COURSES SCHEME

&

SYLLABUS

FOR

B.E.
ELECTRICAL ENGINEERING

2014

SEMESTER-I

S. No.	Course No.	Course Name	L	T	P	Cr
1.	UMA001	MATHEMATICS–I	3	1	0	3.5
2.	UPH001	PHYSICS	3	1	2	4.5
3.	UES002	SOLID MECHANICS	3	1	2	4.5
4.	UHU002	BUSINESS & TECHNICAL COMMUNICATION	2	0	2	3.0
5.	UTA001	ENGINEERING GRAPHICS	2	0	4	4.0
6.	UTA003	COMPUTER PROGRAMMING	3	0	2	4.0
7.	UDP004	INTRODUCTION TO ELECTRICAL ENGINEERING	2	0	0	2.0
		TOTAL				**25.5**

SEMESTER-II

S. No.	Course No.	Course Name	L	T	P	Cr
1.	UCB008	APPLIED CHEMISTRY	3	1	2	4.5
2.	UMA002	MATHEMATICS–II	3	1	0	3.5
3.	UES008	ENGINEERING THERMODYNAMICS	3	1	0	3.5
4.	UES001	ELECTRICAL AND ELECTRONIC SCIENCE	3	1	2	4.5
5.	UTA002	MANUFACTURING PROCESS	2	0	3	3.5
6.		ELECTIVE-I				3.5
		TOTAL				**23.0**

SEMESTER – III

S. No.	Course No.	Course Name	L	T	P	Cr
1	UEI201	ANALOG ELECTRONIC DEVICES AND CIRCUITS	3	1	2	4.5
2	UEE301	DIRECT CURRENT MACHINES AND TRANSFORMERS	3	1	2	4.5
3	UEE302	ELECTROMAGNETIC FIELD THEORY	3	1	0	3.5
4	UMA031	OPTIMIZATION TECHNIQUES	3	1	0	3.5
5	UHU031	ORGANIZATIONAL BEHAVIOUR	3	1	0	3.5
6	UEE303	POWER GENERATION AND ASSOCIATED ECONOMICS	3	1	0	3.5
7	UEI303	TECHNIQUES ON SIGNAL AND SYSTEMS	3	1	0	3.5
TOTAL			**21**	**7**	**4**	**26.5**

SEMESTER – IV

S. No.	Course No.	Course Name	L	T	P	Cr
1	UEE401	ALTERNATING CURRENT MACHINES	3	1	2	4.5
2	UEI301	DIGITAL ELECTRONICS	3	1	2	4.5
3	UES031	FLUID MECHANICS	3	1	2	4.5
4	UHU034	HUMAN VALUES, HUMAN RIGHTS AND IPR	2	1	0	2.5
5	UMA032	NUMERICAL AND STATISTICAL METHODS	3	1	2	4.5
6	UEE402	TRANSMISSION AND DISTRIBUTION OF POWER	2	1	0	2.5
7	UEN003	ENVIRONMENTAL STUDIES	2	0	0	2.0
TOTAL			**18**	**6**	**8**	**25.0**

SEMESTER – V

S. No.	Course No.	Course Name	L	T	P	Cr
1	UEI501	CONTROL SYSTEMS	3	1	2	4.5
2	UEE503	NETWORK ANALYSIS AND SYNTHESIS	3	1	0	3.5
3	UEE502	HIGH VOLTAGE ENGINEERING	3	0	2	4.0
4	UEE504	POWER ELECTRONICS	3	1	2	4.5
5		ELECTIVE-II	3	1	0	3.5
6	UTA012	INNOVATION AND ENTREPRENEURSHIP	1	0	2	4.5
7	UEE591	SUMMER TRAINING (6 WEEKS AFTER 2ND YEAR DURING SUMMER VACATION)	-	-	-	4.0
TOTAL			**16**	**4**	**8**	**28.5**

SEMESTER – VI

S. No.	Course No.	Course Name	L	T	P	Cr
1	UEI503	DIGITAL SIGNAL PROCESSING AND APPLICATIONS	3	1	0	3.5
2	UEE604	FLEXIBLE AC TRANSMISSION SYSTEMS	3	1	0	3.5
3	UEI504	MICROPROCESSOR AND APPLICATIONS	3	1	2	4.5
4	UEE605	POWER SYSTEM ANALYSIS AND STABILITY	3	1	2	4.5
5	UEE603	SWITCHGEAR AND PROTECTION	3	0	2	4.0
6	UEE691	ENGINEERING DESIGN PROJECT	-	-	2	5.0
TOTAL			**15**	**4**	**8**	**25.0**

SEMESTER – VII

S. No.	Course No.	Course Name	L	T	P	Cr
1	UEE801	ELECTRIC DRIVES	3	1	2	4.5
2	UHU081	ENGINEERING ECONOMICS	3	1	0	3.5
3	UEE802	INTELLIGENT ALGORITHMS IN POWER SYSTEMS	3	0	2	4.0
4	UEE804	OPERATION AND CONTROL OF POWER SYSTEMS	3	1	2	4.5
5		ELECTIVE –III	3	1	0	3.5
6	UEE793	CAPSTONE PROJECT	-	-	2	8.0
TOTAL			**15**	**4**	**8**	**28.0**

SEMESTER – VIII

S. No.	Course No.	Course Name	L	T	P	Cr
1	UEE791	PROJECT SEMESTER	–	–	–	16.0
OR						
(ALTERNATE SEMESTER)						
1	UEE792	PROJECT	–	–	–	6.0
2	UEE712	ELECTRICAL ENGINEERING MATERIALS	3	1	0	3.5
3	UPH061	MODERN PHYSICS	3	1	0	3.5
4	UEE711	ALTERNATE SOURCES OF ENERGY	3	0	0	3.0
TOTAL			**9**	**2**	**0**	**16.0**

ELECTIVE-I

S. No.	Course No.	Course Name	L	T	P	Cr
1	UTA005	INTERNET AND JAVA PROGRAMMING	3	0	1	3.5
2	UTA006	WEB DESIGNING	3	0	1	3.5

ELECTIVE – II

S. No.	Course No.	Course Name	L	T	P	Cr
1	UCS401	COMPUTER SYSTEM ARCHITECTURE	3	1	0	3.5
2	UEI622	DATA NETWORKS	3	1	0	3.5
3	UEI623	OBJECT ORIENTED PROGRAMMING AND APPLICATIONS	2	1	2	3.5
4	UEI511	PRINCIPLES OF COMMUNICATION ENGINEERING	3	1	0	3.5
5	UEE522	ENERGY AUDITING AND MANAGEMENT	3	1	0	3.5
6	UEE523	HIGH VOLTAGE TRANSMISSION SYSTEMS	3	1	0	3.5
7	UEE524	POWER QUALITY MONITORING AND CONDITIONING	3	1	0	3.5
8	UEE501	GENERALIZED THEORY OF ELECTRICAL MACHINES	3	1	0	3.5

ELECTIVE – III

S. No.	Course No.	Course Name	L	T	P	Cr
1	UCS048	DATA STRUCTURE AND IT	3	1	0	3.5
2	UTA004	INFORMATION TECHNOLOGY	2	1	2	3.5
3	UEE841	INDUSTRIAL ELECTRONICS	2	1	2	3.5
4	UEI602	MICROCONTROLLERS AND APPLICATIONS	3	1	0	3.5
5	UEE521	ELECTRIC MACHINE DESIGN	3	1	0	3.5
6	UEI841	ADVANCED CONTROL SYSTEMS	3	1	0	3.5

UDP004: INTRODUCTION TO ELECTRICAL ENGINEERING

L	T	P	Cr
2	0	0	2.0

Course Objectives: To teach the basic terms used in Electrical Engineering and their importance. To give over-view of Generation, Transmission, Distribution, Utilization and control of Electric Power.

Introduction: Background of electricity, Symbols of various electrical components, Active and passive elements, Voltage and current sources, Electric circuit, Energy storage elements, Active power, Reactive power and Power factor.

Generation: Conventional and non-conventional energy resources, their types, Benefits and cost, AC and DC power generation and Scenario of power generation in India.

Transmission and Distribution of Power: Supply systems and their comparison, Types of substations, Substation equipment, Single line diagram of power system network, Protection Devices, Requirements of Earthing of system, General Earthing, Role of power factor improvement devices and Power quality

Power control &Utilization of Electrical energy: History of semiconductor devices and their applications for power control , Recent trends in utilization, House wiring, Electronic ballast, Battery charger, Power and Energy meter.

