SAVITRIBAI PHULE PUNE UNIVERSITY

FACULTY OF ENGINEERING

SYLLABUS FOR S. E. (ELECTRICAL ENGINEERING)

(2015 course)

WITH EFFECT FROM YEAR 2016-2017

SavitribaiPhule Pune University
S.E. Electrical Engineering 2015 – Course
(w. e. f. 2016-2017)

Semester I													
Sr. No.	Subject Code	Subject Title	Teaching Scheme			Semester Examination Scheme of Marks						Credit	
						Paper		TW	PR	OR	Total	TH/ TUT	PR+OR
			Th.	Tut.	Pr.	In Sem(Online)	End Sem						
1.	203141	Power Generation Technologies	04	--	--	50	50	--	--	--	100	04	---
2.	207006	Engineering Mathematics-III	04	01	--	50	50	25	--	--	125	05	---
3.	203142	Material Science	04	--	02	50	50	--	--	50	150	04	01
4.	203143	Analog and Digital Electronics	04	--	02	50	50	25	50	--	175	04	01
5.	203144	Electrical Measurements and Instrumentation	04	--	02	50	50	25	50	--	175	04	01
6.	203151	Soft Skills	--	--	02	--	--	25	--	--	25	--	01
											Total	21	04
7.	203154	Audit Course I	--	--	--	--	--	--	--	--	--	Grade: PP/NP	
	Total		20	01	08	250	250	100	100	50	750	25	

Semester II													
Sr. No.	Subject Code	Subject Title	Teaching Scheme			Semester Examination Scheme of Marks						Credit	
						Paper		TW	PR	OR	Total	TH/ TUT	PR+OR
			Th.	Tut.	Pr.	In Sem (Online)	End Sem						
1.	203145	Power System I	04	--	--	50	50	--	--	--	100	04	--
2.	203146	Electrical Machines I	04	--	02	50	50	25	50	--	175	04	01
3.	203147	Network Analysis	04	--	02	50	50	50	--	--	150	04	01
4.	203148	Numerical Methods and Computer Programming	04	01	02	50	50	25	50	--	175	05	01
5.	203149	Fundamentals of Microcontroller and Applications	04	--	02	50	50	--	--	50	150	04	01
											Total	21	04
6.	203155	**Audit Course II**										Grade: PP/NP	
Total			20	01	08	250	250	100	100	50	750	25	

TW: Term Work **OR:Oral** **PR:** Practical
PP: Passed (Only for non-credit courses) **NP:** Not Passed (Only for non-credit courses)

Audit Course

- Audit Course: Optional for 1st and 2nd term of SE 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.

203154:Audit Course I **Solar Thermal Systems.**

203155:Audit Course II **(A) Solar PV Systems.**
(B)Installation & Maintenance of Electrical appliances.

203141: Power Generation Technologies

Teaching Scheme	Credits	Examination Scheme [Marks]
Th:04 Hrs/ Week	Th/Tut:04	In Sem (Online):50 Marks End Sem:50 Marks

Prerequisite:

- Fuel calorific value.
- Semiconductor materials for PV cells.
- Work, power and energy calculation.

Course Objective:

- To introduce conventional energy conversion system with steam, hydro based and nuclear based power plant.
- To initiate non-conventional energy conversion system with solar, wind, fuel cell, tidal ocean, geothermal, biomass etc.
- To commence interconnection of energy source to gird, stand alone and hybrid system.

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

- Identify operations of thermal power plant with all accessories and cycles.
- Be aware of the principle of operation, components, layout, location, environmental and social issues of nuclear, diesel and gas power plant.
- Identify and demonstrate the components of hydro power plant and calculation of turbine required based on catchment area.
- Find the importance of wind based energy generation along with its design, analysis and comparison.
- Apply solar energy in thermal and electrical power generation considering energy crisis, environmental and social benefits.
- Understand the operation of electrical energy generation using biomass, tidal, geothermal, hydel plants, fuel cell and interconnection with grid.

Unit 01 : Thermal Power Plant (9 Hrs)

Basic thermodynamic cycles: Thermodynamic cycle of steam flow; Rankine cycle; Actual Rankine cycle; Reheat cycle; Carnot cycle, heat rate.

Thermal Power Plants: Site selection, Main parts and its working. Types of boilers, Feed water and its treatment, Various boiler controls, assessment of heat recovery systems Steam turbines types, selection and control of turbines.

Fuel Handling: delivery of load, unloading, preparation, transfer, outdoor (dead) storage, indoor (live) storage, In-plant Handling, Coal weighing.

Ash disposal and dust collection: Draught systems, electrostatic precipitator. Recent Development in thermal power plants.

Unit 02 : (9 Hrs)

A. **Nuclear Power Plant:** Introduction, atomic physics, nuclear reaction, materials, site selection, nuclear reactors and working of each part, classification of nuclear reactor, nuclear waste disposal, plant layout. Recent Development in nuclear power plants.
B. **Diesel Power Plants:** Main components and its working, Diesel plant efficiency and heat balance, choice and characteristic of diesel power plant. Selection of components and sizing.
C. **Gas Power Plant:** Introduction to gas cycles. Simple gas turbine power plant, methods to improve thermal efficiency, open loop and closed loop cycle power plants, gas fuels, gas turbine materials, plant layout. Combined cycle power plants and concept of heat to power ratio. Recent Development in Gas power plants.

Unit 03 : Hydro Power Plant (8 Hrs)

Site selection, Hydrology, storage and pondage, general arrangements and operation of hydro power plant, Hydraulic turbines, turbine size, pelton wheel turbine, Francis and Kaplan turbines, selection of turbines, Dams, Spillways, gates, intake and out take works, canals and layout of penstocks, water hammer and surge tank, simple numerical on hydrographs and number of turbine required. Control of hydro turbines. Small, mini and micro hydro power plant, Recent Development in hydro power plants.

Unit 04 : Wind Energy Systems (8 Hrs)

Historical Development of Wind Power, Types of wind turbine electrical generators, Power in the Wind, Impact of Tower Height, Maximum Rotor efficiency, Speed control for Maximum Power, Average Power in the wind, Wind turbine power converters (block diagrams), Wind Turbine Economics, Simple Estimates of Wind Turbine Energy, Environmental Impacts of Wind Turbines. Change in wind pattern and its effect on power generation. Control of wind turbine generator.

Unit 05 : Solar Energy (8 Hrs)

Principles of solar radiations, solar constant, cloudy index and concentration ratio, measurement of solar radiation. Solar energy collectors (solar thermal applications), principle of energy conversion, collection systems and their features, types of collectors with comparison. Solar thermal power plants. Over view of recent development of PV technologies. A Generic Photovoltaic Cell, The Simplest Equivalent Circuit for a Photovoltaic Cell From Cells to Modules to Arrays, The PV I–V Curve under Standard Test Conditions (STC), Impacts of Temperature and Insolation on I–V Curves, Shading Impacts on I–V curves, System: Introduction to the Major Photovoltaic System Types.

Unit 06 : Other Sources and Grid Connection (6 Hrs)

Biomass energy, conversion to electricity, municipal solid waste to energy conversion, geothermal energy and ocean energy and Fuel cell Energy storage requirements and selection criteria, stand alone, hybrid stand alone and grid connected renewable systems and their requirements.

Industrial Visit: One industrial visit to conventional /non-conventional power plant is necessary. A separate report file should be maintained in the department.

Text Books:

[T1] P. K. Nag, “Power Plant Engineering”, Tata McGraw Hill Publications.
[T2] Dr. P. C. Sharma, “Power Plant Engineering”, S.K. Kataria Publications.
[T3] R. K. Rajput, “A text book on Power System Engineering”, Laxmi Publications (P) Ltd.
[T4] Chakrabarti, Soni, Gupta, Bhatnagar, “A text book on Power System Engineering”, DhanpatRai publication.
[T5] R.K. Rajput, “Non-Conventional Energy Sources and Utilization”, S. Chand Publications.
[T6] M.M. Wakil, “Power Plant Engineering”, McGraw Hill, Indian Edition.
[T7] G. D. Rai, “Renewable Energy Sources”, Khanna Publications.

Reference Books:

[R1] Arora and Domkundwar, "A Course in Power Plant Engineering", DhapatRai Publication.
[R2] Dr. S. P. Sukhatme, "Solar Energy", Tata McGraw Hill Publication.
[R3] Mukund Patel, "Wind and Solar Power Plants", CRC Press.
[R4] Gilbert Masters John, "Renewable Energy", Wiley and sons' publications.

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

SE(Electrical/Instrumentation and Control)
207006: Engineering Mathematics-III

Teaching Scheme	Credits	Examination Scheme [Marks]
Th:04 Hrs/ Week	Th/Tut: 05	In Sem (Online):50 Marks
Tut:01 Hr/Week		End Sem:50 Marks
		Term Work:25 Marks

Prerequisite:

- Differential and Integral Calculus
- Taylor series and Infinite series
- Differential equations of first order and first degree
- Fourier series, Vector algebra
- Algebra of complex numbers.

Course Objective: After completion of the course, students will have adequate background, conceptual clarity and knowledge of appropriate solution techniques related to:-

- Linear differential equations of higher order applicable to Control systems.
- Transforms such as Laplace transform, Fourier transform, Z-Transform and applications to Control systems and Signal processing.
- Vector differentiation and integration required in Electro- Magnetics and Wave theory.
- Complex functions, conformal mappings, contour integration applicable to Electrostatics, Digital filters, Signal and Image Processing.

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

- Solve higher order linear differential equation using appropriate techniques for modeling and analyzing electrical circuits.
- Solve problems related to Laplace transform, Fourier transform, Z-Transform and applications to Signal processing and Control systems.
- Perform vector differentiation and integration, analyze the vector fields and apply to Electro-Magnetic fields.
- Analyze conformal mappings, transformations and perform contour integration of complex functions in the study of electrostatics and signal processing.

Unit 01 : Linear Differential Equations (LDE) and Applications (9 Hrs)

LDE of nth order with constant coefficients,Method of variation of parameters, Cauchy's & Legendre's DE, Simultaneous & Symmetric simultaneous DE. Modeling of Electrical circuits.

Unit 02 : Laplace Transform(LT) (9 Hrs)

Definition of LT, Inverse LT, Properties & theorems, LT of standard functions, LT of some special functions viz. Periodic, Unit Step, Unit Impulse. Applications of LT for solving Linear differential equations.

Unit 03 : Fourier and Z - transforms (9 Hrs)

Fourier Transform (FT): Complex exponential form of Fourier series, Fourier integral theorem, Fourier Sine & Cosine integrals, Fourier transform, Fourier Sine and Cosine transforms and their inverses.

Z - Transform (ZT): Introduction, Definition, Standard properties, ZT of standard sequences and their inverses. Solution of difference equations.

Unit 04 : Vector Differential Calculus (9Hrs)

Physical interpretation of Vector differentiation, Vector differential operator, Gradient, Divergence and Curl, Directional derivative, Solenoidal, Irrotational and Conservative fields, Scalar potential, Vector identities.

Unit 05 : Vector Integral Calculus and Applications (9Hrs)

Line, Surface and Volume integrals, Work-done, Green's Lemma, Gauss's Divergence theorem, Stoke's theorem. Applications to problems in Electro-magnetic fields.

Unit 06 : Complex Variables (9Hrs)

Functions of Complex variables, Analytic functions, Cauchy-Riemann equations, Conformal mapping, Bilinear transformation, Cauchy's integral theorem, Cauchy's integral formula, Laurent's series and Residue theorem.

Text Books:

[T1] Erwin Kreyszig, "Advanced Engineering Mathematics", 9e,(Wiley India).

[T2] Peter V. O'Neil, "2. Advanced Engineering Mathematics", 7e,(Cengage Learning).

Reference Books:

[R1] M. D. Greenberg, "Advanced Engineering Mathematics", 2e, Pearson Education.

[R2] Wylie C.R. & Barrett L.C. "Advanced Engineering Mathematics", McGraw-Hill, Inc.

[R3] B. S. Grewal, "Higher Engineering Mathematics", Khanna Publication, Delhi.

[R4] P. N. Wartikar& J. N. Wartikar, "Applied Mathematics (Volumes I and II)", Pune VidyarthiGrihaPrakashan, Pune.

[R5] B.V. Ramana, "Higher Engineering Mathematics", Tata McGraw-Hill.

[R6] Thomas L. Harman, JamesDabney and Norman Richert, "Advanced Engineering Mathematics with MATLAB", 2e, Brooks/Cole, Thomson Learning.

Guidelines for Tutorial and Term Work:

1. Tutorial shall be engaged in four batches (batch size of 20 students maximum) per division.
2. Term work shall be based on continuous assessment of six assignments (one per each unit) and performance in internal tests.

203142: Material Science

Teaching Scheme	Credits	Examination Scheme [Marks]
Th:04 Hrs/ Week	Th/Tut: 04	In Sem (Online):50 Marks
PR:02 Hrs/ Week	PR:01	End Sem : 50 Marks
		Oral :50 Marks

Prerequisite:

- Students should have knowledge of various classes of materials like solid, liquid, gaseous, conducting, insulating and resistive along with their basic characteristics.

Course Objective:

- To classify different materials from Electrical Engineering application point of view.
- To understand various properties and characteristics of different classes of materials.
- To select materials for applications in various electrical equipment.
- Toimpart knowledge of Nano-technology, battery and solar cell materials.
- Todevelop ability to test different classes of materials as per IS.

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

- Categorize and classify different materials from Electrical Engineering applications point of view.
- Explain and summarize various properties and characteristics of different classes of materials.
- Choose materials for application in various electrical equipment.
- Explain and describe knowledge of nanotechnology, batteries and solar cell materials.
- Test different classes of materials as per IS.

Unit 01 A] : Dielectric Properties of Insulating Materials: (6Hrs)

Static Field, Parameters of Dielectric material [Dielectric constant, Dipole moment, Polarization, Polarizability], Introduction to Polar and Non- Polar dielectric materials. Mechanisms of Polarizations-Electronic, Ionic and Orientation Polarization (descriptive treatment only), ClausiusMossotti Equation, Piezo-Electric, Pyro-Electric & Ferro-Electric Materials, Dielectric loss and loss tangent, Concept of negative tan delta (δ).

