers lying at memory location and display the result.
4. Write a program to check a number for being ODD or EVEN and show the result on display.
5. Write a program to split a byte in two nibbles and show the two nibbles on display.
6. Write a program to arrange TEN numbers stored in memory location in ascending and descending order.
7. Write a program to find a factorial of a given number.
8. Study of interrupt structure of 8051/8031 micro-controllers.
9. Write a program to show the use of INT0 and INT1.
10. Write a program of flashing LED connected to port 1 of the micro-controller.
11. Write a program to control a stepper motor in direction, speed and number of steps.
12. Write a program to control the speed of DC motor.
13. Implementation of different gates using PLC.
14. Implementation of DOL and star delta starter using PLC.
15. Implement basic logic operations, motor start and stop operation using
    (i) Timers
    (ii) Counters
16. Motor forward and reverse direction control using PLC.
17. Write and implement the LD control program for rack feeder.
18. Make a PLC based system for separating and fetching work pieces.
19. Make a PLC based control system for conveyor belt.
20. Implement a PLC based traffic light control.

BTEE-801 POWER SYSTEM ANALYSIS

Internal Marks:	**40**	**L**	**T**	**P**
External Marks:	**60**	**3**	**1**	**0**
Total Marks:	**100**			

SYSTEM MODELLING: System modelling of synchronous machines, transformers, loads etc, per unit system, single line diagram of electrical networks, single phase impedance diagrams. Formulation of impedance and admittance matrices for the electrical networks.

LOAD FLOW STUDIES: Data for the load flow studies, Swing Bus, Formulation of simultaneous equations, Iterative solutions by the Gauss-Seidal method and Newton Raphson Method.

FAULT ANALYSIS: Transients on transmission line, short circuit of synchronous machine, selection of circuit breakers, Algorithm for short circuit studies, Symmetrical Component transformation, construction of sequence networks of power systems. Symmetrical Analysis of Unsymmetrical Line-to-ground (LG), Line-to line (LL), double line to ground (LLG) faults using symmetrical components.

POWER SYSTEM STABILITY: Steady state stability, Dynamics of a synchronous machine , Power angle equations , Transient stability, equal area criterion, Numerical solution of swing equation , factors effecting transient stability.

BOOKS RECOMMENDED:

1. Elgerd O.I., *Electric Energy Systems Theory*, Tata McGraw Hill
2. Nagrath I.J., Kolthari D.P., *Modern Power System Analysis*, Tata McGraw Hill
3. Stevenson W.D., *Elements of Power System* Analysis, McGraw Hill
4. Nagrath I.J. and Kothari D.P., *Power System Engineering, Tata McGraw Hill*
5. Arrillaga J. and Arnold C.P., *Computer Analysis of Power Systems, John Wiley & Sons*
6. Stagg Glenn W. and Ei-Abiad Ahmed H., *Computer Methods in Power System Analysis, Tata* McGraw Hill
7. Kusic G.L., *Computer Aided Power System analysis, Prentice Hall, India*

Note: *External question paper shall be set following guidelines to paper setter given at Page 44.*

BTEE-802 HIGH VOLTAGE ENGINEERING

Internal Marks:	**40**	**L**	**T**	**P**
External Marks:	**60**	**4**	**1**	**0**
Total Marks:	**100**			

Extra High Voltage (EHV) Transmission and Corona Loss: Need for EHV Transmission. Use of bundled conductors, corona characteristics of smooth bundled conductors with different configurations, Corona loss. Factors affecting the corona loss. Radio interference due to corona. Shunt and series compensation in EHV lines. Tuned power lines. Insulation Co-ordination.

High Voltage Direct Current (HVDC) Transmission: Advantages, disadvantages and economics of HVDC Transmission system. Types of Direct Current (DC) links, converter station equipment, their characteristics.

Insulating materials for High Voltage Applications of insulating materials used in power transformers rotating machines, circuit breakers, cables, power capacitors.

Conduction and breakdown in Gases, Liquids and Solid Dielectrics:

Solids - Intrinsic, electromechanical and thermal breakdown composite dielectrics, solid dielectrics used in practice.

Liquids:- Conduction and breakdown in pure and commercial liquids, suspended particle theory, cavitation and bubble theory, stressed oil volume theory, Liquids used in practice.