Safety and Standards: Energy Conservation and efforts, Electricity hazards, Safety guidelines, Electricity specifications and standards.

Course Learning Outcomes (CLO):

- Types of generation in India
- Transmission and distribution networks
- Protection devices and Earthing
- Energy conservation, Safety guidelines, Electricity specifications and standards.

Text Books:

1. *Electric Power Generation, Transmission and Distribution, PHI, 2nd Edison: 2008.*
2. *Del Toro, V., Electrical Engineering Fundamentals, Prentice–Hall of India Private Limited (2004).*
3. *P.S. Satnam & P.V. Gupta, Substation Design &Equipment,, Dhanpat Rai Publishers, 2012.*

Reference Books:

1. *J.D. McDonald, Electric Power Substations Engineering, Second Edition CRC Press, 2007.*
2. *Bare ACT 2000, The Indian Electricity Rules, 1956, Law Publishers*

UES001: ELECTRICAL & ELECTRONIC SCIENCE

L	T	P	Cr
3	1	2	4.5

Course Objectives: **To inculcate the basics and solution methodology using network laws and theorems. To impart knowledge about the Principle, Construction, Working, Characteristics and Applications of Electro-mechanical conversion devices and basic Electronic devices**

Introduction: Basic electrical quantities, Electric circuit sources and circuit elements and their behavior (Active and Passive).

D.C. Networks: Mesh and Nodal analysis, Star-delta transformation, Superposition theorem, Thevenin's theorem, Norton's theorem, Maximum power transfer theorem, Millman's theorem and Reciprocity Theorem; Steady state and transient response of RL, RC and RLC Circuits.

Sinusoidal Steady-State Response of Circuits: Concept of Phasors, Phasor representation of circuit elements, Complex notation representation, Series and parallel circuits, Power and power factors, Resonance in series and parallel circuits, Balanced and unbalanced 3-phase circuit - voltage, Current and power relations, 3-phase power measurement.

Magnetic Circuits: Concept of magnetic fields, Analysis of Magnetic circuits, AC excitation of magnetic circuit, Interaction of currents and fields, B–H curve, Iron Losses, Fringing and stacking, Energy stored in magnetic fields.

Supply Systems: AC Supply system (Single phase, three phase–three wire, and three-phase-four wire), DC supply system, Their specifications and comparison.

Electromagnetic Induction: Faraday's law, self and mutual inductance, Dot convention, Equivalent inductance, Energy stored in electric fields.

Concepts of Electro-mechanical Conversion Principles: Constructional features of transformer and rotating machines, their operating principles and applications, EMF and torque equations, equivalent circuits , phasor analysis and calculation of performance indices.

Electronics Devices: Working and V-I characteristics and applications of diode, Zener Diode, BJT, FET, Thyristor and IGBT.

Course Learning Outcomes (CLO):

- **Application of network laws and theorems to solve electric circuits**
- **Types of supply system**
- **Phasor and complex notation representation of series, parallel and combined circuits**
- **Principle, construction, characteristics and applications of Electro-Mechanical energy conversion devices and basic Electronic devices**

Laboratory Work:

Network laws and theorems, A.C. series and parallel circuits, Measurement of power in 3 phase circuits, Reactance calculation of variable reactance choke coil, open circuit and short circuit tests on single phase transformer, Starting of rotating machines, V-I characteristics of diode and Zener diode, Input-output characteristics of BJT, Diode as rectifier.

Textbooks:

1. *Hughes, E., Smith, I.M., Hiley, J. and Brown, K., Electrical and Electronic Technology, Prentice Hall (2008) 10th ed.*

2. *Nagrath, I.J. and Kothari, D.P., Basic Electrical Engineering, Tata McGraw Hill (2002).*
3. *Naidu, M.S. and Kamashaiah, S., Introduction to Electrical Engineering, Tata McGraw Hill (2007).*

Reference Books:

1. *Chakraborti, A., Basic Electrical Engineering, Tata McGraw–Hill (2008).*
2. *Del Toro, V., Electrical Engineering Fundamentals, Prentice–Hall of India Private Limited (2004).*

UEE301: DIRECT CURRENT MACHINES AND TRANSFORMERS

L	T	P	Cr.
3	1	2	4.5

Course Objective: To introduce the fundamentals of dc machines and transformer.

General concepts of Rotating Electrical Machines: Electromagnetic torque, Reluctance torque, Constructional features of rotating electrical machines, Classifications of rotating electrical machines, Construction of DC machines.

DC Generators: Classification of DC generator, Condition for maximum efficiency, Armature reaction, Compensating windings, Commutation, Value of reactance voltage, Methods of improving commutation, Equalizer rings, Characteristic of DC generators, Voltage build up of shunt generators, Voltage regulation, Parallel operation of DC generators, Applications of DC generators.

DC Motors: Classification of DC motor, Condition for maximum mechanical power, Armature torque, Characteristic of DC motors, Speed control of DC motors, Ward–Leonard control (Voltage control), Three point starter, Four point starter, DC shunt motor starter design, Electric breakings of DC shunt and series motors, Testing of DC machines: Brake test, Swinburne's test, Hopkinson's test or back to back test, Retardation test or Running test, Field's test, Applications of DC motors.

Single Phase Transformers: Introduction, Basic principle, Types of transformer, Construction, Transformer on no–load and on load, Equivalent circuit, Open circuit and short circuit, Separation of core losses, Per unit representation, Voltage regulation of a transformer, Losses in a transformer, Efficiency of a transformer, Condition for maximum efficiency, All day efficiency, Polarity test of a single–phase transformer, Sumpner's test, Parallel operation, Auto transformer.

Three–phase Transformer: Advantages of three phase transformer, Principle of operation, Construction, Three–phase transformer connections, Open delta or V–V connection, Scott connection or T–T connection, Three–phase to two–phase conversion, Three–phase to six–phase conversion, Three–winding transformer, Parallel operation of transformers.

Special Purpose Transformers: Instrument transformers (CT and PT), Earthing transformer, Pulse transformer, High frequency transformer, Converter transformer.

Laboratory Work:

DC Machines: Characteristics of generators and motors, Speed control, Efficiency, DC generators in parallel, Transformers: Open and short circuit tests, Parallel operation, Harmonics in no-load current, Three-phase connections, 3–phase to 2–phase and 6–phase conversions.

Course Learning Outcomes (CLO):

After the completion of the course the students will be able to:

1. Test the transformer and calculate its efficiency and performance in distribution system.
2. Scrutinize three-phase transformer connections and use special purpose transformer for measurement and protection.
3. Select appropriate DC motor for specific purpose and can compute their steady performance.
4. Compute the performance with DC generators and can supply increasing load with parallel operation.
5. Thoughtfully select the speed control and starting method of DC motor.

Text Books:

1. *Bimbhra, P.S., Electrical Machinery, Khanna Publishers (2008).*
2. *Mukherjee, P.K. and Chakravorty, S., Electrical Machines, Dhanpat Rai (2004).*
3. *Nagrath, I.J. and Kothari, D.P., Electric Machines, Tata McGraw Hill (2004).*

Reference Books:

1. *Bimbhra, P.S., Generalized Theory of Electrical Machines, Khanna Publishers (2007).*
2. *Toro, Vincert, Electromechanical Devices for Energy Conversion, Prentice Hall of India (2004).*
3. *Fitzgerald, A.E., Kingsley, C. Jr. and Umans, Stephen, Electric Machinery, McGraw Hill (2002).*

Evaluation Scheme:

Sr. No.	**Evaluation Elements**	**Weightage (%)**
1	MST	25
2	EST	35
3	Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	40

UEE302: ELECTROMAGNETIC FIELD THEORY

L	T	P	Cr.
3	1	0	3.5

Course Objective: To understand the concepts of vector analysis, electrostatic fields, time varying fields, Maxwell transmission line and wave guide.

Vector Analysis: Review of vector algebra, Review of cartesian, Cylindrical and spherical coordinate systems, Introduction to del ∇ (operator, Use of del operator as gradient, divergence,curl).