Unit 01 B] : Optical Properties of Materials: (2 Hrs)

Comparison between materials used for Photo-Conductive, Photo-Electric Emissive and Photo-Voltaic cell. Different materials used for plastic, organic and thin-film solar cells (Mono-Crystalline, Poly-Crystalline). Introduction to fiber optics, materials used and its applications.

Unit 02 A] : Insulating Materials, Properties & Applications: (6Hrs)

Introduction, Characteristics of Good Insulating Material, Classification, Solid Insulating Materials-Paper, Press Board, Fibrous Materials, Ceramics, Mica, Asbestos, Resins, Amorphous materials Polymers, Ceramics, Enamels. Liquid Insulating Materials such as Transformer Oil, Varnish, Askarel. Insulating Gases like Air, SF_6. Insulating Materials for Power & Distribution Transformers, Rotating Machines, Capacitors, Cables, Line Insulators and Switchgears.

Unit 02 B] : Dielectric Breakdown: (2 Hrs)

Introduction, Concept of Primary and Secondary Ionization of Gases (descriptive treatment only), Breakdown Voltage, Breakdown Strength, Factors affecting Breakdown Strengths of Solid, Liquid and Gaseous dielectric materials.

Unit 03 : Magnetic Materials: (8Hrs)
Introduction, Parameters of Magnetic material [Permeability, Magnetic Susceptibility, Magnetization], Classification of Magnetic Materials, Diamagnetism, Paramagnetism, Ferromagnetism, Ferri-magnetism, Ferro-magnetic behavior below Critical Temperature, Spontaneous Magnetization, Curie-Weiss law, Anti-ferromagnetism, Ferrites, Applications of Ferro-magnetic Materials, Magnetic materials for Electric Devices such as Transformer Core , Core of Rotating Machines, Soft Magnetic Materials, Hard Magnetic Materials, Magnetic Recording Materials, Compact Discs. Introduction to laser and magnetic strip technology.

Unit 04 : Conducting Materials: (8Hrs)
General Properties of Conductor, Electrical Conducting Materials - Copper, Aluminum and its applications, Materials of High & Low Resistivity-Constantan, Nickel-Chromium Alloy, Tungsten, Canthal, Silver & Silver alloys, Characteristics of Copper Alloys (Brass & Bronze), Materials used for Lamp Filaments, Transmission Lines, Electrical Carbon Materials, Materials for Super-capacitors. Material used for Solders, Metals & Alloys for different types of Fuses, Thermal Bimetal & Thermocouple. Introduction to Superconductivity and Super Conductors.

Unit 05 A] : Nanotechnology: (6Hrs)
Introduction, Concepts of Energy bands & various Conducting Mechanism in Nano-structures, Carbon Nano-structures, Carbon Molecules, Carbon Clusters, Carbon Nano-tubes and applications. Special Topics in Nano Technology such as Single Electron Transistor, Molecular Machines, BN Nanotubes, Nano wires.

Unit 05 B] : Batteries: (2 Hrs)
Materials used for Batteries: Lead Acid, Lithium-ion, Sodium-Sulphur, Nickel-Cadmium, Zero Emission Battery Research Activity (ZEBRA) Batteries. Batteries used in Electric Vehicle (EV) and Electric Hybrid Vehicle (EHV).

Unit 06 : Testing of Materials: (8Hrs)
Explanation of following with objectives, equipment required, circuit diagrams and observations to be taken.

1. Measurement of Dielectric Loss Tangent (tan δ) by Schering Bridge-IS 13585-1994.
2. Measurement of Dielectric Strength of Solid Insulating Material-IS 2584.
3. Measurement of Dielectric Strength of Liquid Insulating Material – IS 6798.
4. Measurement of Dielectric Strength of Gaseous Insulating Material as per IS.
5. Measurement of Flux Density by Gauss-meter.

Guidelines for Instructor's Manual

Practical Sessions:-

Instructor's Manual should contain following things related to every experiment-

1. The circuit diagram of the experiment should be drawn at the start.
2. Aim, apparatus, theory related to that experiment should be written.
3. One sample calculation should be shown, result table should be made and graph should be plotted if required.
4. Conclusion based on calculations, result and graph (if any) should be written.
5. Five - six questions based on that experiment should be written at the end.

Guidelines for Student's Lab Journal

Student's Lab Journalshould be **Hand Written/ Drawn** containing, following things related to every experiment-

1. The circuit diagram of the experiment should be drawn on the graph paper at the start of the experiment.
2. Aim, apparatus, theory related to that experiment should be written.
3. One sample calculation should be shown, result table should be made and graph should be plotted if required.
4. Conclusion based on calculations, result and graph (if any) should be written.
5. Students should write answers to five - six questions based on that experiment at the end.

Guidelines for Lab /TW Assessment

There is **no Term Work** for the subject. But continuous assessment should be carried out such as checking of previous experiment along with its mock oral session (minimum 4-5 questions to each student), while conducting new experiment.

Guidelines for Laboratory Conduction

1. The circuit diagram should be explained to students in such a way that they should be able to develop it at their own.
2. Detail explanation of the experiment along with its circuit diagram, observation table, calculations, result table and plotting of graphs (if any).
3. While conducting new experiment, assessment of previous experiment should be carried out by its checking along with its mock oral session (minimum 4 -5 questions to each student).

List of Experiments: (Any **eight experiments** from the list below).

1. To measure dielectric strength of solid insulating materials.
2. To measure dielectric strength of liquid insulating materials.
3. To measure dielectric strength of gaseous insulating materials using Sphere Gap-Unit.
4. To obtain Hysteresis Loop of the Ferro-Magnetic Material.
5. To understand the principle of thermocouple & to obtain characteristics of different thermocouples.
6. To measure Insulation Resistance &kVAr capacity of power capacitor.
7. To measure Resistivity of High Resistive Alloys.
8. To observe development of tracks due to ageing on different insulating materials e.g. Bakelite, Perspex, polyesters, Mica, Fiberglass etc.
9. Testing of resins and polymers.
10. Measurement of Tangent of Dielectric Loss Angle (tan δ) of solid/liquid dielectric materials.
11. Measurement of Flux Density by Gauss-meter.

Industrial Visit: Minimum one visit should be arranged to an industry related to manufacturing of batteries, capacitors, cables, transformers (Any one industry). A hand written report should be submitted by every student as a part of term work.

Text Books:

[T1] S. P. Seth, "A Course in Electrical Engineering Materials", DhanpatRai and Sons publication.

[T2] "Electrical Engineering Materials", T.T.T.I, Madras.

[T3] K. B. Raina& S. K. Bhattacharya, "Electrical Engineering Materials", S. K. Kataria& Sons.

[T4] P.K. Palanisamy, "Material Science for Electrical Engineering", SciTech Pub. (India) Pvt. Ltd., Chennai.

[T5] Charles P. Poole, Jr. Frank & J. Ownes, "Introduction to Nanotechnology", Wiley Student Edition.

[T6] Ronald M. Dell and David A.J. Rand, "Understanding Batteries", Royal Society of Chemistry, 2001 Publication.

Reference Books:

[R1] D. M. Tagare, "Electrical Power Capacitors-Design & Manufacture", Tata McGraw Hill Publication.

[R2] S. P. Chalotra& B. K. Bhatt, "Electrical Engineering Materials", Khanna Publishers, Nath Market.

[R3] C. S. Indulkar& S. Thiruvengadam, "Electrical Engineering Materials", S. Chand & Com. Ltd.

[R4] Kamraju& Naidu, "High Voltage Engineering", Tata McGraw Hill Publication.

[R5] James F. Shackelford & M. K. Muralidhara, "Introduction to Material Science for Engineering", Sixth Edition by Pearson Education.

[R6] "Insulation Technology Course Material of IEEMA Ratner", Pearson Education.

[R7] Traugott Fischer, "Materials Science for Engineering Students", Elsevier publications.

[R8] Rakosh Das Begamudre, "Energy Conversion Systems", New Age International Publishers.

[R9] David Linden, "Handbook of Battery and Fuel Cells", McGraw Hill, 1984, Publication.

[R10] Chetan Singh Solanki, "Solar Photovoltaic: Fundamentals, Technologies and Applications", Prentice Hall of India Publication.

[R11] R. P. Deshpande, "Ultra capacitors – future of energy storage", McGraw Hill, Publication.

[R12] Linden and Reddy, "Handbook of Batteries", New York McGraw Hill, 2002, Publication.

[R13] R. P. Khare, "Fiber optics and Optoelectronics", Oxford University publication.

Unit	Text Books	Reference Books
1	T1, T3	R1, R3, R8, R10, R13
2	T1, T4	R1, R3
3	T1, T2	R2, R3, R5
4	T1, T2	R1, R3, R6
5	T5, T6	R7, R9, R11, R12
6	T1	R4

203143: Analog And Digital Electronics

Teaching Scheme	Credits	Examination Scheme [Marks]
Lecture : 04 Hrs/ Week	Th/Tut: 04	In Sem (Online) : 50 Marks
Practical : 02 Hrs/ Week	PR:01	End Sem : 50 Marks
		Practical : 50 Marks
		Term Work : 25 Marks

Prerequisite:

- Basics of numbering system.
- Basics of diodes and BJT.

Course Objective:

- To demonstrate the concept of numbering system & Boolean's algebra reduction using K map.
- To design and analyze sequential and combinational circuits.
- To develop the concept of basics of operational Amplifier and its applications.
- To introduction to BJT and diode rectifier.

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

- Understand conversion of number system, perform binary arithmetic and reduce Boolean expressions by K- Map.
- Demonstrate basics of various types of Flip flops, design registers and counter.
- Analyze parameter of Op-amp and its applications.
- Apply the knowledge of Op-amp as wave form generators & filters.
- Use BJT as amplifier with various configurations.
- Analysis of uncontrolled rectifier.

Unit 01 : Number system & Boolean's Algebra: (8 Hrs)

Numbering systems-binary, octal, decimal and hexadecimal and their conversion, codes-BCD, Grey and excess3, Binary arithmetic: - addition and subtraction by 1's and 2's compliment. Booleans algebra, De-Morgan's theory etc. K-map: - structure for two, three and four Variables, SOP and POS form reduction of Boolean expressions by K-map.

Unit 02 : Combinational & Sequential circuits: (9 Hrs)

Concept of Combinational & Sequential circuits, Flip flops – R-S, Clocked S-R, D latches, Edge Triggered D flip-flops, Edge triggered JK flip flops, JK Master - slave flip flop, Register- Buffer registers, shift registers, controlled shift registers, ring counter, Counters – asynchronous Counters, synchronous counter, up - down counter , twisted ring counters, N –moduleCounters.

Unit 03 : Operational Amplifier & Applications: (8 Hrs)

Op-Amp: Block diagrams of 741, ideal and practical parameters, open loop and close loop configuration of Op-Amp. Applications of Op- Amp- Comparator, Schmitt trigger, zero crossing detectors, V-I and I-V converters, Instrumentation amplifier, peak detector.

Unit 04 : Waveform generators, Filters & Regulators: (8 Hrs)

Waveform generation using Op-amp - sine, square, saw tooth and triangular generator, Active filters-Its configuration with frequency response, Analysis of first order low pass and high pass filters, IC 555 –construction, working and modes of operation- astable and monostable multi vibrators, Sequence generator, voltage regulators using ICs 78xx, 79xx, LM 317

Unit 05 : BJT & Applications: (8 Hrs)
BJT amplifier: Introduction, Class A amplifier, AC-DC load line analysis, Single stage and Multistage BJT amplifier, direct coupled, RC coupled and transformer coupled, Darlington pair, Push-Pull amplifier and differential amplifier FET-construction, Parameters, Characteristics.

Unit 06 : Diode & Precision Rectifiers: (7 Hrs)
Diode rectifier: Introduction, Single phase half wave rectifier with R, RL loads. Single phase full wave rectifier-Center tap and bridge rectifier supplying R and RL load and performance parameters. Three phase full wave bridge rectifier with R load. Comparison of single phase half wave and full wave rectifiers,
Precision rectifiers: Half wave and Full wave. Comparison of diode and precision rectifier.

Guidelines for Instructor's Manual

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

- Brief theory related to the experiment.
- Connection diagram /circuit diagram
- Observation table
- Sample calculations for one reading
- Result table
- Graph and Conclusions.
- Data sheets of the ICs used.
- Few questions related to the experiment (3 to 5)
- List of components required with their specifications , data sheets of ICs used

Guidelines for Student's Lab Journal

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

- Theory related to the experiment.
- Connection diagram /circuit diagram
- Observation table
- Sample calculations for one reading
- Result table
- Graph and Conclusions.
- Data sheets of the ICs used.
- List of components required with their specifications, data sheets of ICs used.

Guidelines for Lab /TW Assessment

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

Guidelines for Laboratory Conduction

- First half an hour should be utilized for explaining the circuit diagram and theory related to the experiment.
- Next one hour for connection and conduction of the experiment.
- Remaining half an hour for continuous assessment and timely checking of the experiment (This time slot can be adjusted as per convenience)
- Separate breadboard should be provided for every student for those experiments which are compulsory to be performed on breadboard.

List of Experiments:

Total **ten** experiments are to be conducted out of following experiments:

First seven experiments are compulsory.

1. Study of ring counter and twisted ring counter.
2. Study of up - down counters (IC 74192/74193) and N- modulo counter. (IC 7490/7493).

3*. Study of Op-amp as Schmitt trigger.

4. Study of Instrumentation amplifier using three Op-amp, CMR measurement

5*. Study of Op-amp as sine, and triangular wave generator.

6*. Study of IC-555 applications- astable, monostablemultivibrator.

7*. Study of Single Phase Full-wave bridge rectifier with RL load.

Any three experiments are to be conducted of following experiments:

1. Study of Three Phase Full-wave Rectifier with R load.

2*. Study of active filters- Low pass and high pass filters.

3. Transistor amplifiers: frequency response of BJT, multistage BJT amplifier.

4*. Study of Single Phase Half-Wave Rectifier.

5. Study of op-amp as a ZCD & Comparator
6. Study of various flip-flops and verification of truth table.
7. Study and verify shift register operation (IC 7495).

