THAPAR INSTITUTE
OF ENGINEERING & TECHNOLOGY
(Deemed to be University)

COURSES SCHEME

&

SYLLABUS

FOR

B.E.

ELECTRICAL

ENGINEERING

2016

B.E. (Electrical Engineering) 2016
Revised Course Scheme and Syllabus

SEMESTER – I

SR. NO.	COURSE NO.	TITLE	L	T	P	CR
1	UMA003	MATHEMATICS-I	3	1	0	3.5
2	UTA007	COMPUTER PROGRAMMING-I	3	0	2	4.0
3	UPH004	APPLIED PHYSICS	3	1	2	4.5
4	UEE001	ELECTRICAL ENGINEERING	3	1	2	4.5
5	UHU003	PROFESSIONAL COMMUNICATION	2	0	2	3.0
6	UTA008	ENGINEERING DESIGN-I	2	4	0	4.0
		TOTAL	16	7	8	23.5

SEMESTER – II

SR. NO.	COURSE NO.	TITLE	L	T	P	CR
1	UMA004	MATHEMATICS-II	3	1	0	3.5
2	UTA009	COMPUTER PROGRAMMING-II	3	0	2	4.0
3	UES009	MECHANICS	2	1	2*	2.5
4	UEC001	ELECTRONIC ENGINEERING	3	1	2	4.5
5	UCB008	APPLIED CHEMISTRY	3	1	2	4.5
6	UTA010	ENGINEERING DESIGN-II (Catapult and more such projects) (6 Self Effort Hours)	1	0	2	5.0
		TOTAL	15	4	8	24.0

* EACH STUDENT WILL ATTEND ONE LAB SESSION OF TWO HOURS IN A SEMESTER FOR A BRIDGE PROJECT IN THIS COURSE (MECHANICS).

SEMESTER – III

SR. NO.	COURSE NO.	TITLE	L	T	P	CR
1	UMA031	OPTIMIZATION TECHNIQUES	3	1	0	3.5
2	UTA002	MANUFACTURING PROCESSES	2	0	3	3.5
3	UES010	SOLIDS AND STRUCTURES	3	1	2	4.5
4	UES011	THERMO-FLUIDS	3	1	2	4.5
5	UTA019	ENGINEERING DESIGN-III (Buggy and more such projects)(with 6 self effort hours)	1	0	4	6.0
6	UEE301	DIRECT CURRENT MACHINES AND TRANSFORMERS	3	1	2	4.5
		TOTAL	15	4	13	26.5

SEMESTER – IV

SR. NO.	COURSE NO.	TITLE	L	T	P	CR
1	UMA007	NUMERICAL ANALYSIS	3	1	2	4.5
2	UES012	ENGINEERING MATERIALS	3	1	2	4.5
3	UHU005	HUMANITIES FOR ENGINEERS	2	0	2	3.0
4	UEN002	ENERGY AND ENVIRONMENT	3	0	0	3.0
5	UEE505	ANALOG AND DIGITAL SYSTEMS	3	1	2	4.5
6	UEE405	NETWORK THEORY AND DESIGN (Project with 7 self effort hours)	3	1	2	8.0
		TOTAL	17	4	10	27.5

* The L T P of Department Specific subjects may vary for different branches but the weekly contact hours should not exceed 32. The design projects have higher number of credits to compensate for self effort hours each student is expected to put in.

SEMESTER – V

SR. NO.	COURSE NO.	TITLE	L	T	P	CR
1	UEE401	ALTERNATING CURRENT MACHINES	3	1	2	4.5
2	UEE403	MEASUREMENT AND TRANSDUCERS	3	0	2	4.0
3	UEE404	TRANSMISSION AND DISTRIBUTION OF POWER	3	1	0	3.5
4	UEE507	ENGINEERING ELECTROMAGNETICS	3	1	0	3.5
5	UEE504	POWER ELECTRONICS	3	1	2	4.5
6	UEE506	DIGITAL SIGNAL PROCESSING FUNDAMENTALS	3	1	0	3.5
7	UTA012	INNOVATION AND ENTREPRENEURSHIP (with 5 self effort hours)	1	0	2	4.5
		TOTAL	19	5	8	28.0

SEMESTER – VI

SR. NO.	COURSE NO.	TITLE	L	T	P	CR
1	UEI609	FUNDAMENTALS OF MICROPROCESSORS AND MICROCONTROLLERS	3	1	2	4.5
2	UEI501	CONTROL SYSTEMS	3	1	2	4.5
3	UEE605	POWER SYSTEM ANALYSIS AND STABILITY	3	1	2	4.5
4	UEE603	SWITCHGEAR AND PROTECTION	3	0	2	4.0
5	UEE801	ELECTRIC DRIVES	3	1	2	4.5
6	UEE	ELECTIVE-I	3	0	0	3.0
7	UEE693	CAPSTONE PROJECT (START)(with 4 self effort hours)	0	0	2	0.0
		TOTAL	18	4	12	25.0