Electrostatic Fields: Introduction to coulomb's law, Gaussian law and its applications in determination of field of spherical and cylindrical geometries, Laplace's and poission's equation in various coordinate systems. Effect of dielectric on capacitance, Boundary conditions at electric interfaces, Method of images and its applications.

Magnetostatics: Introduction to ampere's law, Magnetic vector potential, Magnetic forces, Boundary conditions at magnetic interfaces.

Time Varying Fields and Maxwell's Equations: Continuity of charge, Concept of displacement current, Maxwell's equation in integral and differential form: For static fields, For time varying fields, For free space, For good conductors, For harmonically varying fields, Poynting theorem: Energy stored and radiated power, Complex poynting vector, Properties of conductor and dielectrics, Wave equations for free space, Wave equations for conductors.

Uniform Plane Waves: Introduction, Uniform plane wave propagation: Wave equations, Transverse nature of uniform plane waves, Perpendicular relation between $\vec{E}$ and $\vec{H}$, EM waves in charge free, Current free dielectric, Reflection by ideal conductor: Normal incidence, reflection and transmission with normal incidence at another dielectric, Plane wave in lossy dielectric, Wave impedance and propagation constant, Depth of penetration, Surface impedance and surface resistance, Application of EM propagation through Transmission Lines and Rectangular Waveguides.

Course Learning Outcomes (CLO):

After the completion of the course the students will be able to:

1. Calculate electric and magnetic fields in different coordinates for various charge and current configurations
2. Demonstrate different aspects of plane wave and in dielectric and conducting media
3. Realize the analogy of wave with transmission line and Calculate the transmission line performance
4. Select the appropriate guide for electromagnetic waves

Text Books:

1. *Hayt, W.H., Engineering Electromagnetics, Tata McGraw–Hill (2008).*
2. *Kraus, J.D., Electromagnetics, McGraw–Hill (2006).*
3. *Sadiku, M.N.O, Elements of Electromagnetics, Oxford University Press (2009).*

Reference Books:

1. *Jordan, E.C. and Balmain K.G., Electromagnetic Waves and Radiating Systems, Prentice Hall of India (2008).*
2. *Paramanik, A, Electromagnetism: Theory and Applications, Prentice–Hall of India (2006).*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)

1	MST	30
2	EST	45
3	Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	25

UEE303: POWER GENERATION AND ASSOCIATED ECONOMICS

L	T	P	Cr.
3	1	0	3.5

Course Objective: To impart learning about the principle and concept of conventional, non-conventional power plants and power plant economies.

Introduction: Energy sources and their availability, Principle types of power plants, their special features and applications, Present status and future trends.

Hydro Electric Power Plants: Essentials, Classifications, Hydroelectric survey, Rainfall run-off, Hydrograph, Flow duration curve, Mass curve, Storage capacity, Site selection, Plant layout, various components, Types of turbines, Governor and speed regulation, Pumped storage, Small scale hydro−electric plants (mini and micro).

Thermal Power Plant: General developing trends, Essentials, Plant layout, Coal−its storage, Preparation, Handling, Feeding and burning, Cooling towers, Ash handling, Water treatment plant, High pressure boilers and steam turbines, Components of thermal power plant.

Gas Turbine Power Plants: Field of use, Components, Plant layout, Comparison with steam power plants, combined steam and gas power plants.

Nuclear Power Plant: Nuclear fuels, Nuclear energy, Main components of nuclear power plant, Nuclear reactors types and applications, Radiation shielding, Radioactive and waste disposal safety aspect.

Non-Conventional Power Generation: Geothermal power plants, Electricity from biomass, Direct energy conversion systems (Solar and Wind) Thermo-electric conversion system, Fuel cells, Magneto Hydro dynamic system.

Cogeneration: Definition and scope, Cogeneration technologies, Allocation of costs, Sale of electricity and impact on cogeneration.

Power Plant Economics: Cost of electrical energy, Selection of type of generation and generation equipment, Performance and operating characteristics of power plants, Economic scheduling principle, Load curves, Effect of load on power plant design, Load forecasting, electric tariffs, Peak load pricing.

Course Learning Outcomes (CLO):

After the completion of the course the students will be able to:

1. Apply knowledge of India’s power scenario, power system structure and related agencies.
2. Harness power from conventional and renewable sources.
3. Select the methods and size of plant generating power for overall economy.
4. Decide the tariff structure for different type of users.

Text Books:

1. *Arora, S.C and Domkundawar, S., A course in Power Plant Engineering, Dhanpat Rai (2002).*
2. *Deshpande, M.V., Power Plant Engineering, Tata McGraw Hill (2004).*
3. *Gupta, B.R., Generation of Electrical Energy, S. Chand (1998).*

Reference Books:

1. *Deshpande, M.V., Electrical Power System Design, McGraw Hill (2004).*
2. *Wood, A.J. and Wollenberg, B.F., Power Generation and Control, John Wiley (2004).*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	30
2	EST	50
3	Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	20

UEE401: ALTERNATING CURRENT MACHINES

	L	T	P	Cr.
	3	1	2	4.5

Course Objective: To introduce the concept of single phase and three phase AC machines, their construction and performance parameters.

Three–Phase Induction Motors: Construction, working principle, Sip and its effect on rotor parameters: rotor frequency, Torque–slip characteristics, Power flow diagram, Efficiency, Synchronous watt, Measurement of slip, Equivalent circuit, No–load test, Blocked rotor test, Circle diagram, Starting methods, Speed control methods, Crawling, Cogging, Deep cage and Double cage rotors, Applications, self excited and grid connected Induction generator.

Fractional kW Motors and Special Machines: Classification, Production of rotating field, Double revolving field theory, Equivalent circuit, Determination of equivalent circuit parameters, Split phase induction motor, Capacitor motor, Permanent split capacitor motor; Shaded pole motor, Universal motor, Stepper motor.

Synchronous Generators/Alternators: Introduction, Comparison with DC generator, Advantages of rotating field over rotating armature, Constructional features, Excitation systems, Armature windings, EMF equation, Winding factor, Harmonics, Armature resistance, Armature reaction: Unity power factor, Zero lagging and Zero leading power factor, Armature reaction reactance, Equivalent circuit of an alternator, Voltage equation, Phasor diagram of a loaded alternator for various types of loads, Voltage regulation and methods of estimation of voltage regulation, Load characteristic of alternators, power equation, Two reaction theory of salient pole alternator, Torque–angle characteristic of a salient–pole alternator, Maximum reactive power for a salient–pole alternator, Losses and efficiency, Determination of X_d and X_q, Parallel operation of alternators, Synchronising procedures, Synchronising power and Torque co–efficient, Damper Windings, Hunting.

Synchronous Motors: Voltage equation, Phasor diagram, Operation at constant load with variable excitation, Power equations, salient pole Synchronous motor, Starting of synchronous motors, Applications, Synchronous condensers

Laboratory Work:

Voltage regulation, Direct and quadrature axis reactances, Operating characteristics, Synchronizing, Parallel operation and load division, Sudden short circuit analysis and determination of sub transient, Transient and steady state reactances and various time constants, Determination of positive, negative and zero sequence reactances, Synchronous motor starting, Efficiency. Three phase induction motors: starting methods, Equivalent circuit parameters, Load test, Polarity test, Single phasing, Efficiency, Schrage motor, Single-phase induction motors: Equivalent circuit parameters and performance indices.

Course Learning Outcomes (CLO):

After the completion of the course the students will be able to:

1. Simulate the steady-state and transient state performance of induction and synchronous machines to identify performance measures
2. Validate and identify the machine parameters.
3. Select the appropriate AC motor for different large power application.
4. Analyse the stability of single machine – infinite bus system and form the grid to supply large load.
5. Choose the appropriate fractional horse power motor as per the usage in daily life.

Text Books:

1. *Bimbhra, P.S., Electrical Machinery, Khanna Publishers (2008).*
2. *Mukherjee, P.K. and Chakravorty, S., Electrical Machines, Dhanpat Rai and Co. (P) Ltd. (2004).*
3. *Nagrath, I.J. and Kothari, D.P., Electric Machines, Tata McGraw Hill (2004).*

Reference Books:

1. *Bimbhra, P.S., Generalized Theory of Electrical Machines, Khanna Publishers (2007).*
2. *Toro, Vincert, Electromechanical Devices for Energy Conversion, Prentice Hall of India (2004).*
3. *Fitzgerald, A.E., Kingsley, C. Jr., and Umans, Stephen, Electric Machinery, McGraw–Hill (2002).*

Evaluation Scheme:

Sr. No.	**Evaluation Elements**	**Weightage (%)**
1	MST	25
2	EST	35
3	Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	40

UEE402: TRANSMISSION AND DISTRIBUTION OF POWER

L	T	P	Cr.
2	1	0	2.5

Course Objective: To introduce the concepts of transmission lines, line insulators, cables.