**** These experiments should be performed on general purpose PCB/ Breadboard.***

Text Books:

[T1] Floyd and Jain, “Digital Fundamentals”, Pearson Education.

[T2] R. P. Jain, “Digital Electronics”, Tata McGraw Hill, New Delhi.

[T3] Malvino, “Digital Computer Electronics- An Introduction to Microcomputers,” Tata McGraw Hill.

[T4] Gaikwad R., “Operational Amplifier”, PHI New Delhi.

[T5] Floyd, “Electronics Devices”, Pearson Education.

[T6] Mottershed, “Electronics Devices & Circuits”, PHI New Delhi

[T7] Muhammad H. Rashid, “Power Electronics: Circuits, Devices and Applications”, 3rd edition, Pearsons Education.

Reference Books:

[R1] Tokheim, "Digital Electronics-Principles and Application", 6th edition, Tata McGraw Hill, New Delhi.
[R2] A Jaico and Charles H. Roth, "Fundamentals of Logic Design" Jr. Forth Edition.
[R3] K. R. Botkar, "Integrated Circuits", Khanna Publication, New Delhi.
[R4] James, "Operational Amplifier and Linear Integrated Circuits Theory and Application."
[R5] P John Paul, "Electronics Devices and circuits", New Age international Publications.
[R6] P. S. Bimbhra, "Power Electronics", Khanna Publications.

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

203144: Electrical Measurements and Instrumentation

Teaching Scheme	Credits	Examination Scheme [Marks]
Th : 04 Hrs/ Week	Th/Tut: 04	In Sem (Online) : 50 Marks
PR : 02 Hrs/ Week	PR:01	End Sem : 50 Marks
		Practical : 50 Marks
		Term Work : 25 Marks

Course Objective:

- To provide the knowledge of system of units, classification and essentials of measuring instruments.
- To get the knowledge about the construction & operation of various electrical & non electrical measuring instruments.
- To apply the knowledge to identify the measuring instruments & make use of it for quantifying measurements of electrical parameters.

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

- Understand various characteristics of measuring instruments, their classification and range extension technique.
- Classify resistance, apply measurement techniques for measurement of resistance, inductance.
- Explain construction, working principle and use of dynamometer type wattmeter for measurement of power under balance and unbalance condition.
- Explain Construction, working principle of 1-phase and 3-phase induction, static energy meter and calibration procedures.
- Use of CRO for measurement of various electrical parameters, importance of transducers, their classification, selection criterion and various applications.
- Measurement of various physical parameters using transducers.

Unit 01 : (9 Hrs)

A. Classification of Measuring Instruments - Characteristics of measuring instruments: static and dynamic, accuracy, linearity, speed of response, dead zone, repeatability, resolution, span, reproducibility, drifts. Necessity of calibration, standards and their classification, absolute and secondary instruments, types of secondary instruments: indicating, integrating, and recording, analog / digital.
Ammeter and Voltmeter Theory: Essentials of indicating instruments deflecting, controlling and damping systems. Construction, working principle, torque equation, advantages and disadvantages of Moving Iron (MI) (attraction and repulsion), and Permanent Magnet Moving Coil (PMMC), block diagram and operation of digital ammeter & voltmeter.

B. Range Extension: PMMC ammeters and voltmeters using shunts, multipliers. Universal shunt, universal multiplier. Instrument Transformers : Construction, connection of CT & PT in the circuit, advantages of CT / PT over shunt and multipliers for range extension of MI Instruments, transformation ratio, turns ratio, nominal ratio, burden, ratio and phase angle error.(descriptive treatment only)

Unit 02 : (8 Hrs)

A. Measurement of Resistance: Measurement of low, medium and high resistance. Wheatstone bridge, Kelvin's double bridge, ammeter-voltmeter method, megger, loss of charge method. Earth tester for earth resistance measurement.

B. Measurement of Inductance: Introduction, sources and detectors for A.C. bridge, general equation for bridge at balance. Measurement of inductance: Maxwell's inductance & Maxwell's inductance – Capacitance Bridge, Anderson's bridge.

Unit 03 : (8 Hrs)

Measurement of Power: Construction, working principle, torque equation, errors and their compensation, advantages and disadvantages of dynamometer type wattmeter, low power factor wattmeter, poly-phase wattmeter. Active & reactive power measurement in three phase system for balanced and unbalanced load using three wattmeter method, two wattmeter method & one wattmeter method. Power analyzer, Multi meter.

Unit 04 : (7 Hrs)

Measurement of Energy: Construction, working principle, torque equation, errors and adjustments of single phase conventional (induction type) energy meter. Calibration of energy meter. Block diagram and operation of electronic energy meter. Three phase energy meter, TOD meter.

Unit 05 : (8 Hrs)

A. **Oscilloscope:** Introduction, various parts, front panel controls, use of CRO for measurement of voltage, current, period, frequency. Phase angle & frequency by lissajous pattern & numerical. Introduction to DSO.
B. **Transducers:** Introduction, classification, types: resistive, inductive, capacitive, basic requirements for transducers.
C. **Pressure Measurement:** Introduction, classification of pressure as low, medium & high, absolute, gauge, vacuum, static, dynamic & head pressure. High pressure measurement using electric methods, low pressure measurement by McLeod gauge and pirani gauge, capacitive pressure transducer.

Unit 06 : (8 Hrs)

A. **Level Measurement:** Introduction and importance of level measurement, level measurement methods: mechanical, hydraulic, pneumatic, electrical, nucleonic and ultrasonic.
B. **Displacement Measurement:** LVDT & RVDT – construction, working, application, null voltage, specifications, advantages & disadvantages, effect of frequency on performance.
C. **Strain Gauge**: Introduction, definition of strain, types of strain gauge: Wire strain gauge, foil strain gauge, semiconductor strain gauge etc.; their construction, working, advantages and disadvantages.

Guidelines for Instructor's Manual

- The instructor’s manual is to be developed as a hands-on resource and reference.
- The instructor's manual need to include prologue (about University / program / institute / department / foreword / preface etc), University syllabus, conduction & Assessment guidelines, topics under consideration- concept, objectives, outcomes, list of experiments, references etc.
- The feedback seeking sheet for enhancement of instructor's manual may be added as annexure.

Guidelines for Student's Lab Journal

- The laboratory experiments are to be submitted by student in the form of journal.
- Journal consists of prologue, Certificate, table of contents, and write-up of each experiment (Title, Objectives, Outcomes, List of apparatus, Circuit diagram, Theory, Observation Table, Sample Calculation, Result Table, Conclusion / Analysis, exercises - MCQs, assignments, Date of Completion, Assessment grade and assessor's sign with date).

Guidelines for Lab /TW Assessment

- Each experiment will be assigned grade based on parameters with appropriate weightage.
- Suggested parameters include- timely completion, performance, innovation, punctuality and neatness.

Guidelines for Laboratory Conduction

- The instructor is expected to shortlist necessary experiments from the suggested list of experiments. During the practical session the instructor may divide the total students in groups of 4 to 5 students and assign them with different experiments to be performed.
- Proper safety instructions and demonstration of the experiment is to be given before asking the students to perform the experiment. The experiment is carried out by the students under the supervision of the instructor.
- The instructor should take utmost care towards safety of the students, self and other hazards that may be caused by improper operation of the equipment.
- The instructor may also design an experiment which is relevant to the subject and beyond the scope of syllabus.

List of Experiments:

Compulsory Experiments: (06) Six.

1. Demonstration of working parts of various types of meter by opening the instrument & explanation of symbols & notations used on instruments.
2. Extension of instrument range: ammeter, voltmeter, watt meter using CT & PT.
3. Measurement of active & reactive power in three phase circuit using two wattmeter methods (balanced & unbalanced loads).
4. Measurement of active & reactive power in three phase balanced circuit using one wattmeter method with two way switch.
5. Calibration of single phase static energy meter at different power factors.
6. Measurement of voltage, current, time period, frequency & phase angle using CRO.

Any four experiments are to be conducted of following experiments:

1. Measurement of reactive power by one wattmeter with all possible connections of current coil and pressure coil.
2. Measurement of power in three phase, four wire system using three CTs & two wattmeter.
3. Calibration of single phase wattmeter at different power factors.
4. i) Measurement of resistance by ammeter voltmeter method.
   ii) Measurement of low resistance using Kelvin's double bridge.
5. Measurement of inductance using Anderson's bridge/ Maxwell's bridge.

6. Displacement measurement by LVDT.
7. Electrical methods for measurement of liquid level.

Industrial Visit (If Any): Minimum one visit should be arranged to electrical instrument manufacturing company or where electrical instruments are calibrated or where various measuring instruments (Electrical/Mechanical) can be seen or observed.

Text Books:

[T1] A. K. Sawhney, "A Course in Electrical and Electronic Measurements & Instrumentation" DhanpatRai& Co.

[T2] J. B. Gupta, "A Course in Electronics and Electrical Measurements and Instrumentation" S. K. Kataria& Sons,

[T3] R. K. Jain, "Mechanical and Industrial Measurements" Khanna Publishers.

[T4] B. C. Nakra& K. K. Chaudhari, "Instrumentation Measurement and Analysis", Tata McGraw Hill.

Reference Books:

[R1] E. W. Golding & F. C. Widdies, "Electrical Measurements & Measuring Instruments" Reem Publications.

[R2] Dr. Rajendra Prasad, Electronic Measurements & Instrumentation, Khanna Publishers

[R3] Arun K. Ghosh, "Introduction to Measurements and Instrumentation, PHI Publication

[R4] M. M. S. Anand "Electronics Instruments and Instrumentation Technology" by, PHI Publication.

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

203151: Soft Skills

Teaching Scheme	Credits	Examination Scheme [Marks]
PR : 02 Hrs/ Week	PR: 01	Term Work : 25 Marks

Course Objective: The course aims to:-

- To possess knowledge ofthe concept of Self-awareness and Self Development.
- To Understand the importance of Speaking Skills, listening skills, Presentation Skills and leadership skills.
- To gain the knowledge of corporate grooming & dressing, Email & telephone etiquettes, etiquettes in social & office setting.
- To get conversant with Team work, Team effectiveness, Group discussion, Decision making.
- To recognize the importance of time management and stress management.

Course Outcome: Students will be able to :-

- DoSWOT analysis.
- Develop presentation and take part in group discussion.
- Understand andImplement etiquettes in workplace and in society at large.
- Work in team with team spirit.
- Utilize the techniques for time management and stress management.

Unit 01 : Self-Awareness & self-Development: (4Hrs)

A) **Self-Assessment , Self-Appraisal, SWOT, Goal setting - Personal & career** - Self-Assessment, Self-Awareness, Perceptions and Attitudes, Positive Attitude, Values and Belief Systems, Self-Esteem, Self-appraisal, Personal Goal setting,

B) Career Planning, Personal success factors, Handling failure, Depression and Habit, relating SWOT analysis & goal setting and prioritization.

Unit 02 : Communication Skill: (6 Hrs)

A) Importance of communication, types, barriers of communication, effective communication.

B) **Speaking Skills:** Public Speaking, Presentation skills, Group discussion- Importance of speaking effectively, speech process, message, audience, speech style, feedback, conversation and oral skills, fluency and self-expression, body language phonetics and spoken English, speaking techniques, word stress, correct stress patterns, voice quality, correct tone, types of tones, positive image projection techniques.

C) **Listening Skills:**Law of nature- you have 2 ears and 1 tongue so listen twice and speak once isthe best policy, Empathic listening, Avoid selective listening-

D) **Group Discussion:**Characteristics, subject knowledge, oral and leadership skills, team management, strategies and individual contribution and consistency.

E) **Presentation skills:**Planning, preparation, organization, delivery.

F) **Written Skills:** Formal & Informal letter writing, Report writing, Resume writing - Sentence structure, sentence coherence, emphasis. Paragraph writing. Letter writing skills – form and structure, style and tone. Inquiry letters, Instruction letters, complaint letters,

Routine business letters, Sales Letters etc.

Unit 03 : Corporate / Business Etiquettes: (2 Hrs)

Corporate grooming & dressing, Email & telephone etiquettes, etiquettes in social & office setting: Understand the importance of professional behavior at the work place, Understand andImplement etiquettes in workplace, presenting oneself with finesse and making otherscomfortable in a business setting. Importance of first impression, Grooming, Wardrobe, Bodylanguage, Meeting etiquettes (targeted at young professionals who are just entering businessenvironment), Introduction to Ethics in engineering and ethical reasoning, rights andresponsibilities.

Unit 04 : Interpersonal relationship: (4 Hrs)

A) **Team work, Team effectiveness, Group discussion, Decision making –** Team Communication. Team, Conflict Resolution, Team Goal Setting, Team Motivation Understanding Team Development, Team Problem Solving, Building the team dynamics. Multicultural team activity.
B) **Group Discussion**- Preparation for a GD, Introduction and definitions of a GD, Purpose of a GD, Types of GD, Strategies in a GD, Conflict management, Do's and Don'ts in GD

Unit 05 : Leadership skills: (2 Hrs)

Leaders' role, responsibilities and skill required - Understanding good Leadership behaviors, Learning the difference between Leadership and Management, Gaining insight into your Patterns, Beliefs and Rules, Defining Qualities and Strengths of leadership, Determining how well you perceive what's going on around you, interpersonal Skills and Communication Skills, Learning about Commitment and How to Move Things Forward, Making Key Decisions, Handling Your and Other People's Stress, Empowering, Motivating and Inspiring Others, Leading by example,effective feedback.

Unit 06 : Other skills: (2 Hrs)

A) **Time management**- The Time management matrix, apply the Pareto Principle (80/20 Rule) to time management issues, to priorities using decision matrices, to beat the most common time wasters, how to plan ahead, how to handle interruptions , to maximize your personal effectiveness, how to say "no" to time wasters, develop your own individualized plan of action.
B) **Stress management**- understanding the stress & its impact, techniques of handling stress.
C) Problem solving skill, Confidence building Problem solving skill, Confidence building

Term Work/Assignments:

Term work will consist the record of any 8 assignments of following exercises

1. SWOT analysis
2. Personal & Career Goal setting – Short term & Long term
3. Presentation Skill
4. Letter/Application writing
5. Report writing
6. Listening skills
7. Group discussion
8. Resume writing
9. Public Speaking
10. Stress management
11. Team Activity-- Use of Language laboratory

**** Perform any 8 exercises out of above 11 with exercise no. 11 as compulsory.***

Teaching Methodology:

Each class should be divided into three batches of 20-25 students each. The sessions should be activity based and should give students adequate opportunity to participate actively in each activity. Teachers and students must communicate only in English during the session. Specific details about the teaching methodology have been explained in every activity given below.