Gases:- Ionization process, Townsend's current growth equations, Ist and 2nd ionization coefficients. Townsend's criterion for breakdown. Streamer theory of breakdown, Pashen's law of Gases. Gases used in practice.

Generation of High Voltages: High Voltage Direct Current (HVDC), High Voltage Alternating Current (HVAC), Power frequency and High frequency: Impulse voltage and impulse current Generation, Tripping and contact of Impulse Generator. Measurement of voltage and current: High voltage direct current, Alternating current and Impulse voltage and currents.

BOOKS RECOMMENDED:

1. Bagamudre, Rakesh Das *Extra High Voltage A.C. Transmission Engineering*, New Age International Publishers.
2. Kimbark E.W., *High Voltage Direct Current Transmission*, Wiley-Interscience
3. Kamaraju V. and Naidu M.S., *High Voltage Engineering*, Tata McGraw-Hill Education
4. Jha R.S., *High Voltage Engineering, Dhanpat Rai*
5. Kuffel, E. and Abdullah, M., *High Voltage Engineering*, Pergamon Press
6. Wadhwa C. L., *High Voltage Engineering*, New Age Publications.
7. Padiyar, K.R. *HVDC Power Transmission Systems: Technology and System Interactions*, New Age International

Note: *External question paper shall be set following guidelines to paper setter given at Page 44.*

BTEE-803 NON-CONVENTIONAL ENERGY SOURCES

Internal Marks:	**40**	**L**	**T**	**P**
External Marks:	**60**	**3**	**1**	**0**
Total Marks:	**100**			

INTRODUCTION: Limitation of conventional energy sources, need and growth of alternative energy source, basic scheme and application of direct energy conservation.

MHD GENERATORS: Basic principles, gaseous, conduction and hall effect, generator and motor effect, different types of Magneto-Hydro-Dynamic (MHD) generator, types of MHD material, conversion effectiveness, analysis of constant area MHD generator, practical MHD generator, application and economic aspects.

THERMO-ELECTRIC GENERATORS: 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.

PHOTOVOLTAIC EFFECT AND SOLAR ENERGY: Photovoltaic effect, different types of photovoltaic cells, cell fabrication, characteristics of photovoltaic cells, conversion efficiency, solar batteries, application, solar radiation analysis, solar energy in India, solar collectors, solar furnaces and applications.

FUEL CELLS: Principle of action, Gibb's free energy, general description of fuel cells, types, construction, operational characteristics and application.

MISCELLANEOUS SOURCES: Geothermal system, hydro-electric plants, wind power, tidal energy, Bio-mass energy

BOOKS RECOMMENDED:

1. Gupta B. R., *Generation of Electrical Energy*, S. Chand.
2. Rai, G.D., *Non Conventional Energy Sources*, Khanna Publishers (2005).
3. Rao, S. and Parulekar, *B.B., Energy Technology: Non Conventional, Renewable and Conventional*, Khanna Publishers (2005).
4. Wadhwa, C.L., *Generation, Distribution and Utilization of Electric Energy*, New Age International (P) Limited, Publishers (2007).
5. *Simon , Christopher A., Alternate Source of Energy*, Rowman and LittleField Publishers Inc.(2007).
6. *Venikov, V.A. and Putyain, E.V., Introduction to Energy Technology*, Mir Publishers (1990).
7. Chakrabarti A., Soni M. L., Gupta P. V. and Bhatnagar U. S., *Power System Engineering*, Dhanpat Rai and Co.
8. Kothari D.P., Singal K.C. and Ranjan R., *Renewable Energy Sources and Emerging Technologies*, Prentice Hall (India)

Note: *External question paper shall be set following guidelines to paper setter given at Page 44.*

BTEE-804A POWER SYSTEM OPERATION AND CONTROL

Internal Marks:	**40**	**L**	**T**	**P**
External Marks:	**60**	**3**	**1**	**0**
Total Marks:	**100**			

Introduction to Power Generation Units: Characteristics and its variations,

Economic Operation of Power Systems: Fuel consumption, Characteristics of thermal unit, Incremental fuel rate and their approximation, minimum and maximum power generation limits.