Introduction: Structure of power systems, Growth of power systems–Indian overview, Interconnections and their advantages.

Transmission Line Parameters: Choice of voltage and frequency, Types of conductor, Size of conductor, Resistance, Inductance and capacitance of single phase and three phase transmission lines

Mechanical Design of Overhead Transmission Lines: Tension and sag calculations, Factors affecting Sag, Sag template, Stringing charts, Vibrations and vibration damper.

Insulators: Insulator types, String efficiency, Improvement of String Efficiency Grading rings, Insulator an Failure, Arcing horns, Armored rods and Bushing.

Transmission Line Performance: Characteristics and performance of power transmission lines: Short, Medium, Long lines, Generalized constants, Power flow, regulation, Power circle diagrams, Series and shunt compensation, Corona visual and disruptive, Critical voltage, Phenomenon of Corona, Corona loss, Factors affecting Corona, Ferranti Effect, Electrostatic and Electromagnetic interference with communication lines.

Insulated Cables: Constructional features, Parameters, Cable laying procedures, Fault location Methods, High voltage cables, Thermal characteristics, Ratings of Cables, Introduction to XLPE cables.

Distribution Systems: Classification of distribution system, Primary and secondary distribution, Ring main and radial systems, Systematic design of distribution systems.

EHV transmission and HVDC transmission: Need of EHV transmission system, types of DC links, advantages of DC transmission, HVDC systems in India.

Course Learning Outcomes (CLO):

After the completion of the course the students will be able to:

1. Understand the structure of power system.
2. Analyse the transmission line models and evaluate its performance parameters.
3. Design the transmission lines under various working conditions.
4. Describe and select the configurations of different line insulators and evaluate their performance.
5. Supervise the laying of cables and fault detection in cables.
6. Design the distribution system network.

Text Books:

1. *Chakrabarti, A., Soni, M.L., Gupta, P.V. and Bhatnagar, U.S., A Text Book on Power System Engineering, Dhanpat Rai (2008).*
2. *Wadhwa, C.L., Electrical Power Systems, New Age International (P) Limited, Publishers (2008).*

Reference Books:

1. *Gupta, B.R., Power System Analysis and Design, S. Chand (2009).*
2. *Nagrath, I.J. and Kothari, D.P., Power System Engineering, Tata McGraw–Hill (2007).*
3. *Pabla, A.S., Electric Power Distribution, McGraw Hill (2008).*

4. *Stevenson, W.D., Power System Analysis, McGraw–Hill (2007).*

Evaluation Scheme:

Sr. No.	**Evaluation Elements**	**Weightage (%)**
1	MST	30
2	EST	45
3	Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	25

UEE503: NETWORK ANALYSIS AND SYNTHESIS

L	T	P	Cr.
3	1	0	3.5

Course Objective: To make the students understand concepts of graph theory, two port networks, and network synthesis.

Graph theory: Graph, Tree and link branches, Network matrices and their relations, Choice of linearly independent network variables, Topological equations for loop current and topological equation for nodal voltage, Duality

Network Theorems: Source transformation, Superposition Theorem, Thevenin's theorem, Norton's theorem, Millman's theorem, Reciprocity theorem and Maximum power transfer theorem as applied to A.C. circuits, Compensation theorem, Tellegen's theorem and their applications.

Two Port Networks: Two port network description in terms of open circuits impedance, Short circuit admittance, Hybrid and inverse hybrid, ABCD and inverse ABCD parameters, Inter-connection of two port network, Indefinites admittance matrix and its applications

Network Functions: Concepts of complex frequency, Transform impedance, Networks function of one port and two port network, concepts of poles and zeros, property of driving point and transfer function.

Passive Network Synthesis: Introduction, Positive Real Functions **:** Definition, Necessary and sufficient conditions for a function to be positive real, Elements of circuit synthesis, Foster and cauer forms of LC Networks, Synthesis of RC and RL networks.

Course Learning Outcomes (CLO):

After the completion of the course the students will be able to:

1. Understand the various laws and theorems related to electric networks.
2. Understand the concept of two port networks.
3. Familiarize with network synthesis.

Text Books:

1. *Hayt, W., Engineering Circuit Analysis, Tata McGraw–Hill (2006).*
2. *Hussain, A., Networks and Systems, CBS Publications (2004).*
3. *Valkenberg, Van, Network Analysis, Prentice–Hall of India Private Limited (2007).*
4. *Gayakwad, A. Op-Amps and Linear Integrated Circuits, Prentice–Hall of India (2006).*

Reference Books:

1. *Chakarbarti,A., Circuit Theory, Dhanpat Rai and Co. (P) Ltd. (2006).*
2. *Roy Chowdhuary, D., Networks and Systems, New Age International (P) Limited, Publishers (2007).*
3. *Sudhakar, A., Circuits and Networks, Tata McGraw–Hill (2006).*
4. *Suresh Kumar, K.S. Electrical circuits and Networks, Pearson Education, (2009).*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	30
2	EST	45
3	Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	25

UEE502: HIGH VOLTAGE ENGINEERING

L	T	P	Cr.
3	0	2	4.0

Course Objective: To introduce the concepts of breakdown in gases, solids, generation and measurement of high voltage and their tests.

Introduction: Introduction to AC and DC impulse high voltages and their use, Problems in dealing with high voltages.

Breakdown in Gases: Elementary ideas on ionization by electron collision, Townsend mechanism, Townsend first and second ionization coefficients, Paschen law, breakdown in non-uniform fields and corona discharges, vacuum breakdown mechanisms, breakdown in liquids, fundamentals of insulating oils, conduction and breakdown in pure and commercial liquids.

Breakdown in Solids: Fundamentals of solid insulating materials intrinsic, electromechanical and thermal breakdown, breakdown in simple and composite dielectrics, types of insulating materials, temperature classification, factor affecting dielectric strength, insulation design of rotating machines, transformers, transmission lines, Switch gear, etc.

Generation of High Voltages: Generation of high voltages, testing transformers in cascade, series resonant circuits and their advantages, half and full wave rectifier circuits, voltage doubler and cascade circuits, electrostatic generator, characteristics parameters of impulse voltages, single stage impulse generator circuits, multistage impulse generation circuits.

Measurement of High Voltages: Measurement of direct, alternating and impulse voltages by electrostatic voltmeters, sphere gap, uniform field gap, ammeter in series with high voltage resistors and voltage divider (Resistive, Capacitive and mixed).

Non-Destructive High Voltage Tests: Loss in a dielectric, dielectric loss measurement by schering bridge, partial discharges at alternating voltages, external and internal partial discharges and discharge measurements.

Laboratory Work:

Alternating voltages, Voltage measurement by sphere gap and Chubb and Fortesque methods. Impulse voltage: Experimental setup for standard lightning wave, Efficiency and peak voltage measurement by sphere gap impulse voltage time curves, Use of standard software package for the electric stress calculations in H.V. bushings, Liquid dielectric: Breakdown voltage, Conductivity and dissipation factor measurement with schering bridge, partial discharge measurements.

Course Learning Outcomes (CLO):

After the completion of the course the students will be able to:

1. Conceptualize the idea of high voltage and safety measures involved
2. Analyse the breakdown mechanism of solids, liquids and gases
3. Design insulation associated with various power system components such as transformer, rotating machines and switchgear
4. Analyse and calculate the circuit parameters involved in generation of high voltages
5. Measure direct, alternating and impulse high voltage signals.
6. Measure the dielectric loss and partial discharge involved in non-destructive high voltage tests

Text Books:

1. *Khalifa, M., High Voltage Engineering: Theory and Practice, Marcel Dekker Inc. (2000).*
2. *Naidu, M.S. and Kamraju, V., High Voltage Engineering, Tata McGraw–Hill (2008).*

3. *Wadhwa, C .L., High Voltage Engineering, New Age International (P) Limited, Publishers (2006).*

Reference Books:

1. *Dass, R., Extra High Voltages, Tata McGraw–Hill (2006).*
2. *Kind, D. and Feser, K, High Voltage Test Techniques, Reed Educational and Professional Publishing Limited (2001).*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	25
2	EST	40
3	Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	35

UEE504: POWER ELECTRONICS

L	T	P	Cr.
3	1	2	4.5

Course Objective: To understand the concept of power electronic devices, phase controlled converters, dc choppers, inverters, ac voltage controllers and cycloconverter.