Practical Assignments (Term work)

Minimum 8 assignments are compulsory and teachers must complete them during the practical sessions within the semester. The teacher should explain the topics mentioned in the syllabus during the practical sessions followed by the actual demonstration of the exercises. Students will submit report of their exercise (minimum 8) assignments as their term work at the end of the semester but it should be noted that the teacher should assess their assignment as soon as an activity is conducted. The continual assessment process should be followed.

1. **SWOT analysis:**

   The students should be made aware of their goals, strengths and weaknesses, attitude, moral values, self-confidence, etiquettes, non-verbal skills, achievements etc. through this activity. The teacher should explain to them on how to set goals, SWOT Analysis, Confidence improvement, values, positive attitude, positive thinking and self-esteem. The teacher should prepare a questionnaire which evaluate students in all the above areas and make them aware about these aspects.

2. **Personal & Career Goal setting – Short term & Long term**

3. **Presentation Skills:**

   Students should make a presentation on any informative topic of their choice. The topic may be technical or non-technical. The teacher should guide them on effective presentation skills. Each student should make a presentation for at least 10 minutes.

4. **Letter/Application writing:**

   Each student will write one formal letter, and one application. The teacher should teach the students how to write the letter and application. The teacher should give proper format and layouts.

5. **Report writing:**

   The teacher should teach the students how to write report. The teacher should give proper format and layouts. Each student will write one report based on visit / project / business proposal etc.

6. **Listening skills:**

   The batch can be divided into pairs. Each pair will be given an article (any topic) by the teacher. Each pair would come on the stage and read aloud the article one by one. After reading by each pair, the other students will be asked questions on the article by the readers. Students will get marks for correct answers and also for their reading

skills. This will evaluate their reading and listening skills. The teacher should give them guidelines on improving their reading and listening skills. The teacher should also give passages on various topics to students for evaluating their reading comprehension.

7. Group discussion:

Each batch is divided into two groups of 12 to 14 students each. Two rounds of a GD for each group should be conducted and teacher should give them feedback.

8. Resume writing:

Each student will write one formal letter, and one application. The teacher should teach the students how to write the letter and application. The teacher should give proper format and layouts.

9. Public Speaking:

Any one of the following activities may be conducted :

A) **Prepared speech**(topics are given in advance, students get 10 minutes to prepare the speech and 5 minutes to deliver.
B) **Extempore speech** (students deliver speeches spontaneously for 5 minutes each on a given topic)
C) **Story telling** (Each student narrates a fictional or real life story for 5 minutesearch)
D) **Oral review**(Each student orally presents a review on a story or a book read by them)

10. Team Activity-- Use of Language laboratory

Text Books:

[T1] Sanjay Kumar and PushpaLata, "Communication Skills", Oxford University Press.
[T2] Krishna Mohan, MeeraBanerji, "Developing Communication Skill", McMillan India Ltd.
[T3] Simon Sweeney, "English for Business Communication", Cambridge University Press

Reference Books:

[R1] Accenture, Convergys, Dell et.al, "NASSCOM-Global Business Foundation Skills, Foundation Books, Cambridge University Press.
[R2] E. H. McGrath, "Basic Managerial Skills for all", Eastern Economy Edition, Prentice hall India.
[R3] Barun K. Mitra, "Personality Development and Group Discussions", Oxford University Press.
[R4] PriyadarshiPatnaik, "Group Discussions and Interview Skills: Foundation Books", Cambridge University Press.
[R5] Napoleon Hill, "Thinks and Grow Rich", Ebury Publishing, ISBN 9781407029252.
[R6] Tony Robbins, "Awaken the Giant Within", Harper Collins Publishers, ISBN-139780743409384.

[R7] Wayne Dyer, "Change Your Thoughts, Change Your Life", Hay House India, ISBN-139788189988050.
[R8] Stephen Covey, "Habits of Highly Effective People", Pocket Books, ISBN-139781416502494.
[R9] Dr. Joseph Murphy, "The Power of Your Subconscious Mind", MaanuGraphics, ISBN-13 9789381529560.
[R10] Daniel Coleman, "The new Leaders", Sphere Books Ltd, ISBN-139780751533811.
[R11] Richard Koch, "The 80/20 Principal", Nicholas Brealey Publishing , ISBN-13 9781857883992.
[R12] Julie Morgenstern, "Time management from inside out", Owl Books (NY),ISBN-13 9780805075908.
[R13] SharuRanganekar, "Wonderland of Indian Manageress", Vikas Publishing Houses, ISBN-13 9788125942603.
[R14] Shiv Khera, "You can win", Macmillan, ISBN-139789350591932.
[R15] Gopalaswamy Ramesh, Mahadevan Ramesh, "The Ace of Soft Skills: Attitude, Communication and Etiquette for Success".

203154:Audit Course I

Solar Thermal Systems

Course Name: Solar Thermal Systems

Prerequisite: Completion of FE or equivalent

Teaching Scheme:
Lectures: 2 h per week
Field Visit: 4 h

Examination Schemes: Audit (P/F)
Written and MCQ
Term paper

Description:

The course will introduce the basics of: solar energy, availability, applications, heat transfer as applied to solar thermal systems, various types of solar thermal systems, introduction to manufacturing of the systems, characterization, quality assurance, standards, certification and economics. The following topics may be broadly covered in the classroom. The field visits will be designed for firsthand experience and basic understanding of the system elements.

Course Objective:

- To understand basics and types of solar thermal systems.
- To get knowledge of various types of concentrators.
- To make students aware of different Standards and certification for Concentrator Solar Power.

Course Outcome: Student Will be able to

- Differentiate between types of solar Concentrators
- Apply software tool for solar concentrators
- Design different types of Solar collectors and balance of plant

Course Contents:

- Sun, Earth and seasons
- Solar Radiation
- Basics of heat transfer
- Absorption, reflection and transmission of radiation
- Types of Solar thermal systems
- Basic design of different types of systems
- Applications of solar thermal systems and their economics
- Need for solar concentration
- Various types of solar concentrators
- Movement of Sun and tracking
- Control systems for solar tracking
- Concentrating solar thermal (CSP)
- Concentrating solar PV (CPV)
- Balance of plant for CSP
- Critical points in concentrating solar system installation
- Operation and maintenance of CSP

- Typical financial analysis of CSP
- Software tools for concentrating solar power
- Environmental impact assessment
- Standards and certification for CSP
- Basics of solar thermal (STH) systems
- Elements of various STH systems
- Design, materials and manufacturing of
  - Flat plate solar collector
  - Evacuated tube solar collector
  - Parabolic trough collector
  - Dish type solar concentrators
  - Concentrating PV systems
  - Balance of plant
- 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

References:

- Trainers Textbook Solar Thermal Systems Module, Ministry of New and Renewable Energy, Government of India
- Students Workbook for Solar Thermal Systems Module, Ministry of New and Renewable Energy, Government of India

203145: Power System I

Teaching Scheme	Credits	Examination Scheme [Marks]
Th : 04 Hrs/ Week	Th/Tut: 04	In Sem (Online) : 50 Marks End Sem : 50 Marks

Prerequisite:

- Power Generation.
- Various insulating materials and properties.
- Knowledge of fundamental of electrical circuit components.

Course Objective:

- To learn basic structure of electrical power systems, various electrical terms related with power system and understand various types of tariffs.
- To understand specifications and applications of major electrical equipment present in power plant.
- To get knowledge of mechanical & electrical design of overhead and underground transmission system.
- To learn representation of transmission lines for performance evaluation.

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

- Recognize different patterns of load curve, calculate different factors associated with it and tariff structure for LT and HT consumers.
- Aware of features, ratings, application of different electrical equipment in power station and selection of overhead line insulators.
- Analyze and apply the knowledge of electrical and mechanical design of transmission lines.
- Identify and analyze the performance of transmission lines.

Unit 01 : Structure of Electrical Power Systems and tariff: (8 Hrs)

A) Structure of Electrical Power Systems: Structure of Electrical Power System**,** Different factors associated with generating stations such as Connected load, Maximum Demand, Demand Factor, average load, load factor, diversity factor, plant capacity factor, reserve capacity, plant use factor, Load curve, load duration curve, concept of base load and peak load stations, Interconnected grid system. Fitting of available generating stations into the area load duration curve.

B) Tariff : Introduction of Tariff, Tariff setting principles, desirable characteristics of Tariff, various consumer categories and implemented tariffsuch as two part, three part, Time of Day tariff for H.T. & L.T. industrial and commercialconsumers along with current electricity charges, Introduction to Availability Based Tariff (ABT), Interruptible tariff, Incentives and penalties applied to various consumers.

Unit 02 : Major Electrical Equipment's in Power Stations and Overhead line insulators : (8 Hrs)

A) Major Electrical Equipment's in Power Stations : Descriptive treatment of ratings of various equipment used in power station, Special features, field of use of equipment like alternators, necessity of exciters, various excitation systems such as dc excitation, ac excitation and static excitation systems, transformers, voltage regulators, bus-bars, current limiting reactors, circuit breakers, protective relays, current transformers, Potential transformers, Lightning arresters, Earthingswitches, isolators, carrier current equipment (P.L.C.C.), Control panels, battery rooms, metering and other control room equipment in generating stations.

B) Overhead Line Insulators: Types of insulators & their applications such as pin type, suspension type, strain type, Silicon Rubber insulators, post insulators, Shackle insulators, bushings, voltage distribution along string of suspension insulators, string efficiency, equalization of potential across each unit, method of improving string efficiency, insulator failure.

Unit 03 : Mechanical Design of Overhead Lines and Underground Cables: (8 Hrs)

A) Mechanical Design of Overhead Lines: Main components of overhead lines, Line supports, conductor spacing, length of span, calculation of sag for equal and unequal supports and effect of ice and wind loadings.

B) Underground Cables: Classification, Construction of cable, XLPE cables, insulation resistance, dielectric stress in single core cable, capacitance of single core and three core cable, cables used for HVDC transmission. Grading of cables, inter sheath grading, capacitance grading.

Unit 04 : Resistance and Inductance of Transmission Line: (9 Hrs)

Resistance of transmission line, skin effect and its effects, proximity effect, internal & external flux linkages of single conductor, inductance of single phase two wire line, inductance of three phase line with symmetrical and unsymmetrical spacing, concept of G.M.R. and G.M.D, necessity of transposition,inductance of three phase double circuit line with symmetrical and unsymmetrical spacing, inductance of bundled conductors.

Unit 05 : Capacitance of Transmission Line: (7 Hrs)

Electric potential at single charged conductor, potential at conductor in a group of charged conductors, capacitance of single phase line, Capacitance of single phase line with effect of earth's surface on electric field, Concept of G.M.R. and G.M.D for capacitance calculations, capacitance of three phase line with symmetrical and unsymmetrical spacing, capacitance of double circuit three phase line with symmetrical and unsymmetrical spacing.

Unit 06 : Performance of Transmission Lines: (8 Hrs)

Classification of lines based on length and voltage levels such as short, medium and long lines. Performance of short transmission line with voltage current relationship and phasor diagram, Representation of medium lines as 'Nominal Pi' and 'Nominal Tee' circuits using R, L and C parameters. Ferranti effect, Representation of 'Tee' and 'Pi' models of lines as two port networks, evaluation and estimation of generalized circuit constants (ABCD) for short and medium lines, Estimation of Efficiency & regulation of short & medium lines.

Industrial visit: Minimum one visit to HV substations is recommended.

Text Books:

[T1] J. B. Gupta, "Transmission and Distribution", S. K. Kataria& Sons, New Delhi.

[T2] V. K. Mehta, Rohit Mehta, "Principles of Power System", S. Chand Publication

[T3] J. B. Gupta, "Generation and Economic Considerations", S. K. Kataria& Sons, New Delhi.

[T4] Dr. B. R. Gupta, "Generation of Electrical Energy",S. Chand Publication

[T5] A Chakraborty, M. L. Soni, P. V. Gupta, U.S. Bhatnagar, "A text book on Power System Engineering", Dhanpatrai& Co., Delhi.

[T6] S. N. Singh, "Electric Power Generation, Transmission and Distribution", Prentice Hall of India.

Reference Books:

[R1] Nagrath& Kothari, "Power System Engineering", Tata McGraw Hill Publications.
[R2] D. Das, "Electrical Power System", New Age Publication.
[R3] W.D. Stevenson, "Power System Analysis", Tata McGraw Hill Publications.
[R4] "Know your Power – citizen's primer" – Prayas energy group

References:

www.mahadiscom.in
www.mercindia.org.in

203146: Electrical Machines I

Teaching Scheme	Credits	Examination Scheme [Marks]
Th : 04 Hrs/ Week	Th/Tut: 04	In Sem (Online) : 50 Marks
PR : 02 Hrs/ Week	PR:01	End Sem : 50 Marks
		Practical : 50 Marks
		Term Work : 25 Marks

Prerequisite:

- Magnetic circuit, mutual induced EMF, Dynamically induced EMF, Direction of magnetic field in current carrying conductor, Flemings LHR & RHR, Electromechanical energy conversion.

Course Objective:

- To understand energy conversion process.
- To understand selection of machines for specific applications.
- To test & analyze the performance of machine.
- To understand the construction, principle of operation of transformers, DC Machine & Induction Machine.

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

- Apply energy conversion principles to different machines.
- Select machine for specific applications.
- Test the various machine for performance calculation.

