

SAVITRIBAI PHULE PUNE UNIVERSITY



FACULTY OF ENGINEERING

**SYLLABUS FOR T. E. (ELECTRICAL
ENGINEERING)**

(2015 course)

WITH EFFECT FROM YEAR 2017-2018

Savitribai Phule Pune University
FACULTY OF ENGINEERING
T.E. Electrical Engineering (2015 Course)
(w.e.f. 2017-2018)

SEMESTER-I													
Sr. No	Subject Code	Subject Title	Teaching Scheme			Examination Scheme					Total Marks	Credit	
			Th	Pr.	Tu.	PP		TW	PR	OR		TH/TU	PR+OR
						In Sem	End Sem						
1	311121	Industrial and Technology Management	03	--	--	30	70	--	--	--	100	03	--
2	303141	Advance Microcontroller and its Applications	04	02	--	30	70	--	--	50	150	04	01
3	303142	Electrical Machines II	04	02	--	30	70	--	50	--	150	04	01
4	303143	Power Electronics	04	02	--	30	70	--	50	--	150	04	01
5	303144	Electrical Installation, Maintenance and Testing	03	02	--	30	70	50	--	--	150	03	01
6	303145	Seminar and Technical Communication	--	02	--	--	--	50	--	--	50	--	01
	303152	Audit Course III											
TOTAL			18	10	--	150	350	100	100	50	750	18	05

SEMESTER-II													
Sr. No.	Subject Code	Subject Title	Teaching Scheme			Examination Scheme					Total Marks	Credit	
			Th.	Pr.	Tu.	PP		TW	PR	OR		TH/TU	PR+OR
						In Sem	End Sem						
1.	303146	Power System II	04	02	--	30	70	--	50	--	150	04	01
2.	303147	Control System I	04	02	--	30	70	-	--	50	150	04	01
3.	303148	Utilization of Electrical Energy	03	--	--	30	70	--	--	--	100	03	--
4.	303149	Design of Electrical Machines	04	02	--	30	70	25	--	50	175	04	01
5.	303150	Energy Audit and Management	03	02	--	30	70	25	--	--	125	03	01
6.	303151	Electrical Workshop	--	02	--	--	--	50	--	--	50	--	01
	303153	Audit Course IV											
Total			18	10	--	150	350	100	50	100	750	18	05

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

Audit Course

- Audit Course: Optional for 1st and 2nd term of TE Electrical Engineering
- ‘Audit Courses’ means a Course in which the student shall be awarded Pass or Fail only. It is left to the discretion of the respective affiliated institute to offer such courses to the students. Evaluation of audit course will be done at institute level itself.
- Teaching-learning process for these subjects is decided by concern faculty/industry experts appointed by the affiliated Engineering College.
- Marks obtained by student for audit course will not be taken into consideration of SGPA or CGPA.

Audit Course III	(A) Wind Energy Systems
	(B) Microcontroller MSP 430 and Applications
Audit Course IV	(A) Bioenergy Systems
	(B) Applications of Power Electronics

311121: Industrial And Technology Management

Teaching Scheme	Credits	Examination Scheme [Marks]
Theory: 03 Hrs./Week	03	In Sem. : 30 Marks End Sem.:70 Marks

Course Objective:

The course aims to

- Possess knowledge of types of business organizations; explore the fundamentals of economics and Management.
- Understand the basic concepts of Technology management and Quality management.
- Analyse and differentiate between marketing management and financial management.
- 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, copy rights and trademarks.

Course Outcome:

Upon successful completion of this course, the students will be able to

- Differentiate between different types of business organization and discuss the fundamentals of economics and management.
- Explain the importance of technology management and quality management.
- Describe the characteristics of marketing and its types.
- Discuss the qualities of a good leader.

Unit 01: Introduction to managerial and economical demand (06Hrs)

Managerial Economics: Definition of economics, Demand and Supply concept, Law of demand and supply, Elasticity of demand and supply, Demand forecasting: Meaning and methods.

Management: Meaning, scope, function, and importance of management. Difference between administration and management. Types of business ownership: Sole proprietorship, Partnership (Act 1934), LLP (Limited Liability Partnership), (Act2008). Business Organizations: Line organization, Line and Staff organization and Functional Organization. Joint Stock Company: Public Limited and Private Limited, Public Sector Undertaking (PSU)

Unit 2: Technology and Industrial Management (06Hrs)

Introduction to industrial management: Concept, development, application and its scope.

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.

Unit 3: Quality Management**(06Hrs)**

Definition of Quality Management: Definition of quality, continuous improvement, Types of quality. Quality of design, Assistance Tools: Ishikawa diagram – Pareto Analysis. Pokka Yoke (Mistake Proofing) quality circles, Kaizen. TQM, 5S (Case study of Toyota, descriptive treatment). 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 4: Marketing and Financial Management**(06Hrs)**

Marketing Management: Market, meaning, characteristics and its types: Perfect Competition, Monopoly, Monopolistic completion and Oligopoly. 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 5: Human Resource Management**(06Hrs)**

Motivation: Introduction to Motivation, theories of work motivation: Maslow Hierarchy of need's theory, Theory X, Theory Y and F. Herzberg's two factor theory. Group dynamics: Types and interactions of groups, stages of group dynamics: Norming, Storming, Forming, Performing and Adjourning. Leadership- Laissez-faire, importance, qualities of good leadership. Human Resource Management- Introduction, importance, scope. HR planning. Recruitment, selection, training and development, Performance management.

Unit 6: Entrepreneurship**(06Hrs)**

Entrepreneurship- Definition, concept, traits, qualities of entrepreneur. Importance and limitations of rational decision making, Decision making under certainty, uncertainty and risk. Incentives for small business development, Government policies and incentives, Case study on Small scale industries in India. Introduction to Intellectual Property Rights (IPR), Meaning of IPR, Different forms of IPR, Patents, Criteria for securing Patents. Patent format and structure, Copy and trademark (Descriptive treatment only).

Text Books:

- [T1] O.P. Khanna, industrial engineering and management, Dhanpat Rai and sons, New Delhi.
- [T2] E. H. McGrah, S. J. Basic managerial skill for all.
- [T3] Tarek Khalil, Management of Technology Tata Mc Graw Hill Publication Pvt. Ltd.
- [T4] Prabuddha Ganguli Intellectual Property rights TATA McGraw-Hill Publishing Company
- [T5] Management Accounting and financial management by "M. Y. Khan and P. K. Jain", Mcgraw Hill-Tata-ISBN.

Reference Books:

- [R1]** C. B. Mamoria and V.S.P.Rao- Personnel Management, Himalaya Publishing House, 30th Edition 2014
- [R2]** Harold Koonlz and O D’onne1 – Management.McGrawHill Publication 1980
- [R3]** Philip Kotler- Marketing Management. Pearson Edition 2008
- [R4]** Robert Heller, Managing Teams, Dorling Kindersley, London.
- [R5]** Kelly John M, Total Quality Management, InfoTech Standard, Delhi.
- [R6]** Joseph M. Juran Juran’s Quality Handbook TATA McGraw-Hill.
- [R7]** Dale H. Besterfield and CarolBesterfield Total Quality Management Prentice Hall of India Pvt. Ltd.
- [R8]** Shiv Sahai Singh[Editor] The Law of Intellectual Property rights.
- [R9]** N. R. Subbaram, What Everyone Should Know About Patents, Pharma Book Syndicate, Hyderabad.
- [R10]** Principles and Practices of Management –Dr. P.C. Shejwalkar, Dr. Anjali Ghanekar, Prof. Deepak Bhivpathki.
- [R11]** Financial Management by “I M Pandey”, Vikas Publishing House Pvt. Ltd., Delhi Philip Kotler- Marketing Management

Unit	Text Books	Reference Books
1	T1	R2,R10
2	T1, T2,T3	R5
3	-	R3,R5,R6
4	T5	R3, R11
5	T1	R1,R2
6	T4	R8

303141: Advance Microcontroller and its Applications

Teaching Scheme	Credit	Examination Scheme[Marks]
Theory : 04 Hrs./week	04	In Sem. : 30 Marks
Practical : 02 Hrs./week	01	End Sem.: 70 Marks
		Oral : 50 Marks

Prerequisite:

- Knowledge of Number system
- Knowledge of basic logic components.
- Programming skills in C Language,
- Microprocessor and Microcontroller Architecture.

Objectives:

The objectives of this course are

- To provide understanding of architecture of PIC 18F458 microcontroller
- To develop ability to Write and Interpret Assembly and C language programs for PIC 18F458
- To interface various devices with PIC18F458

Course outcomes:

On successful completion of the course the student will be able to

- Explain architecture of PIC18F458 microcontroller, its instructions and the addressing modes.
- Develop and debug program in assembly language or C language for specific applications
- Use of an IDE for simulating the functionalities of PIC microcontroller and its use for software and hardware development.
- Interface a microcontroller to various devices.
- Effectively utilize advance features of microcontroller peripherals.

Unit 01 : PIC Architecture (08 Hrs.)