Economic Dispatch: Economic dispatch problem with and without transmission line losses, Unit Commitment and solution methods. Hydrothermal scheduling: fixed-head and variable head, Short-term and Long-term,

Power System Control: Power system control factors, interconnected operation, tie-line operations, Reactive power requirements, during peak and off peak hours, Elementary ideas of load frequency and voltage, reactive power control; block diagrams of P-f and Q-V controllers, ALFC control, Static and Dynamic performance characteristics of automatic load frequency control (ALFC) and automatic voltage regulator (AVR) controllers, Excitation systems.

Power System Security: Factors affecting security, Contingency analysis, Network sensitivity, correcting the generation dispatch by using sensitivity method and linear programming.

Power flow analysis in AC/DC systems: General, modelling of DC links, solution of DC load flow, discussion, per unit system for DC quantities, solution techniques of AC-DC power flow equations.

BOOKS RECOMMENDED:

1. Nagrath, I.J. and Kothari, D.P., *Power System Engineering*, Tata McGraw Hill (2007).
2. Stevenson W.D. and Grainger J.J., *Power System Analysis*, McGraw Hill (2007).
3. Arrillaga J. and Smith Bruce, *AC-DC Power System Analysis*, IEE Press
4. Elgerd, O.I., *Electric Energy Systems Theory: An Introduction*. 2nd Ed., Tata McGraw Hill, 1983.
6. Dhillon J.S., Kothari D.P., *Power System Optimisation*, 2nd Ed., Prentice Hall India, 2010
7. Kundur P, "*Power System Stability and Control*", Third Reprint, tat McGraw Hill, 2007
8. Murthy, P.S.R., "*Power System Operation and Control*", Tata McGraw Hill, 1984.
9. Saadat Hadi, "*Power System Analysis*", Tata McGraw Hill Edition, 2002.
10. Wood, A.J., and B. Wollenberg, "*Power Generation, Operation and Control*", 2nd Edition, John Wiley, NY, 1996.

Note: *External question paper shall be set following guidelines to paper setter given at Page 44.*

BTEE-804B POWER SYSTEM STABILITY

Internal Marks:	**40**	**L**	**T**	**P**
External Marks:	**60**	**3**	**1**	**0**
Total Marks:	**100**			

Introduction: Basic concepts and definitions of angular stability and voltage stability, mid-term and long-term stability, classification.

Dynamic Modelling of Power System components: Generators, linear and non linear model using d-q transformation, power capability curve, reactive capability limits, Excitation systems, Turbine and speed governing systems, loads.

Transient Stability: Overview, Simulation of power system dynamic response, Analysis of unbalanced faults, protective relaying and case study of large power systems.

Small Scale Stability Analysis: State space representation, Eigen value and participation factor Analysis,

Voltage Stability: Basic concepts, Voltage collapse, P-V and Q-V curves, impact of load, static and dynamic analysis of voltage stability, prevention of voltage collapse.

BOOKS RECOMMENDED:

1. Kundur P, *Power System Stability and Control*, Third Reprint, Tata McGraw Hill, 2007.
2. Kimbark, Edward Wilson., *Power System Stability*, vol. 1 and 2, John Wiley and sons, 1995.
3. Nagrath, I.J. and Kothari, D.P., *Power System Engineering*, Tata McGraw Hill (2007).
4. Stevenson W.D. and Grainger A.P.S.A.., *Power System Analysis*, McGraw Hill (2007).
5. Elgerd, O.I., *Electric Energy Systems Theory: An Introduction*. 2nd Edition, McGraw Hill, 1983.
6. Murthy, P.S.R., "*Power System Operation and Control*", Tata McGraw Hill, 1984.
7. Saadat Hadi, "*Power System Analysis*", Tata McGraw Hill Edition, 2002.
8. Chakarborty A.K., Haldar S., *Computer Aided Power System Analysis*, Prentice Hall, 2006
9. Grigsby Leonard L., *Power System Stability and Control*, 3rd edition, CRC press, 2012.
10. Taylor C.W., *Power System Voltage Stability*, McGraw-Hill, 1994**.**

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BTEE-804C DIGITAL SIGNAL PROCESSING

Internal Marks:	**40**	**L**	**T**	**P**
External Marks:	**60**	**3**	**1**	**0**
Total Marks:	**100**			

Introduction: Signals, Systems and Signal processing, Classification of Signals, Concept of frequency in continuous time and discrete time signals.