Unit 01 : Transformers: (8 Hrs)

Single phase Transformer: Concept of ideal transformer. Corrugated core transformer. Toroidal core Transformer Useful and leakage flux, its effects. Resistance, leakage reactance and leakage impedance of transformer windings & their effects on voltage regulation and efficiency. Exact and approximate equivalent circuits referred to L.V. and H. V. side of the transformer. Phasor diagrams for no-load and on load conditions. Transformer ratings. Losses in a transformer, their variation with load, voltage & Frequency on no load losses Efficiency and condition for maximum efficiency. All day Efficiency. Open circuit and short circuit tests, determination of equivalent circuit parameters from the test data and determination of voltage regulation and efficiency. Autotransformers, their ratings and applications. Comparison with two winding transformer with respect to saving of copper and size.

Unit 02 : Transformers: (8 Hrs)

Polarity test. Parallel operation of single phase transformers, conditions to be satisfied, load sharing under various conditions. & Welding Transformer

Three Phase Transformers: Standard connections of three phase transformers and their suitability for various applications, voltage Phasor diagrams and vector groups. Descriptive treatment of Parallel operation of three phase transformers Scott connection and V connections. Three winding (tertiary windings) transformers

Unit 03 : D.C. Machines: (8 Hrs)

Construction, main parts, magnetic circuits, poles, yoke, field winding, armature core, Armature windings: Simple lap and wave winding, commutator and brush assembly. Generating action, E.M.F equation, magnetization curve, Flashing of Generator. Motoring action. Types of DC motors, significance of back E.M.F torque equation, working at no-load and on-load. Losses, power flow diagram and efficiency. Descriptive treatment of armature reaction.

Unit 04 : D.C. Machines: (8 Hrs)

Characteristics and applications of D.C. Shunt and Series Motors, Starting of DC motors, study of starters for series and shunt motor, solid state starters, speed control of various types of DC motors.

Commutation: Process of commutation, time of commutation, reactance voltage, straight line commutation, commutation with variable current density, under and over commutation, causes of bad commutation and remedies, inter poles, compensating windings. (Descriptive treatment only)

Unit 05 : Three Phase Induction Motor: (8 Hrs)

Production of rotating mmf by 3-phase balanced voltage fed to a symmetrical 3-phase winding. Construction: Stator, Squirrel cage & wound rotors. Principle of working, simplified theory with constant air gap flux; slip, frequency of rotor emf and rotor currents, mmf produced by rotor currents, its speed w.r.t. rotor and stator mmf. Production of torque, torque-slip relation, condition for maximum torque, torque-slip Characteristics, effect of rotor resistance on torque-slip characteristics. Relation between starting torque, full load torque and maximum torque. Losses in three phase induction motor, power-flow diagram. Relation between rotor input power, rotor copper loss & gross mechanical power developed, efficiency.

Unit 06 : Three Phase Induction Motor: (8 Hrs)

Induction motor as a generalized transformer; phasor diagram. Exact & approximate equivalent circuit. No load and blocked rotor tests to determine the equivalent circuit parameters and plotting the circle diagram. Computation of performance characteristics from the equivalent circuit and circle diagram. Performance curves. Necessity of starter for 3-phase induction motors. Starters for slip-ring and cage rotor induction motors; stator resistance starter, auto transformer starter, star delta starter and rotor resistance starter. D.O.L. starter and soft starting, with their relevant torque and current relations. Comparison of various starters. , testing of three phase induction motor as per IS 325 & IS 4029.

Guidelines for Instructor's Manual

- Prepare 4/5 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 and whether moving coil or moving iron 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:**
    - **Comments if any:**
    - **Questions / Answers**: Write minimum 5/ 6 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.
7. Use black or blue ink pen for writing.

Guidelines for Laboratory Conduction

1. Check whether the MCB / ELCB / 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 / ELCB / main switch.
6. Write the experiment in the journal and get it checked within week.

Guidelines for Lab /TW Assessment

1. Do the continuous assessment. The experiment performed in a particular week, should be checked within same week or at the most in next week.
2. While assessment, teacher should put the remark by writing word “Complete” and not simply “C”. Put the signature along with date at the end of experiment and in the index.
3. Assign 10 marks for each experiment as per following format
   Timely completion = 03 marks
   Neat and clean writing = 02 marks
   Depth of understanding = 03 marks
   Regular attendance = 02 marks
4. Maintain continuous assessment sheet. At the end of semester, convert these marks out of as prescribed in syllabus structure and display on the notice board.

List of Experiments:

Compulsory Experiments:

1. O.C. and S.C. test on single phase Transformer.
2. Polarity test on single phase and three phase transformer
3. Parallel operation of two single phase transformers and study of their load sharing under various conditions of voltage ratios and leakage impedances.

Any five experiments are to be conducted of following experiments:

1. Speed control of D.C. Shunt motor and study of starters.
2. Brake test on D.C. Shunt motor
3. Load characteristics of D.C. series motor.
4. Hopkinson's test on D.C. shunts machines.
5. Load test on 3-phase induction motor.
6. No load & blocked-rotor test on 3-phase induction motor :
    a) Determination of parameters of equivalent circuit.
    b) Plotting of circle diagram.
7. Calculation of motor performance from (a) & (b) above.
8. Determination of sequence impedance of the transformer
9. To study Sumpner's test.
10. Measurements of non-sinusoidal current waveform of transformer at no load Swinburne Test on DC shunt Motor.

Industrial Visit:

- Minimum One visit to above machines manufacturing industry (mentioned in syllabus) is recommended.
- Assignment based on IS 2026.

Text Books:

[T1] Edward Hughes "Electrical Technology", ELBS, Pearson Education.
[T2] Ashfaq Husain, "Electrical Machines", DhanpatRai& Sons.
[T3] S. K. Bhattacharya, "Electrical Machine", Tata McGraw Hill publishing Co. Ltd, 2nd Edition.
[T4] Nagrath& Kothari, "Electrical Machines", Tata McGraw Hill.
[T5] Bhag S Guru, Husein R. Hiziroglu, "Electrical Machines", Oxford University Press.
[T6] K Krishna Reddy, "Electrical Machines- I and II", SCITECH Publications (India) Pvt. Ltd. Chennai.

Reference Books:

[R1] A.E. Clayton and N. N. Hancock, "Performance and Design of Direct Current Machines", CBS Publishers, Third Edition.
[R2] A.E. Fitzgerald, Charles Kingsley, Stephen D. Umans, "Electrical Machines", Tata McGraw Hill Publication Ltd., Fifth Edition.
[R3] A.S. Langsdorf, "Theory and performance of DC machines", Tata McGraw Hill.
[R4] M.G. Say, "Performance and Design of AC. Machines", CBS Publishers and Distributors.
[R5] SmarajitGhosh, "Electrical Machines", Pearson Education, New Delhi.
[R6] Charles I Hubert, "Electrical Machines Theory, Application, & Control", Pearson Education, New Delhi, Second Edition.

203147: Network Analysis

Teaching Scheme	Credits	Examination Scheme [Marks]
Th : 04 Hrs/ Week	Th/Tut: 04	In Sem (Online) : 50 Marks
PR : 02 Hrs/ Week	PR:01	End Sem : 50 Marks
		Term Work : 50 Marks

Prerequisite:

- Terminology of electrical networks, Laplace transforms linear differential equations.

Course Objective:

- To develop the strong foundation for Electrical Networks.
- To develop analytical qualities in Electrical circuits by application of various theorems.
- To understand the behavior of circuits by analyzing the transient response using classical methods and Laplace Transform approach.
- To apply knowledge of Network theory for analysis of 2-port networks and design of other circuits like filters.

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

- Developing strong basics for network theory.
- Develop the problem solving technique for networks by application of theorems.
- Understand the behavior of the network by analyzing its transient response.
- Apply their knowledge of network theory for designing special circuits like filters.

Unit 01 : Basics of Network: (8 Hrs)

Source transformation: voltage and current sources, mesh analysis, nodal analysis, Concept of super node and super mesh, coupled circuits and dot conventions. Concept of network graphs (incidence, tie set and cut set matrix), Concept of duality and dual networks.

Unit 02 : Network Theorems: (8 Hrs)

Superposition, Thevenin, Norton, Maximum Power Transfer Theorem, Reciprocity theorem, Millman theorems applied to both ac/dc circuits.

Unit 03 : Analysis of Transient Response in Circuits-Classical Method: (8 Hrs)

Initial and Final Condition of network, General and Particular Solution, time constant. Transient response of R-L, R-C and R-L-C network in time domain.

Unit 04 : Analysis of Transient Response in Circuits: Laplace Transform Approach: (8 Hrs)

Standard test inputs: Step, Ramp, Impulse, Their Laplace transform, Representation of R,L,C in S domain, transformed network, Application of Laplace transform to solve series and parallel R-L, R-C and R-L-C circuits (Source free, Source driven).

Unit 05 : Two Port Network and Network Functions: (8 Hrs)

Two port parameters: Z, Y, H and Transmission parameters Network Functions for 1 and 2 port, calculation of network functions, Poles and zeros of network functions, Restrictions on poles and zeros, Time–domain behavior from the pole and zero location, Necessary conditions for stable driving point function and Transfer function.

Unit 06 : Filters: (8 Hrs)

Classification of filters: Low pass, High Pass, Band pass, Band stop, Symmetrical networks : characteristic impedance , propagation constant, Design of constant K- low pass and constant K- high pass filters using symmetrical networks.

Guidelines for Instructor's Manual

- Specify objective(s) of the experiment.
- List out equipment required to perform the experiment with their ratings.
- Include circuit diagram with specifications.
- Related theory of the experiment must be included.
- Include step by step procedure to perform the experiment.
- Tabular representation of results taken from the experiment/observation table must be included wherever applicable.
- It should include the formulae required to calculate desired results.
- Instructions for plotting the graphs must be included wherever required.
- Provide space to write conclusion on their own.
- For simulation experiments using MATLAB, the Simulink diagram with proper details must be included.

Guidelines for Student's Lab Journal

- Students are expected to write the journal in the following sequence:
  - Aim –
  - Equipment –
  - Circuit diagram –
  - Theory –
  - Procedure –
  - Observation table –
  - Calculations –
  - Graphs –
  - Conclusion.
- Students are expected to draw the circuit diagrams on 1mm graph paper.
- For plotting the characteristics they must use 1mm graph papers.
- Students should write conclusion on their own.
- Students should get the assignment and lab write up checked within 1 week after performing the experiment.

Guidelines for Lab /TW Assessment

Assessment should be on the basis of:

- Neatness of circuit diagram.
- Completed write up including theory, procedure.
- The detail calculations to obtain results.
- Graph with title, scale, labeling of axes etc.
- Conclusion.
- Punctuality, discipline, attendance, understanding and neatness of the journal.
- Few questions on the basis of the experiment can be asked to verify the understanding of the students about that experiment.

Guidelines for Laboratory Conduction

- Give the safety instructions to students.
- Allow 4-5 students per group for performing the experiment.
- Explain theory related to the experiment to be conducted.
- Introduce the equipment required to students.
- Explain students the calibration process of equipment.
- Explain the circuit diagram of the experiment.
- Connections should be completed by the students according to circuit diagram.
- Perform the experiment in the presence of instructor.
- Verify the results obtained.

List of Experiments:

Any **four** experiments from the first five of the following and any **four** experiments from rest of the list. (Minimum four experiments should be based on simulation software PSPICE/MATLAB along with hardware verification)

1. Verification of Superposition theorem in A.C. circuits.
2. Verification of Thevenin's theorem in A.C. circuits.
3. Verification of Reciprocity theorem in A.C. circuits.
4. Verification of Millmans' theorem.
5. Verification of Maximum Power Transfer theorem in A.C. circuits.
6. Determination of time response of R-C circuit to a step D.C. voltage input. (Charging and discharging of a capacitor through a resistor)
7. Determination of time response of R-L circuit to a step D.C. voltage input. (Rise and decay of current in an inductive circuit)
8. Determination of time response of R-L-C series circuit to a step D.C. voltage input.
9. Determination of parameter of Two Port Network.
10. Frequency response of constant K- low pass filters
11. Frequency response of constant K- high pass filters.

Text Books:

[T1] M. E. Van Valkenburg, "Network Analysis", Prentice Hall of India Private Limited, Third Edition,

[T2] D Roy Choudhary, "Network and Systems", New age international publishers.

[T3] AbhijitChakroborty, "Circuit Theory", DhanpatRai and Company, 7th edition.

[T4] Ravish R Singh, "Network Analysis and synthesis", McGraw Hill education (India) Pvt. Ltd, 3rd edition 2015.

Reference Books:

[R1] William H. Hayt, Jr. Jack E. Kemmerly, "Engineering Circuit Analysis" McGraw Hill Publication.

[R2] N.C. Jagan, "Network Analysis", BS Publication, Hyderabad, Second Edition.

[R3] G. K. Mittal, "Network Analysis and Synthesis", Khanna Publication.

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

203148: Numerical Methods and Computer Programming

Teaching Scheme	Credits	Examination Scheme [Marks]
Th : 04 Hrs/ Week	Th/Tut: 05	In Sem (Online) : 50 Marks
PR : 02 Hrs/ Week	PR:01	End Sem : 50 Marks
Tutorial : 01 Hr/ Week		Practical : 50 Marks
		Term Work : 25 Marks

Prerequisite:

- Differentiation and integration of a single real variable, ordinary differential equations.
- Fundamentals of Programming languages.
- Linear Algebra.

Course Objective:

- To emphasize the need of computational techniques and analyze errors involved in the computation.
- To provide sound knowledge of various numerical methods.
- To apply various numerical methods to obtain solution of different types of equations such as transcendental, simultaneous, ODE etc. and also for interpolation, integration and differentiation.
- To impart skills to develop programs using C language.

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

- Develop algorithms and implement programs using C language for various numerical methods.
- Demonstrate types of errors in computation and their causes of occurrence.
- Identify various types of equations and apply appropriate numerical method to solve different equations.
- Apply different numerical methods for interpolation, differentiation and numerical integration.
- Apply and compare various numerical methods to solve first and second order ODE.
- Apply and compare various numerical methods to solve linear simultaneous equations.

Unit 01 : Basics of C Language: (8 Hrs)

Revision: Basics of 'C' language - Data types, Operators and its precedence. Control statements: 'if-else' and nested 'if-else', 'for, while and do-while'.

Arrays: Introduction, one and two dimensional arrays.