Comparison of CISC and RISC, RAM and Program memory organization, Program counters, Stack pointer, Bank Select Register, Status register, Data transfer instructions, Arithmetic and logical instructions. Assembly language programs.

Unit 02 : Assembly language programming (08 Hrs.)

Addressing Modes for PIC 18 microcontroller, Branch instruction, CALL, RETURN, Bit addressable instruction. Assembly language programs I/O ports, SFR related to PORTs, I/O port programming.

Unit 03 : Programming of PIC microcontroller in C (08 Hrs.)

Embedded C concepts, Header and source files and pre-processor directives, Data types, data structures, Control loops, functions, bit operations. I/O port programming in C, Delay programming. PIC 18 Timer 0 Programming in C

Unit 04 : Special Hardware features and Programming (08 Hrs.)

Timers required for CCP Applications, CCP module in PIC 18 microcontroller, Applications of CCP mode Generation of waveform using Compare mode of CCP module. Period measurement of a unknown signal using Capture mode in CCP module, Speed control of DC motor using PWM mode of CCP module

Unit 05 : Interrupt programming (08 Hrs.)

Interrupt Programming, Programming of Timer interrupts, Programming of External interrupts, Serial port programming. Interfacing of PIC18F458 8 bit model LCD(16x2)

Unit 06 : Interfacing of PIC Microcontroller (08 Hrs.)

PIC ADC, Programming of ADC using interrupts, Measurement of temperature and voltage Using PIC microcontroller. Interfacing DAC with PIC18F458, Interfacing of Electromechanical Relays and Opto-isolators.

Guidelines for Instructor's Manual

- Commands to be followed in order to operate the PIC18 micro controller kit.
- Detailed connection diagram / Circuit Diagram of the KIT.
- Pin Diagram and PIN layout of PIC 18F458, all supporting ICs.
- Manuals for interfacing kits such as DC motor, DAC.
- User manuals of all the interfacing kits such as stepper motor, DC motor, DAC etc.

Guidelines for Student's Lab Journal

- Title of the program.
 - The program has to be written in the following format. Address- Instruction- Comment
 - Input data has to be specified.
 - Result of the program.
- Flow Chart for each program has to be drawn on separate page.

Guidelines for Laboratory Conduction

- Each student within the group has to enter and execute the program turn wise. Staff member has to check the result of all the groups after the execution of the program.
- Each subgroup of students in the laboratory should consist of maximum three numbers.

List of Experiments:

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

Section A.

1. i) Introduction to MPLAB. ii) Programs on Addition, Subtraction and Multiplication
2. Data transfer to ports
3. Timer, Counter, Delay programming
4. Interfacing 18F458 to 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 LM35 with PIC 18F458 and display temperature on it.
4. Measurement of speed using optical encoder.
5. Measurement of level using sensors and PIC 18F458.

Text Books:

- [T1] PIC Microcontroller and Embedded Systems Using Assembly and C for PIC18 by Muhammad Ali Mazidi, Rolind D. McKinley, Danny Causey, Pearson Education.
- [T2] Fundamentals of Microcontrollers and Applications in Embedded Systems with PIC by Ramesh Gaonkar, Thomson and Delmar learning, First Edition.
- [T3] Programming And Customizing the PIC Microcontroller by MykePredko, TATA McGraw-Hill.
- [T4] PIC microcontroller: An introduction to software and Hardware interfacing by Han-Way-Huang Thomson Delmar Learning.
- [T5] Microcontroller Theory and Applications with PIC18F, M.Rafiquzzaman, John Wiley and Sons

Reference Books:

- [R1] PIC18F458 datasheet
- [R2] MPLAB IDE user guides
- [R3] MICROCHIP Technical Reference Manual of 18F4520 Embedded Design with PIC 18F452 Microcontroller by John B. Peatman, Prentice Hall

Unit	Text Books	Reference Books
1	T1,T2,T3,T4	R1
2	T1, T2,T3,T4,T5	R1,R2
3	T1,T4,T5	R1
4	T1,T2,T3,T4	R1
5	T1,T2,T3,T4	R1
6	T1,T2,T3,T4	R1,R3

303142: Electrical Machines II

Teaching Scheme		Credits	Examination Scheme [Marks]	
Theory	: 4 Hrs./Week	04	In Sem.	: 30 Marks
Practical	: 2 Hrs./Week	01	End Sem.	: 70 Marks
			Practical	: 50 Marks

Prerequisites:

- Working principle and concepts of electrical machines
- Construction of DC series motor
- Phasor diagram and equivalent circuit of single phase transformer
- Construction and working of three phase induction motor.

Course Objectives:

- Learn construction & working principle of three phase synchronous machines.
- Define regulation of alternator & calculate it by direct and indirect methods.
- Study the methods of starting 3- phase synchronous motor, & its operation under Different conditions.
- Learn Speed control methods of three phase induction motor.
- Develop phasor diagram & circle diagram of a c series motor.
- Develop equivalent circuit of single phase induction motor.

Course Outcomes:

Students will be able to

- Explain construction & working principle of three phase synchronous machines
- Estimate regulation of alternator by direct and indirect methods.
- Demonstrate operation of synchronous motor at constant load and variable excitation (v curves & \wedge curves) & constant excitation and variable load.
- Explain Speed control methods of three phase induction motor.
- Plot circle diagram of ac series motor
- Obtain equivalent circuit of single phase induction motor by performing no load & blocked rotor test.

Unit 01: Three phase Synchronous machines.

(08Hrs.)

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

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.

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 reactance's and their determination by slip test. Phasor diagram of Salient-pole generator and calculation of voltage regulation.

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 current, power and torque.

Unit 03: Three phase synchronous motor: (08 Hrs.)

Principle of operation. Methods of starting. Equivalent circuit, significance of torque angle, 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-phase synchronous motors. Introduction to synchronous – induction motor. Comparison of 3 phase synchronous motor with 3-phase induction motor.

Unit 04: 3-ph induction motor, Induction generator and special purpose 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 of induction generator. Introduction to Energy Efficient three phase Induction Motor and Super conducting Generator.

Special Purpose Motors (Descriptive Treatment Only): Construction, principle of working, characteristics ratings and applications of Brushless D.C. motors, Stepper motors (permanent magnet and variable reluctance type only), Permanent Magnet motor (A.C. & D.C.) 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 AC. 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, magnetizing 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 composites 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, double field revolving theory. 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 capacitor run motor and permanent capacitor motor). Shaded pole induction motor: their construction, operation, torque-slip characteristics and applications. Comparison of 1-phase induction motor with 3-phase induction motor.

Guidelines for Instructor's Manual

Prepare 3/4 sets of standard experiments. It must contain title of the experiment. Also, Aim, Apparatus including name of machines with their specifications, rheostats, ammeter, voltmeter, wattmeter if used along with their ratings / ranges etc.

- **Theory:** Brief theory explaining the experiment
- **Circuit / connection diagram** or construction diagram must be drawn either manually using geometrical instruments or using software on A-4 size quality graph paper / plain white paper.
- **Procedure:** Write down step by step procedure to perform the experiment.
- **Observation table:**
- **Sample calculation:** For obs. number ---
- **Result table:**
- **Nature of graph:**
- **Conclusion:**
- **Questions / Answers:** Write minimum 4 /5, questions / answers based on each experiment.

Theory part must be typed on A-4 good quality paper on single side. Put these pages of experiments / circuit diagram in plastic folder and provide it to a group of 4/5 students.

Guidelines for Student's Lab Journal

1. Students should write the journal in his own hand writing.
2. Circuit / Connection diagram or construction diagram must be drawn either manually using or using software. [Do not use Xerox copy of standard journal]
3. Hand writing must be neat and clean.
4. Journal must contain certificate indicating name of the institute, student, department, subject, class/ year, number of experiments completed, signature of staff, Head of the department and the Principal.
5. Index must contain sr. number, title of the experiment, page number, and the signature of staff along with date.
6. Put one blank page in between two experiments. Prepare the parallelogram at the center of page and write experiment number, date and title of the experiment in separate line.

(Use black or blue ink pen for writing.)

Guidelines for Laboratory Conduction

1. Check whether the MCB / main switch is off.
2. Make connections as per circuit diagram. Use flexible wire for connection of voltmeter and pressure coil connection of wattmeter. For rest of the connections, use thick wire. Do not keep loose connection. Get it checked from teacher / Lab Assistant.
3. Perform the experiment only in presence of teacher or Lab Assistant.
4. Do the calculations and get it checked from the teacher.
5. After completion of experiment, switch off the MCB / main switch.

Write the experiment in the journal and get it checked within week

List of Experiments: To perform any eight experiments from the following list

A) 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

B) Optional experiments (any Three)

1. Determination of Regulation of alternator by direct loading.
2. Load test on three phase synchronous motor.
3. Load test on Single -phase induction motor.
4. Load test on Single-phase series motor.
5. No load and blocked-rotor test on a single phase Capacitor-start 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 three phase induction motor on MATLAB to obtain its performance.
9. Speed control of three phase induction motor by rotor resistance control method.