Introduction: Introduction to Thyristors and its family, static and dynamic characteristics, turn-on and turn - off methods and firing circuits, Ratings and protection of SCR'S, series and parallel operation.

Phase Controlled Converters: Principle of phase control, Single phase and three phase converter circuits with different types of loads, continuous and discontinuous conduction, effect of source inductance, Dual converters and their operation

DC Choppers: Principle of chopper operation, control strategies, types of choppers, step up and step down choppers, steady state time domain analysis with R, L, and E type loads, voltage, current and load commutated choppers.

Inverters: Single phase voltage source bridge inverters and their steady state analysis, modified Mc murray half bridge inverter, series inverters, three phase bridge inverters with 180^0 and 120^0 modes. single-phase PWM inverters, current source inverters, CSI with R load (qualitative approach).

AC Voltage Controllers: Types of single-phase voltage controllers, single-phase voltage controller with R and RL type of loads.

Cycloconverters: Principles of operation, single phase to single phase step up and step down cycloconverters, three phase to single phase cycloconverters, output voltage equation for a cycloconverter.

Course learning outcome (CLO):

After the completion of the course the students will be able to:

1. Identify the power – electronic devices and inference their usage as switch for energy conversion and control
2. Select and design appropriate converter configuration / topology for typical power application such as DC drive, AC drive, HVDC and FACTS.
3. Design the firing and commutation circuit for different converter configurations.
4. Use power converters for harmonic mitigation, voltage and frequency control

Text Books:

1. *Dubey, G.K., Doradla, S.R., Joshi, A. and Sinha, R.M.K., Thyristorised Power Controllers, New Age International (P) Limited, Publishers (2004).*
2. *Rashid, M., Power Electronics, Prentice–Hall of India (2006).*
3. *Bimbhra,P.S., Power Electronics, Khanna Publishers(2012).*

Reference Books:

1. *Mohan, N., Underland, T. and Robbins, W. P., Power Electronics: Converter Applications and Design, John Wiley (2007).*
2. *Bose, B.K., Handbook of Power Electronics, IEEE Publications*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	25

2	EST	35
3	Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	40

UEE604: FLEXIBLE AC TRANSMISSION SYSTEMS

L	T	P	Cr.
3	1	0	3.5

Course Objective: To introduce the concept of power system control, various compensators, FACTS controllers and their application in power system operation and control.

Power Transmission Control: Fundamentals of ac power transmission, Transmission problems and needs, Overview of stability, The emergence of FACTS, FACTS controller and consideration.

Static Power Convertor: Review of Power Electronics fundamentals: Static power convertor structures, AC controller based structure, DC link convertor topologies, Convertor output and harmonic control.

Shunt Compensation: Shunt SVC principles, Configuration and control, STATCOM, Configuration applications

Series Compensation: Fundamental of series compensation, Principle of operation, Application of TCSC for different problems of power system, TCSC lay out, SSSC principle of operation.

Phase Shifter: Principle of operation, Steady state model of static phase shifter, Operating characteristics of SPS, Power current configuration of SPS application

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

Course Learning Outcomes (CLO):

After the completion of the course the students will be able to:

1. Decide the scheme for power system stability and voltage control
2. Decide the converter configuration for different power systems applications such as HVDC, FACTS etc.
3. Decide the usage of different FACTS compensators for for different purposes.
4. Compute the harmonics on AC and DC side and decide their filtering.

Text Books:

1. *Hingorani, N.G. and Gyragyi,L., Understanding FACTS :Concepts and Technology of Flexible AC Transmission System, Standard Publishers and Distributors (2005).*
2. *Sang, Y.H. and John, A.T., Flexible AC Transmission Systems, IEEE Press (2006).*
3. *Ghosh,A. and Ledwich,G., Power Quality Enhancement Using Custom Power Devices, Kluwer Academic Publishers (2005).*

Reference Books:

1. *Mathur, R.M. and Verma, R.K., Thyristor Based FACTS Controllers for Electrical Transmission Systems, IEEE Press (2002).*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	30
2	EST	45
3	Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	25

UEE605: POWER SYSTEM ANALYSIS AND STABILITY

L	T	P	Cr.
3	1	2	4.5

Course Objective: To understand the concepts of unit commitment, economic thermal and hydro-thermal scheduling and rotor angle stability.

Representation of Power System: Representation of power system components, regulating transformers generators, transmission line and loads, phase shift in star-delta transformer, sequence impedance of transmission line, transformer and generators, sequence networks of power system, Y-Bus and Z-Bus formulation.

Load Flow Study: Load flow problem, power flow equations, load flow solution using Gauss Seidal and Newton Raphson methods, decoupling between real and reactive power control, decoupled and fast decoupled methods, comparison of load flow methods.

Fault Analysis: Symmetrical fault, algorithm for symmetrical fault analysis, unbalanced faults (Single line to ground fault, Line to line and double line to ground, Open conductor), Bus Impedance matrix method for the analysis of unsymmetrical shunt faults.

Power System Stability: Concepts of types of stability limits, steady state stability analysis, transient stability analysis, Swing equation and its solution by point-by-point method, Equal area criterion, critical clearing angle and improvement of transient stability.

Laboratory Work:

Develop software for various matrix inversion techniques, load flow problems with all methods, Fault analysis and stability studies; Use of standard software- ETAPS for simulation and steady state analysis of power system.

Course Learning Outcomes (CLO):

After the completion of the course the students will be able to:

1. Develop an appropriate mathematical model of power system
2. Carry out power flow analysis of practical power system for balanced three-phase system.
3. Decide generation scheduling of thermal units leading to overall economy.
4. Conduct studies during balanced and unbalanced faults to decide the fault levels and circuit breaker ratings.
5. Analyze the stability of single machine-infinite bus system and can decide the critical clearing time of circuit breakers.

Text Books:

1. *Chakraborti, A., Soni, M.L., Gupta, P.V. and Bhatnagar, U.S., A Text Book on Power System Engineering, Dhanpat Rai and Co. (P) Ltd. (2008).*
2. *Nagrath, I.J. and Kothari, D.P., Power System Engineering, Tata McGraw–Hill (2007).*
3. *Stevenson, W.D., Power System Analysis, McGraw–Hill (2007).*

Reference Books:

1. *Gupta, B.R., Power System Analysis and Design, S.Chand and Company Limited (2009).*
2. *Pabla, A.S., Electric Power Distribution, Tata McGraw–Hill (2008).*
3. *Wadhwa, C.L., Electrical Power Systems, New Age International (P) Limited, Publishers (2008).*

Evaluation Scheme:

Sr.	Evaluation Elements	Weightage

No.		(%)
1	MST	25
2	EST	35
3	Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	40

UEE603: SWITCHGEAR AND PROTECTION

L	T	P	Cr.
3	0	2	4.0

Course Objective: To introduce the concept of protection system attributes, types of fuses, circuit breakers, earthing, relays, and various protection schemes.

Introduction: A protection system and its attributes, System transducers, various power system elements that needs protection.

Fuses: Types, ratings and characteristics, construction and application of HRC fuses, limitations, introduction to MCBs, application of fuses.

Circuit Breakers: Theory of arc formation and its extinction (AC and DC), re-striking and recovery voltage, Current chopping, duties of switchgear, circuit breakers: specifications of circuit breakers, different types of circuit breakers like oil, Air, Vacuum and SF6, comparative merits and demerits, HVDC circuit breaker system.

Earthing: Earthing requirements, Earthing practices, Earth resistivity and earth gradient, Neutral shift.

Protective Relays: Functions, Constructional and operating principles of electromagnetic type like over-current, Directional, Differential and distance relays, Characteristics, General equation. Basic principles of static relaying, Phase and amplitude comparator, Microprocessor based relays.

Protection Schemes: Over–current and Over–voltage protection of transmission lines, differential protection, transformer protection, Bus bar protection, distance protection of transmission line, carrier aided protection of transmission lines, generator protection, induction motor protection.

