University of Pune
FACULTY OF ENGINEERING
T.E. Electrical Engineering
(2012 Course)
(w.e.f. 2014-2015)

SEMESTER-I

Sr. No	Subject Code	Subject Title	Teaching Scheme			Examination Scheme					Total Marks
			Th.	Pr.	Tu.	PP In Sem	PP End Sem	TW	PR	OR	
1	311121	Industrial and Technology Management	04	--	--	**30**	**70**	--	--	--	100
2	303141	Advance Microcontroller and its Applications	04	02	--	**30**	**70**	--	--	50	150
3	303142	Electrical Machines II	04	02	--	**30**	**70**	--	50	--	150
4	303143	Power Electronics	04	02	--	**30**	**70**	--	50	--	150
5	303144	Electrical Installation, Maintenance and Testing	04	02	--	**30**	**70**	50	--	--	150
6	303145	Seminar and Technical Communication	--	02	--	--	--	50	--	--	50
TOTAL			**20**	**10**	**--**	**150**	**350**	**100**	**100**	**50**	**750**

SEMESTER-II

Sr. No	Subject Code	Subject Title	Teaching Scheme			Examination Scheme					Total Marks
			Th.	Pr.	Tu.	PP In Sem	PP End Sem	TW	PR	OR	
1.	303146	Power System II	**04**	**02**	**--**	**30**	**70**	**25**	**50**	**--**	**175**
2.	303147	Control System I	**04**	**02**	**--**	**30**	**70**	**-**	**--**	**50**	**150**
3.	303148	Utilization of Electrical Energy	**04**	**--**	**--**	**30**	**70**	**--**	**--**	**--**	**100**
4.	303149	Design of Electrical Machines	**04**	**04**	**--**	**30**	**70**	**25**	**--**	**50**	**175**
5.	303150	Energy audit and Management	**04**	**--**	**--**	**30**	**70**	**--**	**--**	**--**	**100**
6.	303151	Electrical Workshop	**--**	**02**	**--**	**--**	**--**	**50**	**--**	**--**	**50**
Total			**20**	**10**	**--**	**150**	**350**	**100**	**50**	**100**	**750**

Th. Theory lectures hours/week
Pr. Practical hours/week
Tu. Tutorial hours/week

TW Term work
PR Theory
OR Oral
PP Paper- In semester and End Semester

311121 : Industrial and Technology Management

Teaching Scheme		Examination Scheme	
Lectures:	**4 hrs/week**	In-Sem Assessment	30
		End-Sem Assessment	70

Objectives:

From the study of this course students will learn:

- Possess knowledge of types of business organizations; explore the fundamentals of economics and Management.
- Understand the basic concepts of Technology management and Quality management.
- Analyze and differentiate between marketing management and financial management.
- Be able to recognize the importance of Motivation, Group dynamics, Team work, leadership skill and entrepreneurship.
- Explain the fundamentals of Human Resource management.
- Identify the importance of Intellectual property rights and understand the concept of patents.

Unit 01: Basic Concept (08 hrs)

Business organizations -Types of business ownership- proprietary firm, partnership firm, joint stock company, public sector under takings, cooperative society.

Introduction to economics -Basic economics concepts- supply, demand, elasticity of supply, methods of demand forecasting, Role of government in macro economics

Management- Meaning, scope, function, and importance of management. Difference between administration and management, contribution of F.W.TAYLOR, HENRY FAYOL, ELTON MAYO, meaning of organization, principles, types of organization structure.

Unit 02: Technology Management (10 hrs)

Introduction of Technology Management :Definition of technology ,Management and its relation with society, classification of technology, Management of technology at various levels- its importance on National Economy, Ethics in technology management, Critical Factors in technology management.

Quality Management-Definition of quality, goalpost view of quality, continuous improvement definition ofquality, Types of quality – quality of design, conformance and performance phases of quality management, Juran's and Demings view of quality Quality Management Assistance Tools: Ishikawa diagram – Pareto Analysis – Pokka Yoke (Mistake Proofing) quality circles, TQM, Kaizen, Five S (5S), Six sigma, Quality Management Standards (Introductory aspects only) The ISO 9001:2000 Quality Management System Standard- The ISO 14001:2004. Environmental Management System Standard.

Unit 03: Marketing and Financial Management (08 hrs)

Marketing Management – Marketing function, marketing and selling, marketing planning, market survey and market research, online Marketing.

Financial Management- Definition of financial management, cost, types of costs, and methods of costing, price, capital, debit, credit, books of accounts and final accounts

Unit 04: Motivation (07 hrs)

Motivation, human needs ,theories of work motivation, Maslow of Hierarchy need theory of motivation, Theory X, Theory Y and F.Herzberg's two factor theory of motivation.

Group dynamics- theories of group formation, types and interactions of groups, formation of teams and team work

Leadership, importance, theories and styles, qualities of good leadership.

Entrepreneurship-Definition, concept, traits, qualities of entrepreneur

Unit 05: Human Resource Management (08 hrs)

Human Resource Management- introduction, importance, scope, HR planning, recruitment, selection, training and development, performance management., methods of performance appraisal

Industrial Relations and Labour Welfare.

Personality, development of personality, attitude, job satisfaction and organizational commitment, self development, time, stress management and conflict.

Professional and Business ethics.

Unit 06: IPR and Patents (07 hrs)

Introduction to Intellectual Property Rights(IPR), Meaning of IPR, Different forms of IPR, Patents, Criteria for securing Patents, Patent format and structure, Introduction to patents Laws, Trade mark and copy Right Laws.

Learning Outcomes: Students will be able to

- Differentiate between different types of business organization and discuss the fundamentals of economics and management.
- Understand and implement the concepts of technology management and quality management.
- Relate between marketing management and financial management.
- Effectively communicate in Group discussions and work in team, develop leadership and entrepreneurship skills.
- Employ the concepts of Human resource management, IPR and document Patent.

Text Books:

1. O.P. Khanna, industrial engineering and management, Dhanpat Rai and sons, New Delhi.
2. E. H. McGrah, S. J. Basic managerial skill for all.
3. Tarek Khalil, Management of Technology Tata Mc Graw Hill Education Pvt. Ltd.

References:

1. C. B. Mamoria- Personnel Management
2. Harold Koonlz and O D'onnel – Management
3. Philip Kotler- Marketing Management
4. M.Kay Dupont, Business Etiquette and Professionalism, Vira Book Pvt.Ltd
5. Dandi Daly Mackally, Self Development, Vira Book Pvt.Ltd, Mumbai.
6. Robert Heller, Managing Teams, Dorling Kindersley, London.
7. Robert Heller, Communicate Clearly, Dorling Kindersley, London.
8. Kelly John M, Total Quality Management, InfoTech Standard, Delhi.
9. Joseph M. Juran Juran's Quality Handbook TATA McGraw-Hill
10. Dale H. Besterfield and CarolBesterfield Total Quality Management Prentice Hall of IndiaPvt. Ltd.
11. Prabuddha Ganguli Intellectual Property rights TATA McGraw-Hill Publishing Company
12. Shiv Sahai Singh[Editor] The Law of Intellectual Property rights
13. N. R. Subbaram What Everyone Should Know About Patents Pharma Book Syndicate, Hyderabad.
14. Principals and Practices of Management –Dr. P.C. Shejwalkar, Dr. Anjali Ghanekar, Prof. Deepak Bhivpathki

303141: Advance Microcontroller and its Applications

Teaching Scheme		Examination Scheme[Marks]	
Lectures	**4 hrs/week**	In-Sem Assessment	30
Practical	**2 hrs/week**	End-Sem Assessment	70
		Oral	50

Prerequisite:

- Digital Logic Design,
- C Language,
- Microprocessor and Microcontroller Architecture.