SEMESTER – VII

SR. NO.	COURSE NO.	TITLE	L	T	P	CR
1	UEE502	HIGH VOLTAGE ENGINEERING	3	0	2	4.0
2	UEE604	FLEXIBLE AC TRANSMISSION SYSTEMS	3	1	0	3.5
3	UEE702	INTELLIGENT TECHNIQUES IN ELECTRICAL ENGINEERING	3	0	2	4.0
4	UEE804	OPERATION AND CONTROL OF POWER SYSTEMS	3	1	2	4.5
5	-	ELECTIVE-II	3	1	0	3.5
6	UEE795	CAPSTONE PROJECT (COMPLETION) (with 8 self effort hours)	0	0	2	8.0
7		GENERIC ELECTIVE	3	0	0	3.0
		TOTAL	18	3	8	30.5

SEMESTER – VIII

SR. NO.	COURSE NO.	TITLE	L	T	P	CR
1	UEE891	PROJECT	–	–	–	20.0
		OR				
		ALTERNATE PROJECT SEMESTER				
1	UEE892	DESIGN PROJECT	–	–	–	13.0
2	UEE806	ALTERNATE SOURCES OF ENERGY	3	0	2	4.0
3	UEI805	ENVIRONMENTAL INSTRUMENTATION	3	0	0	3.0
		TOTAL	6	0	2	20
		OR				
1	UEE893	START- UP SEMESTER	–	–	–	20.0

ELECTIVE-I

SR. NO.	COURSE NO.	TITLE	L	T	P	CR
1	UEE631	HVDC TRANSMISSION SYSTEMS	3	0	0	3.0
2	UEE632	POWER GENERATION AND ECONOMICS	3	0	0	3.0
3	UEE633	GENERALIZED THEORY OF ELECTRICAL MACHINES	3	0	0	3.0
4	UCS049	DATA STRUCTURES AND ALGORITHMS	2	0	2	3.0

ELECTIVE-II

SR. NO.	COURSE NO.	TITLE	L	T	P	CR
1	UEE524	POWER QUALITY MONITORING AND CONDITIONING	3	1	0	3.5
2	UEE841	INDUSTRIAL ELECTRONICS	3	1	0	3.5
3	UEE521	ELECTRIC MACHINE DESIGN	3	1	0	3.5
4	UEE850	SMART GRID	3	1	0	3.5
5	UEI841	ADVANCED CONTROL SYSTEMS	3	1	0	3.5

GENERIC ELECTIVE

S.No	COURSE NO.	TITLE	L	T	P	Cr.
1	UHU007	EMPLOYABILITY DEVELOPMENT SKILLS	2	2	0	3.0
2	UHU006	INTRODUCTORY COURSE IN FRENCH	2	2	0	3.0
3	UHU009	INTRODUCTION TO COGNITIVE SCIENCE	3	0	0	3.0
4	UHU008	INTRODUCTION TO CORPORATE FINANCE	3	0	0	3.0
5	UCS001	INTRODUCTION TO CYBER SECURITY	3	0	0	3.0
6	UPH063	NANOSCIENCE AND NANOMATERIALS	3	0	0	3.0
7	UEN004	TECHNOLOGIES FOR SUSTAINABLE DEVELOPMENT	3	0	0	3.0
8	UMA066	GRAPH THEORY AND APPLICATIONS	3	0	0	3.0
9	UMA061	ADVANCED NUMERICAL METHODS	3	0	0	3.0
10	UBTXXX	BIOLOGY FOR ENGINEERS	3	0	0	3.0

TOTAL CREDITS: 205

UEE001: ELECTRICAL ENGINEERING

L	T	P	Cr.
3	1	2	4.5

Course Objective: To introduce concepts of DC and AC circuits, electromagnetism, single-phase transformers, DC motor and generators.

DC Circuits: Kirchhoff's voltage and current laws; power dissipation; Voltage source and current source; 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; Transient response of series RL and RC circuits.

Steady state analysis of DC Circuits: The ideal capacitor, permittivity; the multi-plate capacitor, variable capacitor; capacitor charging and discharging, current-voltage relationship, time-constant, rise-time, fall-time; inductor energisation and de-energisation, inductance current-voltage relationship, time-constant; Transient response of RL, RC and RLC Circuits.

AC Circuits: Sinusoidal sources, RC, RL and RLC circuits, Concept of Phasors, Phasor representation of circuit elements, Complex notation representation, Single phase AC Series and parallel circuits, power dissipation in ac circuits, power factor correction, Resonance in series and parallel circuits, Balanced and unbalanced 3-phase circuit - voltage, current and power relations, 3-phase power measurement, Comparison of single phase and three phase supply systems.

Electromagnetism: Electromagnetic induction, Dot convention, Equivalent inductance, Analysis of Magnetic circuits, AC excitation of magnetic circuit, Iron Losses, Fringing and stacking, applications: solenoids and relays.

Single Phase Transformers: Constructional features of transformer, operating principle and applications, equivalent circuit, phasor analysis and calculation of performance indices.

Motors and Generators: DC motor operating principle, construction, energy transfer, speed-torque relationship, conversion efficiency, applications, DC generator operating principle, reversal of energy transfer, emf and speed relationship, applications.

Laboratory Work:
Network laws and theorems, Measurement of R,L,C parameters, 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, Magnetisation curve of DC generator.