Discrete Time Signals and Systems: Discrete time signals, Discrete time systems, Analysis of discrete time linear time-invariant systems, Discrete time systems described by difference equations, Implementation of discrete system, Correlation of discrete time signals.

Z-Transform: The Z-transformation, properties of Z-transformation, Rational Z-transformation, Inversion of Z-transform, Analysis of linear time invariant systems in Zdomain.

Frequency Analysis of Signals and Systems: Frequency analysis of continuous time signals, Frequency analysis of discrete time signals, Properties of Fourier Transform for discrete time signals, Frequency domain characteristics of linear time invariant systems, linear invariant systems as frequency selective filters, Inverse systems and de-convolution.

The Discrete Fourier Transform: Frequency domain sampling, Properties of Discrete Fourier Transform (DFT), Linear filtering methods based on DFT, Frequency analysis of signals using the DFT.

Design of Digital Filters: General considerations, Design of Finite Impulse Response (FIR) filters, Design of Infinite Impulse Response (IIR) filters from analog filters, Frequency transformations, Design of digital filters based on least-square method and window method, Comparison of IIR and FIR filters.

BOOKS RECOMMENDED:

1. Oppenheim A.V. and Schafer, R.W., *Digital Signal Processing*, Prentice Hall (India)
2. Kuo, Sen-Maw and Gan, Woon-Seng, *Digital Signal Processing* architectures, Implementations, and Applications McGraw Hill
3. Proakais John G., *Digital Signal Processing: Principles, Algorithms, and Applications*, Pearson Education 4th Ed. (2007)
4. Richard G Lyons, *Understanding Digital Signal Processing*, Pearson Education Publications.
5. Mitra K. Sanjit, Digital Signal Processing, 3rd ed. Tata McGraw Hill
6. Hayes Mansen, *Schaum's Outline of Digital Signal Processing*, Tata MGraw Hill, (2001)

Note: *External question paper shall be set following guidelines to paper setter given at Page 44.*

BTEE-804D INDUSTRIAL PROCESS CONTROL

Internal Marks:	**40**	**L**	**T**	**P**
External Marks:	**60**	**3**	**1**	**0**
Total Marks:	**100**			

Description And Modeling of Various Industrial Processes: Model Classification, Mathematical Models, Physical Models, Analog Models, Estimation of Model Parameters, System Identification, Experimental Nature of Simulation, Steps Involved in Simulation Studies, Validation of Simulation Models, Computer Simulation of Continuous and Discrete Systems, Examples

Process Control: Types and Description of Processes, Blending, batch processes, compressor and chiller controls, distillation control, steam turbine and water treatment controls, boiler controls, reactor controls

Conventional Controllers: On-off Controllers, Cascade and Feed forward Controllers, Split Range Controllers, ratio controls, Single loop, multi loop and self tuning controllers, set point control (SPC), discrete digital control (DDC)

Intelligent Controllers: Fuzzy logic control, programmable logic controllers, PC based system, conventional and Widows-NT based distributed control system (DCS) systems, artificial intelligence and neural networks, smart and intelligent transmitters.

BOOKS RECOMMENDED:

1. Padmanabhan, Tattamangalam R, *Industrial Process Instrumentation and control* Springer Publishing
2. Andrew W.G. and Williams H.B., *Applied Instrumentation in the Process Industries,* Gulf Publishing,Houston
3. Nolting B.E., *Instrumentation Reference Book,* Elsevier India Pvt, New Delhi
4. Liptak B.G., *Instrument Engineer's Handbook (Process Control),* Elsevier India Pvt ,New Delhi.