Functions: Types of functions User Defined Functions - declaration and prototypes, Local and Global variables.

Pointers: Introduction, declaring and initializing pointers.

Unit 02 : Numerical Methods , Errors and Concept of root of equation: (8 Hrs)

A) Basic principle of numerical methods. Floating point algebra with normalized floating point technique, Significant digits.
Errors: Different types of errors, causes of occurrence and remedies to minimize them. Generalized error formula.

B) **Concept of roots** of an equation. Descartes' rule of signs, Sturm's theorem, Intermediate value theorem. Synthetic division, Roots of Polynomial Equations using Birge-Vieta method.

Unit 03 : Solution of Transcendental and polynomial equation and Curve Fitting: (8 Hrs)

A) **Solution of Transcendental and polynomial equation:** Bisection, Secant, Regula-Falsi, Chebyeshev and Newton-Raphson methods, Newton-Raphson method for two variables.

B) **Curve Fitting** using least square approximation – First order and second order.

Unit 04 : Interpolation and Numerical Differentiation: (8 Hrs)

A) **Interpolation:** Difference operators, Introduction to interpolation - Newton's forward, backward interpolation formulae, Stirling's and Bessel's central difference formulae, Newton's divided difference formula, Lagrange's interpolation.

B) **Numerical Differentiation** using Newton's forward and backward interpolation formulae.

Unit 05 : Solution of Ordinary Differential Equation(ODE) and Numerical Integration: (8 Hrs)

A) Solution of First order Ordinary Differential Equation (ODE) using Taylor's series method, Euler's, Modified Euler's methods. Runge-Kutta second and fourth order methods. **Solution of Second order ODE** using 4th order Runge-Kutta method.

B) Numerical Integration: Trapezoidal and Simpson's rules as special cases of Newton-Cote's quadrature technique for single and double integrals.

Unit 06 : Solution of linear simultaneous equation: (8 Hrs)

A) **Solution of simultaneous equation:** Direct methods - Gauss and Gauss-Jordan elimination methods, concept of pivoting – partial and complete. Iterative methods – Jacobi and Gauss Seidel methods.

B) **Matrix Inversion** using Jordon method and Eigen values using Power method.

Guidelines for Instructor's Manual

Practical Sessions -

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

- Theory related to the method.
- Algorithm and Flowchart of the method.
- One or two solved numerical.
- Brief description of the few C commands used in the program.
- Seven - eight questions based on method and related C commands.
- Printout of C program and output.

Tutorial Sessions -

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

- Algorithm, flowchart and program related to the tutorial C assignments.
- One – two solved numerical related to every method in the tutorial.

Guidelines for Student's Lab Journal

Practical Sessions -

The Student's Lab Journal should be a <u>hand written</u> containing following related to every experiment –

- Theory related to the method.
- Algorithm and Flowchart of the method.
- One solved numerical.
- Brief description of the few C commands used in the program.
- Questions & Answers based on method and related C commands.
- Printout of C program and output.

Tutorial Sessions –

The Student's Tutorial Notebook should contain following related to every Tutorial –

- Algorithm, flowchart and program related to the tutorial C assignments.
- At least one solved numerical related to every method in the tutorial.

Guidelines for Lab /TW Assessment

- There should be continuous assessment of the TW.
- TW assessment should be based on – understanding of the method, proficiency in C programming, involvement during lab sessions, neatness in journals and timely submission.
- Students performance in tutorial sessions should also be evaluated and considered for final TW assessment with due weightage.

Guidelines for Laboratory Conduction

- Detail theory and numerical related to the method should be taken in the lecture prior to the lab session.
- Algorithm should be discussed in detail in the lab session.
- Students are expected to do the program based on the discussed algorithm individually.
- Printout of the program and output should be taken on the day when the program is performed.

List of Experiments:

Term work shall consist of minimum **EIGHT** computer programs in C language with flowcharts and results.

1. Solution of a polynomial equation using Birge-Vieta method.
2. Solution of a transcendental equation using Bisection or Regula-Falsi method.
3. Solution of two variable non-linear equation using N-R method.
4. Program for interpolation using Newton's forward or backward interpolation.
5. Program for interpolation using Lagrange's or Newton's Divided difference interpolation.
6. First order curve fitting using Least square approximation.
7. Solution of simultaneous equation using Gauss Seidel or Jacobi method.
8. Solution of simultaneous equation using Gauss elimination or Jordon method.
9. To find largest Eigen value using Power method.

10. Solution of Numerical Integration using Simpson's (1/3) rd or (3/8) thrule.
11. Solution of first order ODE using 4th order RK method or Modified Euler method.

List of Tutorials:

***** Tutorials should be based on following methods.**

1. Minimum 6 'C' programs based on decision making, for, while, and do-while loops, one and two dimensional arrays and user defined functions.
2. Sturm's Theorem and BirgeVieta method.
3. RegulaFalsi method, Newton Raphson method and Second order Least Square Approximation method.
4. Any two methods of interpolation with equal interval and all methods for unequal interval.
5. One direct and one iterative method for solution of linear simultaneous equations.
6. 4th order R-K method for first order ODE and 2nd order ODE and Simpson's rule for single and double integrals.

****** A Tutorial can be extended for more than one week to include all the mentioned methods.***

Text Books:

[T1] M. K. Jain, S.R.K. Iyangar, R. K. Jain, "Numerical Methods for Scientific and Engineering Computations", New Age Publications.

[T2] T. Veerarajan and T. Ramchandran, "Numerical Methods with Programs in C and C++", Tata McGraw Hill Publication.

[T3] P.P. Gupta & G.S Malik, "Calculus of Finite Difference and Numerical Analysis", Krishna Prakashan Media Ltd, Meerut**.**

[T4] Dr. B. S. Grewal, "Numerical Methods in Engineering & Sciences", Khanna Publishers.

[T5] E. Balagurusamy, "Programming in ANSI C", Tata McGraw Hill Publication.

[T6] E. Balagurusamy, "Numerical Methods", Tata McGraw Hill Publication.

Reference Books:

[R1] J. B. Scarborough, "Numerical Mathematical Analysis", Oxford & IBH, New Delhi.

[R2] Steven Chapra, Raymond P. Canale, "Numerical Methods for Engineers", Tata McGraw Hill Publication.

[R3] YashwantKanetkar, "Let us C", BPB Publications.

[R4] S.S. Sastry, "Introductory methods of Numerical Analysis", PHI Learning Private Ltd.

[R5] P. Thangaraj, "Computer oriented Numerical Methods", PHI Learning Private Ltd.

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

203149: Fundamentals of Microcontroller and Applications

Teaching Scheme	Credits	Examination Scheme [Marks]
Th : 04 Hrs/ Week	Th/Tut: 04	In Sem (Online) : 50 Marks
PR : 02 Hrs/ Week	PR:01	End Sem : 50 Marks
		Oral : 50 Marks

Prerequisite:

- Knowledge of numbering systems and Boolean algebra.
- Knowledge of combinational and sequential logic circuits.

Course Objective:

- To understand the differences between microcontrollers and microprocessors learn microcontroller architecture & describe the features of a typical microcontroller.
- To use the 8051 addressing modes and instruction set and apply this knowledge to perform programs - arithmetic & logic operations, data & control transfer operations, input & output operations.
- To define the protocol for serial communication and understand the microcontroller development systems.
- To build and test a microcontroller based system; interface the system to switches, keypads, displays, A/D and D/A converters.
- To provide students with the concepts and techniques required in designing computer hardware interfaces embedded software for microcontrollers and measurement of various analog parameters.

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

- Differentiate between microprocessor and microcontroller.
- Describe the architecture and features of various types of microcontroller.
- Demonstrate programming proficiency using the various addressing modes and all types of instructions of the target microcontroller.
- Program using the capabilities of the stack, the program counter the internal and external memory, timer and interrupts and show how these are used to execute a programme.
- Write assemble assembly language programs on PC and download and run their program on the training boards.
- Design electrical circuitry to the Microcontroller I/O ports in order to interface with external devices.
- Write assembly language programs and download the machine code that will provide solutions real-world control problems such as fluid level control, temperature control, and batch processes.

Unit 01 : (8 Hrs)

Introduction to concept of microcontroller, comparison of Microprocessor and microcontroller, Comparison of all 8 bit microcontrollers, Intel 8051 microcontroller architecture, Pin diagram, Memory organization of 8051, special function registers, Internal structure of I/O ports, operation of I/O ports. Interfacing of 8051 with externalmemory.

Unit 02 : (8 Hrs)

Addressing modes of 8051, Instruction set of 8051, Stack and Stack Related instruction, Data exchange, byte level logical operations, bit level logical operations, rotate and swap operations, instruction affecting flags, incrementing, decrementing, arithmetic operations, jump and recall instruction, Call and return subroutines.

Unit 03 : (8 Hrs)

Assembly language programming of 8051. Counters and timers in 8051, timer modes and its programming.

Unit 04 : (8 Hrs)

Interrupts- timer flag interrupt, serial port interrupt, external interrupts, software generated, interrupt control and interrupt programming. Serial communication and its programming. Serial data input, output, Serial data modes, interfacing of 8051 with PC through RS232.

Unit 05 : (8 Hrs)

Microcontroller development tools- study of simulator, emulator, assemblers, programmers, cross assembler for microcontrollers. Study, interfacing and programming of PPI 8255 - mode 0, 1, BSR mode. Interfacing of 8051 with 8255 for expanding of I/O. Programming and Interfacing of 8051 with 8 bit ADC (0809) and DAC (0808).

Unit 06 : (8 Hrs)

Part A: (Theoretical Treatment only)

Measurement of parameters such as matrix (4 x 4) Keyboard pressure, temperature, flow, level, voltage, current, power (KW), power factor and frequency using 8051.

Part B: Interfacing and Programming

Interfacing of 8051 with single key, LED, Relay, voltage, current, speed control of dc motors, Stepper motor control (speed /position).

Guidelines for Instructor's Manual

1. Commands to be followed in order to operate the 8051 micro controller kit.
2. Architecture of 8051 micro controller kit-Functional block diagram & its explanation.
3. Pin Diagram of 8051 micro controller with description of all the 40 pins.
4. Addressing modes-Explanation with an example.
5. Instruction set for Data transfer, Arithmetic, Logical, Branching& Bit manipulation along with explanation.
6. User manuals of all the interfacing kits such as stepper motor, DC motor,DAC, ADC &LED.

Guidelines for Student's Lab Journal

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

Guidelines for Laboratory Conduction

1. Each group in the lab should have not more than three students.
2. Each student within the group has to enter and execute the program turn wise.
3. Staff member has to check the result of all the groups after the execution of the program.

List of Experiments:

Compulsory Experiments:

1. Study and use of 8051 Microcontroller trainer kit.
2. Assembly Language Program for arithmetic operation of 8 bit numbers.
3. Assembly Language Program for finding largest number and smallest number from a given array of 8 bit numbers.
4. Assembly Language program to arrange 8 bit numbers stored in array in ascending order and descending order.
5. Assembly Language Program for data conversion.
6. Assembly Language Program for use of Timer/Counter for various applications.

Any six experiments are to be conducted of following experiments:

1. Implementation of Serial Communication by using 8051 serial ports.
2. Programming using cross assembler.
3. Blinking display of LED's interfaced with 8051 through 8255.
4. Interfacing of 8 bit DAC 0808 with 8051 to generate various waveforms.
5. Interfacing of 8 bit ADC 0809 with 8051 Microcontroller.
6. Interfacing of relay with 8051.
7. Stepper motor control by 8051 Microcontroller.
8. Interfacing of matrix keyboard/ 7 segment display with 8051

Text Books:

[T1] V Udayashankara and M S MallikarjunaSwamy, "8051 Microcontroller, Hardware, software and applications", TATA McGraw Hill.

[T2] Muhammad Ali Mazidi, J.G. Mazidi, "The 8051 Microcontroller and Embedded Systems", Pearsons Publishers.

[T3] Ajay Deshmukh, "Microcontroller 8051" –TATA McGraw Hill.

[T4] Theagrajan," Microprocessor and Microcontroller", BS Publication.

[T5] K. J. Ayala, "The 8051 Microcontrollers- Architecture, Programming and Applications", Peram International Publications.

[T6] SubrataGhoshal, "8051 microcontroller", Pearsons Publishers.

Reference Books:

[R1] Scott Mackenzie, "8051 Microcontroller", Pearson Education.

[R2] Intel Microcontroller data book.

[R3] Intel Corporation 1990- 8 bit embedded controller handbook.

NOTE: - Text books given covers total syllabus.

203155: Audit Course II

(A) Solar Photovoltaic Systems

Course Name: Solar Photovoltaic Systems

Prerequisite: Completion of FE or equivalent

Teaching Scheme:
Theory: 02Hrs/ Week
Practical: 2 h x 3

Examination Schemes: Audit (P/F)
Written and MCQ

Description:
The course will introduce the basics of: solar energy, availability, semiconductors as photovoltaic convertors and solar cells, applications of photovoltaic, various types of solar photovoltaic systems, and introduction to manufacturing of the systems, characterization, quality assurance, standards, certification and economics. The following topics may be broadly covered in the classroom. The practical will be designed for basic understanding of the system elements.

Course Objective:

- To learn Solar PV system and its appliances
- To get knowledge of balance of PV system, batteries, inverters etc.
- To understand grid tied SPV solar plants

Course Outcome: Students

- Will be able to do design of Solar PV system for small and large installations
- Will be able to handle software tools for Solar PV systems

Course Contents:

- Physics of photovoltaic (PV) electricity
- Photodiode and solar cell
- Solar radiation spectrum for PV
- Types of solar cell and comparison
- Introduction to various types of solar module manufacturing
- Basic system design and economics
- Types of systems
- Common applications of solar PV
- Introduction to solar PV (SPV) systems
- SPV appliances
- Small capacity SPV power plants
- Grid tied SPV power plants
- Large scale SPV power plants
- Balance of system
- Solar inverters
- Batteries
- Financial modeling of SPV
- Operation and maintenance of SPV
- Software tools for SPV
- Environmental impact assessment
- Standards and certification for SPV
- Basics of SPV systems
- Elements of SPV appliances and power plants

- 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

Practical:

- PV characterization
- Batteries and energy storage
- PV system design

References:

[1] A.S.Kapur -A Practical Guide for Total Engineering of MW capacity Solar PV Power Project

[2] Solanki C.S- Solar Photovoltaic Technology and Systems: A Manual for Technicians, Trainers and Engineers- PHI

[3] Solanki C.S- SolarPhotovoltaics - Fundamentals, Technologies and Applications- PHI

[4] S. Sukhatme -Solar Energy : Principles of Thermal Collection and Storage- McGraw Hill

203155: Audit Course II

(B) Course Name: Installation & Maintenance of Electrical appliances

Prerequisite: Completion of FE/DEE or equivalent

Teaching Scheme:
Theory / Practical: **02Hrs/ Week**

Examination Schemes: Audit (P/F)
Written and MCQ
Term paper

Field Visit: 4 h

Course Objective:
This course has been designed to provide the knowledge of Repairing and Maintenance of home appliances. Students will be familiar with maintenance of everyday household necessities.