Course Learning Outcome (CLO):
After the completion of the course the students will be able to:

- Learn about applications of networks laws and theorems to solve electric circuits.
- Represent AC quantities through phasor and compute AC system behaviour during steady state.
- Learn about principle, construction, characteristics and application of Electro-Mechanical energy conversion devices.

Text Books:

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

Evaluation Scheme:

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

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, Armature reaction, Compensating windings, Commutation, Methods of improving commutation, Characteristic of DC generators, Voltage buildup of shunt generators, Voltage regulation, Parallel operation of DC generators, Condition for maximum efficiency, Applications of DC generators.

DC Motors: 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, Condition for maximum mechanical power, 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, 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:

- Test the transformer and calculate its efficiency and performance in distribution system.
- Scrutinize three-phase transformer connections and use special purpose transformer for measurement and protection.
- Select appropriate DC motor for specific purpose and can compute their steady performance.
- Compute the performance with DC generators and can supply increasing load with parallel operation.
- 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

UEE505: ANALOG AND DIGITAL SYSTEMS

L	T	P	Cr.
3	1	2	4.5

Course Objective: To introduce the students about h-model of BJT and FET, working of power devices, and oscillators. To understand design concept of combinational and sequential digital circuits.

Bipolar Junction Transistor and Field Effect Transistor: Different configurations and their static characteristics; CE configuration as two port network: h–parameters, h–parameter equivalent circuit; Biasing and load line analysis; High frequency operation of BJT; Structure and working of JFET and MOSFET; output and transfer characteristics, Applications of JFET and MOSFET

Oscillators and Wave Shaping Circuits: Condition for sustained oscillation, R-C phase shift, Hartley, Colpitts, Crystal and Wien Bridge Oscillators, Negative Resistance oscillator; Switching characteristics of diodes and transistors including square wave response, High pass and low pass filters using R-C Circuits; R–L, R–L–C circuits, Attenuators; Clipping and clamping circuits; Clamping circuit theorem; Comparators; Multivibrators.

Simplification of Boolean Expressions: Quine-McClusky method in SOP and POS forms, determination of prime implications, simplification using Map-entered variables.

Combinational and Sequential Circuits: Introduction, Adders: Parallel Binary adder, Serial adder, BCD adder, Subtractors, Binary multiplier, Dividers, ALU, Code converters, Magnitude comparators, Parity Generators/checkers, Encoders, Decoders, Multiplexers, Demultiplexer; Introduction of sequential circuits, Flip-flops, Registers: Serial/Parallel in/out, Bi-directional, Universal shift register, Counters: Synchronous, Asynchronous, Decade, Binary, Modulo-n, Shift register counters; Design of Synchronous sequential circuits, FSM, Concept of Moore and Mealy machines, Synchronous detector.

Memories: Introduction and classification of ROM, ROM organization, Static and Dynamic RAM, DRAM Refreshing, Representative circuits for cells using BJT and FET's, Timing diagrams of memories, Memory expansion using IC's, Flash memory, CCD, Magnetic Memories.

Converters: Digital to Analog conversion, R2R ladder DAC, Weighted Resistor DAC, Analog-Digital conversion, Flash type, Counter type ADC, Dual-slope ADC, Successive approximation type ADC.

Laboratory Work: Series voltage regulator, RC coupled amplifier in CE mode, Use of Bistable, Astable and monostable multivibrator, Hartley and Colpitts Oscillator, shift register and binary counting using JK flip flop, asynchronous/synchronous up/down counters, Variable modulus counters, Usage of IC tester, Computer simulation using EDA tools.

Minor Project: Design of LED lighting system for household application; street lighting system; soft starting of DC machine.

Course Learning Outcome (CLO):
After the completion of the course the students will be able to:
- Design different type of circuits such as rectifiers, clippers, clampers, filters etc.
- Design power supplies and solve problems related to amplifiers and oscillators.
- Design combinational and sequential circuits.

- Differentiate various type of memories and there use in different applications.
- Demonstrate the concept of logic circuits and converters.

Text Books:

1. *Boylestad R. L., Electronic Devices and Circuit Theory, Pearson Education (2007).*
2. *Millman, J. and Halkias, C.C., Integrated Electronics, Tata McGraw Hill (2006).*
3. *Floyd, T.L. and Jain, R. P., Digital Fundamentals, Pearson Education (2008).*
4. *Tocci, R. and Widmer, N., Digital Systems: Principles and Applications, Pearson Education (2007).*

Reference Books:

1. *Neamen, Donald A., Electronic Circuit Analysis and Design, McGraw Hill (2006).*
2. *Sedra A. S. and Smith K. C., Microelectronic Circuits, Oxford University Press (2006).*
3. *Mano, M. M. and Ciletti, M., Digital Design, Pearson Education (2008).*
4. *Kumar, A., Fundamentals of Digital Circuits, Prentice Hall (2007).*

Evaluation Scheme:

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

UEE405: NETWORK THEORY AND DESIGN

L	T	P	Cr.
3	1	2	8.0

Course Objective: To make the students understand concepts of graph theory, two port networks, filter design, attenuators, oscillator 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, Synthesis vs. analysis, Elements of circuit synthesis, Foster and cauer forms of LC Networks, Synthesis of RC and RL networks.

Filters and Attenuators: Classification of filters, Analysis of a prototype low pass filter, High pass filter, Band pass filter, Band stop filter, M–derived filter, Attenuation, Types of attenuators: symmetrical and asymmetrical.