Text Books:

- [T1] Nagrath and Kothari, Electrical Machines, 2nd Ed., Tata McGraw Hill.
- [T2] S. K. Bhattacharya, Electrical Machines, Tata McGraw Hill.
- [T3] A.S. Langsdorf, Theory of Alternating Current Machinery, Tata McGraw Hill
- [T4] P. S. Bimbhra, Electric Machinery, Khanna Publications.
- [T5] B.R. Gupta and Vandana Singhal -Fundamentals of Electric Machines, New Age International (P) Ltd.
- [T6] E. Openshaw Taylor, Performance and design of a.c. commutator motors, Wheeler Publishing.
- [T7] V. K. Mehta and Rohit Mehta, Principles of Electrical Machines, S Chand Publications
- [T8] Krishna Reddy –Electrical Machines vol.II and III, SCITECH publications.
- [T9] Ashfaq Husain, Electrical Machines, Dhanpat Rai and Co.
- [T10] M V Deshpande, Electrical Machines, Prentice Hall of India

Reference Books:

- [R1]** M.G. Say, Performance and Design of A.C. Machines (3rd Ed.), ELBS
- [R2]** J B Gupta - Theory and performance of Electrical Machines, S K Kataria Publications
- [R3]** Samarjit Ghosh, Electrical Machines, Pearson Publication.
- [R4]** Bhag S Guru and Huseyin R Hiziroglu, Electrical Machinery and Transformer, 3rd Edition, Oxford University Press.
- [R5]** E G Janardanan, Special Electrical Machines, Prentice Hall of India.
- [R6]** Suvarnsingh Kalsi Application of high Temperature super conductors to electric power equipments (Rotating Machines) Wiley publication.

Unit	Text Books	Reference Books
1	T1,T2,T7,T9	R3
2	T4,T7,T9	R2
3	T1,T4,T7	R2,R4
4	T4,T7,T9	R5,R6
5	T4,T6,T3	R1,R2
6	T2,T3,T7,T9	R2,R3

303143: Power Electronics

Teaching Scheme	Credits	Examination Scheme[Marks]	
Lectures : 4hrs/ week	04	In sem	30
Practical 2hrs/week	01	End sem	70
		Practical	50

Prerequisite:

- Knowledge of semiconductor material, basic electronics, diode, BJT,UJT,FET and its characteristics
- Working of Diode based rectifier, concept of rms and average value
- Use square notebooks for notes and plotting of waveforms

Course 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.

Course Outcomes :

The students will be able to:

- Develop characteristics of different power electronic switching devices
- Reproduce working principle of power electronic converters for different types of loads
- Analyse the performance of power electronic converters

Unit 01: Silicon Controlled Rectifier (08 hrs)

Construction, Static and dynamic Characteristics, specifications/rating of SCR ,Triggering Circuits (R, R-C, UJT), Commutation Circuits (class C&D), Protection (over voltage, over current, and Thermal), Gate Turn Off(GTO) Thyristor (Construction, Working and Application).

Unit 02: Transistor based Devices and DC-DC converter (08 hrs)

Transistor based Devices: MOSFET, IGBT, Construction, working, Static and Dynamic Characteristics, specifications, safe operating area, Latching of IGBT.

DC-DC converter: Principle of operation of chopper, classification on the basis of Operating quadrants (A,B,C,D,E), 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, Buck Boost Chopper (Descriptive Treatment).

Unit 03: Single Phase AC-DC Converter (08 hrs)

Single phase Converter: Fully controlled converter (rectification and inversion mode), Half controlled converter (Semi- converter), Operation of all converters with R, RL 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).

Unit 04: Three Phase Converter and AC Voltage Regulator

(08 hrs)

Three phase converter: Fully controlled converter, rectification and inversion mode, Half controlled converter (Semi-converter), Operation of all converters with R, RL 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 (With R and R-L load).

Unit 05: Single phase DC-AC Converter (Transistor based)

(08 hrs)

Full bridge VSC, derivation of output voltage and current, Numericals, current source converter with ideal switches. **PWM techniques:** Single pulse, multiple pulse and sinusoidal pulse modulation with Fourier analysis.

Unit 06: Three phase DC-AC Converter (Transistor based)

(08 hrs)

Three phase VSC using 120° and 180° mode and their comparison, PWM based VSC, voltage control and harmonic elimination techniques (Single Pulse Modulation, Transformer Connection, Multilevel Control, Stepped Wave), Multilevel Converter concept its classification (Neutral Point Clamped Converter, Flying Capacitor Converter, cascaded multilevel converter) comparison between multilevel converters, balancing of dc voltage across capacitor

Guidelines for Instructor's Manual

- Title and circuit diagram of power electronic switching device and converter circuit.
- Working operation and output characteristics / output waveforms of power electronic switching device /converter circuit.
- Procedure to carry out the experiment.

Guidelines for Student's Lab Journal

- Title, aim, circuit diagram, procedure and theory of power electronic switching device or converter circuit.
- Equipments along with the specifications needed to carry out the experiment.
- Circuit diagram, observation table, calculations must be written on left side of the journal and aim, theory related to experiment and procedure must be written on right side.
- Analyse and interpret the experimental results and write the conclusions appropriately.

Guidelines for Laboratory Conduction

- Each group in the lab should have not more than three students.
- All the students in the group must do the connections and perform the practical under the the guidance of the staff member.
- Staff member has to check the result of all the groups.

List of Experiments:**Group A : Hardware Experiments (Any Six)**

1. Static VI characteristic of SCR /GTO
2. Static VI characteristic of TRIAC
3. Single phase Half controlled converter with R and RL load
4. Single phase fully controlled converter with R load.
5. Single Phase fully controlled converter with and without Free Wheeling diode with RL load
6. Single phase A.C. voltage regulator with R load
7. Study of DC step down chopper
8. Output and Transfer Characteristic of MOSFET and IGBT (Both)
9. Three phase voltage source converter using 120° and 180° mode

Group B: Perform any THREE experiments based on Software

1. Three phase AC-DC fully controlled bridge converter R and RL load
2. Three phase voltage source inverter using 120° and 180° mode
3. Study of DC step down chopper
4. Single phase A.C. voltage regulator R and RL load
5. Study and Design of single phase VSC
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.

Reference Books:

1. Vedam Subramanyam - Power Electronics , New Age International , New Delhi
2. Dubey, Donald, Joshi, Sinha, Thyristorised Power controllers, Wiley 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 by Dr.B.G.Fernandis,IIT,Mumbai.

Unit	Text Books	Reference Books
1	T5,T6	R3,R8,R10
2	T4,T5,T6	R3,R5,R6,R9,R10
3	T1,T5	R3,R10
4	T5,T6	R1,R7,R10
5	T1,T2,T3	R3,R10
6	T1,T2,T3	R3,R10

303144: Electrical Installation, Maintenance and Testing

Teaching Scheme		Credits	Examination Scheme [Marks]	
Theory	: 03 Hrs./Week	03	In Sem	: 30 Marks
Practical	: 02 Hrs./Week	01	End Sem	: 70 Marks
			Term work	: 50 Marks

Prerequisites:

- Introduction of Electrical supply system, Typical AC power supply scheme, Classification of Supply systems.
- Single line Diagram of electrical supply system.

Course Objective:

The course aims :-

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

Course Outcome:

Upon successful completion of this course, the students will be able to :-

- Classify distribution systems, its types and substations
- Design of different earthing systems for residential and industrial premises
- Select methods of condition monitoring and testing of various Electrical Equipments
- Estimate and Costing of residential and industrial premises

Unit 01: Distribution Systems:

(06 Hrs.)

Classification of supply systems (State Only)

(i)DC, 2-wire system, (ii) Single phase two wire ac system, (iii) Three phase three wire ac supply system, iv) Three phase four wire ac supply system. Comparison between overhead and underground systems (For above mentioned systems) on the basis of volume requirement for conductor. AC Distribution System: Types of primary and secondary distribution systems, calculation of voltage drops in ac distributors (Uniform and Non Uniform Loading) (Numerical) Economics of power transmission: Economic choice of conductor (Kelvin's law) (Derivation and Numerical) Distribution Feeders: Design considerations of distribution feeders; radial and ring types of primary feeder's voltage levels, energy losses in feeders.

Unit 02: Substation and Earthing: (06 Hrs.)

Substation: Classification of substations, Various equipments used in substation with their specifications, Bus bar arrangements in the substation: Simple arrangements like single bus bar, sectionalized single bus bar, main and transfer bus bar system with relevant diagrams. Earthing: Necessity of Earthing, Types of earthing system (Equipment and Neutral), and Maintenance Free Earthing system. Methods of testing earth resistance, Different electrode configurations (Plate and Pipe electrode), Tolerable step and touch voltages, Steps involved in design of substation earthing grid as per IEEE standard 80 – 2000.

Unit 03: Maintenance and Condition Monitoring: (06 Hrs.)

Importance and necessity of maintenance, different maintenance strategies like breakdown maintenance, planned/preventive 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. Advance tools and techniques of condition monitoring, Thermography.

Unit 04: Condition Monitoring and Testing of Electrical Equipment: (06 Hrs.)