Objectives: Students will learn

- PIC 18F458 Microcontroller architecture.
- Assembly and C language programming for PIC 18F458.
- Architecture and behavior of different ports of PIC18F458.
- Use of Timer in PIC 18F458.
- Serial port and Interrupt handling for PIC 18F458.
- ADC, DAC, and Sensor interfacing with PIC 18F458.

Unit 01: PIC Architecture (08 hrs)

Comparison of CISC and RISC, Overview of PIC microcontroller Family 10Fxx, 12Fxx, 16Fxx and 18Fxx 18F458 Architecture [Block Diagram and Pin Diagram], RAM organization, Memory Support RAM, FLASH, EEPROM, Oscillator support, Power down modes, Special Function Register, Program counters, Stack.

Unit 02: Instruction Set and Programming (08 hrs)

Pic18F458 addressing modes and Instruction set, Small assembly language programs.
Embedded C concepts, Header and source files and pre-processor directives, Data types, data structures, Control loops, functions, bit operations.

Unit 03: Development Tools and Hardware features (08 hrs)

Development tools-Editors, Assemblers, Compilers, Linkers, Simulators, Emulators, Debugger Programmers, Introduction to MPLAB Integrated Development Environment.
Timers, Interrupts, I/O Port, Programming of each of these in C.

Unit 04: Special Hardware features (08 hrs)

Serial port programming, Introduction to SPI protocol, Interfacing of PIC18F458 with LED, LCD(16x2) Keypad (4x4).

Unit 05: Interfacing of PIC Microcontroller-I (08 hrs)

Capture, Compare, PWM modes with and without interrupt, Interfacing of Stepper motor, Speed control of DC motor, Programming of these applications

Unit 06: Interfacing of PIC Microcontroller-II (08 hrs)

PIC ADC, Measurement of physical parameters such as temperature, pressure, level, flow, voltage, current etc., interfacing of DAC with PIC18F458

Learning Outcomes:

- PIC 18F458 Microcontroller internal Architecture.
- Architecture and behavior of different PIC 18F458 ports.
- C language programming for PIC 18F458.

- Understanding of hardware connection with PIC 18F458.
- Architecture and Programming for Timer of PIC 18F458.
- Architecture and programming of Serial port.
- Interrupts programming.
- ADC, DAC and Sensor interfacing with PIC 18F458.
- Serial port programming and Introduction to SPI protocol

List of Experiments:

Any six experiments from section (A) and any three experiments from section (B)

Section A.

1) i) Introduction to MPLAB.
   ii) Addition, Subtraction and Multiplication
2) Data transfer to ports
3) Timer, Counter, Delay programming
4) Interfacing 18F458 to Keypad ,Switch and LED
5) Interfacing of LCD [16 X 2] with PIC 18F458
6) Generation of square, positive ramp, negative ramp, triangular waveforms using DAC interface
7) Generating PWM waveform using PWM mode of 18F458 timer
8) Driving relay from 18F458 using software and hardware interrupts

Section B.

1) Interfacing DC motor with PIC 18F458
2) Interfacing Stepper motor with PIC 18F458
3) Interfacing of LM35 with PIC 18F458 and displaying of temperature
4) Measurement of speed using optical encoder.
5) Measurement of level using sensors and PIC 18F458.

Text Books:

1. PIC Microcontroller and Embedded Systems Using Assembly and C for PIC18 by Muhammad Ali Mazidi, Rolind D. Mckinlay, Danny Causey, Pearson Education
2. Fundamentals of Microcontrollers and Applications in Embedded Systems with PIC by
3. Ramesh Gaonkar ,Thomson and Delmar learning, First Edition
4. Embedded Systems Architecture, Programming and Design by Raj Kamal, TATA McGraw-Hill
5. Programming And Customizing the PIC Microcontroller by Myke Predko, TATA McGrawHill
6. PIC microcontroller: An introduction to software and Hardware interfacing by Han-Way-Huang , Thomson Delmar Learning.

References:

1. www.microchip.com
2. PIC18F458 datasheet
3. MPLAB IDE user guides
4. MICROCHIP Technical Reference Manual of 18F4520

Embedded Design with PIC 18F452 Microcontroller by John.B.Peatman, Prentice Hall

303142: Electrical Machines-II

Teaching Scheme		Examination Scheme[Marks]	
Lectures	**04hrs/ week**	In semester assessment	**30**
Practical	**02hrs/week**	End semester assessment	**70**
		Practical	**50**

Prerequisites:

- Basic working principle of machines and its rotating theory
- Construction working of DC series motor
- Phasor diagram of single phase transformer

Objectives:

- To understand construction and working of synchronous machines
- To study various speed control methods of a.c. motors.
- To impart various applications of a.c. motors.
- To understand various methods to determine regulation and efficiency of a.c. machines.

Unit 01: Three phase Synchronous machines: (08 hrs)

Three phase Synchronous machines: Construction, rotating-field type and rotating-armature type, salient-pole type and non-salient-pole type and their comparison. Damper winding

Three phase Synchronous generator (cylindrical rotor type): Principle of operation. Emf equation and winding factors, rating of generator. Generator on no-load and on balanced load. Armature reaction and its effect under different load power factors. Voltage drop due to armature resistance, leakage flux and synchronous reactance. Per phase equivalent circuit and phasor diagram. Power - power angle relation. Load characteristics. Losses and efficiency, power–flow chart. Brushless synchronous generator

Three phase Synchronous generator (salient pole type): Armature reaction as per Blondel's two-reaction theory for salient-pole machines, Direct-axis and quadrature-axis synchronous reactances and their determination by slip test. Phasor diagram of Salient-pole generator and emf equation.

Unit 02: Voltage regulation of Three phase Synchronous generator: (08 hrs)

Performance of open circuit and short circuit test on synchronous generator, determination of voltage regulation by emf, mmf, and Potier triangle methods. Determination of voltage regulation by direct loading. Short circuit ratio.

Parallel operation of 3-phase alternators: Necessity, conditions, Load sharing between two alternators in parallel. Parallel-Generator theorem. Process of synchronizing alternator with infinite bus-bar by lamp methods and by use of synchroscope. Synchronizing torque, power and current.

Unit 03: Three phase synchronous motor: (08 hrs)

Principle of operation. Methods of starting. Pull-in and pull-out torques. Equivalent circuit, significance of torque angle and torque equation. Losses, efficiency and Power flow chart. Operation of 3-phase Synchronous motor with constant excitation and variable load. Operation with constant load and variable excitation ('V' Curves and 'inverted V' curves). Phenomenon of hunting and its remedies. Applications of 3-ph synchronous motors. Introduction to synchronous – induction motor. Comparison of 3 ph synchronous motor with 3-phase induction motor.

Unit 04: Three phase induction motor, generator and special motors: (08 hrs)

Speed control of three phase induction motor by various methods (Stator side and rotor side controls). Action of 3-phase induction motor as induction generator, applications as induction generator. Singe phase and three phase Induction voltage regulator: construction, principle of working and applications.

Special Motors (Descriptive Treatment Only): Construction, principle of working, characteristics,

ratings and applications of Brushless d.c. motors, Stepper motors (only permanent and variable reluctance type), Permanent Magnet motor and linear induction motors.

Unit 05: A.C. series motor (08 hrs)

Operation of d.c. series motor on a.c. supply, nature of torque developed, problems associated with a.c. operation and remedies.

Plain Series motor: direct and quadrature axis fluxes. Transformer and rotational emfs in the field winding and the armature winding. Approximate phasor diagram (Ignoring leakage fluxes, magnetising current and currents in the short-circuited armature coils). Circle diagram, performance characteristics from circle diagram. Drawbacks of plain series motor.

Compensated series motor: Compensating winding, conductively and inductively compensated motor. Use of compoles for improving commutation. Ratings and applications of Compensated Series motors.