Active Filters and Oscillators: Introduction to Active filters, first and second order low pass Butterworth filter, First and second order high pass Butterworth filter, Band pass filter, Oscillators: Principles, types, Phase shift Oscillators, Wein Bridge Oscillators, Square wave generators.

Laboratory Work:
Verification of Network Theorems, Determination of Z, Y, hybrid and ABCD parameters of two port network, Inter-connection of two port networks, Analysis of T and ∏-Attenuator Networks.

Course Learning Outcome (CLO):
After the completion of the course the students will be able to:
- Apply the various laws and theorems related to electric networks.
- Explain the concept of two port networks.
- Familiarisation with network synthesis
- Theory and designing of passive filters and attenuators
- Design of active filters

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	20
2	EST	30
3	Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	50

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:

- Simulate the steady-state and transient state performance of induction and synchronous machines to identify performance measures
- Validate and identify the machine parameters.
- Select the appropriate AC motor for different large power application.
- Analyse the stability of single machine – infinite bus system and form the grid to supply large load.
- 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

UEE403: MEASUREMENT AND TRANSDUCERS

L	T	P	Cr.
3	0	2	4.0

Course objective: To introduce the classification of standards, to get familiar with principle, operation and comparison of electromechanical indicating instruments. To get familiarize with power and energy measurement systems, working and applications of various type of bridges and transducer.

Units, Systems and Standards: SI units, Classification of standards, Time and frequency standards, Electrical standard.

Electromechanical Indicating Instruments: PMMC galvanometer, Ohmmeter, Electrodynamometer, Moving iron meter, Rectifier and thermo-instruments, Comparison of various types of indicating instruments.

Power and Energy Measurement: Electrodynamometer type of wattmeter and power factor meter, Single-phase induction and Electronic energy meters.

Bridges for Measurement: Kelvin double bridge, AC bridges: Maxwell's bridge, Hay's bridge, Schering bridge, Wien's bridge, Low and High resistance measurement.

Electronic Instruments: Electronic multi-meter, Quantization error, Digital frequency meter, Q meter, Spectrum Analyzer, Digital Storage Oscilloscopes.

Sensors and Transducers: Basic principle and applications of Resistive, Inductive, Capacitive and, Piezoelectric sensors, Synchros and Resolvers, Fiber optic sensors, Hall-Effect, Photo transducer, Photovoltaic, Digital transducers, Tacho-generators, shaft parameters measurement in rotating shafts.

Course Learning Outcomes (CLO):

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

- Use various types of instruments for measurement of variables.
- Select and use various types of sensors in different conditions.
- Select and use various type of bridge circuits with different sensors.

Text Books:

1. *Golding, E.W., and Widdis, F.C., Electrical Measurements and Measuring Instruments, Pitman (2003).*
2. *Sawhney, A.K., A Course in Electrical and Electronic Measurements and Instrumentation, DhanpatRai and Co. (P) Ltd. (2007).*
3. *Nakra, B. C. and Chaudhry, K. K., Instrumentation Measurement and Analysis, Tata McGraw–Hill (2003).*

Reference Books:

1. *Murthy, D.V.S., Transducers and Instrumentation, Prentice–Hall of India Private Limited (2003).*
2. *Doeblin, E.O., Measurement systems, Applications and Design, McGraw–Hill (1982).*

Evaluation Scheme:

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

UEE404: TRANSMISSION AND DISTRIBUTION OF POWER

L	T	P	Cr.
3	1	0	3.5

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:

- Analyse the transmission line models and evaluate its performance parameters.
- Design the transmission lines under various working conditions.
- Describe and select the configurations of different line insulators and evaluate their performance.
- Supervise the laying of cables and fault detection in cables.
- 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

UEE507: ENGINEERING ELECTROMAGNETICS

L	T	P	Cr.
3	1	0	3.5

Course objective: To provide the basic skills required to understand, develop and design various engineering applications involving electromagnetic fields.

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 andMaxwell'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:

- Appraise need analysis for different coordinate systems in electromagnetics and their interrelations
- Apply vector calculus to solve field theory problems
- Calculate electric and magnetic fields in different coordinates for various charge and current configurations
- Exhibit the concept of time varying fields
- Demonstrate different aspects of plane wave in dielectric and conducting media
- Realize the analogy of wave with transmission line and determine the transmission line performance

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

UEE504: POWER ELECTRONICS

L	T	P	Cr.
3	1	2	4.5

Course objective: To review the operational aspects of power electronic devices and principle of conversion and control of AC and DC voltages for high power applications.

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.

Laboratory Work: SCR V-I characteristics, Methods of turning on of an SCR through gate triggering, DC -DC chopper, Solid state fan regulator, Semi converter and Full converter with R and RL type of loads, DC shunt motor speed control, Single phase AC voltage controller with R load, Simulation of all converters using software CASPOC
.
Project: Design and development of power converters

Course learning Outcomes (CLO):
After the completion of the course the students will be able to:

- Select the power devices as per the usage for energy conversion and control.
- Exhibit the designing of firing and commutation circuits for different converter configurations.
- Demonstrate capability to analyse various converter configuration / topology.
- Identify converter configurations for various power applications such as electric drives, HVDC and FACTS.
- Exhibit the usage of 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) 3rd ed.*
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

UEE506: DIGITAL SIGNAL PROCESSING FUNDAMENTALS

L	T	P	Cr.
3	1	0	3.5

Course objective: To explain the concepts of Fourier analysis, digital signal processing and its applicability. To explain the stability analysis of digital system, digital filter design and application of DSP for specific protection and drive.