Note: *External question paper shall be set following guidelines to paper setter given at Page 44.*

BTEE-804E NETWORKS AND DATA COMMUNICATION

Internal Marks:	**40**	**L**	**T**	**P**
External Marks:	**60**	**3**	**1**	**0**
Total Marks:	**100**			

Introduction: Basic Concepts of analog and digital signals, data transmission concepts, Analog and digital transmission, transmission impairments

Transmission Media: Guided and Un-guided media, Performance, Shannon Capacity, Media Computerization

Encoding and Modulating: Digital–to-Digital conversion, Analog and digital conversion, Digital to Analog conversion, Analog to Analog conversion

Digital Data Communication: Digital data transmission, Data terminal equipment (DTE) - data circuit-terminating equipment (DCE) Interface, Electronic Industries Alliance (EIA)-449, EIA- 530, X.21 (Communication standard), Modems, Cable Modems

Multiplexing And Switching: Frequency-division multiplexing **(**FDM), wavelength-division multiplexing (WDM), Time-division Multiplexing (TDM) application- telephone systems, Digital subscriber line (DSL), Par Circuit switching , Packet Switching and Message switching virtual circuits

Spread Spectrum: Concept, Frequency hoping spread spectrum, direct sequence spread spectrum, code division Multiple Access

Error Detection and Correction: Types of Errors, Detection, Vertical Redundancy Check (VRC), longitudinal redundancy check (LRC), cyclic redundancy check (CRC), Checksum, Error Correction

Protocol Architecture: Protocols, Standards, OSI (Open Systems Interconnection) model, TCP (Transmission Control Protocol)/ IP (Internet Protocol) Protocol Architecture

BOOKS RECOMMENDED:

1. Ulylers D Balck, *Data Communication and Distributed Networks*, Prentice Hall (India)
2. Andrew S. Teanebaum, *Computer Networks*, Prentice Hall (India)
3. William Stallings, *Data and Computer Communication*, Pearson Education
4. Behrouz A Ferouzan *Data Communications and Networking*, Tata McGraw Hill.

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BTEE-804F DATA MINING AND PATTERN RECOGNITION

Internal Marks:	**40**	**L**	**T**	**P**
External Marks:	**60**	**3**	**1**	**0**
Total Marks:	**100**			

Data Mining: What is data mining, on what kind of data, Data Mining Functionalities

Data Warehouse: Difference Between operational database systems and data warehouses, A multidimensional data model, Data Warehouse architecture, data warehouse architecture, Data Warehouse implementation.

Data preprocessing: Data cleaning, data integration and transformation, data reduction.

Data Mining Query Language: Characterization and Comparison, Generalization, Mining association rules in large databases, constraint based association Mining Classification and prediction Classification by decision Tree Induction, Bayesian classification, classification by Back propagation Cluster analysis Partitioning Methods, Hierarchical methods, and Density and Grid based methods, Mining complex types of data, applications and trends in data mining, Social impacts of data mining.

Pattern recognition: Its importance and applications, applications in Bioinformatics, recognizing important bio-informatics sequences, other applications of pattern discovery.

Laboratory Work: Implementation of various data mining techniques like classification, clustering, generalization, cleaning etc.

BOOKS RECOMMENDED:.

1. Pal. Sankar K. and Mitra P., *Pattern Recognition Algorithms for Data Mining*, Chapman and Hall/CRC
2. Elden L. *Matrix Methods in Data Mining and Pattern Recognition.* SIAM, 2007.

Note: *External question paper shall be set following guidelines to paper setter given at Page 44.*

BTEE-805A POWER QUALITY MONITORING AND CONDITIONING

Internal Marks:	**40**	**L**	**T**	**P**
External Marks:	**60**	**3**	**1**	**0**
Total Marks:	**100**			

Overview and definition of power quality (PQ): Sources of pollution, and regulations, Power quality problems rapid voltage fluctuations voltage unbalance, Voltage dips and voltage swells, Short duration outages,

Definitions Voltage sag analysis and mitigation: Sag caused by motor starting, Sag caused by utility fault clearing, Sag mitigation, Sag magnitude and duration calculations in single-phase systems, Equipment performance in presence of sag, Computers, Alternating current (AC) and direct current (DC) drives.

Harmonics: Effects-within the power system, Interference with communication Harmonic measurements. Harmonic elimination.

Harmonic distortion: Power system harmonics: harmonic analysis, Harmonic sources-the static converters, Transformer magnetization and non-linearities, Rotating machines, arc furnaces, Fluorescent lighting. Introduction to power converters, Fourier analysis, Total harmonic distortion, rms and average value calculations, Arcing and saturable devices, Effects of harmonic distortion, System response characteristics.