Course Outcome: At the end of the course the students will be having knowledge of: -

- Observing the safety precautions while working,
- Test line cord for continuity with test lamp/ multimeter
- Dismantle and reassemble an electric iron
- Heater, kettle, room heater, toaster, hair dryer, mixer grinder etc.
- Install a ceiling fan and the regulator
- Check a fluorescent lamp chock, starter and install it
- Domestic installation testing before energizing a domestic installation

Course Contents:

- **General safety & electrical safety –**
  - What is safety, Why safety is needed,
  - Tools for electrical safety,
  - Safety rules
  - Precaution during electrical maintenance
- **Crimping & crimping tool, soldering**
  - What is crimping, crimping tool, How to use RJ-11 connector, telephone wire, UTP Cable
  - crimping technique, precaution during crimping
  - Soldering Iron, Soldering wire, Soldering Flux,
  - Soldering method, Zero defect soldering
- **Earthing& types of Earthing**
  - Introduction of Earthing ,
  - Need of Earthing, Hazard,
  - Types of Earthing
  - Advantage of Earthing, working of Earthing
- **Simple house wiring circuit**
  - Introduction of Wiring ,types of wiring,
  - need of wiring, advantage of wiring,
  - wiring methods
  - electrical panel, cable type
- **Install, service and repair of automatic electric iron, mixer grinder, ceiling and table fan, heater, iron, kettle, washing machine etc**
  - Installation procedure of electric iron,
  - Installation procedure mixer grinder
  - Installation procedure of ceiling and table fan,

- Installation procedure heater, iron, kettle
- Installation procedure washing machine
- fault finding & removal of faulty component in electric iron, mixer grinder, ceiling and table fan
- fault finding & removal of faulty component in heater, iron, kettle, washing machine

- **Assemble and install of a fluorescent lamp**
  - Parts of fluorescent lamp,
  - Working principle of fluorescent lamp,
  - assembling procedure of lamp
- **Thermostat heat controls of Automatic electric iron, steam iron, spray irons.**
  - Thermostat, Bimetal, Wax Pallet , Gas Expansion, Pneumatic,
  - Bimetallic Switching thermostat, Simple two wire thermostats
  - Combination heating/Cooling regulation, Heat Control of Steam Iron, Electric Iron
- **Maintenance of decorative serial lamp for a required supply voltage**
  - What is decorative lamp, Working of decorative lamp
  - Description of decorative serial lamp,
  - Maintenance of decorative serial lamp
- **Introduction to re- winding Insulating material used**
  - Material, Types of Material
  - Insulating Material, Types of Insulating Material
  - Need of insulating material, winding, re-winding

References:

[1] S. K. Shastri – Preventive Maintenance of Electrical Apparatus – Katson Publication House

[2] B.K.N.Rao -Hand book of condition monitoring- Elsevier Advance Tech., Oxford(UK).

[3] Eric Kleinert-Troubleshooting and Repairing Major Appliances / Edition 3- McGraw Hill

[4] Service Manual of Electrical Home Appliances

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'onnel – 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 Programing 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 & ∧ 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 compoles for improving commutation. Ratings and applications of Compensated Series motors.

Universal motors: ratings, performance and applications, comparison of their performance on A.C. and D.C. supply.

Unit 06: Single phase induction motor (08 Hrs.)

Construction of single phase induction motor, 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 Machinary 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 120^0 and 180^0 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 120^0 and 180^0 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 120^0 and 180^0 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, Donalda, Joshi,Sinha, Thyristorised Power controllers, Wiely Eastern New Delhi.
3. M. D. Singh and K. B. Khandchandani, Power Electronics, Tata McGraw Hill
4. Jai P. Agrawal, Power Electronics systems theory and design LPE, Pearson Education, Asia.
5. L. Umanand, Power Electronics – Essentials and Applications Wiley Publication.
6. J. Michael Jacob – Power Electronics Principal and Applications.
7. M.H.Rashid - Power Electronics Handbook, Butterworth-Heinemann publication, 3 edition
8. M.S. Jamil Asghar, Power Electronics, PHI.
9. V.R. Moorthi, Power Electronics Devices, circuits, and Industrial applications, Oxford University Press.
10. NPTEL Web course and video course on Power Electronics 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:	**Examination Schemes: Audit (P/F)**
Lectures 2 h per week	Written / MCQ /
Field Visit: 1 day	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 go 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-maunals
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-Hurwithz 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 m e t h o d s –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-pentograph, 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. Bonntt '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. Partb, 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)

[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 Convertor(Full convertor and Semi Convertor)
4. Fundamentals of Single phase and Three Phase DC-AC Convertor(Full convertor and Semi Convertor)

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 fs 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 fs, 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

- Vin(min)= 4V Vin(max)=5V
- Vout=12V Iout=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

- Vin(min)= 9V Vin(max)=15V, Vout=5V Iout=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 Donalda, Joshi,Sinha, Thyristorised Power controllers, Wiely 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

SAVITRIBAI PHULE PUNE UNIVERSITY

FACULTY OF ENGINEERING

SYLLABUS FOR

B.E. ELECTRICAL ENGINEERING

(2015 course)

WITH EFFECT FROM YEAR 2018-2019

Savitribai Phule Pune University

FACULTY OF ENGINEERING

B.E. Electrical Engineering (2015 Course)
(w.e.f. 2018-2019)

SEMESTER-I													
Sr No	Subject Code	Subject Title	Teaching Scheme (Hrs/Week)			Examination Scheme (Marks)					Total Marks	Credit	
						PP		TW	PR	OR			
			TH	PR	TU	In Sem	End Sem					TH / TU	PR + OR
1	403141	Power System Operation and Control	03	02	--	30	70	25	--	25	150	03	01
2	403142	PLC and SCADA Applications	04	02	--	30	70	25	50	--	175	04	01
3	403143	Elective I	03	02	--	30	70	25	--	--	125	03	01
4	403144	Elective II	03	--	--	30	70	--	--	--	100	03	--
5	403145	Control System II	03	02	--	30	70	25	--	25	150	03	01
6	403146	Project I	--	--	02	--	--	--	--	50	50	02	--
	403152	Audit Course V											
TOTAL			16	08	02	150	350	100	50	100	750	18	04

SEMESTER-II													
Sr No	Subject Code	Subject Title	Teaching Scheme (Hrs/Week)			Examination Scheme (Marks)					Total Marks	Credit	
						PP		TW	PR	OR			
			TH	PR	TU	In Sem	End Sem					TH / TU	PR + OR
1	403147	Switchgear and Protection	03	02	--	30	70	50	--	25	175	03	01
2	403148	Power Electronic Controlled Drives	04	02	--	30	70	25	50	--	175	04	01
3	403149	Elective III	03	02	--	30	70	25	--	25	150	03	01
4	403150	Elective IV	03	--	--	30	70	--	--	--	100	03	--
5	403151	Project II	--	--	06	--	--	50	--	100	150	06	--
	403153	Audit Course VI											
TOTAL			13	06	06	120	280	150	50	150	750	19	03

TH	**Theory lectures hours/week**	**TW**	**Term work**
PR	**Practical hours/week**	**OR**	**Oral**
TU	**Tutorial hours/week**	**PP**	**Paper- In semester and End Semester**

Elective I (403143) **A) Fundamentals of Microcontroller MSP430 and its Applications [Open Elective]** **B) Power Quality** **C) Renewable Energy Systems** **D) Digital Signal Processing**	**Elective II (403144)** **A) Restructuring and Deregulation** **B) Electromagnetic Fields** **C) EHVAC Transmission** **D) Electric and Hybrid Vehicles** **E) Special Purpose Machines**
Elective III (403149) **A) High Voltage Engineering** **B) HVDC and FACTS** **C) Digital Control System** **D) Intelligent Systems and Applications in Electrical Engineering** **E) Analog Electronics and Sensing Technology [Open Elective]**	**Elective IV (403150)** **A) Smart Grid** **B) Robotics and Automation** **C) Illumination Engineering** **D) VLSI Design[Open Elective]**

Audit Course

- Audit Course: Optional for 1st and 2nd term of BE 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 based on the syllabus and guidelines given.
- Marks obtained by student for audit course will not be taken into consideration of SGPA or CGPA.

Audit Course V 403152	**(A) Hydro Energy Systems** **(B) Foreign Language – German**
Audit Course VI 403153	**Energy Storage Systems**

403141: Power System Operation and Control

Teaching Scheme		Credits	Examination Scheme [150 Marks]		
Theory	: 03 Hr/Week	03	In Sem	:	30 Marks
Practical	: 02 Hr/Week	01	End Sem	:	70 Marks
			Oral	:	25 Marks
			Term work	:	25 Marks

Prerequisite:
Basics of Power System

Course Objective: The course aims:-

- To develop ability to analyze and use various methods to improve stability of power systems
- To understand the need for generation and control of reactive power
- To impart knowledge about various advanced controllers such as FACTs controllers with its evolution, principle of operation, circuit diagram and applications
- To illustrate the automatic frequency and voltage control strategies for single and two area case and analyze the effects, knowing the necessity of generation control.
- To understand formulation of unit commitment and economic load dispatch tasks and solve it using optimization techniques
- To illustrate various ways of interchange of power between interconnected utilities and discuss planning, reliability aspects at all stages of power system.

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

1. Identify and analyze the dynamics of power system and suggest means to improve stability of system.
2. Comprehend the effect of reactive power on Power system and suggest the suitable means of reactive power management.
3. Selection of appropriate FACTs devices
4. Analyze the generation-load balance in real time operation and its effect on frequency and develop automatic control strategies with mathematical relations.
5. Formulate objective functions for optimization tasks such as unit commitment and economic load dispatch and get solution using computational techniques.
6. Evaluate reliability indices of Power system

Unit 01 : Power System Stability (06 Hrs)

Introduction to stability, dynamics of synchronous machine, swing equation, power angle equation and curve, types of power system stability (concepts of steady state, transient, dynamic stability), equal area criterion, applications of equal area criterion (sudden change in mechanical input, effect of clearing time on stability, critical clearing angle, short circuit at one end of line, short circuit away from line ends and reclosure), solution of swing equation by point by point method, methods to improve steady state and transient stability, numerical based on equal area criteria.

Unit 02 : Reactive Power management (06 Hrs)

Necessity of reactive power control, reactive power generation by a synchronous machine, effect of excitation, loading capability curve of a generator, compensation in power system: series and shunt compensation using capacitors and reactors, Problems with Series Compensation, synchronous condenser.

Unit 03 : FACTs Technology (06 Hrs)

Problems of AC transmission system, evolution of FACTs technology, Working principle, circuit diagram, VI characteristics, applications, advantages and limitations of SVC, TCSC, STATCOM and UPFC.

Unit 04 : Automatic Generation and Control (AGC) (06 Hrs)

Concept of AGC, complete block diagram representation of load-frequency control of an isolated power system, steady state and dynamic response, control area concept, two area load frequency control. Schematic and block diagram of alternator voltage regulator scheme.

Unit 05 : Economic Load Dispatch and Unit Commitment (06 Hrs)

A. **Economic load dispatch:** Introduction, revision of cost curve of thermal and hydropower plant, plant scheduling method, equal incremental cost method, method of Lagrange multiplier (neglecting transmission losses), B_{mn} coefficient, economic scheduling of thermal plant considering effect of transmission losses, penalty factor, procedure of load dispatch at state level load dispatch center, Regional Load Dispatch Center, numerical on penalty factor, exact coordination equation.

B. **Unit commitment:** Concept of unit commitment, constraints on unit commitment – spinning reserve, thermal and hydro constraints, methods of unit commitment – priority list and dynamic programming, Numerical on priority list method.

Unit 06 : Energy Control and Planning and Reliability of Power Systems (06 Hrs)

A. **Energy Control:** Interchange of power between interconnected utilities, economy interchange evaluation, interchange evaluation with unit commitment, types of interchange, capacity and diversity interchange, energy banking, emergency power interchange, inadvertent power exchange, power pools.

B. **Planning and Reliability of Power Systems:** Need of short term planning and long term planning in generation, transmission, distribution expansion. Definition of reliability of power system, Hierarchical levels for reliability study, Reliability evaluation of generation system, loss of load probability (LOLP), loss of load expectation (LOLE), Expected Energy Not Supplied (EENS), generation model, load model, risk model, composite system reliability evaluation, Distribution system reliability evaluation for radial and parallel system, customer oriented and energy based reliability indices.

Guidelines for Instructor's Manual

Practical Sessions:-

Instructor's Manual should contain following things related to every experiment-

- Specify prerequisite and objective(s) of experiment.
- List out equipment required to perform the experiment with their ratings (for hardware experiments).
- Include circuit diagram with specifications (for hardware experiments).
- Related theory of the experiment must be included.
- The circuit diagram of the experiment should be drawn at the beginning.
- For simulation experiments using MATLAB, the Simulink diagram with proper details must be included in write up. For programming, take printout of program and result.
- Conclusion based on calculations, result and graph (if any) should be written. Provide space for same.

Guidelines for Student's Lab Journal

- Students should write the journal in own hand writing particularly results, diagram, conclusion, question answers etc.
- Circuit / Connection diagram or construction diagram must be drawn either manually using or using software on graph paper.
- Hand writing and figures must be neat and clean.