Introduction: Definition, conversion from analog signal to digital signal, advantages and disadvantages of digital signal processing.

z-Transform: Region of Convergence (ROC), Properties of z-transform, Initial and Final Value theorems, Partial Sum, Parseval's Theorem, z-transform of standard sequences, Inverse z-transform, Pole-Zero plot, System function of LTI system, Causality and Stability in terms of z-transform.

Discrete Fourier Transform (DFT) and Fast Fourier Transform (FFT): Discrete Fourier Series, Discrete Fourier Transform and its Properties, Efficient Computation of DFT using FFT algorithms, Linear Filtering Approach to Computation of DFT.

Digital Filter Structure: Describing Equation, Structures for FIR Systems, Structures for IIR Systems. Representation of Structures using Signal Flow Graph.

Design of Digital Filters: Introduction, Difference between analog and digital filters, Implementation of digital filter, Types of filters, LTI systems as filters, Design of IIR filters from analog filters, IIR filter design using Butterworth Approximation, Frequency transformation, FIR filters design, Least square filter design, Designing digital filter from pole-zero placement, Butterworth filter design using Bilinear transformation, FIR filter design using windows, Design of filters using pole-zero combination, Analysis of coefficient quantization effects in FIR filters, Analysis of round-off errors, Dynamic range scaling, Low sensitivity digital filters, Limit cycles in IIR filters.

Hardware Architecture of DSP Processor: Desirable features of DSP processors, Types of architectures, Internal architecture, Features, System interface and Instruction set of ADSP-21xx, ADSP-21xx Development tools, TMS DSP processor.

Applications: Dual-tone multi frequency signal detection, Spectral analysis using DFT, Short term DFT, oversampling, Protection.

Course Learning Outcomes (CLO):
After the completion of the course the students will be able to:

- Explain the digital signal processing concepts and stability analysis of digital system.
- Demonstrate the hardware architecture of DSP Processor.
- Design digital filterand harmonic mitigation.
- Carryout spectrum analysis using DFT.
- Apply DSP concepts for power system purposes such as relaying, protection and metering

Text Books:

1. *Proakis, J.G. and Manolakis, D.G., Digital Signal Processing, Prentice Hall of India Private Limited (1996).*
2. *Rabiner, C.R. and Gold, B., Theory and Applications of Digital Signal Processing, Prentice Hall of India Private Limited (2000)*

Reference Books:

1. *Antonion, A., Digital Filters: Analysis Design and Application, Prentice-Hall of India Private Limited (1999).*
2. *Oppenhein, A.V. and Schafer, R.W., Digital Signal Processing, Prentice-Hall of India Private Limited (1998).*
3. *Helmut, U. and Willibald, W., Protection Techniques in Electrical Engg. Systems,Marcel Dekker Inc. (2001)*

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 explain power system components models during steady state and faults, and concepts of power flow analysis, fault analysis and power system 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 building algorithm.

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:

- Develop an appropriate mathematical model of power system
- Carry out power flow analysis of practical power system for balanced system.
- Conduct studies during balanced and unbalanced faults to decide the fault levels and circuit breaker ratings.
- 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. No.	Evaluation Elements	Weightage (%)
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:

- Select the protection elements such as fuse, circuit breakers, relays etc. for a given configuration.
- Design the basic Earthing requirement for residential and other purposes.
- Select required protection measures against overcurrent, overvoltage in transmission lines.
- 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:
- Conceptualize the basic drive system and analyse it for different types of loads
- Analyse the motor situation during starting and braking
- Develop control circuitry and devices for control of motor
- Estimate the motor rating for different condition of load
- Design the converter circuit for control purpose along with its different configuration
- 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. No.	Evaluation Elements	Weightage (%)
1.	MST	25
2.	EST	35
3.	Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	40

UEE693: Capstone Project (Start)

L	T	P	Cr
0	0	2	--

Course Objective: To facilitate the students learn and apply an engineering design process in electrical engineering, including project resource management. As a part of a team, the students will make a project, that emphasizes, hands-on experience, and integrates analytical and design skills. The idea is to provide an opportunity to the students to apply what they have learned throughout the course of graduate program by undertaking a specific problem.