Principles for controlling harmonics: Locating sources of harmonics, Passive and active filters, Harmonic filter design.

Monitoring power quality: Monitoring essentials, Power quality measuring equipment, Current industry trends.

Power Conditioning: Electric power conditioning, Active and passive filters, IEEE, IEC, ANSI standards, Power Acceptability Curves, Various standards

BOOKS RECOMMENDED:

1. Beaty, H. and Santoso,S., *Electrical Power System Quality*, McGraw□Hill (2002).
2. Kennedy, B., *Power Quality Primer*, McGraw Hill (2000).
3. Bollen, M.H.J., *Power Quality Problems: Voltage Sag and Interruptions*, IEEE Press (2007).
4. Mohan, N., *Power Electronics*, New Age International (P) Limited, Publishers (2007).

Note: *External question paper shall be set following guidelines to paper setter given at Page 44.*

BTEE-805B HIGH VOLTAGE DIRECT CURRENT TRANSMISSION

Internal Marks:	**40**	**L**	**T**	**P**
External Marks:	**60**	**3**	**1**	**0**
Total Marks:	**100**			

Direct Current (DC) power transmission technology: Introduction, comparison of Alternating Current (AC) and Direct Current (DC) transmission, application of DC transmission, application of DC transmission, description of DC transmission system, Configurations, planning for High Voltage Direct Current (HVDC) transmission, modern trends in DC transmission. Introduction to Device: Thyristor valve, valve tests, recent trends.

Analysis of High Voltage Direct Current (HVDC) converters: Pulse number, choice of converter configuration, simplified analysis of Graetz circuit, converter bridge characteristics, characteristics of a twelve-pulse converter, detailed analysis of converters with and without overlap.

Converter and HVDC system control: General, principles of DC link control, converter control characteristics, system control hierarchy, firing angle control, current and extinction angle control, starting and stopping of DC link, power control, higher level controllers, telecommunication requirements.

Converter faults and protection: Introduction, converter faults, protection against over-currents, over-voltages in a converter station, surge arresters, protection against over-voltages.

Smoothing reactor and DC line: Introduction, smoothing reactors, DC line, transient over voltages in DC line, protection of DC line, DC breakers, Monopolar operation, effects of proximity of AC and DC transmission lines.

Component models for the analysis of AC/DC systems: General, converter model, converter control, modelling of DC network, modelling of AC networks.

RECOMMENDED BOOKS:

1. Bagamudre, Rakesh Das *Extra High Voltage A.C. Transmission Engineering*, New Age International Publishers.
2. Kimbark E.W., *High Voltage DC Transmission*, Wiley-Interscience
3. Kamaraju V. and Naidu M.S., *High Voltage Engineering*, Tata McGraw-Hill Education
4. Jha R.S., *High Voltage Engineering, Dhanpat Rai*
5. Kuffel, E. and Abdullah, M. High Voltage Engineering, Pergamon Press
6. Wadhwa C. L., *High Voltage Engineering*, New Age Publications.
7. Padiyar, K.R. HVDC Power Transmission Systems: Technology and System Interactions, New Age International

Note: *External question paper shall be set following guidelines to paper setter given at Page 44.*

BTEE-805C VIRTUAL INSTRUMENTATION

Internal Marks:	**40**	**L**	**T**	**P**
External Marks:	**60**	**3**	**1**	**0**
Total Marks:	**100**			

Introduction: Virtual Instrumentation - Definition, flexibility, Block diagram and Architecture of Virtual Instruments, Virtual Instruments versus Traditional Instruments, Review of LABVIEW software in virtual Instrumentation and programming techniques.

Data Acquisition In Virtual Instrumentation: Analog-to-Digital, Digital-to-Analog converters, plug-in Analog input/output cards, Digital Input/ Output cards, Organization of the Data acquisition (DAQ)-VI system, Opto-isolation, Performing analog input and analog output, Scanning multiple analog channels, Issues involved in selection of data acquisition cards, Data acquisition modules with serial communication.