Failure modes of transformer, Condition monitoring of oil as per the IS/IEC standards, Filtration/reconditioning of insulating oil, Condition monitoring of transformer bushings, On load tap changer, dissolved gas analysis, degree of polymerization. Induction motor fault diagnostic methods – Vibration Signature Analysis, Motor Current Signature Analysis. Testing of Power cables – Causes of cable failure, fault location methods and Remedial actions. Testing of Transformer - Type tests and Routine tests.

Unit 05: Estimation and Costing: (06 Hrs.)

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 (Numericals) installations and estimate for underground LT service lines.

Unit 06: Electrical Safety: (06 Hrs.)

Causes of Accidents, Prevention of Accidents & precautions to be taken. Dangers arising as a result of faulty equipments and tools, chemicals, water, poor joints and insulation strains and moving machines. Contents of first aid box, treatment for cuts, burns and electrical shock. Procedures for first aid (e.g. removing casualty from contact with live wire and administering artificial respiration). Various statutory regulations (Electricity supply regulations, factory acts and Indian electricity rules of Central Electricity Authority (CEA), Classification of hazardous area.

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 earthing.
2. Estimation for 11 kV feeders and substation.
3. Assignment on design of earthing grid for 132/220 kV substation.

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.
7. Project design and estimation of power circuit of labs/industry.
8. Measurement of insulation resistance of motors and cables

Guidelines for Instructor's Manual Practical Sessions –

The Instructor's Manual should contain following related to every experiment –

- Brief theory related to the experiment.
- Apparatus with their detail specification as per IS code.
- Basic AUTOCAD instructions for drawing the sheet.
- Design / Solving of given problem using data book as a reference.
- Students should be encouraged to visit workshops or small industries of transformer/ induction motor / cables also for repairing of household equipment.
- Students should write the troubleshooting charts and visit report based on visit as mentioned above.
- Few short questions related to design.

Guidelines for Student's Manual Practical Sessions –

The student's Manual should contain following related to every experiment –

- Brief theory related to the experiment.
- Apparatus with their detail specification as per IS code.
- Design/Solve a given problem.
- Students should visit workshops or small industries of transformer/ induction motor / cables also for repairing of household equipment.
- Students should write the troubleshooting charts and visit report based on visit as mentioned above.
- Few short questions related to experiment.

Guidelines for Lab /TW Assessment

- There should be continuous assessment for the TW.
- Assessment must be based on understanding of theory, attentiveness during practical.
- Session, how efficiently the student is able to do connections and get the results.
- Timely submission of journal.

Text Books:

- [T1] B. R. Gupta- Power System Analysis and Design, 3rd edition, Wheelers publication.
- [T2] S. Rao, Testing Commissioning Operation and Maintenance of Electrical Equipment, Khanna publishers.
- [T3] S. L. Uppal - Electrical Power - Khanna Publishers Delhi.
- [T4] Hand book of condition monitoring by B. K. N. Rao, Elsevier Advance Tech., Oxford (UK).
- [T5] S. K. Shastri – Preventive Maintenance of Electrical Apparatus – Katson Publication House.
- [T6] B. V. S. Rao – Operation and Maintenance of Electrical Equipment – Asia Publication.
- [T7] Hand book on Electrical Safety.

Reference Books:

- [R1] P.S. Pabla –Electric Power Distribution, 5th edition, Tata McGraw Hill.
- [R2] S. L. Uppal, Electrical Wiring and Costing Estimation, Khanna Publishers, New Delhi.
- [R3] Surjit Singh, Electrical wiring, Estimation and Costing, Dhanpat Rai and company, New Delhi.
- [R4] Raina K.B. and Bhattacharya S.K., Electrical Design, Estimating and Costing, Tata McGraw Hill, New Delhi
- [R5] B.D. Arora-Electrical Wiring, Estimation and Costing,- New Heights, New Delhi.
- [R6] M.V. Deshpande, Elements of Power Station design and practice, Wheelers Publication.
- [R7] S. Sivanagaraju and S. Satyanarayana, Electric Power Transmission and Distribution, Pearson 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 up to 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.
7. IEEE 142 Guide for Earthing.
8. Indian Electricity Rules.

Unit	Text Books	Reference Books
1	T1	R2, R7
2	T2	R7
3	T3,T4	R6,R1
4	T5,T6	R6,R1
5	-	R3, R4,R5
6	T7	-

303145: Seminar and Technical Communication

Teaching Scheme

Credits

Examination Scheme

Practical : 02 Hr/Week

01

Term work :

50 Marks

Course Objectives:

- Gaining of actual 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.

Course Outcomes:

At the end of this student will able to

- Relate with the current technologies and innovations in Electrical engineering.
- Improve presentation and documentation skill.
- Apply theoretical knowledge to actual industrial applications and research activity.
- Communicate effectively.

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

It is expected that the student should collect the information from journals, internet and reference books in consultation with his/her teacher/mentor, have rounds of discussion with him/her. The report submitted should reveal the students assimilation of the collected information. Mere compilation of information from the internet and any other resources is discouraged.

Format of the Seminar report should be as follows:

1. The report should be neatly typed on white paper. The typing shall be with normal spacing, Times New Roman (12 pt) font and on one side of the paper. (A-4 size).
2. Illustrations downloaded from internet are not acceptable.
3. The report should be submitted with front and back cover of card paper neatly cut and bound together with the text.
4. 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.
5. Certificate from institute as per specimen, Acknowledgement and Contents.
6. The format of the text of the seminar report should be as follows
 - i. The introduction should be followed by literature survey.

- II. The report of analytical or experimental work done, if any.
 - III. The discussion and conclusions shall form the last part of the text.
 - IV. They should be followed by nomenclature and symbols used.
 - V. The Reference Books are to be given at the end.
- 7. The total number of typed pages, excluding cover shall from 20 to 25 only.
 - 8. All the pages should be numbered.
 - 9. Two spiral bound copies of the seminar report shall be submitted to the college.
 - 10. Candidate shall present the seminar before the examiners.
 - 11. 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.

Audit Course III

303152 (A): Wind Energy Systems

Course Name: Wind Energy Systems

Prerequisite: Completion of FE or equivalent

Teaching Scheme:

Lectures 2 h per week

Field Visit: 1 day

Examination Schemes: Audit (P/F)

Written / MCQ /

Term paper

Description:

The following topics may be broadly covered in the classroom. The course will introduce the basics of: wind energy, availability, introduction to wind machines, generators, basics of design of wind electric generators, small and large wind machines, various designs and types of wind machines, grid interaction, advantages and limitations of the technology, environmental impact, introduction to manufacturing of the systems, characterization, quality assurance, standards, certification and economics. The site visit will be organized to understand the basic operation and system elements.

Details:

- Energy in wind, Basic wind energy conversion
- Introduction to wind turbines, Types of wind energy systems
- Typical construction of various wind energy systems
- Wind electricity generation systems
- Environmental impact of wind electricity generators
- Economics and sustainability of wind electricity
- Introduction to Wind Electricity Generation (WEG) systems
- Wind turbine basics and design
- Generator designs for WEG
- Small and large WEG systems, Site requirements for WEG
- Controllers for WEG systems
- Grid integration of WEG
- Economics of WEG
- Financial modeling of WEG
- Software tools for simulation, validation and economics of WEG
- Operation and maintenance of WEG
- Environmental impact assessment
- Standards and certification for WEG
- Basics of WEG systems, Elements of WEG systems for small and large scale
- Procurement versus production
- Bought-outs, assemblies, sub-assemblies
- Manufacturing and assembly, Manufacturing standards
- Quality assurance and standards, Certification
- Special purpose machines and Automation in manufacturing
- Site assembly and fabrication
- Typical shop layouts
- Inventory management
- Economics of manufacturing

Site Visit:

- Large-scale wind power plant
- If possible any nearby manufacturing facility for wind machines

Audit Course III

303152(B): Microcontroller MSP 430 and Applications

Teaching Scheme:

Examination Scheme

Lecture and Practicals: Total 24 Hours

Written/Assignment

- 16 bit MSP430 microcontroller architecture, Pin diagram, Memory organization of MSP430, special function registers, GPIO control.
- Interrupts and interrupt programming, Watchdog timer. System clocks.
- Programming MSP430 in embedded C, Timers and RTC using MSP430, timer modes and its programming.
- Analog interfacing and data acquisition: ADC and Comparator in MSP430.
- Case study: MSP430 based embedded system applications using ADC & PWM etc.