Course Description: Capstone Project is increasingly interdisciplinary, and requires students to function on multidisciplinary teams. It is the process of devising a system, component or process to meet desired needs. It is a decision-making process (often iterative), in which the basic sciences, mathematics, and the engineering sciences are applied to convert resources optimally to meet these stated needs. It typically includes both analysis and synthesis performed in an iterative cycle. Thus, students should experience some iterative design in the curriculum. As part of their design experience, students have an opportunity to define a problem, determine the problem scope and to list design objectives. The project must also demonstrate that students have adequate exposure to design, as defined, in engineering contexts. Engineering standards and realistic constraints are critical in engineering design. The program must clearly demonstrate where standards and constraints are taught and how they are integrated into the design component of the project. Each group will have 4-5 students. Each group should select their team leader and maintain daily diary. Each Group will work under mentorship of a Faculty supervisor. Each group must meet the assigned supervisor (2hrs slot/week) till the end of the semester (record of attendance will be maintained), as per the time slot which will be provided to them by the respective supervisor. This is mandatory requirement for the fulfilment of the attendance as well as the successful completion of the project. The faculty supervisor of the project will continuously assess the progress of the works of the assigned groups. Some part of the analysis and design of the system will be done in the first section of project in semester VI. The second section would comprise of completion of the project in semester VII in which each team will have to submit a detailed report of the project along with a poster.

Course Learning Outcomes:

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

1. To identify design goals and analyze possible approaches to meet given specifications with realistic engineering constraints.
2. To design an electrical engineering project implementing an integrated design approach applying knowledge accrued in various professional courses.
3. To perform simulations and incorporate appropriate adaptations using iterative synthesis.
4. To use modern engineering hardware and software tools.
5. To work amicably as a member of an engineering design team.
6. To improve technical documentation and presentation skills.

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:

- Conceptualize the idea of high voltage and safety measures involved
- Analyse the breakdown mechanism of solids, liquids and gases
- Design insulation associated with various power system components such as transformer, rotating machines and switchgear
- Analyse and calculate the circuit parameters involved in generation of high voltages
- Measure direct, alternating and impulse high voltage signals.
- 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

UEE604: FLEXIBLE AC TRANSMISSION SYSTEMS

L	T	P	Cr.
3	1	0	3.5

Course objective: To review the concept of power system control, operational aspects of various FACTS compensators, and their usage for power flow and stability improvement**.**

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:

- Describe the converter configuration for different power systems applications such as HVDC, FACTS etc.
- Evaluate the converters, harmonics on AC and DC side and filtering.
- Classify various compensators suited for various power system purposes.
- Analyze power system behaviour with different shunt compensators.
- Appraise series compensated power system behaviour with different series compensators.
- Analyse system behaviour with hybrid shunt-series compensators.

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

UEE702: INTELLIGENT TECHNIQUES IN ELECTRICAL ENGINEERING

L	T	P	Cr.
3	0	2	4.0

Course objective: To elucidate the concepts of techniques based on artificial intelligence such as fuzzy logic, neural networks and genetic algorithms and their problem solving capability.

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:

- Examine the fuzzy system and implement fuzzy controllers for control and classification.
- Explain neural networks behaviour and use them for classification, control system and optimization problem.
- Obtain the optimum solution of well formulated optimisation problem using evolutionary approach.
- 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.

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.

Course learning Outcomes:
After the completion of the course the students will be able to:

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

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

UEE795: Capstone Project (Completion)

L	T	P	Cr
0	0	2	8.0

Course Objective: To facilitate the students learn and apply an engineering design process in electrical engineering, including project resource management. As a part of a team, the students will make a project, that emphasizes, hands-on experience, and integrates analytical and design skills. The idea is to provide an opportunity to the students to apply what they have learned throughout the course of graduate program by undertaking a specific problem.

Course Description: Capstone Project is increasingly interdisciplinary, and requires students to function on multidisciplinary teams. It is the process of devising a system, component or process to meet desired needs. It is a decision-making process (often iterative), in which the basic sciences, mathematics, and the engineering sciences are applied to convert resources optimally to meet these stated needs. It typically includes both analysis and synthesis performed in an iterative cycle. Thus, students should experience some iterative design in the curriculum. As part of their design experience, students have an opportunity to define a problem, determine the problem scope and to list design objectives. The project must also demonstrate that students have adequate exposure to design, as defined, in engineering contexts. Engineering standards and realistic constraints are critical in engineering design. The program must clearly demonstrate where standards and constraints are taught and how they are integrated into the design component of the project. Each group will have 4-5 students. Each group should select their team leader and maintain daily diary. Each Group will work under mentorship of a Faculty supervisor. Each group must meet the assigned supervisor (2hrs slot/week) till the end of the semester (record of attendance will be maintained), as per the time slot which will be provided to them by the respective supervisor. This is mandatory requirement for the fulfilment of the attendance as well as the successful completion of the project. The faculty supervisor of the project will continuously assess the progress of the works of the assigned groups. Some part of the analysis and design of the system will be done in the first section of project in semester VI. The second section would comprise of completion of the project in semester VII in which each team will have to submit a detailed report of the project along with a poster.

Course Learning Outcomes:

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

1. To identify design goals and analyze possible approaches to meet given specifications with realistic engineering constraints.
2. To design an electrical engineering project implementing an integrated design approach applying knowledge accrued in various professional courses.
3. To perform simulations and incorporate appropriate adaptations using iterative synthesis.
4. To use modern engineering hardware and software tools.
5. To work amicably as a member of an engineering design team.
6. To improve technical documentation and presentation skills.

UEE806: ALTERNATE SOURCES OF ENERGY

L	T	P	Cr.
3	0	2	4.0

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

- Explain the basic renewable energy sources like solar, wind ,biomass etc
- Explain various advantages and disadvantages of renewable energy sources.
- Familiarization with different standalone, off grid energy sources
- Explain different technology associate with solar, wind, biomass and other renewable energy sources.
- Describe the working of micro/mini hydropower system.