Universal motors: ratings, performance and applications, comparison of their performance on a.c. and d.c. supply.

Unit 06: Single phase induction motor (08 hrs)

Construction of single phase induction motor, mmf produced by single phase stator winding carrying an alternating current. Its representation by two revolving fields. Equivalent circuit and torque-slip characteristics on the basis of double revolving field theory. Tests to determine the parameters of equivalent circuit and calculation of performance characteristics of motor. Methods of self-starting. Types of single phase induction motors: Split-phase motors (Resistor split-phase motor, Capacitor-start motor, Capacitor start and run motor and permanent capacitor). Shaded pole induction motor – their construction, operation, torque-slip characteristics and applications. Comparison of 1-phase induction motor with 3-phase induction motor.

Learning Outcomes: Students will be able to

- Explain construction and working of synchronous machines.
- Understand Speed control methods of induction motor.
- State applications of various AC machines.
- Determine regulation and efficiency of AC machines experimentally.

List of Experiments:

Compulsory experiments:

1. Determination of regulation of cylindrical rotor alternator by following methods a) EMF method b) MMF method.
2. Determination of regulation of cylindrical rotor alternator by Potier method.
3. Determination of regulation of salient pole alternator by slip test.
4. V and inverted V curve of synchronous motor at constant load.
5. Speed control of three phase induction motor by V/F method (Using alternator)

Any **three experiments** are to be performed out of following:

1. Determination of Regulation of alternator by Direct loading.
2. Load test on three phase synchronous motor.
3. Load test on 1-phase induction motor.
4. Load test on 1-phase series motor.
5. No load and blocked-rotor test on a Capacitor-start 1-phase induction motor and Determination of its equivalent circuit parameters.
6. Performance characteristics of single phase series motor using circle diagram.
7. Synchronization of three phase alternator by Lamp and Synchroscope methods.
8. Simulation of performances characteristics of three phase induction motor on MATLAB.
9. Speed control of three phase induction motor by rotor resistance control method.

Text Books:

1. Nagrath and Kothari , Electrical Machines , 2nd Ed.,Tata McGraw Hill.
2. S. K. Bhattacharya, Electrical Machines, Tata McGraw Hill.
3. A.S. Langsdorf, Theory of Alternating Current Machinery , Tata McGraw Hill
4. P. S. Bimbhra, Electric Machinery, Khanna Publications.
5. B.R. Gupta and Vandana Singhal -Fundamentals of Electric Machines, New Age International (P) Ltd.
6. E.Openshaw Taylor, Performance and design of a.c. commutator motors, Wheeler Publishing.
7. V. K. Mehta and Rohit Mehta , Principles of Electrical Machines , S Chand Publications
8. Krishna Reddy –Electrical Machines vol.II and III, SCITECH publications.
9. Ashfaq Husain, Electrical Machines, Dhanpat Rai and Co.
10. M V Deshpande, Electrical Machines, Prentice Hall of India

References:

1. M.G. Say , Performance and Design of A.C. Machines (3rd Ed.) , ELBS
2. J B Gupta - Theory and performance of Electrical Machines, S K Kataria Publications
3. Samarjit Ghosh, Electrical Machines, Pearson Publication.
4. Bhag S Guru and Huseyin R Hiziroglu, Electrical Machinary and Transformer, 3rd Edition,Oxford University Press.
5. E G Janardanan, Special Electrical Machines, Prentice Hall of India.

303143: Power Electronics

Teaching Scheme		Examination Scheme[Marks]	
Lectures	**4hrs/ week**	In semester assessment	30
Practical	**2hrs/week**	End semester assessment	70
		Practical	50

Prerequisite:

- Knowledge of semiconductor material, basic electronics, diode, BJT and its characteristics
- Diode Rectifier, concept of rms and average value

Objectives: To enable students to gain knowledge and understanding in the following aspects:

- Fundamentals of power electronic devices and characteristics.
- The concepts and operating principles of power electronics circuits.
- Design procedures and techniques of power electronics systems.

Unit 01: Silicon Controlled Rectifier (08 hrs)

Construction, Static and dynamic Characteristics, specifications/rating of SCR Two-Transistor Analogy, Gate Characteristics, Triggering Circuits (R, R-C, UJT), Protection (over voltage, over current, and Thermal), design of snubber circuit for dv/dt and di/dt protection, Gate Turn Off(GTO) Thyristor.

Unit 02: Single Phase AC-DC Converter (08 hrs)

Single phase Converter: Half wave converter, Mid-point converter, Fully controlled converter (rectification and inversion mode), Half controlled converter (Semicoverter), Operation of all converters with R, RL and RLE load, derivation of Average and RMS output voltage, power factor, THD, TUF. Numerical based on output voltage and current calculations, Effect of source inductance on operation of converter, Concept of overlap angle and voltage drop calculation. Single phase dual converter (Descriptive treatment only), **Current source converter:** Concept of current source converter, operation with and without overlap angle (Descriptive treatment only)

Unit 03: Three Phase Converter and AC Voltage Regulator (08 hrs)

Three phase converter: Half wave converter, Fully controlled converter, rectification and inversion mode, Half controlled converter (Semicoverter), Operation of all converters with R, RL and RLE load, derivation of Average and RMS output voltage, power factor, THD, TUF. Numerical based on output voltage and current calculations

AC voltage regulator: DIAC, TRIAC- four mode operation, triggering of TRIAC using DIAC; Single phase AC Voltage regulator principle with R and RL Load, derivation of Average and RMS output voltage, Concept of two stage AC voltage regulator, Three phase A.C. voltage regulator (Descriptive)

Unit 04: Transistor based Devices and DC-DC converter (08 hrs)

Transistor based Devices: MOSFET, IGBT, Construction, working, transfer and VI characteristic, specifications, safe operating area, MCT construction and VI characteristics.

DC-DC converter: Principle of operation of chopper, classification on the basis of Operating quadrants. Control techniques: CLC, TRC, PWM and FM Techniques. Analysis of Step up Chopper and Numerical with RLE load. Necessity of input filter, Areas of application.

Unit 05: Single phase DC-AC Inverter (Transistor based) (08 hrs)

Half bridge voltage source inverter, full bridge VSI derivation of output voltage and current, current source inverter, Numerical. **PWM techniques:** Single pulse, multiple pulse and sinusoidal pulse modulation with Fourier analysis.

Unit 06: Three phase DC-AC Inverter (Transistor based) (08 hrs)

Three phase VSI using 120^0 and 180^0 mode and comparison, PWM based CSI and VSI, voltage

control and harmonic elimination techniques, Multilevel inverter concept, cascaded multilevel inverter, comparison of multilevel converters with multi-pulse inverter.

Learning Outcomes:

Professional knowledge and skills: Upon completion of the subject, students will be able to:

1. Understand the fundamental principles and applications of power electronics circuits.
2. Solve problems and design switching regulators according to specifications.
3. Use Computer-aided techniques for the design of power converter circuits.
4. Appreciate the latest developments in power electronics.