Laboratory Work:

Sequence impedance and their calculations, Symmetrical fault level measurement on a D.C. network analyzer, Unsymmetrical fault level measurement on a D.C. network analyzer for various types of faults, Measurement of ground resistivity and resistance of a ground electrode, Plotting of characteristics of different types of relays, Performance or different types of protection schemes, ABCD constants of an artificial transmission line, String efficiency of insulator string, use of standard software package for short circuit studies and relay co-ordination.

Course Learning Outcomes (CLO):

After the completion of the course the students will be able to:

1. Select the protection elements such as fuse, circuit breakers and relays etc. for a given configuration.
2. Design the basic Earthing requirement for residential and other purposes.
3. Select required protection measures against overcurrent, overvoltage in transmission lines.
4. Select suitable protection scheme for different power system equipment.

Text Books:

1. *Chakraborti, A., Soni, M.L., Gupta, P.V. and Bhatnagar, U.S., A Text Book on Power System Engineering, Dhanpat Rai and Co. (P) Ltd. (2008).*
2. *Pathinkar, Y.G. and Bhide, S.R., Fundamentals of Power System Protection, PHI Learning Pvt. Limited (2008).*
3. *Rao, S.S., Switchgear and Protection, Khanna Publishers (2007).*

Reference Books:

1. *Deshpande, M.V., Switchgear and Protection, Tata McGraw–Hill (2005).*
2. *Elmore, W.A., Protective Relaying Theory and Applications, ABB Power T and D Company Inc. (2003).*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	25
2	EST	40
3	Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	35

UEE801: ELECTRIC DRIVES

L	T	P	Cr.
3	1	2	4.5

Course Objective: To introduce the concept of electric drives and control strategies.

Definitions and Dynamics of Electric Drives: Concept of electric drive and its classifications, Types of loads, Four-quadrant drive, Dependence of load torque on various factors, Dynamics of motor-load combination, Steady state stability of an electric drive system, Load Equalization.

Drive Features of Importance: Multi-quadrant operations of DC and AC motors, Energy relations during starting and braking.

Static Control of Motors: Contactors and relays for electric drives, Control circuits for automatic starters of DC and AC motors.

Estimation of Motors Rating: Thermal modeling of motors, Types of duty cycles, Calculation of motor rating for duty cycles, Overload factor calculation for short and intermittent duty cycle, Use of load diagrams.

Solid State Controlled Drives: Control of DC drives fed through single-phase and three-phase semi converter and full-converter phase-controlled configurations. Their analysis, Regeneration and braking through static power converters.
Control of three phase induction motors by stator voltage and frequency control for speeds below and above synchronous speed. Static rotor resistance control, Static kramer and scherbius drives, V/f and Vector control
Energy efficient drives, Losses in electrical drive system, Energy conservation in electric drives.

Laboratory Work:

Starting and running characteristics of converter fed AC and DC motor control, Harmonic analysis of AC and DC Drives, V/f based drive, Microprocessor based Drive, PLC based drive. Project on drives using standard software.

Course Learning Outcomes (CLO):

After the completion of the course the students will be able to:

1. Conceptualize the basic drive system and analyse it for different types of loads
2. Analyse the motor situation during starting and braking
3. Develop control circuitry and devices for control of motor
4. Estimate the motor rating for different condition of load
5. Design the converter circuit for control purpose along with its different configuration
6. Use PLC and converter control to drive on the basis of energy efficiency

Text Books:

1. *Dubey, G.K., Power Semiconductor Controlled Drives, Prentice Hall Inc. (1989).*
2. *Pillai, S.K., A Course in Electric Drives, New Age International (P) Limited, Publishers (1989).*

Reference Books:

1. *Bose, B.K., Modern Power Electronics and AC Drives, Prentice-Hall of India Private Limited (2006).*
2. *Dubey, G.K., Fundamentals of Electric Drives, Narosa Publications (2001).*
3. *Sen, P.C., Thyristor DC Drives, John Wiley and Sons (1981).*

Evaluation Scheme:

Sr.	Evaluation Elements	Weightage

No.		(%)
1	MST	25
2	EST	35
3	Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	40

UEE802: INTELLIGENT ALGORITHMS IN POWER SYSTEMS

L	T	P	Cr.
3	0	2	4.0

Course Objective: To introduce the concept of artificial intelligence, fuzzy systems, neural networks and genetic algorithm and their applications in various areas of power system.

Introduction: Concept of artificial intelligence, Introduction to classical problem solving methods and heuristic search techniques.

Fuzzy Systems: Fuzzy sets, Operation on fuzzy sets, Fuzzy relations, measures, Fuzzy logic, Fuzzy logic controller (FLC).

Artificial Neural Networks: Fundamental concepts, Basic models, Learning rules, Single layer and multi-layer feed-forward and feedback networks, Supervised and unsupervised methods of training, Recurrent networks, Modular network.

Genetic Algorithm: Basic principle, Evolution of genetic algorithm, Hybrid genetic algorithm, trends in stochastic search.

Hybrid Systems: Integrated hybrid systems such as neuro-fuzzy, fuzzy-neuro.

Applications: Short term and long term load forecasting, Identification, Classification, Fault location and fault diagnosis, Economic load dispatch, DC/AC four quadrant drive control.

Laboratory Work:

Training algorithms of neural networks and fuzzy logic, Implementation of fuzzy logic, Neural networks and genetic algorithms on various applications, Use of matlab tools of fuzzy logic and NN.

Course Learning Outcomes (CLO):

After the completion of the course the students will be able to:

1. Implement fuzzy controllers by modelling the human intelligence into mathematical model
2. Mathematically model the human learning capability and solve classification, control system and optimization problem.
3. Obtain the optimum solution of well formulated optimisation problem using evolutionary approach.
4. Formulate hybrid intelligent algorithms for typical electrical application.

Text Books:

1. *Lin, C., Lee, G., Neural Fuzzy Systems, Prentice Hall International Inc. (2000).*
2. *Rajashekran, S. and Vijaylaksmi Pai, G.A., Neural Networks, Fuzzy Logic and Genetic Algorithm Systhesis and Applications, Prentice□Hall of India Private Limited (2004).*
3. *Zurda, J.M., C++ Neural Networks and Fuzzy Logics, BPS Publication (2001).*

Reference Books:

1. *Kosko, B., Neural Networks and Fuzzy Systems: A Dynamical systems Approach to Machine Intelligence, Prentice Hall of India Private Limited (1992).*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	25
2	EST	40
3	Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	35

UEE804: OPERATION AND CONTROL OF POWER SYSTEMS

L	T	P	Cr.
3	1	2	4.5

Course Objective: To make the student able to understand the basics of economic operation of Power Systems, load-frequency control, power system security and voltage stability.

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, Their solution methods.

Hydrothermal Co-ordination: Hydro-scheduling, Plant models, Scheduling problems, Hydrothermal scheduling problems and its approach.

Power System Control: Elementary ideas of load frequency and voltage control, Reactive power control, Block diagrams of P-f and Q-V controllers, ALFC control, Static and dynamic performance characteristics of ALFC and AVR controllers, Excitation systems model, concept of area and Tie-line operations.

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

Small Scale Stability Analysis: d-q model of generator, 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.

Course Learning Outcomes (CLO):

After the completion of the course the students will be able to:

1. Decide the scheduling of thermal units and hydro-thermal units for overall economy
2. Develop small scale model of alternator, excitation and governing systems.
3. Design and apply control for frequency and voltage of power system represented by single or multi-area.
4. Comprehend power system security and contingency.
5. Computation of small scale and voltage stability.

Laboratory Work:

Simulation of thermal scheduling with and without losses, Unit commitment by dynamic programming, simulation of hydro-thermal scheduling by gradient method, Stability analysis of single area frequency control, Bias control of two area system and AVR.