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	25
2.	EST	40
3.	Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	35

UEE891: PROJECT

L	T	P	Cr
-	-	-	20.0

Course Objectives

The project semester is aimed at developing the undergraduate education programme in Electrical Engineering to include a practical training in a professional engineering set up (a company, top educational institution, research institute etc.) hereafter referred to as host "organization" as deemed appropriate. The participating organizations are selected that are either already visiting Thapar University for placement or are forming new relationships of mutual benefit. The project semester gives the student the opportunity to translate engineering theory into practice in a professional engineering environment. The technical activity in the project semester should be related to both the student's engineering studies and to the host organization's activities and it should constitute a significant body of engineering work at the appropriate level. It should involve tasks and methods that are more appropriately completed in a professional engineering environment and should, where possible, make use of human and technology resources provided by the organization. It consolidates the student's prior learning and provides a context for later research studies. The student remains a full time registered student at Thapar University during the project semester and this activity is therefore wholly distinct from any industrial interactions which may occur over vacation periods.

Assessment Details

Each student is assigned a faculty supervisor who is responsible for managing and assessment of the project semester. The faculty supervisor monitors the student's progress in a semester and interacts with the industry mentor during his/her visit to the host organization twice. This includes a Reflective Diary which is updated throughout the project semester, an Interim Project Report, a Final Report with Learning Agreement/Outcomes and a Final Presentation & Viva which involves the faculty Supervisor and some other members from the department. The mentor from the host organization is asked to provide his assessment on the designated form. The faculty supervisor is responsible for managing and performing the assessment of the project semester experience.

Course learning Outcomes (CLO):

Upon completion of project semester, the students will be able to:

1. Acquire knowledge and experience of software and hardware practices in the area of project.
2. Carry out design calculations and implementations in the area of project.
3. Associate with the implementation of the project requiring individual and teamwork skills.
4. Communicate their work effectively through writing and presentation.
5. Demonstrate the knowledge of professional responsibilities and respect for ethics.

UEE892: DESIGN PROJECT

	L	T	P	Cr
Course Objectives	**-**	**-**	**-**	**13.0**

The design project is introduced in Electrical Engineering undergraduate programme to include a practical training in the university itself for six months. The project offers the student the opportunity to demonstrate engineering theory into practice under the supervision of a faculty supervisor in electrical engineering department. The students are also offered with two courses. The technical activity in the project semester should be related to both the student's engineering studies and the faculty supervisor's guide lines to make working model in the area of application of electrical engineering. It involves tasks and methods that are more appropriately completed in an academic practical environment and should, where possible, make use of human and technology resources provided by the university. It consolidates the student's prior learning and provides a context for later research studies. The student remains a full time registered student at Thapar University during the project semester and this activity is, therefore, wholly distinct from any industrial interactions which may occur over vacation periods.

Assessment Details

Each student is assigned a faculty supervisor who is responsible for managing and assessment of the alternate project semester. The faculty supervisor guides the students till the end of semester and monitors the student's progress throughout the same. This includes a Reflective Diary which is updated throughout the alternate project semester, an Interim Project Report, a Final Report with Learning Agreement/Outcomes and a Final Presentation & Viva which involves the faculty Supervisor and some other faculty members from the department.

Course learning Outcomes (CLO):
Upon completion of project semester, the students will be able to:

1. Acquire knowledge and experience of software and hardware practices in the area of project.
2. Carry out design calculations and implementations in the area of project.
3. Associate with the implementation of the project requiring individual and teamwork skills.
4. Communicate their work effectively through writing and presentation.
5. Demonstrate the professional responsibilities and respect for ethics in university ambiance.

UEE631: HVDC TRANSMISSION SYSTEMS

L	T	P	Cr.
3	0	0	3.0

Course objective: To introduce the concepts of DC transmission systems, HVDC control, protection methods and AC & DC side filter design.

DC power transmission technology: Introduction, Comparison of HVAC and HVDC transmission system, Applications of DC transmission, Description of DC transmission system, Configurations, Modern trends in DC transmission.

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, Modelling 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:
- Choose intelligently AC and DC transmission systems for the dedicated application(s).
- Identify the suitable two-level/multilevel configuration for high power converters.
- Select the suitable protection method for various converter faults.
- Identify suitable reactive power compensation method.
- 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	50
3.	Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	20

UEE632: POWER GENERATION AND ECONOMICS

L	T	P	Cr.
3	0	0	3.0

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:

- Apply knowledge of India’s power scenario, power system structure and related agencies.
- Harness power from conventional and renewable sources.
- Select the methods and size of plant generating power for overall economy.
- 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

UEE633: GENERALIZED THEORY OF ELECTRICAL MACHINES

L	T	P	Cr.
3	0	0	3.0

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 Outcomes (CLO):
After the completion of the course the students will be able to:

- Express the revolving field and reference frame theory
- Develop mathematical model of three-phase AC machines and parameters in different reference frame
- Simulate the transient performance of three-phase ac machines in different reference frames.
- Investigate the transient performance of different DC machines.
- 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	50
3.	Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	20