Attributes for all-roundedness

5. Communicate effectively, think critically and creatively.
6. Assimilate new technological and development in related field

List of Experiments:

Group A: Perform any THREE experiments (Hardware)

1. Static VI characteristic of SCR and TRIAC (Both)
2. Single phase fully controlled converter with R and RL load
3. Single phase A.C. voltage regulator
4. Static VI characteristic of GTO

Group B: Perform any THREE experiments (Hardware)

1. VI Characteristic of MOSFET and IGBT (Both)
2. DC step down chopper
3. 1- phase full bridge type PWM based VSI using transistor devices
4. 3-phase full bridge type PWM based VSI using transistor devices

Group C: Perform any THREE experiments (Hardware/Software)

1. Three phase AC-DC fully controlled bridge converter
2. Three phase voltage source inverter using 120^0 and 180^0 mode
3. Study of cascaded type multilevel inverter
4. Harmonic analysis of three phase VSI inverter with different PWM techniques.
5. Single phase half controlled converter with R and RL load
6. Design of snubber circuit and verification using simulation

Text Books:

1. M.H.Rashid - Power Electronics 2nd Edition, Pearson publication
2. Ned Mohan, T.M. Undeland, W.P. Robbins - Power Electronics, 3rd Edition, John Wiley and Sons
3. B.W. Williams: Power Electronics 2nd edition, John Wiley and sons
4. Ashfaq Ahmed- Power Electronics for Technology, LPE Pearson Edition.
5. Dr. P.S. Bimbhra, Power Electronics, Third Edition, Khanna Publication.
6. K. Hari Babu, Power Electronics , Scitech Publication.

References:

1. Vedam Subramanyam - Power Electronics , New Age International , New Delhi
2. Dubey, Donalda, Joshi,Sinha, Thyristorised Power controllers, Wiely Eastern New Delhi.
3. M. D. Singh and K. B. Khandchandani, Power Electronics, Tata McGraw Hill
4. Jai P. Agrawal, Power Electronics systems theory and design LPE, Pearson Education, Asia.
5. L. Umanand, Power Electronics – Essentials and Applications Wiley Publication.
6. J. Michael Jacob – Power Electronics Principal and Applications.
7. M.H.Rashid - Power Electronics Handbook, Butterworth-Heinemann publication, 3 edition
8. M.S. Jamil Asghar, Power Electronics, PHI.
9. V.R. Moorthi, Power Electronics Devices, circuits, and Industrial applications, Oxford University Press.
10. NPTEL Web course and video course on Power Electronics

303144: Electrical Installation, Maintenance and Testing

Teaching Scheme		Examination Scheme[Marks]	
Lectures	**4hrs/ week**	In semester assessment	30
Practical	**2hrs/week**	End semester assessment	70
		Term Work	50

Prerequisite:

- Introduction of Electrical supply system, typical A.C power supply scheme, Classification of Supply systems.
- Single line diagram of electrical supply system.

Objectives:

- To understand the basic concepts, design and estimation of distribution systems, substation
- To enable candidate to design earthing system for residential and commercial
- To understand practical aspects of condition monitoring and maintenance of various electrical equipments
- To learn the testing of various electrical equipments.

Unit 01: Maintenance and Condition Monitoring: (08 hrs)

Importance and necessity of maintenance, different maintenance strategies like Breakdown maintenance, planned maintenance and condition based maintenance. Planned and preventive maintenance of transformer, induction motor and alternators. Insulation stressing factors, insulation deterioration, polarization index, dielectric absorption ratio. Concept of condition monitoring of electrical equipments. Advanced tools and techniques of condition monitoring (Only theory)

Unit 02: Condition Monitoring of Transformers (06 hrs)

Testing and condition monitoring of oil as per the IS/IEC standards. Filtration/reconditioning of insulating oil. Failure modes of transformer. Condition monitoring of transformer bushings, On load tap changer, dissolved gas analysis, degree of polymerization. IS/Specifications for testing of transformer bushing and oil.

Unit 03: Condition Monitoring of Induction Motors (06 hrs)

Parameters of induction motors, Induction motor fault diagnostic methods, the induction motor fault monitoring method and Remedies

Unit 04: Testing of Electrical Equipments (08 hrs)

i) Testing of Power cables – Causes of cable failure, fault location methods and Remedial actions.
ii) Testing of Transformer - Type tests, Routine tests and Special tests. Various abnormal conditions, trouble shooting, faults, causes and remedies
iii) Testing of Induction motor – Various abnormal conditions, trouble shooting, faults, causes and remedies.
iv) Testing of Capacitor banks

Unit 05: Distribution Systems (10 hrs)

Classification of Supply systems. (State only)
i) DC 2-wire system ii)1 Phase 2 wire system iii) 3 Phase 3 wire systems iv) 3 Phase 4 wire systems.
Comparison between overhead and underground systems (for above mentioned systems) on the basis of volume requirement for conductor.
AC Distribution system Design: Types of primary distribution systems, Types of secondary

distribution systems, Voltage drops in ac distributors (uniform and non-uniform loading), (Numerical) Economics of power transmission- Economic choice of conductor size (kelvins law), (numerical), Economic choice of AC transmission voltage

Distribution Feeders: Design Considerations of Distribution Feeders: Radial and Ring types of primary feeders, voltage levels, energy losses in feeders.

Unit 06: Substation and Estimation (10 hrs)

Substation: Classification and types of substation, Indoor and Outdoor substations: Bus bar arrangements in the Sub-Stations: Simple arrangements like single bus bar, sectionalized single bus bar, main and transfer bus bar system with relevant diagrams. Substation earthing system i) Types of earthing (Equipment and Neutral), Maintenance free earthing system. ii) Different electrode configuration (Plate and Pipe Electrode) iii) Tolerable step and Touch Voltages. Methods of testing earth resistance.

Estimation: Introduction, HT, LT overhead lines and underground cables, cable sizing, price catalogue, labour rates, schedule of rates and estimating data (only theory)

Estimation and conductor size calculations of internal wiring for Residential and Commercial (Numerical) Calculations, installation and estimates for underground LT service lines.

Learning Outcomes: Students will able to learn,

- Condition monitoring and Testing of various electrical equipments
- Distribution systems, its types and substations
- Design of different earthing systems
- Estimation and costing of residential and commercial buildings

Industrial Visit: Visit to repair workshop (Any One). i) Three phase induction motor ii) Transformer iii) Power Cable.

List of Experiments:

Compulsory experiments: (Drawing sheets for 1 and 2 using AutoCAD or other CAD software)

1. Single line diagram of 132 or 220 or 400 KV substation (based on actual field Visit) Symbols, Plate or Pipe earthling
2. Estimation for 11 kV feeders and substation.
3. Project report on area electrification.

Any **five experiments** are to be performed out of following:

1. Measurement of Dielectric Absorption Ratio and Polarization Index of insulation.
2. Study of troubleshooting of electrical equipment based on actual visit to repair workshop (Any One).i) Three phase induction motor ii) Transformer iii) Power Cable
3. Study of thermograph images and analysis based on these images.
4. Assignment – Construction, working and troubleshooting of any two household Electrical equipments (Fan, Mixer, Electric Iron, Washing machines, Electric Oven, Microwave - Limited to electrical faults)
5. Study the various types of earthing for electrical appliances/systems, Practice of earthing and Measurement of Earth resistance of Campus premises.
6. Design, Estimation and costing of Earthing pit and earthing connection for computer lab, Electrical Machines Lab ,HT Substation.

Text Books:

1. S. Rao, Testing Commissioning Operation and Maintenance of Electrical Equipment, Khanna publishers.
2. S.L.Uppal - Electrical Power - Khanna Publishers Delhi.
3. Hand book of condition monitoring by B.K.N.Rao, Elsevier Advance Tech.,Oxford(UK).

4. S. K. Shastri – Preventive Maintenance of Electrical Apparatus – Katson Publication House
5. B. V. S. Rao – Operation and Maintenance of Electrical Equipment – Asia Publication

References Books:

1. B. R. Gupta- power system analysis and design, 3th edition wheelers publication.
2. P.S. Pabla –electric power distribution, 5th edition, Tata McGraw Hill.
3. S. L. Uppal, "Electrical Wiring and costing Estimation " Khanna Publishers, New Delhi.
4. Surjit Singh, "Electrical wiring, Estimation and Costing" Dhanpat Rai and company,
    a. New Delhi.
5. Raina K.B. and Bhattacharya S.K., "Electrical Design, Estimating and Costing", Tata McGraw Hill, New Delhi
6. B.D. Arora- Electrical wiring, Estimation and costing- New Heights, New Delhi.
7. M.V. Deshpande, "Elements of Power Station design and practice", Wheelers Publication.