Text Books:

1. *Chakraborti A., Soni,M.L., Gupta,P.V. and Bhatnagar,U.S., A Text Book on Power System Engineering, Dhanpat Rai and Co. (P) Ltd. (2008).*
2. *Nagrath, I.J. and Kothari, D.P., Power System Engineering, Tata McGraw Hill (2007).*
3. *Stevenson, W.D., Power System Analysis, McGraw Hill (2007).*

Reference Books:

1. *Kothari, D.P., Dhillon, J.S., Power System Optimization, PHI Learning (2010).*

2. *Allen J. Wood, Bruce F. Wollenberg and Gerald B. Sheble, Power Generation, Operation and Control, Wiley-Interscience (2013).*
3. *Kimbark, E. W., Power System Stability, Volumes-I, IEEE Press (1995).*
4. *Jizhong Z., Optimization of power system operation, Edition Wiley (1996).*
5. *5.Elgerd, O. Electric Energy Systems Theory, McGraw Hill Education Private Limited (2001).*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	25
2	EST	35
3	Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	40

UEE712: ELECTRICAL ENGINEERING MATERIALS

L	T	P	Cr.
3	1	0	3.5

Course Objective: To understand the concept of electrical properties and magnetic properties of materials along with their applications in Electrical Engineering.

Elementary Materials Science Concepts: Bonding and types of solids and its defects, temperature dependence of resistivity, skin effect, Hall effect.

Dielectric Properties of Insulators in Static and Alternating Field: Dielectric constant of gases, molecules and solids, Internal field in solids and liquids, Properties of ferro-electric materials, polarization, Piezoelectricity, Frequency dependence of electronic and ionic polarizability, dielectric losses.

Magnetic Properties and Superconductivity: Magnetization of matter, magnetic material classification, ferromagnetic origin, Curie-Weiss law, soft and hard magnetic materials, Superconductivity and its origin,Zero resistance and Meissner Effect, critical current density.

Conductivity of Metals: Ohm’s law and relaxation time of electrons, collision time and mean free path, electron scattering and resistivity of metals.

Semiconductor Materials: Classification of semiconductors, semiconductor conductivity, temperature dependence, Carrier density and energy gap. Trends in materials used in Electrical Equipment.

Course Learning Outcomes (CLO):
After the completion of the course the students will be able to:
1. Explain the basic concepts of elementary material science.
2. Elaborate the dielectric properties of insulators in static and alternating field.
3. Explain the concept of superconductivity.
4. Classify semiconductor materials and its properties.

Text Books:

1. *Dekker, A.J., Electrical Engineering Materials, PHI, New Delhi (2007).*
2. *Gupta, P.V and Seth S.P., Course in Electrical Engineering Materials, Dhanpat Rai and Sons (1998).*

Reference Books:

1. *Kasap, S.O., Principles of Electrical Engineering Materials and Devices, McGraw Hill Inc., New York (1997).*
2. *Raghvan, V., Material Science and Engineering: A first Course, PHI, New Delhi (2004).*
3. *Solymar and Walsh, Lectures on Electrical Properties of Material, Oxford Science Publishers, Oxford, (2014).*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	30
2	EST	45
3	Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	25

UEE711: ALTERNATE SOURCES OF ENERGY

L	T	P	Cr.
3	0	0	3.0

Course Objective: To make student learn about energy scenario, services, availability and characteristics of renewable sources.

Introduction: Global and national energy scenarios, concept of energy services, patterns of energy supply, energy resource availability, cultural, economic and national security aspects of energy consumption, forms and characteristics of renewable energy sources, energy classification, source and utilization, thermodynamic power cycles and binary cycles

Solar Energy: Solar radiation, flat plate collectors, solar concentration, thermal applications of solar energy, photovoltaic technology and applications, energy storage.

Biomass Energy: Energy from biomass, thermo chemical, biochemical conversion to fuels, biogas and its applications.

Wind Energy: Wind characteristics, resource assessment, horizontal and vertical axis wind turbines, electricity generation and water pumping, Micro/Mini hydro power system, water pumping and conversion to electricity, hydraulic ram pump.

Other Alternate Sources: Ocean thermal energy conversion, Geothermal, Tidal, Wave energy, MHD, Fuel cells, environmental issues of energy services.

Stand Alone Generating Units: Synchronous generator and induction generator, operation and characteristics, voltage regulation, lateral aspects of renewable energy technologies and systems.

Course Learning Outcomes (CLO):

After the completion of the course the students will be able to:

1. familiarize with another source of electrical generation like solar, wind ,biomass etc
2. Understand the need of other types of sources , their advantages and disadvantages
3. familiarize with different standalone, off grid energy sources
4. understand different technology associate with solar, wind , biomass and other renewable energy sources

Text Books:

1. *Rai, G.D., Non Conventional Energy Sources, Khanna Publishers (2005).*
2. *Rao, S. and Parulekar, B.B., Energy Technology: Non Conventional, Renewable and Conventional, Khanna Publishers (2005).*
3. *Wadhwa, C.L., Generation, Distribution and Utilization of Electric Energy, New Age International (P) Limited, Publishers (2007).*
4. *Simon , Christopher A., Alternate Source of Energy, Rowman and LittleField Publishers Inc.(2007).*

Reference Books:

1. *Venikov, V.A. and Putyain, E.V., Introduction to Energy Technology, Mir Publishers (1990).*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	30
2	EST	50
3	Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	20

UEE522: ENERGY AUDITING AND MANAGEMENT

L	T	P	Cr.
3	1	0	3.5

Course Objective: To make the student understand about the energy scenario and its importance.

Energy Scenario: Energy scenario of growing economy, Energy pricing, Energy sector reforms, Energy and environment, Energy security, Energy conservation and its importance, Energy conservation Act-2001 and its features.

Energy Management and Audit: 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: Methods for preparing process flow, Material and energy balance diagrams.

Financial Management: Investment-need, Appraisal and criteria, Financial analysis techniques-Risk and sensitivity analysis, Financing options, Energy performance contracts and role of ESCOs.

Electrical System: Electricity tariff, Load management and maximum demand control, T&D losses. Losses and efficiency in induction motors, Factors affecting motor performance and remedial solutions, 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.

HVAC and Refrigeration System: Vapor compression refrigeration cycle, Coefficient of performance, Capacity, performance and savings opportunities, Vapor absorption refrigeration system: Working principle, Saving potential, Fans, Blowers and pumps- Types, Performance evaluation, Flow control strategies and energy conservation opportunities.

Course Learning Outcomes (CLO):
After the completion of the course the students will be able to:
1. Analyze about energy scenario nationwide and worldwide
2. Decide about energy management in more effective way.
3. Analyze about various energy related aspect of electrical system.
4. Carry out financial management.
5. Conduct studies related to operational aspects of compressed air system and refrigeration system.

Text Books:

1. *Abbi, Y.P. and Jain, S., Handbook on Energy Audit and Environment Management, Teri Bookstore (2006).*
2. *Diwan, P., Energy Conservation, Pentagon Press (2008).*

Reference Books:

1. *Younger, W., Handbook of Energy Audits, CRC Press (2008).*

Evaluation Scheme:

Sr.	Evaluation Elements	Weightage

No.		**(%)**
1	MST	30
2	EST	45
3	Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	25

UEE523: HIGH VOLTAGE TRANSMISSION SYSTEMS

L	T	P	Cr.
3	1	0	3.5

Course Objective: To introduce the concepts of AC and DC transmission systems, distribution systems, protection methods and AC & DC filter design procedure.

DC Power Transmission Technology: Introduction, Comparison of AC and DC transmission, Applications of DC transmission, Description of DC transmission system, Configurations, Modern trends in DC transmission. Introduction to Device: Thyristor valve, Valve tests, Recent trends.

Analysis of 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.

Converter Faults and Protection: 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.

Reactive Power Control: Reactive power requirements in steady state, Sources of reactive power, Static VAR systems, Reactive power control during transients, Harmonics and filters, Generation of harmonics, Design of AC filters, DC filters.

Component Models for the Analysis of AC/DC Systems: General, Converter model, Converter control, Modelling of DC network, Modelling of AC networks.

Power Flow Analysis in AC/DC Systems: General, Modeling of DC links, Solution of DC load flow, Discussion, Per unit system for DC quantities.

Course Learning Outcomes (CLO):

After the completion of the course the students will be able to:

1. Choose intelligently AC and DC transmission systems for the dedicated application(s).
2. Identify the suitable two-level/multilevel configuration for high power converters.
3. Select the suitable protection method for various converter faults.
4. Identify suitable reactive power compensation method.
5. Decide the configuration for harmonic mitigation on both AC and DC sides.