Text Books:

1. Getting Started with the MSP430 Launchpad by Adrian Fernandez, Dung Dang, Newness publication ISBN-13: 978-0124115880
2. MSP430 microcontroller basics 1st Edition by John H. Davies (Author), Newnes Publication ISBN- 13: 978-0750682763
3. Ajay V. Deshmukh, "Microcontrollers, Theory and applications", Tata McGraw-Hill Companies – 2005

Other References:

1. http://processors.wiki.ti.com/index.php/MSP430_LaunchPad_Low_Power_Mode
2. http://processors.wiki.ti.com/index.php/MSP430_16-Bit_Ultra-Low_Power_MCU_Training
3. RF430CL330H :
Datasheet: <http://www.ti.com/lit/ds/symlink/rf430cl330h.pdf>
4. RF430CL331H:
Datasheet: <http://www.ti.com/lit/ds/symlink/rf430cl331h.pdf>
5. Datasheet: RF430FRL15xH:
Datasheet: <http://www.ti.com/lit/ds/symlink/rf430frl152h.pdf>
User Guide: <http://www.ti.com/lit/ug/slau506/slau506.pdf>
6. CC2538:
Datasheet: <http://www.ti.com/lit/ds/symlink/cc2538.pdf>
7. CC256x:
Datasheet: <http://www.ti.com/lit/ds/symlink/cc2560.pdf>
8. CC2640:
Datasheet: <http://www.ti.com/lit/ds/symlink/cc2640.pdf>
User Guide: <http://www.ti.com/lit/ug/swcu117f/swcu117f.pdf>
9. CC3100 and CC3200: <http://www.ti.com/lit/ug/swru368a/swru368a.pdf>

List of Experiments:

1. Learn and understand how to configure MSP-EXP430G2 Launchpad digital I/O pins. Write a C program for configuration of GPIO ports for MSP430 (blinking LEDs, push buttons interface).

Exercises:

- a. Modify the delay with which the LED blinks.
- b. Modify the code to make the green LED blink.
- c. Modify the code to make the green and red LEDs blink:
 - i. Together
 - ii. Alternately
- d. Alter the code to turn the LED ON when the button is pressed and OFF when it is released.
- e. Alter the code to make the green LED stay ON for around 1 second every time the button is pressed.
- f. Alter the code to turn the red LED ON when the button is pressed and the green LED ON when the button is released.

2. Learn and understand GPIO based Interrupt programming. Write a C program and associated GPIO ISR using interrupt programming technique.

Exercises:

- a) Write the code to enable a Timer interrupt for the pin P1.1.
- b) Write the code to turn on interrupts globally

3. Implement Pulse Width Modulation to control the brightness of the on-board, green LED. This experiment will help you to learn and understand the configuration of PWM and Timer peripherals of the MSP430G2553.

Exercises:

- a) Observe the PWM waveform on a particular pin using CRO.
- b) What is the maximum resolution of PWM circuitry in MSP430G2 Launchpad?
- c) Change the above code to create a PWM signal of 75% duty cycle on particular PWM pin.

4. The main objective of this experiment is to control the on-board, red LED by the analog input from a potentiometer. This experiment will help you to learn and understand how to configure an ADC to interface with a potentiometer.

Exercises:

- a) Alter the threshold to 75% of Vcc for the LED to turn on.
- b) Modify the code to change the Reference Voltage from Vcc to 2.5V.

Lab Manual:

1) www.ti.com/lab-manuals

[Embedded System Design using MSP430 Launchpad Development Kit - Lab Manual](#)

303146 : Power System II

Teaching Scheme	Credits	Examination Scheme [Marks]
Theory : 04 Hrs./Week	04	In Sem. : 30 Marks
Practical : 02 Hrs./Week	01	End Sem. : 70 Marks
		PR : 50 Marks

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.

Course Objective:

The course aims to:-

- Develop analytical ability for Power system.
- Introduce concept of EHVAC and HVDC System.
- Demonstrate different computational methods for solving problems of load flow.
- Analyse the power system under symmetrical and Unsymmetrical fault conditions.

Course Outcome:

Upon successful completion of this course, the students will be able to

- Solve problems involving modelling, design and performance evaluation of HVDC and EHVAC power transmission lines.
- Evaluate 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.

Unit 01: Performance of Transmission Lines (08 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: EHV-AC transmission: (08 Hrs.)

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 03: Per unit system and Load Flow Analysis (08 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 - Descriptive treatment only) Numerical based on Y bus Matrix.

Unit 04: 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 05: Unsymmetrical Fault Analysis: (08 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 components and unsymmetrical fault calculation.

Unit 06: HVDC Transmission (Descriptive treatment only) (08 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, HVDC systems in India, recent trends in HVDC system.

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

List of Experiments (Compulsory experiments):

1. Measurement of ABCD parameters of a medium transmission line with magnitude and angle.
2. Measurement of ABCD parameters of a long transmission line with magnitude and angle.
3. Performance study of the effect of VAR compensation using capacitor bank on the transmission line.
4. Formulation and calculation of Y- bus matrix of a given system using software.
5. Static measurement of sub-transient reactance of a salient-pole alternator.
6. Measurement of sequence reactance of a synchronous machine (Negative and zero).

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

1. Plotting of receiving end circle diagram to evaluate the performance of medium transmission line.
2. Performance study of the effect of VAR compensation on transmission line using synchronous Condenser.
3. Solution of a load flow problem using Newton-Raphson method using software.
4. Simulation of Symmetrical fault of single machine connected to infinite bus.
5. Simulation of Unsymmetrical fault of single machine connected to infinite bus.
6. Simulation of HVDC system.

Guidelines for Instructor's Manual Practical Sessions –

The Instructor's Manual should contain following related to every experiment –

- Brief theory related to the experiment.
- Apparatus with their detailed specifications.
- Connection diagram /circuit diagram.
- Observation table/ simulation waveforms.
- Sample calculations for one/two reading.
- Result table.
- Graph and Conclusions.
- Few questions related to the experiment.

Guidelines for Student's Lab Journal

The Student's Lab Journal should contain following related to every experiment –

- Theory related to the experiment.
- Apparatus with their detailed specifications.
- Connection diagram /circuit diagram.
- Observation table/ simulation waveforms.
- Sample calculations for one/two reading.
- Result table.
- Graph and Conclusions.
- Few short questions related to the experiment.

Guidelines for Lab /TW Assessment

- There should be continuous assessment for the TW.
- Assessment must be based on understanding of theory, attentiveness during practical.
- Session, how efficiently the student is able to do connections and get the results.
- Timely submission of journal.

Text Books:

- [T1] I.J. Nagrath and D.P. Kothari – Modern Power System Analysis – Tata McGraw Hill, New Delhi.
- [T2] B R Gupta , “Power System Analysis and Design”, S.Chand.
- [T3] Ashfaq Hussain, “Electrical Power Systems”, CBS Publication 5th Edition.
- [T4] J.B.Gupta. “A course in power systems” S.K. Kataria Publications.
- [T5] P.S.R. Murthy, “Power System Analysis”, B.S. Publications

Reference Books :

- [R1] H. Hadi Sadat: Power System Analysis, Tata McGraw-Hill New Delhi.
- [R2] G. W. Stagg and El- Abiad – Computer Methods in Power System Analysis – Tata McGraw Hill, New Delhi.
- [R3] M.E.El-Hawary, Electric Power Systems: Design and Analysis, IEEE Press, New York.
- [R4] Rakash Das Begamudre, “Extra High voltage A.C. Transmission Engineering”, New age publication.
- [R5] M.A.Pai, Computer Techniques in Power System Analysis, Tata McGraw Hill Publication.
- [R6] Stevenson W.D. Elements of Power System Analysis (4th Ed.) Tata McGraw Hill, New Delhi.
- [R7] K.R.Padiyar: HVDC Transmission Systems, New Age International Publishers Ltd, New Delhi.
- [R8] Olle I. Elgard – Electric Energy Systems Theory – Tata McGraw Hill, New Delhi.
- [R9] V. K. Chandra, Power Systems, Cyber tech Publications.
- [R10] NPTEL Web course and video course on power system analysis.

Unit	Text Books	Reference Books
1	T1, T4	R1, R2, R3, R10
2	T2	R3, R4
3	T1, T3, T4	R1, R2, R3, R5, R8, R10
4	T3, T4	R1, R2, R3, R6, R8, R9, R10
5	T3,	R1, R2, R3, R6, R8, R9, R10
6	T2, T3, T4	R3, R7

303147 : Control System-I

Teaching Scheme	Credits	Examination Scheme [Marks]
Theory : 04 Hrs./Week	04	In Sem : 30 Marks
Practical : 02 Hrs./Week	01	End Sem : 70 Marks
		Oral : 50 Marks

Prerequisite: Laplace Transform, Ordinary differential equations.

Course Objective: The course aims to:-

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

Course Outcome: Upon successful completion of this course, the students will be able to :-

- Model physical system,
- Determine time response of linear system,
- Analyse stability of LTI system,
- Design PID controller for LTI system

Unit 01 : General (10 Hrs)

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

Unit 02 : 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 impulse, unit step input. steady state errors – static error coefficients. Time domain specifications of second order systems. Importance of dominant closed loop poles of higher order systems Derivation of time domain specifications for second-order under-damped system for unit step input.

Unit 03 : Stability analysis and Root Locus (08 Hrs)

Concept of stability- Absolute, Asymptotic, relative and marginal. Nature of system response for various locations of roots in S-plane of characteristics equation. Routh's-Hurwitz criterion. Root Locus: Basic properties of root locus. Construction of root locus. Angle and magnitude condition for stable system.