IS/IEEE Standards:

1. IS : 1180 – Distribution Transformer
2. IS : 2026 – Power Transformer
3. IS : 4029 – Testing of 3 Phase Induction Motor.
4. IS : 694:1986 – PVC insulated cables for working voltages upto and including 1100 V
5. IS : 900:1992 – Code of practice for installation and maintenance of Induction Motors
6. IEEE 80:2000 – IEEE Guide for Safety in AC Substation Grounding.

303145: Seminar and Technical Communication

Teaching Scheme		Examination Scheme[Marks]	
Practical	**2 hrs/week**	Term Work	50

Objectives:

- Gaining factual knowledge (terminology, classification, methods and advanced trends)
- Learning fundamental principles, generalization or theories
- Discussion and critical thinking about topics of current intellectual importance
- Developing specific skills, competencies, and points of view needed by professionals in the field most closely related to the course

Seminar should be based on a detailed study of any topic related to the advance areas/applications of Engineering. Topic should be related to Electrical Engineering. However it must not include contents of syllabus of Electrical Engineering.

Format of the Seminar report should be as follows:

1. The report should be neatly written or typed on white paper. The typing shall be with normal spacing and on one side of the paper.(A-4 size).
2. The report should be submitted with front and back cover of card paper neatly cut and bound together with the text.
3. Front cover: This shall have the following details with Block Capitals
   a. Title of the topic.
   b. The name of the candidate with roll no. and Exam. Seat No. at the middle.
   c. Name of the guide with designation below the candidate's details.
   d. The name of the institute and year of submission on separate lines at the bottom.
4. Seminar approval sheet.
5. The format of the text of the seminar reports:

The introduction should be followed by literature survey. The report of analytical or experimental work done, if any, should then follow. The discussion and conclusions shall form the last part of the text. They should be followed by nomenclature and symbols used and then acknowledgement. The references are to be given at the end. The total number of typed pages, excluding cover shall from 20 to 25 only. All the pages should be numbered. Two copies of the seminar report shall be submitted to the college. The candidate shall present the seminar before the examiners. The total duration of presentation and after-discussion should be about 30 minutes.

The assessment for the subject shall be based on:

1. Report submitted.
2. Presentation
3. Discussion.

Learning Outcome: At the end of this student will able to

- Understand needs of today's world regarding innovations in Electrical engineering.
- Improve presentation and documentation skill.
- Apply theoretical knowledge to actual industrial applications and research activity.
- Help to contribute in analysis, planning, management and operation in Electrical engineering.

303146: Power Systems II

Teaching Scheme		Examination Scheme[Marks]	
Lectures	**4 hrs/Week**	In-semester	**30**
Practical	**2 hrs/Week**	End Semester	**70**
		Term Work	**25**
		Practical	**50**

Prerequisite:

- Constants, circuit representation and generalized constants of short and medium transmission lines
- Inductance and capacitance for symmetrical and unsymmetrical configuration of transmission lines
- Efficiency and line regulation of transmission line

Objectives:

- To develop analytical ability for Power system subject with prerequisite of power system I
- To introduction of computational methods for solving problems such as load flow
- To discuss in detail techniques and tools for power system analysis with a practical perspective

Unit 01: Performance of Transmission Lines (10 hrs)

Evaluation of ABCD constants and equivalent circuit parameters of Long transmission line. Concept of complex power, power flow using generalized constants, receiving end power circle diagram for transmission line (assuming ABCD constants are already given), surge impedance loading, Line efficiency, Regulation and compensation, basic concepts. Numerical based on: ABCD constants of Long transmission line, Power flow, circle diagram.

Unit 02: HVDC Transmission (Descriptive treatment only) **(06 hrs)**

Classification and components of HVDC system, advantages and limitations of HVDC transmission, comparison with HVAC system, introduction to HVDC control methods - constant current, constant ignition angle and constant extinction angle control, recent developments.

Unit 03: EHV-AC transmission: (06hrs)

Role of EHV-AC transmission, standard transmission voltages, average values of line parameters, power handling capacity and line losses, phenomenon of corona, disruptive critical voltages, visual critical voltages, corona loss, factors and conditions affecting corona loss, radio and television interference, reduction of interference, Numerical Based on Corona, Corona loss and power handling capacity.

Unit 04: Per unit system and Load Flow Analysis (09 hrs)

Per unit system: Single line diagram, Impedance and reactance diagrams and their uses, per unit quantities, relationships, selection of base, change of base, reduction to common base, advantages and application of per unit system. Numerical based on network reduction by using per unit system.

Load Flow Analysis: Network topology, driving point and transfer admittance, concept of Z-bus and formulation of Y-bus matrix using Direct method, singular transformation method, Introduction to load flow analysis, power- flow equations generalization to n bus systems, classification of buses, Newton- Raphson method (using polar coordinates), Gauss- Seidal method. (Descriptive treatment only) Numerical based on Y bus Matrix

Unit 05: Symmetrical Fault Analysis (08 hrs)

3-phase short-circuit analysis of unloaded alternator, sub-transient, transient and steady state current and impedances, D.C. Offset, and effect of the instant of short-circuit on the waveforms, estimation of fault current without pre-fault current for simple power systems, selection of circuit-breakers and current limiting reactors and their location in power system (Descriptive treatment

only) Numerical Based on symmetrical fault analysis

Unit 06: Unsymmetrical Fault Analysis: (09 hrs)

Symmetrical components, transformation matrices, sequence components, power in terms of symmetrical components, sequence impedances of transmission line and zero sequence networks of transformer, solution of unbalances by symmetrical components, L-L, L-G, and L-L-G fault analysis of unloaded alternator and simple power systems with and without fault impedance. Numerical based on symmetrical component and unsymmetrical fault calculation.

Learning Outcomes: Students will able to

- Solve problems involving modeling, design and performance evaluation of HVDC and EHVAC power transmission lines
- Analyze power flow in power transmission networks and apply power flow results to solve simple planning problems.
- Calculate currents and voltages in a faulted power system under both symmetrical and asymmetrical faults, and relate fault currents to circuit breaker ratings.

Industrial Visit: Compulsory visit to HV/EHV-AC substation/ HVDC substation

List of Experiments:

Compulsory experiments:

1.Measurement of ABCD parameters of a medium transmission line
2. Measurement of ABCD parameters of a long transmission line
3. Plotting of receiving end circle diagram to evaluate performance of medium transmission line
4. Study of the effect of VAR compensation using capacitor bank.
5. Static measurement of sub-transient reactance's of a salient-pole alternator.
6. Measurement of sequence reactance's of a synchronous machine (Negative and zero)

Any **three experiments** are to be performed out of following:

1. Calculation of inductance and capacitance for symmetrical and unsymmetrical configuration of transmission line using a software
2. Formulation and calculation of Y- bus matrix of a system
3. Solution of a load flow problem using Gauss-Seidal method
4. Solution of a load flow problem using Newton-Raphson method
5. Symmetrical and Unsymmetrical fault analysis of a 3-bus system
6. Simulation of HVDC system.

Text Books:

1. I.J. Nagrath and D.P. Kothari – Modern Power System Analysis – Tata McGraw Hill, New Delhi.
2. B R Gupta , "Power System Analysis and Design", S.Chand.
3. Abhijit Chakraborty and Sunita Haldar, "Power System Analysis" PHI, New Delhi.
4. J.B.Gupta. "A course in power systems" S.K. Kataria Publications.
5. P.S.R. Murthy, "Power System Analysis", B.S. Publications.