Communication Networked Modules: Introduction to Personal Computer (PC) Busses, Local busses: Industry Standard Architecture (ISA), Peripheral Component Interconnect (PCI), RS232, RS422, RS485, Interface Busses, Universal Serial Bus (USB), Personal Computer Memory Card International Association (PCMCIA), Virtualization eXperience Infrastructure (VXI), Signal Conditioning eXtensions for Instrumentation (SCXI), PCI eXtensions for Instrumentation (PXI). Instrumentation Buses: Modbus, General Purpose Interface Bus (GPIB) Networked busses, ISO (International Organization for Standardization)/OSI (Open Systems Interconnection) Reference model, Ethernet TCP (Transmission Control Protocol)/ IP (Internet Protocol) protocols.

Real Time Control in Virtual Instrumentation and Applications: Design of ON/OFF controller, simulation of industrial instruments and systems, Virtual Instrumentation functions and objects including signal processing and analysis. Typical instruments and systems -digital storage oscilloscope, spectrum analyzer, waveform generator, Data visualization from multiple locations; Distributed monitoring and control devices.

BOOKS RECOMMENDED:

1. Wells L. K. and Travis J., *Labview for everyone*, Prentice Hall
2. Gupta S. and Gupta J.P., *PC interfacing for data acquisition and process control*, ISA
3. Rahman Jamal and Herbert Picklik, *Labview — Applications and solutions*, National Instruments Release
4. Gary Jhonson, *Labview Graphical programming*, McGraw Hill

Note: *External question paper shall be set following guidelines to paper setter given at Page 44.*

BTEE-805E EMBEDDED SYSTEM

Internal Marks:	**40**	**L**	**T**	**P**
External Marks:	**60**	**3**	**1**	**0**
Total Marks:	**100**			

Introduction: Review of Embedded Hardware: Terminology, Gates, Timing Diagram, Memory, Microprocessor Buses, Direct Memory Access, Interrupts, Built instructions on the Microprocessor. Conventions used on Schematic, Interrupts, Microprocessor Architecture, Interrupt Basic, Shared Data Problem,Interrupt Latency.

PIC Micro controller and Interfacing: Introduction, CPU Architecture, Registers, Instruction Sets, Addressing Modes, Programs, Interfacing Methods, Parallel I/O Interface, Parallel Port Interface, Memory Interfacing, High Speed I/O Interfacing, Interrupt, Interrupt Service Routine, features of Interrupts, Interrupt vector and Priority, Timing Generation and Measurements, Input Capture, Output Compare, Frequency Measurement, Serial I/O Device RS232, RS845, Analog Interfacing, Applications.

Software Development and Tools: Embedded System Evolution Trends, Round – Robin, Robin with Interrupts, Function Scheduling architecture, Algorithms, Introduction to assembler, Compiler and Cross compilers and Integrated Development Environment (IDE), Object Oriented Interfacing, Recursion, Debugging Strategies, Simulators.

Real Time Operating Systems (RTOS): Task And Task States, Tasks and Data, Semaphores and shared data, operating system services, Message queues, Timer Function, Events, Memory Management, Interrupt Routines in an RTOS Environment, Basic Design Using RTOS.

BOOKS RECOMMENDED:

1. Gajski D.D., Vahid F., Gong J., Narayan S., *Specification and Design of Embedded Systems*, Prentice Hall.
2. Steve Heath, Newnes *Embedded systems Design*, Prentice Hall.
3. Balarin F., Chiodo, *Hardware Software Co-design of Embedded Systems*, Academic Publishers.

Note: *External question paper shall be set following guidelines to paper setter given at Page 44.*

BTEE-805F VISUAL PROGRAMMING

Internal Marks:	**40**	**L**	**T**	**P**
External Marks:	**60**	**3**	**1**	**0**
Total Marks:	**100**			

Introduction: Visual programming basics, Application framework fundamental, windows programming (Win32 programming), and Visual C++.memory management, Dynamic-link library (DLLs),Win32, Application programming interface (API).

Visual C++ components: Resource compiler, Microsoft Foundation Classes (MFC), modal Dialog, Windows Common Control, the Modeless Dialog and Windows Common Dialogs, ActiveX Control, Bitmap, Reading and Writing Documents, Serial digital interface (SDI), multiple document interface (MDI) applications.

Socket Programming using Win Sock, TCP/IP (TCP (Transmission Control Protocol/Internet Protocol), Document-View Structure, Microsoft Foundation Class (MFC) Libraries viz Cview, Cfile, Cpoint, Cdialog.