Unit 04 : Frequency domain analysis-I (08 Hrs)

Introduction, relation between time and frequency response for second order system. Frequency domain specifications, Polar Plot, Nyquist plot, stability analysis using Nyquist plot.

Unit 05 : Frequency domain analysis-II (08Hrs)

Introduction to Bode plot, Asymptotic approximation: Sketching of Bode plot, stability, stability analysis using Bode plot.

Unit 06 : PID controllers (06Hrs)

Basic concept of P, PI, PID controller, Design specifications in time domain and frequency domain. Design of PID controller by Root-Locus. Tuning of PID controllers. Ziegler-Nichol Method.

Control System Components: Working principle and transfer function of Lag network, lead network, potentiometer, AC and DC servo motors. Working principle of synchros.

Guidelines for Instructor's Manual

Instructor's Manual should contain following related to every experiment –

- Theory related to the experiment
- Apparatus with their detailed specifications.
- Connection diagram /circuit diagram
- Basic MATLAB instructions for control system/ Simulink basics
- Observation table/ Expected simulation results
- Sample calculations for one/two reading
- Result table

Guidelines for Student's Lab Journal

The Student's Lab Journal should contain following related to every experiment –

- Theory related to the experiment
- Apparatus with their detailed specifications.
- Connection diagram /circuit diagram/Simulink diagram/MATLAB program
- Observation table/ simulation results
- Sample calculations for one/two reading
- Result table, Conclusion
- Few short questions related to the experiment.

Guidelines for Laboratory Conduction

- Assessment must be based on understanding of theory, attentiveness during practical session.
- Assessment should be done how efficiently student is able to perform experiment/simulation and get the results. Understanding fundamentals and objective of experiment, timely submission of journal

List of Experiments:**A) Minimum five experiments should be conducted.**

1. Experimental determination of DC servo motor parameters for mathematical modeling, 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 of Lag and Lead compensator.
4. PID control of level/Pressure/Temperature control system.
5. Transfer function of any physical systems (AC Servomotor/ Two Tank System/ Temperature control/ Level control)
6. Study of Synchro transmitter receiver.
7. Experimental analysis of D.C. Motor 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:

- [T1] I.J. Nagrath, M. Gopal, "Control System Engineering", New Age International Publishers, 5th edition, 2007.
- [T2] Katsuhiko Ogata, "Modern control system engineering", Prentice Hall, 2010.
- [T3] Nise N. S. "Control Systems Engineering", John Wiley & Sons, Incorporated, 2011

Reference Books:

- [R1] B. C. Kuo, "Automatic Control System", Wiley India, 8th Edition, 2003.
- [R2] Richard C Dorf and Robert H Bishop, "Modern control system", Pearson Education, 12th edition, 2011.
- [R3] D. Roy Choudhary, "Modern Control Engineering", PHI Learning Pvt. Ltd., 2005.

Unit	Text Books	Reference Books
1	T1, T2, T3	R1,R2
2	T1, T2, T3	R1, R3
3	T1, T2, T3	R2, R3
4	T1, T2, T3	R1, R3
5	T1, T2, T3	R1
6	T3	

303148 : Utilization of Electrical Energy

Teaching Scheme	Credits	Examination Scheme [Marks]
Theory : 03 Hrs./Week	03	In Sem : 30 Marks
		End Sem : 70 Marks

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

Course Objective:

The course aims to:-

- Ensure that the knowledge acquired can be applied in various fields such as electric heating, illumination, chemical processes, and electric traction.
- Make the students aware about the importance of maximizing the energy efficiency by optimum utilization of electrical energy.
- 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
- Provide know how about Refrigeration, Air Conditioning
- Provide know about electrochemical processes and applications of these in practical world, modern welding techniques.
- Develop self and lifelong learning skills, introduce professionalism for successful career.

Course Outcome:

Upon successful completion of this course, the students will revise :-

- Get knowledge of principle of electric heating, welding and its applications.
- Design simple resistance furnaces and residential illumination schemes.
- Calculate tractive effort, power, acceleration and velocity of traction.
- Get knowledge of electric braking methods, control of traction motors, train lighting and signaling system.
- Understand collection of technical information and delivery of this technical information through presentations.

Unit 01: Electric Heating

(06 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, and design of heating element (Numerical).

Applications of resistance heating

Induction heating : Principle, core type and coreless induction furnaces, Ajax Wyatt 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, Equivalent circuit of arc furnace (Numerical) Modern welding techniques like ultrasonic welding and laser welding**

Unit 02: Electrochemical Process (04 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

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 (04 Hrs.)

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

Design of illumination schemes-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. 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 (06 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-pentagraph, catenary

Electric locomotive- Block diagram with description of various equipment 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 equipment in traction substation-transformer, circuit breaker, interrupter

Unit 05: Traction Mechanics**(08 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**(08 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.

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

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

Text Books:

- [T1] E. O. Taylor 'Utilization of Electrical Energy' – Revised in S.I. Units by V.V.L. Rao, Orient Longman
- [T2] J.B. Gupta, 'Utilization of Electric Power and Electric Traction', S.K. Kataria and sons, Delhi
- [T3] C. L. Wadhwa, 'Generation, Distribution and Utilization of Electrical Energy', Eastern Wiley Ltd.
- [T4] A. Chakraborti, M. L. Soni, P. V. Gupta, U.S. Bhatnagar, 'A text book on Power System Engineering', Dhanpat Rai and Co.(P) Ltd – Delhi
- [T5] Clifford F. Bonnett 'Practical Railway Engineering', (Imperial college press)

Reference Books:

- [R1] 'Art and science of Utilization of Electrical Energy' by H. Partab, Dhanpat Rai and Co.(P) Ltd –Delhi
- [R2] 'Modern Electric Traction' by H. Partab, Dhanpat Rai and Co. (P) Ltd – Delhi
- [R3] 'Lamps and lighting' by M. A. Cayless, J.R. Coaton and A. M. Marsden
- [R4] 'BIS, IEC standards for Lamps, Lighting Fixtures and Lighting' By Manak Bhavan, New Delhi
- [R5] 'Illumination Engineering from Edison's Lamp to the Laser' Joseph B. Murdoch
- [R6] 'Two centuries of Railway signalling' by Geoffrey, Kichenside and Alan Willims (Oxford Publishing Co-op)
- [R7] 'Generation and Utilization of Electrical Energy' S. Sivanagaraju, M. Balsubba Reddy, D. Srilatha (Pearson)
- [R8] 'Electrical Powers' S. L. Uppal, Khanna Publication

NOTE

Assignments can be given on following topics

- Types of Electric Welding- Electric arc welding and resistance welding (accessories involved and working of the system, characteristics of arc welding)
- Modern welding techniques like ultrasonic welding and laser welding
- Study of different types of lamps-Incandescent lamp, fluorescent lamp, 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.
- WDM, WDP, WDG series and their capacity. Introduction to metro system, mono rail system.

Unit	Text Books	Reference Books
1	T1,T3,T4	R1,R7, R8
2	T1,T3, T4	R1, R7
3	T1,T3, T4	R1, R3,R4,R5,R7, R8
4	T1,T2,T5, T4	R1, R2,R7, R8
5	T1,T2,T5, T4	R1, R2,R5, R8
6	T1, T2,T5, T4	R1, R2,R6, R8

303149: Design of Electrical Machines

Teaching Scheme	Credits	Examination Scheme [Marks]
Theory : 04 Hrs./Week	04	In Sem : 30 Marks
Practical: 02 Hrs./Week	01	End Sem : 70 Marks
		OR : 50 Marks
		Term work : 25 Marks

Prerequisite:

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

Course Objective: The course aims :-

- 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.

Course Outcome:

Upon successful completion of this course, the students will be able to :-

- Calculate main dimensions and Design of single phase and three phase transformer.
- Calculate main dimensions of three phase Induction motor.
- Determine the parameters of transformer.
- Determine parameters of three phase Induction motor.

Unit 01: Transformer (7 Hrs.)

Modes of heat dissipation. Heating and cooling curves. Calculations of heating and cooling time constants. 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 three phase transformers as per IS 2026(Part I).

Unit 02: Transformer Design (8 Hrs.)

Output equation with usual notations, optimum design of transformer for minimum cost and loss. 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 (8 Hrs.)

Estimation of no-load current, losses, efficiency and regulation of transformer. Calculation of mechanical forces developed under short circuit conditions, measures to overcome this effect. Introduction to Computer aided design of transformer, generalized flow chart for design of transformer.

Unit 04: Three phase Induction Motor Design : Part I (9 Hrs.)

Specification and Constructional features. Design of ac windings. Output equation with usual notations, specific electrical and magnetic loadings, ranges of specific loadings, turns per phase, number of stator slots.

Unit 05: Three phase Induction Motor Design : Part II (8 Hrs.)

Suitable combinations of stator and rotor slots .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 (8 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. Calculation of short time and continuous rating of electrical machine.