References:

1. H. Hadi Sadat: Power System Analysis, Tata McGraw-Hill New Delhi.
2. G. W. Stagg and El- Abiad – Computer Methods in Power System Analysis – Tata McGraw Hill, New Delhi.
3. M.E.El-Hawary, Electric Power Systems: Design and Analysis, IEEE Press, New York.
4. Rakash Das Begamudre, Extra High voltage A.C. Transmission Engineering, New age publication.
5. M.A.Pai, Computer Techniques in Power System Analysis", Tata McGraw Hill Publication.
6. Stevenson W.D. Elements of Power System Analysis (4th Ed.) Tata McGraw Hill, New Delhi.
7. K.R.Padiyar: HVDC Transmission Systems, New Age International Publishers Ltd, New Delhi.
8. Olle I. Elgard – Electric Energy Systems Theory – Tata McGraw Hill, New Delhi.
9. NPTEL Web course and video course on power system analysis

303147: Control System I

Teaching Scheme		Examination Scheme[Marks]	
Lectures	**04 hrs/Week**	In semester assessment	30
Practical	**02 hrs/Week**	End semester assessment	70
		Oral	50

Prerequisite: Laplace Transform, ordinary differential equations.

Objectives:

- To understand basic concepts of the classical control theory.
- To model physical systems mathematically.
- To analyze behaviour of system in time and frequency domain.
- To design controller to meet desired specifications.

Unit 01: General (08 hrs)

Basic concepts of control system, open loop, close loop, classification of control systems. Types of control system: Feedback, tracking, regulator system, feed forward system. Transfer function, Pole and zero concept. Modelling and representation of control system-Basic concept. Mechanical, Electrical and equivalent system. Block diagram reduction, signal flow graph, Mason's gain formula.

Unit 02: Control System Components (08 hrs)

Modelling and transfer function of control system components such as simple electrical, mechanical, electromechanical systems, Lag network, lead network, potentiometer, synchros, AC and DC servo motors, gear trains, AC-DC tacho-generators, Optical encoder, two tank systems.

Unit 03: Time domain analysis (08 hrs)

Standard test signal –step, ramp, parabolic and impulse signal, type and order of control system, time response of first and second order systems to unit step input, steady state errors – static and dynamic errors coefficients. Generalized errors series method. Time domain specifications of second order systems. Dominant closed loop poles of higher order systems Design specifications in time domain.

Unit 04: Stability analysis and Root Locus (08 hrs)

Concept of stability-Absolute, relative and marginal. Nature of system response for various locations of roots in S plane of characteristics equation. Routh's criterion and Hurwithz criterion.

Root Locus: Basic properties of root locus. Construction of root locus. Angle and magnitude condition for stable system. Root contour design concept.

Unit 05: Frequency domain analysis (08 hrs)

Steady state response of a system due to sinusoidal input. Relation between time and frequency response for second order system. Frequency domain specifications, analysis with Bode plot, Polar plot, Nyquist plot, stability analysis using Nyquist plot and Bode plot.

Unit 06: PID controllers (08 hrs)

Basic concept of PID controller, Design specifications in time domain and frequency domain. Time design of P,PI, PID controllers. Frequency domain design of P,PI,PID controllers, Tuning of PID controllers. Zigler-Nichol Method.

List of Experiments:

A) Minimum five experiments should be conducted.

1. Experimental determination of DC servo motor parameters for mathematical modelling, transfer function and characteristics.
2. Experimental study of time response characteristics of R-L-C second order system: Validation using simulation.
3. Experimental frequency response determination of Lag and Lead compensator.
4. PID control of level/Pressure/Temperature control system.
5. Experimental determination of transfer functions of two tank system.
6. Experimental determination of transfer function of PWM servo amplifier.
7. Experimental analysis of D.C. Position Control System.

B) Minimum three experiments should be conducted.

1. Stability analysis using a) Bode plot b) Root locus c) Nyquist plot using software.
2. Time response of second order system effect of P,PI, PID on it.
3. Analysis of closed loop DC position control system using PID controller.
4. Effect of addition of pole-zero on root locus of second order system.

Text Books:

1. I.J. Nagrath, M. Gopal, “Control System Engineering”, New Age International Publishers, 4th Edition, 2006.
2. Katsuhiko Ogata, “Modern control system engineering”, Prentice Hall, 2010.
3. B. C. Kuo, “Automatic Control System”, Wiley India, 8th Edition, 2003.
4. Natarajan Ananda, Babu P. Ramesh "Control Systems Engineering" , Second Edition, Scitech Publication, 2010.

References:

1. Richard C Dorf and Robert H Bishop, “Modern control system”, Pearson Education, 12th edition, 2011.
2. Nise N. S. “Control Systems Engineering”, John Wiley & Sons, Incorporated, 2011
3. Jacqueline Wilkie, Michael Johnson, Reza Katebi, "Control Engineering: An Introductory Course", Palgrave Publication, 2002.
4. D. Roy Choudhary, "Modern Control Engineering", PHI Learning Pvt. Ltd., 2005.
5. Smarajiti Ghosh, "Control Systems : Theory and Applications" , Dorling Kindersley (RS), 2012.

303148: Utilization of Electrical Energy

Teaching Scheme		Examination Scheme[Marks]	
Lectures	**4 hrs/Week**	In-semester	**30**
		End Semester	**70**

Prerequisite:

- Basics of Electrical Engineering, Effects of electric current
- Chemical reactions in electrolyte
- Control circuit design basics, awareness about artificial lighting, refrigeration, air conditioning
- Characteristics and application of different electric motors, awareness about traction

Objectives:

- To ensure that the knowledge acquired can be applied in various fields such as electric heating, illumination, chemical processes, electric traction.
- To make the students aware about the importance of maximizing the energy efficiency by optimum utilization of electrical energy.
- To develop ability amongst the students to design -heating element for resistance furnaces and design- illumination schemes. To develop ability amongst the students to analyze the performance of arc furnaces, electric traction, different sources of light, illumination schemes, electric traction
- To provide know how about various Control devices and their use in Refrigeration, Air Conditioning
- To provide know about electrochemical processes and applications of these in practical world, modern welding techniques.
- To develop self and lifelong learning skills, introduce professionalism for successful career.

Unit 01: Electric Heating (10 hrs)

Modes of heat transfer, mathematical expressions

Electric heating: Introduction to electric heating, Advantages of electrical heating

Heating methods: - Resistance heating – Direct resistance heating, indirect resistance heating, electric ovens, different types of heating element materials, temperature control of resistance furnaces, design of heating element(Numerical).

Applications of resistance heating

Induction heating : Principle, core type and coreless induction furnaces, Ajaxwyatt furnace, Numerical on melting furnaces Applications of induction heating

Electric arc heating – Direct and indirect arc heating, types of arc furnaces, equivalent circuit of arc furnace, condition for maximum output, power factor at maximum output (Numerical), Heat control in arc furnace, Applications of arc heating

Dielectric heating –Principle, choice of voltage and frequency for dielectric heating (Numerical), Applications of dielectric heating

Electric Welding

Welding methods–Electric arc welding and resistance welding. Modern welding techniques like ultrasonic welding and laser welding

Unit 02: Electrochemical Process (06 hrs)

Need of electro-deposition. Applications of Faraday's laws in electro-deposition. Factors governing electro-deposition. Objectives of electroplating. Equipments and accessories for electroplating plant, Electroplating on non-conducting materials, Principle of anodizing and its applications.

Pilot devices and Control devices - construction and working of push button, limit switches, float switches pressure switches, contactors, thermostats, timers, relays

Application of above devices in 1) Automatic water level controller 2) Lift

Electrical Circuits Used in Refrigeration, Air Conditioning

Brief description of vapour compression refrigeration cycle. Description of electrical circuits used in

Refrigerator, Air Conditioner

Unit 03: Illumination (08hrs)

Definitions of flux, solid angle, luminous intensity, illumination, luminous efficiency, depreciation factor, coefficient of utilization, space to height ratio, reflection factor; Laws of illumination.