WIN32 Programming: WIN32 programming, Difference between a Windows program and a typical DOS program, Windows Programming modal, Windows Memory management, A skeletal Windows Application: WinMain function, Window Function, Componants of a Skeletal Application, Windows style, Device context, Creation of LISTBOX class, Dialog Boxes and SCROLLBAR class.

BOOKS RECOMMENDED:

1. David J. Kruglenski *VISUAL C++ programming*, Microsoft Press
2. Newcomer, Addison, *WIN32 Programming*, Wesley
3. Petzold , Charles, *Programming Windows 3.1*, Microsoft press.

Note: *External question paper shall be set following guidelines to paper setter given at Page 44.*

BTEE-806 Laboratory-XIII (POWER SYSTEM ANALYSIS)

		L	T	P
Internal Marks:	**30**			
External Marks:	**20**	**0**	**0**	**2**
Total Marks:	**50**			

Note: Atleast TEN experiments are to be performed in a semester. List of experiments is given below:

List of Experiments:

1. Design of transmission systems for given power and distance.
2. Short circuit calculations and calculations of circuit breaker ratings for a power system network.
3. Design of substations
4. Design of distribution systems
5. Y-bus formation
6. Z-bus formulation
7. Load flow analysis by Gauss Seidal method
8. Load flow analysis by Newto Raphson method
9. Fault analysis for line-to-line (L-L), Line-to-Ground (L-G) etc
10. Design of underground cabling system for substation.
11. To obtain power system stability on High Voltage Alternating current (HVAC) system with the help of Flexible Alternating Current Transmission Systems (FACTS) devices.
12. Optimal Capacitor placement on a system having variable reactive power and low voltage profile.
13. To obtain relay co-ordination on a power system.
14. To obtain optimal generator pricing on hydro-thermal and renewable energy systems.
15. To find synchronous reactances (Transient, sub-transient) during fault analysis.

BTEE-807 PROJECT WORK

Internal Marks:	**60**	**L**	**T**	**P**
External Marks:	**40**	**0**	**0**	**6**
Total Marks:	**100**			

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

BTEE-808 SEMINAR

Internal Marks:	**100**	**L**	**T**	**P**
External Marks:		**0**	**0**	**2**
Total Marks:	**100**			

Students will be required to prepare a report on a given topic related to latest developments in electrical engineering and deliver a seminar on that topic along with seminar report.

BTEE-701 SOFTWARE TRAINING

		L	T	P
Internal Marks:	**150**			
External Marks:	**100**	**0**	**0**	**2**
Total Marks:	**200**			

Students will be provided training on any of three of the programming language/ application softwares. All the applications shall be related to the Electrical components and systems.

- Any high level procedure oriented or object oriented programming laguange. Such language should be covered under regular or elective subject(s).
- MatLab
- LabView
- PSpice
- PSCAD

Students will undertake one project related to the Electrical components and systems based on the software training imparted during the semester in a group of three students. All the group will select different projects. Students will be required to prepare a report on the Project undertaken and deliver a seminar on the project undertaken. The students will be evaluated based on Project undertaken, project report, seminar and viva-voce examination.

Guidelines to Paper Setters

1. The question paper shall have three sections:
   Section A of 20 marks
   Section B of 20 marks
   Section C of 20 marks.
2. **Section A** is compulsory shall contain only **ONE** question with TEN sub-question carrying **two marks** each distributed from the entire syllabus. These questions shall be of conceptual nature and of short answer type to test the basic grasp of the subject matter by the students.
3. **Section B** shall contain **FIVE** questions and students shall be asked to answer any **FOUR** questions. Each question will carry **five marks**. These questions are to be set from different parts of syllabus with not more than one question from one part.
4. **Section C** shall contain **THREE** questions students shall be asked to answer any **TWO** questions. Each question shall carry tem marks. These questions are to be set from those parts of syllabus, which are not covered in Section B and restricted to not more than one question from each part.
5. At least 40% of the question should be numerical wherever applicable.
6. The paper setter shall provide detailed marking instructions and solution to numerical problems for evaluation purpose in the separate envelopes provided for solution.
7. The two different question papers should not contain more than 15% same/similar questions.