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

Term Work: The term work shall consist of:

1. Details and assembly of three phase transformer with design report.(Sheet in CAD)
2. Details and layout of AC winding with design report.(Sheet in CAD)
3. Assembly of 3- phase induction motor.(Sheet optional CAD or Drawing)
4. Use of Finite Element Analysis(FEA) software for analysis of electrical machines, the report should include:
 - a. Schematic diagram (Diagram/FEA model/Layout)
 - b. Current/Flux/Force distribution.
 - c. Analysis by variation of design parameters.
5. Report based on Industrial visit to a manufacturing unit. (Transformer or Induction motor).

Text Books:

- [T1] M.G. Say – Theory and Performance and Design of A.C. Machines, 3rd Edition, ELBS London.
- [T2] A.K.Sawhney – A Course in Electrical Machine Design, 10th Edition, - Dhanpat Rai and sons New Delhi.
- [T3] K. G. Upadhyay- Design of Electrical Machines, New age publication
- [T4] R. K. Agarwal – Principles of Electrical Machine Design, S. K.Katariya and sons.
- [T5] Indrajit Dasgupta – Design of Transformers – TMH

Reference Books:

- [R1] K.L. Narang , A Text Book of Electrical Engineering Drawings, Reprint Edition : 1993 / 94 – Satya Prakashan, New Delhi.
- [R2] A Shanmugasundaram, G. Gangadharan, R. Palani, - Electrical Machine Design Data Book, 3rd Edition, 3rd Reprint 1988 - Wiely Eastern Ltd., - New Delhi
- [R3] Vishnu Murti, “Computer Aided Design for Electrical Machines”, B.S. Publications.
- [R4] Bharat Heavy Electricals Limited, Transformers - TMH.

Guidelines for Instructor's Manual Practical Sessions-

The instructor's manual should contain following related to every drawing sheet-

1. Brief theory related to the concerned sheet.
2. Apparatus with their detail specification as per IS code.
3. Design as per problem statement.
4. Reference tables used for design purpose.
5. Design parameters details in tabular form.
6. Few short questions related to design.

Guidelines for Student's Lab Journal-

The Student's Lab Journal should contain following related to every drawing sheet-

1. Brief theory related to the concerned sheet.
2. Apparatus with their detail specification as per IS code.
3. Design as per problem statement.
4. Reference tables used for design purpose.
5. Design parameters details in tabular form.
6. Few short questions related to design.

Guidelines for Lab/TW Assessment

1. There should be continuous assessment for the Lab/TW
2. Assessment must be based on understanding of theory, attentiveness during practical session, how efficiently the student is able to design as per the problem statement.
3. Timely submission of design report and sheet.

Unit	Text Books	Reference Books
1	T1, T2,T4,T5	R1,R2,R4
2	T1,T2, T4,T5	R1,R4
3	T2,T5	R3,R4
4	T1,T2,T3,T4	R1,R2,R3
5	T2	R3
6	T2	R3

303150 : Energy Audit and Management

Teaching Scheme	Credits	Examination Scheme [Marks]
Theory : 03 Hrs./Week	03	In Sem. : 30 Marks
Practical : 02 Hrs./Week	01	End Sem. : 70 Marks
		Term Work : 25 Marks

Prerequisite:

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

Course Objective:

The course aims to:-

- Understand importance of energy Conservation and energy security.
- Understand impact of use energy resources on environment and emission standards.
- Follow format of energy management, energy policy.
- Learn various tools of energy audit and management
- Calculate energy consumption and saving options with economic feasibility.

Course Outcome:

Upon successful completion of this course, the students will be able to:-

- To get knowledge of BEE Energy policies, Electricity Acts.
- Use various energy measurement and audit instruments.
- Carry out preliminary energy audit of various sectors
- Enlist energy conservation and demand side measures for electrical, thermal and utility Systems.
- Solve simple problems on cost benefit analysis.

Unit 01: Energy Scenario (6 Hrs.)

Classification of Energy resources, Commercial and noncommercial sources, primary and secondary sources, commercial energy production, final energy consumption. Energy needs of growing economy, short terms and long terms policies, energy sector reforms, energy security, importance of energy conservation, energy and environmental impacts, emission check standard, 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).

Unit 02: Energy Management (6 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 Programs. Energy monitoring systems.

Unit 03: Demand Management (6 Hrs.)

Supply side management (SSM), Generation system up gradation, constraints on SSM. Demand side management (DSM), advantages and barriers, implementation of DSM. Use 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.) Introduction to Net Metering.

Unit 04: Energy Audit (6 Hrs.)

Definition, need of energy audits, 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. Report formats

Unit 05: Energy Conservation in Applications (6 Hrs.)

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

Unit 06: Financial analysis (6 Hrs.)

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.

Practicals:

Minimum 8 practicals/tutorials to be conducted from following groups:

Group A (Any Two of the following)

1. Study of Clean Development mechanism
2. Study of building codes (green building)
3. Study of energy management tool
4. Study of force field analysis from energy management point of views

Group B (Any three of following)

5. Analysis and interpretation of Electricity Bills
Students should calculate electricity charges for
 - a) Residential consumer
 - b) Commercial Consumer (College campus)
6. Assessment and calculations of energy generated by Solar PV or other renewable sources / Diesel generator available in college campus.

7. Use of Power Analyser for measurement of electrical parameters useful for energy audit or power quality audit.
8. Adequacy assessment of Illumination systems by using Lux Meter
9. Use of temperature measuring devices for analysis of heating systems.
10. Use of other transducers (any one)
 - a) Assessment of performance of fans and blowers by using Annemo Meter.
 - b) Use of Flow Meters for Pumping system analysis.
 - c) Use of pressure measuring equipments useful in audit study.
 - d) Smart meters and advanced energy meters
11. Execute Preliminary Energy Audit for (Any One)
(Preferably this activity should be carried out with student group not exceeding 5)
 - a) Laboratory
 - b) Educational Institute
 - c) Commercial Establishment
 - d) Small scale industry
 - e) Residential Building
 - f) Agricultural Equipments
 - g) Municipal Corporations
12. Calculation of energy savings for following (Minimum one)
 - a) Illumination
 - b) Air conditioning System
 - c) Pumping Systems
 - d) DG Sets
 - e) UPS and Inverter Systems
 - f) Lifts and elevators
13. Study of energy audit success stories (any one)
 - a) Paper and Pulp Industry
 - b) Sugar Industry
 - c) Steel Industry
 - d) Commercial Establishment
 - e) Electrical Generation Plant
14. Study of combined heat power system (cogeneration)
15. Study of Ethical Practices in energy audit.

Guidelines for Instructor's Manual

Instructor's Manual shall have

- a. Brief relevant theory.
- b. Equipment with specifications.
- c. Connection diagram/ methodology.
- d. Format of observation table and sample results.

Guidelines for Tutorial Reports (Instruction Manual and Journal Guide lines)

1. Report on Tutorial can be written separately for different batches.
2. Report shall be based on actual case studies presented, audit conducted, and conservation
3. Studies executed.
4. Report shall include following points
 - a) Objective
 - b) Procedure
 - c) Equipment
 - d) Details of Name/Place/Location
 - e) Type and nature of activity
 - f) Result and Calculations if any
 - g) Questions for assessment of Tutorial
 - h) Outcome of activity

Guidelines for Practical Assessment

1. There should be continuous assessment for TW.
2. Assessment must be based on understanding level, presentation skills, efficiency and quality of report.
3. Timely submission of act.

Text Books:

- [T1] Guide books for National Certification Examination for Energy Managers/Energy Auditors Book , 1-General Aspects (available on line)
- [T2] Guide books for National Certification Examination for Energy Managers/Energy Auditors Book 2 – Thermal Utilities (available on line)
- [T3] Guide books for National Certification Examination for Energy Managers/Energy Auditors Book 3- Electrical Utilities (available on line)
- [T4] Guide books for National Certification Examination for Energy Managers/Energy Auditors Book 4 (available on line)

Reference Books:

- [R1] Success stories of Energy Conservation by BEE ([www. Bee-india.org](http://www.Bee-india.org))
- [R2] Utilization of electrical energy by S.C. Tripathi, Tata McGraw Hill.
- [R3] Energy Management by W.R. Murphy and Mackay, B.S. Publication.
- [R4] Generation and utilization of Electrical Energy by B.R. Gupta, S. Chand Publication.
- [R5] Energy Auditing made simple by Balasubramanian, Bala Consultancy Services.

Websites:

- [W1] www.energymanagertraining.com
- [W2] www.em-ea.org
- [W3] www.bee-india.org

Unit	Text Books	Reference Books/websites
1	T1	W1,W2
2	T1	W1,W2
3		R4
4	T1	R4, R5 W1,W2
5	T1, T2, T3	W1,W2
6	T1, T4	W1,W2

303151: Electrical Workshop

Teaching Scheme		credits	Examination Scheme[Marks]	
Lectures	----		In sem	Nil
Practical	2 hrs/week	01	End sem	Nil
			Term Work	50

Objectives:

- 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.

Course Outcomes:

After successful completion of the course, student will be able to

- Integrate electrical/electronic circuits for useful applications
- Acquire hardware skills to fabricate circuits designed.
- Read data manuals/data sheets of different items involved in the circuits.
- Test and debug circuits.
- Produce the results of the testing in the form of report.