Design of illumination scheme-Factors to be considered for design of illumination scheme, Calculation of illumination at different points, considerations involved in simple design problems for indoor installation, illumination schemes, standard illumination level. Design of flood lighting, street lighting Natural day light illumination (brief information)

Different sources of light: Incandescent lamp, fluorescent lamp, comparison between them.

Incandescent and discharge lamps – their construction and characteristics; mercury vapour lamp, sodium lamp, halogen lamp, compact fluorescent lamp, metal halide lamp, neon lamps

Electroluminescent lamp-LEDs, types, LASERs Comparison of all above luminaries.

Unit 04: Electric Traction (09 hrs)

History of Indian railways.

Traction systems - Steam engine drive, electric drive, diesel electric drive, types of diesel locomotives, Advantages of electric traction, Brief treatment to - Indian railway engine coding terminology, WDM,WDP,WDG series and their capacity . Introduction to metro system, mono rail system.

Systems of track electrification: D.C. system, single phase low frequency A.C. system, 3 phase low frequency A.C. systems, composite systems – kando systems, single phase A.C. to D.C. system

Different accessories for track electrification -overhead wires, conductor rail system, current collector-pentograph, catenary

Electric locomotive- Block diagram with description of various equipments and accessories.

Supply system constituents-Layout and description of -Traction substation, feeding post(25kV), feeding and sectioning arrangement, sectioning and paralleling post, neutral section.

Details of major equipments in traction substation-transformer, circuit breaker, interrupter

Unit 05: Traction Mechanics (09 hrs)

Types of services- Urban, Sub-urban, Main line Speed time curves, trapezoidal and quadrilateral speed-time curves, average and schedule speed(Numerical), Tractive effort. Specific energy consumption. Factors affecting specific energy consumption (Numerical), Mechanics of train movement, coefficient of adhesion (Numerical).

Unit 06: Traction Motors, Control of Traction Motors, Train Lighting (06 hrs)

Desirable characteristic of traction motors. Suitability of D.C. series motor, A.C. series motor, 3 phase induction motor and linear induction motor for traction. Control of traction motors -Series-parallel control, Shunt and bridge transition (Numerical), Electrical breaking, Regenerative breaking in traction, Suitability of different motors for braking. Train lighting system.

Railway signalling:- History, necessity, block system route relay interlock and necessity. Metro signalling, Electromechanical system for route relay interlock. Introduction to train tracking system, types. Anti-collision system-brief treatment only.

Learning Outcomes: Students will able to

- Students will be able to understand the importance of maximizing the energy efficiency by its **optimum utilization** and mould their practical work in professional world accordingly
- Students will be **able to design** simple resistance furnaces, illumination schemes
- Students will be able to the **performance** of arc furnace, electric traction
- Collection of technical information and delivery of collected information through presentations
- Students will get technical knowhow of various control devices and their use, modern welding techniques in practical world

- Students will develop lifelong learning skills that will help them in professional world

Industrial Visit: Visit to any one location from the following-

- Railway station (Control room)
- Loco shed
- Traction substation

Text Books:

1. Utilization of Electrical Energy' by E. O. Taylor – Revised in S.I. Units by V.V.L.Rao, Orient Longman
2. 'Utilization of Electric Power and Electric Traction' by J.B. Gupta, S.K. Kataria and sons, Delhi.
3. 'Generation, Distribution and Utilization of Electrical Energy' by C. L. Wadhwa, Eastern Wiley Ltd.
4. 'A text book on Power System Engineering' by A. Chakraborti, M. L. Soni, P. V. Gupta, U.S. Bhatnagar, Dhanpat Rai and Co.(P) Ltd – Delhi
5. "Practical railway engineering" By Clifford F.Bonntt (Imperial college press).

References:

1. Art and science of Utilization of Electrical Energy' by H. Partab, Dhanpat Rai andCo.(P) Ltd – Delhi
2. Modern Electric Traction by H. Partb, Dhanpat Rai and Co. (P) Ltd - Delhi
3. "Lamps and lighting" by M. A. Cayless, J.R. Coaton and A. M. Marsden
4. "BIS, IEC standards for Lamps, Lighting Fixtures and Lighting" By Manak Bhavan, New Delhi
5. "Illumination Engineering from Edison's Lamp to the Laser" Joseph B. Murdoch
6. "Two centuries of Railway signalling" by Geoffrey, Kichenside and Alan Willims (Oxford publishing Co-op).

303149: Design of Electrical Machines

Teaching Scheme		Examination Scheme[Marks]	
Lectures	**04hrs/ week**	In semester assessment	30
Practical	**02hrs/week**	End semester assessment	70
		Term Work	25
		Oral	50

Prerequisites:

- Knowledge of various materials used in electrical machines.
- Knowledge of types, construction and working of transformers
- Knowledge of types, construction and working of three phase induction motor.

Objectives: The students will able to

- To design transformer.
- To understand determination of parameters of transformer.
- To understand specifications of transformer.
- To design Induction motor.
- To understand determination of parameters of Induction motor.
- To understand specifications of Induction motor.

Unit 01: General (07 hrs)

Modes of heat dissipation. Heating and cooling curves. Calculations of heating and cooling time constants, calculation of short time and continuous rating of electrical machine. Types and constructional features of core and windings used in transformer. Transformer auxiliaries such as tap changer, pressure release valve, breather and conservator. Specifications of transformers as per IS 2026(Part I).

Unit 02: Transformer Design: (08 hrs)

Output equation with usual notations, design of main dimensions, core, yoke and windings of transformer. Methods of cooling and Tank design. Estimation of resistance and leakage reactance of transformer.

Unit 03: Performance parameters of Transformer: (08 hrs)

Estimation of no-load current, losses, efficiency and regulation of transformers. Calculation of mechanical forces developed under short circuit conditions, measures to overcome this effect. Introduction to Computer aided design of transformer and induction motor, generalised flow charts for design of electrical machines.

Unit 04: Three phase Induction Motor Design : Part I (09 hrs)

Constructional features, types of ac windings, output equation with usual notations, specific electrical and magnetic loadings, ranges of specific loadings, turns per phase, number of stator slots. Harmonic field effect on the performance of three phase induction motor, suitable combinations of stator and rotor slots. Specifications of Induction motor.

Unit 05: Three phase Induction Motor Design : Part II (08 hrs)

Calculations for main dimensions and stator design parameters. Selection of length of air gap, factors affecting length of air gap, unbalanced magnetic pull. Design of rotor slots, size of bars, end rings for cage rotor and rotor slots, turns and area of cross section of conductor for wound rotor.

Unit 06: Performance parameters of Three Phase Induction motor (08 hrs)

Leakage flux and leakage reactance: Slot leakage, tooth top leakage, zig-zag leakage, overhang leakage, leakage reactance calculation for three phase machines.

MMF Calculation for air gap, stator teeth, stator core, rotor teeth and rotor core, effect of saturation, effects of ducts on calculations of magnetizing current, calculations of no-load current. Calculations of losses and efficiency.

Learning Outcomes:

- Student will be able to design transformer.
- Student will be able to design Induction motor.
- Student will be able to determine of parameters of transformer.
- Student will be able to determine of parameters of Induction motor.

Industrial Visit: Industrial visit to a manufacturing unit of transformer or Induction motor.

Term work:

The term work shall consist of three drawing sheets (**Minimum one** in AutoCAD).

1. Details and assembly of 3- phase transformer with design report.
2. Details and layout of AC winding with design report.
3. Assembly of 3- phase induction motor.(only sheet)
4. Report based on Industrial visit to a manufacturing unit. (Transformer or Induction motor).