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:
- Reliably identify the sources of various power quality problems.
- Estimate the impact of various power quality problems on appliances.
- Educate the harmful effects of poor power quality and harmonics.
- 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

UEE841: INDUSTRIAL ELECTRONICS

L	T	P	Cr.
3	1	0	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:

- Simulate and analyse the semiconductor controlled ac and DC drive system
- Design and develop an illumination system for domestic, industry and commercial sites.
- Design an electric heating system for industrial purposes.
- Equip the skill to design and develop a regulated power supply.
- 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	30
2.	EST	45
3.	Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	25

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 mmf for 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:

- Design DC machines
- Design transformers with reduced losses
- Calculate the losses and efficiency in the 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

UEE850: SMART GRID

L	T	P	Cr.
3	1	0	3.5

Course objective: To understand general communication techniques used in power system communication infrastructure and information system for control centers. To understand interconnection issues related with integration of distributed generation technologies.

Communication Technologies for Power System: Fiber Optical Networks, WAN based on Fiber Optical Networks, IP based Real Time data Transmission, Substation communication network, Zigbee

Information System for Control Centers (ICCS): ICCS Configuration, ICCS communication Network, ICCS Time Synchronization, E-Commerce of Electricity, GIS, GPS.

Integration, Control and Operation of Distributed Generation: Distributed Generation Technologies and its benefits, Distributed Generation Utilization Barriers, Distributed Generation integration to power grid.

Monitoring the smart grid: Load dispatch centers, wide-area monitoring system (WAMS), PMU; Smart sensors/telemetry, advanced metering infrastructure (AMI);smart metering; smart grid system monitoring; communication infrastructure and technologies; self-healing.

Micro grid: Integration of distributed energy sources; concept, operation, control and protection of Micro grid**.**

Hybrid Power Systems: Integration of conventional and non-conventional energy sources.

Course learning Outcomes (CLO):

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

- Explain various aspects of the smart grid, including, Technologies, Components, Architectures and Applications.
- Explain communication infrastructure of smart grid.
- Explain various integration aspects of conventional and non-conventional energy sources.
- Explain distributed generation coordination including monitoring of smart grid using modern communication infrastructure.
- Analyze Microgrid as a hybrid power system with advantages and challenges in future.

Text Books:

1. *INIEWSKI, Smart Grid Infrastructure And Networking, McGraw-Hill Education India Pvt.Ltd (2012), 1st Edition*
2. *James Momoh, Smart Grid: Fundamentals of Design and Analysis, IEEE Computer Society Press (2012)*

Reference Books:

1. *Ekanayake J.,Jenkins N., Liyanage K., Wu, J., Yokoyama A., Smart Grid: Technology and applications, Wiley Publications.*
2. *Momoh J., Smart Grid: Fundamentals of design and analysis, John Wiley & Sons.*
3. *Flick T., Morehouse J., Securing the smart grid: Next generation power grid security, paperback).*

Evaluation Scheme:

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

UCS 049 - : DATA STRUCTURES AND ALGORITHMS

L	T	P	Cr
2	0	2	3.0

Course Objectives: To become familiar with different types of data structures and their applications and learn different types of algorithmic techniques and strategies.

Introduction and Overview: Basic Terminology, Elementary Data Organization, Data Structures, Control Structures, Asymptotic Notations for Algorithms, Big O notation: formal definition and use, Little o, big omega and big theta notation , Arithmetic Expressions, Polish Notations, Arrays, Records, Pointers, Storing Strings, String Operations, Pattern Matching Algorithms, Stacks, Queues, Recursion, Towers of Hanoi.

Searching and Sorting: Linear Arrays, Traversing and Searching in Linear Arrays, Inserting and Deleting, Bubble Sort, Linear Search, Binary Search, Insertion Sort, and Selection Sort.

Non-Linear Data Structures: Trees, Binary Trees, Traversing Binary Trees, Binary Search Trees, Searching and Inserting in Binary Search Trees, Deleting in a Binary Search Tree, Preorder, Postorder and Inorder Traversal, Heaps, Graph, Graph Algorithms, Breadth First Search, Depth First Search.

Linked List: Introduction, Insertion into a linked list, Deletion into a linked list. Stack, Queues, trees using linked list, Hashing, Hash Functions.

Laboratory work: Implementation of Arrays, Recursion, Stacks, Queues, Lists, Binary trees, Sorting techniques, Searching techniques. Implementation of all the algorithmic techniques.

Course learning outcomes (CLOs):

On completion of this course, the students will be able to

1. Implement the basic data structures and solve problems using fundamental algorithms.
2. Implement various search and sorting techniques.

3. Analyze the complexity of algorithms, to provide justification for that selection, and to implement the algorithm in a particular context.

4. Analyze, evaluate and choose appropriate data structure and algorithmic technique to solve real-world problems.

Text Books:

1. Seymour Lipschutz Data Structures, TATA McGraw Hill (2016).

2. Corman, Leiserson&Rivest, Introduction to Algorithms, MIT Press (2009).

3. Narasimha Karumanchi, Data Structures and Algorithms Made Easy (2014).

Reference Books:

1. *Sahni, Sartaj, Data Structures, Algorithms and Applications in C++, Universities Press (2005).*

Evaluation Scheme:

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