Text Books:

1. *Arrillaga, J., HVDC Transmission, IEE Press (2007).*
2. *Edwart, K., Direct Current Transmission (Vol. 1), John Wiley and Sons (2008).*
3. *Padiyar, K.R., HVDC Power Transmission System, New Age International (P) Limited, Publishers (2008).*

Reference Books:

1. *Arrillaga, J. and Smith, B.C., AC to DC Power System Analysis, IEE Press (2008).*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	30
2	EST	45
3	Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	25

UEE524: POWER QUALITY MONITORING AND CONDITIONING

L	T	P	Cr.
3	1	0	3.5

Course Objective: To understand the aspects of power quality in distribution system and various indices to estimate the power quality.

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, RMS voltage, Calculation in 1-phase systems, Equipment performance in presence of sag, Computers, AC and DC drives.

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

Harmonic Distortion: Power Overview system harmonics, Harmonic analysis, Harmonic sources-the static converters, Transformer magnetization and non-linearities, Rotating machines, Arc furnaces, Fluorescent lighting, Total harmonic distortion, rms and average value calculations, Effects of harmonic distortion.

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.

Course Learning Outcomes (CLO):
After the completion of the course the students will be able to:
1. Reliably identify the sources of various power quality problems.
2. Estimate the impact of various power quality problems on appliances.
3. Educate the harmful effects of poor power quality and harmonics.
4. Decide the compensators and filters to keep the power quality indices within the standards.

Text Books:
1. *Kennedy, B., Power Quality Primer, McGrawHill (2000).*
2. *Beaty, H. and Santoso,S., Electrical Power System Quality, McGrawHill (2002).*

Reference Books:
1. *Bollen, M.H.J., Power Quality Problems: Voltage Sag and Interruptions, IEEE Press (2007).*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	30
2	EST	45
3	Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	25

UEE501: GENERALIZED THEORY OF ELECTRICAL MACHINES

L	T	P	Cr.
3	1	0	3.5

Course Objective: To understand the concept of linear transformation in ac and dc machines.

Introduction: Common essential constructional and operational features of electrical machines, basic two pole machine representation of different types of electrical machines, Kron's primitive machine, Voltage equations in matrix form for Kron's primitive machine, Impedance matrix.

Linear Transformations in Machines: Reference frame theory, 3-phase to 2-phase transformation, Transformation from rotating axes to stationary axes, Physical concept of park's transformation, Volt-ampere and torque equations, Space vector concept.

DC Machine: Transfer function for DC machine, (Shunt, Series and compound), Linearization technique, Analysis under motoring and generating made, Dynamic analysis.

Synchronous Machine: General machine equation in different frame, Dynamic analysis, Power angle characteristics, Phases diagram for cylindrical rotor and salient pole machine, Electromagnetic and reluctance torque, Electric braking of synchronous machine.

3-phase Induction Machine: Performance equations in different rotating frames, Equivalent circuit, Different inductance, Effect of voltage and frequency on the performance, Braking, Unbalance operations.

Advanced Machines: 1-phase synchronous motor, 2-phase servomotor, AC tachometers, Switched reluctance motor, Brushless DC machine.

Course Learning Outcome (CLO):

After the completion of the course the students will be able to:

1. Express the revolving field and reference frame theory
2. Develop mathematical model of three-phase AC machines and parameters in different reference frame
3. Simulate the transient performance of three-phase ac machines in different reference frames.
4. Investigate the transient performance of different DC machines.
5. Select special purpose small machines for different applications

Text Books:

1. *Kraus, P.C., Analysis of Electric Machine, McGrawHill (2000).*
2. *Bimbhra, P.S., Generalized Theory of Electric Machines, Khanna Publishers (2006).*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	30
2	EST	45
3	Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	25

UEE841: INDUSTRIAL ELECTRONICS

L	T	P	Cr.
2	1	2	3.5

Course Objective: To understand the concept electric traction system, illumination, electric heating principles, power factor control and DC motor control.

Conventional DC and AC Traction: Electric traction services, Nature of traction load, Coefficient of adhesion, Load sharing between traction motors, Main line and suburban train configurations, Calculation of traction drive rating and energy consumption. Important features of traction drives, Conventional DC and AC traction drives, Diesel electric traction.

Static Converters for Traction: Semi conductor converter controlled drive for ac traction, Semiconductor chopper controlled dc traction.

Illumination: Nature of light, Basic laws of illumination, Light sources and their characteristics, Light production by excitation and ionization, Incandescence and fluorescence, Different types of lamps, Their construction, Operation and characteristics, Applications, Latest light sources, Design of illumination systems.

Electric Heating: Introduction to electric heating, Advantages of electric heating, Resistance heating, Temperature control of furnaces, Induction and dielectric heating.

Power Supplies: Performance parameters of power supplies, Comparison of rectifier circuits, Filters, Regulated power supplies, Switching regulators, Switch mode converter.

Power Factor Control: Static reactive power compensation, Shunt reactive power compensator, Application of static SCR controlled shunt compensators for load compensation, Power factor improvement and harmonic control of converter fed systems, Methods employing natural and forced commutation schemes, Methods of implementation of forced commutation.

Motor Control: Voltage control at constant frequency, PWM control, Synchronous tap changer, Phase control of DC motor, Servomechanism, PLL control of a DC motor.

Course Learning Outcomes (CLO):

After the completion of the course the students will be able to:

1. Simulate and analyse the semiconductor controlled ac and DC drive system
2. Design and develop an illumination system for domestic, industry and commercial sites.
3. Design an electric heating system for industrial purposes.
4. Equip the skill to design and develop a regulated power supply.
5. Simulate and analyse the series and shunt compensators for power factor improvement in drive system.

Text Books:

1. *Dubey, G.K., Power Semiconductor Controlled Drives, Prentice Hall inc. (1989).*
2. *Paul, B., Industrial Electronic and Control, Prentice Hall of India Private Limited (2004).*

Reference Books:

1. *J.M.D. Murphy, F.G. Turnbull, Power Electronic Control of Ac Motors, Pergamon (1990).*
2. *Sen, P.C., Thyristor DC Drives, John Wiley and Sons (1981).*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)

1	MST	20
2	EST	40
3	Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	40

UEE521: ELECTRIC MACHINE DESIGN

L	T	P	Cr.
3	1	0	3.5

Course Objective: To introduce the design concepts of electric machines, transformer.

Introduction: Design of Machines, Factors, limitations, Modern trends. Materials: Conducting, magnetic and insulating materials.

Magnetic Circuits: Calculations of mmffor air gap and teeth, real and apparent flux densities, iron losses, field form, leakage flux, specific permanence.

Heating and Cooling: Modes of heat dissipation, Temperature gradients, types of enclosures, types of ventilation, conventional and direct cooling, amount of coolants used, Ratings.

Armature Windings: Windings for dc and ac machines and their layout.

Design of Transformers: Output equation, Types of transformer windings, design of core and windings and cooling tank, performance calculations.

Concepts and Constraints in Design of Rotating Machines: Specific loading, output equation and output co-efficient, effects of variation of linear dimension.

Skeleton Design of Rotating Machines: Calculation of D and L for dc, induction and synchronous machines, length of air gap, design of field coils for dc and synchronous machines, selection of rotor slots of squirrel cage induction motors, design of bars and ends, design of rotor for wound rotor for induction motors, design of commutator and inter poles for dc machines.

Computer Aided Design of Electrical Machines: Analysis and synthesis approaches, design algorithms, Introduction to optimization techniques, Implementing computer program for design of three phase induction motor.

Course Learning Outcomes (CLO):

After the completion of the course the students will be able to:

1. Design DC machines
2. Design transformers with reduced losses
3. Calculate the losses and efficiency in the machines
4. Learn about the Analysis and Synthesis approaches as well as optimal design of electrical machines.

Text Books:

1. *Ramamoorty, M., Computer Aided Design of Electrical Equipment, Eastern Press Private Limited (1989).*
2. *A.K. Sawhney, A Course in Electrical Machine Design, Dhanpat Rai & CO. (2013).*
3. *Say, M.G., Design and Performance of Machines, CBS Publications (1981).*
4. *Hamdi, E.S., Design of Small Electrical Machine, John Wiley and Sons (1994).*

Reference Books:

1. *Smith, S.P. and Say, M.G., Electrical Engineering Design Manual, Chapman and Hall (1984).*
2. *Walker, J.H., Large AC Machines: Performance and Operation, BHEL (1997).*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	30
2	EST	45
3	Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	25