Text Books:

1. M.G. Say – Theory and Performance and Design of A.C. Machines, 3rd Edition, ELBS London.
2. A.K.Sawhney – A Course in Electrical Machine Design' 10th Edition, - Dhanpat Rai and sons New Delhi.
3. K. G. Upadhyay- Design of Electrical Machines, New age publication.
4. R. K. Agarwal – Principles of Electrical Machine Design, S. K.Katariya and sons.
5. Indrajit Dasgupta – Design of Transformers – TMH

References:

1. K.L. Narang , A Text Book of Electrical Engineering Drawings, Reprint Edition : 1993 / 94 – Satya Prakashan, New Delhi.
2. A Shanmugasundaram, G. Gangadharan, R. Palani, - Electrical Machine Design Data Book, 3rd Edition, 3rd Reprint 1988 - Wiely Eastern Ltd., - New Delhi
3. Vishnu Murti, "Computer Aided Design for Electrical Machines", B.S. Publications.
4. Bharat Heavy Electricals Limited, Transformers - TMH.

303150: Energy Audit and Management

Teaching Scheme	Examination Scheme[Marks]	
Lectures **4hrs/ week**	In semester assessment	30
	End semester assessment	70

Prerequisite:

- Concept of power and energy in three phase and single phase
- Various electrical equipments and specifications

Objectives: Students is able to

- Understand importance of energy and energy security.
- Understand impact of use energy resources on environment and emission standards, different operating frame work.
- Follow format of energy management, energy policy.
- Learn various tools of Demand Control.
- Calculate economic viability of energy saving option.

Unit 01: Energy Scenario (08 hrs)

Classification of Energy resources, Commercial and non-commercial energy, primary and secondary sources, commercial energy production, final energy consumption, Energy needs of growing economy, short terms and long terms policies, energy sector reforms, distribution system reforms and up-gradation, energy security, importance of energy conservation, energy and environmental impacts, emission check standard, United nations frame work convention on climate change, Global Climate Change Treaty, Kyoto Protocol, Clean Development Mechanism, salient features of Energy Conservation Act 2001 and Electricity Act 2003. Indian and Global energy scenario. Introduction to IE Rules. Study of Energy Conservation Building Code (ECBC), Concept of Green Building.

Unit 02: Energy Management (07 hrs)

Definition and Objective of Energy Management, Principles of Energy management, Energy Management Strategy, Energy Manager Skills, key elements in energy management, force field analysis, energy policy, format and statement of energy policy, Organization setup and energy management. Responsibilities and duties of energy manager under act 2001. Energy Efficiency Programmes. Energy monitoring systems. Introduction to SCADA and Automatic meter reading in utility energy management.

Unit 03: Demand Management (08 hrs)

Supply side management (SSM), various measures involved such as use of FACTS, VAR Compensation, Generation system up gradation, constraints on SSM. Demand side management (DSM), advantages and Barriers, implementation of DSM, areas of development of demand side management in agricultural, domestic and commercial consumers. Demand management through tariffs (TOD). Power factor penalties and incentives in tariff for demand control. Apparent energy tariffs. Role of renewable energy sources in energy management, direct use (solar thermal, solar air conditioning, biomass) and indirect use (solar, wind etc.)

Unit 04: Energy Audit (08 hrs)

Definition, need of energy audit, types of audit, procedures to follow, data and information analysis, energy audit instrumentation, energy consumption – production relationship, pie charts. Sankey diagram, Cusum technique, least square method and numerical based on it. Outcome of energy audit and energy saving potential, action plans for implementation of energy conservation options. Bench- marking energy performance of an industry. Energy Audit Report writing as per prescribed format. Audit case studies of sugar, steel, paper and cement industries.

Unit 05: Energy Conservation in Applications (09 hrs)

Motive power (motor and drive system). b) Illumination c) Heating systems (boiler and steam systems) c) Ventilation(Fan, Blower, Compressors) and Air Conditioning systems d) Pumping System e) Cogeneration and waste heat recovery systems f) Utility industries (T and D Sector) g) Diesel generators.

Unit 06: Financial Analysis and Case Studies (08 hrs)

Costing techniques; cost factors, budgeting, standard costing, sources of capital, cash flow diagrams and activity chart. Financial appraisals; criteria, simple payback period, return on investment, net present value method, time value of money, break even analysis, sensitivity analysis and numerical based on it, cost optimization, cost of energy, cost of generation, Energy audit case studies such as IT sector, Textile, Municipal corporations, Educational Institutes, T and D Sector and Thermal Power stations.

Learning Outcomes:

- Analyze and understand energy consumption patterns and environmental impacts and mitigation method.
- Listing various energy conservation measures for various processes.
- Students can carry out preliminary audits.
- Can work out economic feasibility of encon option.

Industrial Visit: Preferable visit to nearby process industry/power plant/utility substation for energy conservation.

Text Books:

1. Guide books for National Certification Examination for Energy Managers/Energy Auditors Book 1, General Aspects (available on line)
2. Guide books for National Certification Examination for Energy Managers/Energy Auditors Book 2 – Thermal Utilities (available on line)
3. Guide books for National Certification Examination for Energy Managers/Energy Auditors Book 3- Electrical Utilities (available on line)
4. Guide books for National Certification Examination for Energy Managers/Energy Auditors Book 4 (available on line)

References:

1. Success stories of Energy Conservation by BEE (www. Bee-india.org)
2. Utilization of electrical energy by S.C. Tripathi, Tata McGraw Hill.
3. Energy Management by W.R. Murphy and Mackay, B.S. Publication.
4. Generation and utilization of Electrical Energy by B.R. Gupta, S. Chand Publication.
5. Energy Auditing made simple by Balasubramanian, Bala Consultancy Services.

Websites:

1. www.energymanagertraining.com
2. www.em-ea.org
3. www.bee-india.org
4. www.pcra.org

303145: Electrical Workshop

Teaching Scheme		Examination Scheme[Marks]	
Lectures	**Nil**	In semester assessment	Nil
Practical	**2 hrs/week**	End semester assessment	Nil
		Term Work	50

Objectives:

- To enhance practical knowledge related to different subjects
- To develop hardware skills such as soldering, winding etc.
- To develop debugging skills.
- To increase ability for analysis and testing of circuits.
- To give an exposure to market survey for available components
- To develop an ability for proper documentation of experimentation.
- To enhance employability of a student.
- To prepare students for working on different hardware projects.

Instructions:

- **The exercises must be carried out in a group of maximum 3 students.**
- **Two faculty members must be engaged in the practical session of Electrical Workshop**
- **Minimum 5 exercises must be carried out. Out of which minimum four exercises must be from list mentioned below and two must be from each group.**
- **Students will present the design, procedure observations and conclusion in the form of report which will be evaluated for term work.**
- **The hardware components, tools necessary for the development of the experiments must be provided by the institution.**

Group A:

1. Design and fabrication of reactor/ electromagnet for different inductance values.
2. Design and fabrication of single phase Induction/three phase motor stator.
3. Start delta starter wiring for automatic and manual operation.
4. Wiring of distribution box with MCB, ELCB, RCCB and MCCB.
5. Wiring of 40 W tube, T-5, LED, Metal Halide lamps and available latest luminaries.
6. Assembly of various types of contactors with wiring.
7. Assembly of DOL and 3 point starter with NVC connections and overload operation.

Group B:

This group consists of electronics circuits which must be assembled and tested on general purpose PCB or bread boards.

1. Design and development of 5 V regulated power supply.
2. Design and development of precision rectifier.
3. Design and development of first order/ second order low pass/high pass filters with an application.
4. Microcontroller Interface circuit for temperature/level/speed/current/voltage measurement.
5. Peak detector using op-amplifers.
6. Zero crossing detector using op-amplifiers.