Instructions:

- The exercises must be carried out in a group of maximum 3 students.
- Minimum 5 exercises must be carried out.
- Students will present the design, procedure observations and conclusion in the form of report which will be evaluated for term work.

Group A (Minimum 2 exercises from this group)

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 (Minimum 2 Exercise from this group)

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

1. Design and development of combined ± 12 V, ± 5 V regulated power supply.
2. Design and development of SCR based half controlled converter using RC trigerring.
3. D.C. step down chopper.
4. Traffic light controller using time delay circuits.
5. Buck/boost converter using LM2596S.

Group C

(All interfacing circuits for Arduino boards must be assembled on general purpose PCB and tested.)

1. Arduino based temperature measurement and display.
2. Arduino based D.C. Motor speed control.
3. Arduino based ramp, sawtooth waveform generation.
4. Arduino based stepper motor control.

303153(A) : Bioenergy Systems

Course Name: Bioenergy Systems

Prerequisite: Completion of FE or equivalent

Teaching Scheme:

Lectures 2 h per week

Field Visit: 4 h

Practical: 4 h

Examination Schemes: Audit (P/F)

Written / MCQ /

Term paper

Description:

The following topics may be broadly covered in the classroom: Bioenergy, availability of biomass, methods to convert it to heat and electricity, technologies for biodiesel, biomass gasification, biogas, composting, introduction to organic fertilizers, introduction to design, manufacturing and construction of biogas and biodiesel plants, specific equipment for pre and post processing, characterization, quality assurance, standards, certification and economics. The field visits and practical will be designed for first-hand experience and basic understanding of the system elements.

Details:

- Introduction to Bioenergy
- Biomass availability in India
- Biomass and carbon cycle
- Environment pollution and biomass
- Energy from biomass
- Biomass burning for energy
- Gasification of biomass
- Biomass reforming
- Anaerobic digestion for biogas
- Biogas purification
- Biogas to electricity
- Aerobic composting
- Organic fertilizers
- Biomass to liquid fuel
- Biodiesel
- Biomass refinery
- Segregated organic waste management
- Algae as source of biomass
- Dealing with agricultural residue

Site Visit:

- Biogas plant for segregated solid waste

Practical:

- Biodiesel making

303153 (B) : Applications of Power Electronics

Teaching Scheme:

Lectures/Practicals : 2 hrs Per week

Total hrs: 22

Examination Scheme: Audit (P/F)

Written/MCQ/TERM Paper/Practical

Course Name : Applications of Power Electronics

Prerequisites:

1. Fundamentals of SCR its V-I Characteristics, construction, working principles and applications.
2. Fundamentals of transistor based devices MOSFET, IGBT, DIAC, TRIAC, GTO and their V-I Characteristics, construction, working principles and applications.
3. Study of Single phase DC-DC and AC-DC Converter(Full convertor and Semi Converter)
4. Fundamentals of Single phase and Three Phase DC-AC Converter(Full convertor and Semi Converter)

Description:

The topics may be broadly covered in the classroom. This course will introduce the hands on learning to understand power supply for real world applications. Students can analyze, simulate and optimize their PMLK Power designs online using WEBENCH Power designer.

The TI lab Kits may be used to investigate the influence of physical parameters and operation conditions of a power supply on its performance.

Broadly the topics needed to be covered are:

Working principle of step down chopper for R-L load (highly inductive) its control strategies. Performance parameters, Study of DC-to-DC converters – buck, boost, buck-boost and cuk; Study of Voltage Regulators and their Circuits using TI Lab Kits. ex: The Buck regulator May be studied using TPS54160, hysteretic buck regulator LM3475, Switching Regulator and characteristics of standard regulator ICs – TPS40200, TPS40210, Low Drop out (LDO) Regulators ICs-TPS 7A4901, TPS7A8300.

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.

Lab setup requirement:

PMLK Buck Kit, PMLK LDO Kit, DC power supply 0-50V/4A with dynamic voltage mode capability , DC electronic load 20V/10A with dynamic current mode capability, 4 digital multimeters with 4 1/2-digit resolution ,250MHz 4-channels Digital Oscilloscope ,10 MHz Function Generator.

Any three out of the four experiments in lab can be performed:

1. With TPS7A4901 and TPS7A8300, study-
 - Impact of capacitor on PSRR
 - Impact of output capacitor on load-transient response
 - Impact of line and load conditions on drop out voltage
 - Impact of line and load conditions on efficiency

2. Study of DC-DC Buck converter

- Investigate how the efficiency of a TPS54160 buck regulator depends on the line and load conditions and on the switching frequency.
- Analyze the influence of switching frequency f_s and of capacitance C and resistance ESR of the input and output capacitors on steady-state waveforms of TPS54160 buck regulator.

3. Study of DC-DC Boost Converter

- Analyze the influence of Input voltage, load current and switching frequency on continuous and discontinuous mode of operation of boost converter.
- Analyze the impact of operating conditions and of the operation mode on the power loss and efficiency of boost converter.

4. Analyze how the switching frequency f_s , the DC accuracy and the line noise rejection of the hysteretic buck regulator depend on line voltage, the load current, the characteristics of the output capacitor and the impact of speed-up capacitor.

Webench Experiment:

Lab Requirement: PC's with internet service connection.

Any Two out of the three can be performed:

Design Statement 1:

Design a Low cost Boost Converter to derive 12V, 100mA from 5V USB

DESIGN SPECIFICATION

- $V_{in(min)} = 4V$ $V_{in(max)} = 5V$
- $V_{out} = 12V$ $I_{out} = 100mA$
- The Efficiency of the converter must be greater than 80%
- The design should have a WEBENCH® tool options like Thermal solution and Electrical simulation and to export in other software's
- The BOM count should not exceed 10 parts
- The design should not have an automatic shutdown
- Lesser BOM cost is preferable
- The solution must be designed using the IC available in DIP package.

Design Statement 2:

Design a low cost and power efficient Buck Converter that could be used as a USB charger for mobile devices deriving its power from an automotive battery.

DESIGN SPECIFICATION

- $V_{in(min)} = 9V$ $V_{in(max)} = 15V$, $V_{out} = 5V$ $I_{out} = 500mA$
- The Efficiency of the converter must be greater than 85%
- Footprint of the Total BOM components should be minimal
- The design should have maximum WEBENCH® tool options, for eg. Thermal simulation, Electrical simulation, Simulation export etc.
- The BOM count is expected to be within 15 parts
- Lower Shut down current is desired
- Lower BOM cost is preferred

Design Statement 3:

Design a low cost synchronous buck converter.

DESIGN SPECIFICATIONS

- Vin (Max): 15 V, Vout: 5 V, Vin (Min): 10 V, Iout: 1 A, Ambient Temp: 30°C
- IC should operate in advance eco-mode
- The efficiency should be greater than 90%
- Foot print should be less than 130 mm²
- BOM cost should be less than \$2 and the solution should have lowest BOM cost
- BOM count should be less than 10
- The design should have maximum WEBENCH® tool options, for eg. Thermal simulation, Electrical simulation, Simulation export etc)
- IC should support a soft start feature
- Design should not exceed 50 Degree Celsius Temperature at IC-Die (use thermal simulation optimization if required)

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.

Reference Books:

1. Vedam Donald, Joshi, Sinha, Thyristorised Power controllers, Wiley Eastern New Delhi.
2. M. D. Singh and K. B. Khandchandani, Power Electronics, Tata McGraw Hill
3. Jai P. Agrawal, Power Electronics systems theory and design LPE, Pearson Education, Asia.
4. L. Umanand, Power Electronics – Essentials and Applications Wiley Publication.
5. J. Michael Jacob – Power Electronics Principal and Applications.
6. M.H.Rashid - Power Electronics Handbook, Butterworth-Heinemann publication, 3rd edition
7. M.S. Jamil Asghar, Power Electronics, PHI.
8. V.R. Moorthi, Power Electronics Devices, circuits, and Industrial applications, Oxford University Press.
9. NPTEL Web course and video course on Power Electronics
10. PMLK BUCK Lab manual - <http://www.ti.com/lit/ug/ssqu007/ssqu007.pdf>
11. PMLK LDO Lab manual - <http://www.ti.com/lit/ug/ssqu006/ssqu006.pdf>
12. WEBENCH – www.ti.com/webench

Other Reference Material:

1. TPS54160: <http://www.ti.com/product/TPS54160>
2. LM3475: <http://www.ti.com/product/LM3475>
3. TPS40200: <http://www.ti.com/product/TPS40200>
4. TPS40210: <http://www.ti.com/product/TPS40210>
5. TPS7A4901: <http://www.ti.com/product/TPS7A4901>
6. TPS7A8300: <http://www.ti.com/product/TPS7A8300>
7. CSD17313Q2Q1: <http://www.ti.com/product/CSD17313Q2Q1>
8. CSD25404Q3: <http://www.ti.com/product/CSD25404Q3>
9. UCC27511: <http://www.ti.com/product/UCC27511>