Guidelines for Laboratory / TW Assessment

- Continuous assessment is to be carried out. The experiment performed in a particular week must be checked in the next turn in next week.
- After assessment, teacher should put the remark by writing word "Complete" and not simply "C". Put the signature along with date at the end of experiment and in the index.

List of Experiments

[Perform experiment 1 or 2 and any seven from 3 to 11 using any simulation software]

1. To determine Steady state Stability of synchronous motor (performance).
2. To determine Steady state stability of medium transmission line (performance).
3. To plot swing curve by Point by Point method for transient stability analysis.
4. To apply equal area criteria for analysis stability under sudden rise in mechanical power input.
5. To apply equal area criteria for stability analysis under fault condition.
6. To study reactive power compensation using any device.
7. To study Lagrange multiplier technique for economic load dispatch.
8. To develop and execute dynamic programming method for unit commitment.
9. To study load frequency control using approximate and exact model.
10. To study load frequency control with integral control.
11. To study the two area load frequency control.

Industrial Visit:

Industrial visit is mandatory to Load Dispatch Center / Power Station Control Room.

Text Books:

[T1] I. J. Nagrath, D. P. Kothari, "Modern Power System Analysis", 4th Edition, Tata McGraw Hill Publishing Co. Ltd. (Edition 2)

[T2] Hadi Saadat, "Power System Analysis", Tata McGraw Hill

[T3] P. S. R. Murthy, "Power System Operation and Control", Tata McGraw Hill Publishing Co. Ltd.

[T4] P. S. R. Murthy, "Operation and Control in Power System", B. S. Publication.

[T5] R. Mohan Mathur, Rajiv K. Varma, "Thyristor based FACTs controller for Electrical transmission system", John Wiley and Sons Inc.

[T6] Abhijit Chakrabarti, Sunita Halder, "Power System Analysis Operation and Control", Prentice Hall of India.

[T7] Narain G. Hingorani and Laszlo Gyugyi, "Understanding FACTS", IEEE Press.

Reference Books:

[R1] Allen J. Wood, Bruce F. Wollenberg, "Power Generation, Operation, and Control", Wiley India Edition.

[R2] "Electrical Power System Handbook", IEEE Press.

[R3] Narain G. Hingorani, Laszlo Gyugyi, "Understanding FACTs Concepts and Technology of Flexible AC Transmission Systems," IEEE Press.

[R4] Olle I. Elgerd, "Electrical Energy System Theory", 2nd Edition, Tata McGraw Hill. Publishing Co. Ltd.

[R5] Prabha Kundur, "Power System Stability and Control", Tata McGraw Hill.

Websites:

1. http://www.mahasldc.in/
2. http://cercind.gov.in/
3. http://www.srldc.org/
4. https://nrldc.in/
5. http://www.mercindia.org.in/
6. http://www.erldc.org/
7. http://nptel.ac.in/courses/108101040/ (PSOC webcourse)
8. http://www.powergridindia.com/

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

403142: PLC and SCADA Applications

Teaching Scheme		Credits	Examination Scheme [175 Marks]		
Theory	: 04 Hr/Week	04	In Sem	:	30 Marks
Practical	: 02 Hr/Week	01	End Sem	:	70 Marks
			PR	:	50 Marks
			Term work	:	25 Marks

Prerequisite:
Logic gates operations, Boolean algebra, Relay logic

Course Objective: The course aims:-

- To understand the generic architecture and constituent components of a Programmable Logic Controller.
- To develop architecture of SCADA explaining each unit in detail.
- To develop a software program using modern engineering tools and technique for PLC and SCADA.
- To apply knowledge gained about PLCs and SCADA systems to real-life industrial applications.

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

1. Develop block diagram of PLC and explain the working.
2. Classify input and output interfacing devices with PLC.
3. Develop architecture of SCADA and explain the importance of SCADA in critical infrastructure.
4. Execute, debug and test the programs developed for digital and analog operations.
5. Describe various SCADA protocols along with their architecture.
6. Observe development of various industrial applications using PLC and SCADA.

Unit 01 : Introduction to PLC (08 Hrs)

Role of automation in Industries, benefits of automation, Necessity of PLC, History and evolution of PLC, Definition as per NEEMA (National Electrical Engineering Manufacturers' Association), types – fixed/modular/dedicated, Overall PLC system, PLC Input and output modules (along with Interfaces), CPU, programmers and monitors, power supplies, selection criterion, advantages and disadvantages, specifications, comparison of various PLCs manufactured by Allen Bradley, Siemens, ABB, Mitsubishi, GE, Fanuc and Schneider.

Unit 02 : Interfacing of PLC with I/O devices (08 Hrs)

Input ON/OFF switching devices, Input analog devices, Output ON/OFF devices, Output analog devices Sensors-temperature, pressure, flow, level Actuators-Electrical, pneumatic, hydraulic Encoders-Incremental, Absolute Transducers, Limit switches, proximity sensors Control Elements- Mechanical, Electrical, Fluid valves

Unit 03 : Programming of PLC (09 Hrs)

Programming languages for PLC, Ladder diagram fundamentals, Rules for proper construction of ladder diagram Timer and counter- types along with timing diagrams, Reset instruction, latch instruction MCR (master control relay) and control zones Developing ladder logic for Sequencing of motors, ON OFF Tank level control, ON OFF temperature control, elevator, bottle filling plant, car parking, traffic light controller.

Unit 04 : Advance function and Applications of PLC (08 Hrs)

Analog PLC operation and PLC analog signal processing, PID principles, Typical continuous process control curves, simple closed loop systems, closed loop system using Proportional, Integral and Derivative (PID), PID modules, PID tuning, tuning methods including "Adjust and observe" method.

Motors Controls: AC Motor starter, AC motor overload protection, DC motor controller, Variable speed (Variable Frequency) AC motor Drive.

PLC Applications in developing systems- Tank level controller using analog signals, temperature controller using RTD, speed control of electric motor.

Unit 05 : SCADA Systems (08 Hrs)

Introduction, definitions and history of Supervisory Control and Data Acquisition, typical SCADA system Architecture, important definitions HMI, MTU, RTU, communication means, Desirable Properties of SCADA system, advantages, disadvantages and applications of SCADA.

SCADA generations (First generation - Monolithic, Second generation - Distributed, Third generation – Networked Architecture), SCADA systems in operation and control of interconnected power system, Functions and features of SCADA systems, Automatic substation control, Energy management systems (EMS), System operating states, SCADA system in critical infrastructure: Petroleum Refining Process, Conventional electric power generation, Water Purification System, Chemical Plant.

Unit 06 : SCADA Protocols (07 Hrs)

Open systems interconnection (OSI) Model, TCP/IP protocol, Modbus model, DNP3 protocol, IEC61850 layered architecture, Control and Information Protocol (CIP), Device Net, Control Net, Ether Net/IP, Flexible Function Block process (FFB), Process Field bus (Profibus).

Guidelines for Instructor's Manual

- Specify objective(s) of the experiment.
- Include ladder diagram.
- Related theory of the experiment must be included.
- Include step by step procedure to perform the experiment.
- Tabular representation of results taken from the experiment/observation table must be included wherever applicable.
- Provide space to write conclusion.

Guidelines for Student's Lab Journal

- Students are expected to write the journal in the following sequence:
- Aim –
- Ladder diagram –
- Theory –
- Conclusion.
- Students are expected to draw the ladder diagrams on 1mm graph paper.
- They should attach print out or draw SCADA HMI.
- Students should write conclusion.
- Students should get the assignment and lab write up checked within 1 week after performing the experiment.

Guidelines for Laboratory conduction

- Give the safety instructions to students.
- Allow 4-5 students per group for performing the experiment.
- Explain theory related to the experiment to be conducted.
- Introduce PLC and SCADA in detail with specifications to students.
- Explain the ladder diagram of the experiment.
- Ladder diagram should be completed by the students.
- Perform the experiment in the presence of instructor.
- Verify the results obtained.

List of Experiments:

Minimum 11 experiments should be conducted. 6 experiments should be on PLC and 5 experiments should be on SCADA.

a) Experiments No. 1 to 5 are compulsory.
b) Any 1 experiment should be conducted from experiment number 6 to 9.
c) Experiments No. 10 to 13 are compulsory.
d) Any 1 experiment should be conducted from experiment number 14 to 17.

1. Interfacing of lamp and button with PLC for ON and OFF operation. Verify all logic gates.
2. Set / Reset operation: one push button for ON and other push button for OFF operation.
3. Delayed operation of lamp by using push button.
4. UP/DOWN counter with RESET instruction.
5. Combination of counter and timer for lamp ON/OFF operation.
6. DOL starter and star delta starter operation by using PLC.
7. PLC based thermal ON/OFF control.
8. Interfacing of Encoder with PLC
9. PLC based speed, position, flow, level, pressure measurement system.
10. PLC interfaced with SCADA and status read/command transfer operation.
11. Parameter reading of PLC in SCADA.
12. Alarm annunciation using SCADA.
13. Reporting and trending in SCADA system.
14. Tank level control by using SCADA.
15. Temperature monitoring by using SCADA.
16. Speed control of Machine by using SCADA.
17. Pressure control by using SCADA.

Industrial Visit: Compulsory visit to SCADA and PLC based automation industry.

Text Books:

[T1] John W. Webb, Ronald A. Reis, “Programmable Logic Controllers: Principles and Application”, PHI Learning, New Delhi, 5th Edition

[T2] John R. Hackworth, Frederick D., Hackworth Jr., “Programmable Logic Controllers Programming Methods and Applications”, PHI Publishers

[T3] Ronald L. Kurtz, “Securing SCADA System”, Wiley Publishing

[T4] Stuart A Boyer, “SCADA supervisory control and data acquisition”, ISA, 4th Revised edition

[T5] Sunil S. Rao, “Switchgear and Protection”, Khanna Publication

[T6] Curtis Johnson, “Process Control Instrumentation Technology”, Prentice Hall of India

[T7] Gary Dunning, “Introduction to Programmable Logic Controllers”, Thomson, 2nd Edition

Reference Books:

[R1] Gordan Clark, Deem Reynders, “Practical Modern SCADA Protocols”, ELSEVIER

[R2] Batten G. L., “Programmable Controllers”, McGraw Hill Inc., Second Edition

[R3] Bennett Stuart, “Real Time Computer Control”, Prentice Hall, 1988

[R4] Krishna Kant, “Computer Based Industrial Control”, PHI

[R5] P. K. Srivstava, “Programmable Logic Controllers with Applications”, BPB Publications

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

Elective I : 403143 (A) : Fundamentals of Microcontroller MSP430 and its Applications [Open Elective]

Teaching Scheme		Credits	Examination Scheme [125 Marks]		
Theory	:03 Hr/Week	03	In Sem	:	30 Marks
Practical	:02 Hr/Week	01	End Sem	:	70 Marks
			Term work	:	25 Marks

Prerequisite:

Basic knowledge of Number system.
Knowledge of basic logic components.
Programming skills in C Language.

Course Objective: The course aims to:-

- Provide understanding of architecture of MSP430 microcontroller
- Develop ability to write and interpret C language programs for MSP430
- Use advance features in PWM for MSP430
- Interface various devices with MSP430
- Understand use of MSP 430 for IoT applications

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

1. Explain architecture of MSP430 microcontroller, its instructions and the addressing modes.
2. Develop and debug program in C language for specific applications.
3. Use of Code Composer Studio IDE for simulating the functionalities of MSP430 microcontroller
4. Interface microcontroller MSP430 to various sensing devices.
5. Develop IoT based application using MSP430.

Unit 01 : Overview of MSP430 (06 Hrs)

Basics of Embedded Systems, Introduction to MSP430, RISC Architecture / Functional Block Diagram of MSP430G2553, Pin Diagram, Memory Organization, CPU, On-Chip-Peripherals. Overview of MSP430G2 Launchpad and its Features.

Unit 02 : Digital I/O, Interrupts and basic of programming (06 Hrs)

GPIO programming and I/O multiplexing; Interrupts and interrupt programming, Issues associated with interrupts, Capacitive touch I/O pin interface.

Software and hardware tools for development of MSP430 based system such as assembler, compiler, IDE, Emulators, debugger, programmer.

Unit 03 : Timers, PWM Control and RTC (06 Hrs)

Watchdog timer, Timers, Measurement in Capture Mode, PWM control – Edge-Aligned PWM, Centred PWM and Sine-PWM, Real Time Clock (RTC).

Unit 04 : ADC and Operating Modes (06 Hrs)

Analog-to-Digital Conversion: General Issues, Successive Approximation. Basic Operation of ADC10, Advanced Operation of ADC10, ADC10 Successive Approximation, Digital to Analog Conversion.

Low Power aspects of MSP430: Operating Modes, low power modes, Active vs Standby current consumption, FRAM vs Flash for low power; reliability.

Unit 05 : Communication (06 Hrs)

Serial communication basics, USCI, Synchronous/Asynchronous interfaces (like UART, USB, SPI, and I2C), UART protocol, I2C protocol, SPI protocol, Implementing and programming UART, I2C, SPI interface using MSP430, Interfacing external devices.

Unit 06 : IoT Basics and Applications of MSP430 (06 Hrs)

IoT overview and architecture, Overview of wireless sensor networks and design examples. Various wireless connectivity: NFC, ZigBee and Bluetooth.

Real world application: MSP430 based Embedded Networking Application: "Implementing Wi-Fi or Bluetooth Connectivity in a Smart Electric Meter".

Guidelines for Instructor's Manual

Instructor's Manual shall have

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

Guidelines for Student's Lab Journal

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

1. Theory related to the experiment.
2. Apparatus with their detailed specifications.
3. Connection diagram /circuit diagram.
4. Observation table/ simulation waveforms.
5. Sample calculations for one/two reading.
6. Result table.
7. Graph and Conclusions.
8. Few short questions related to the experiment.

Guidelines for Laboratory conduction

Lab Requirement:MSP430F2553 Launch Pad, Desktop/ Laptop with Windows7/8 operating system, System with installed circuit CCS software, Breadboard, Single strand and jumper wires, MSP430 Capacitive Touch Booster-Pack, CC3100 Wi -Fi Booster Pack.

List of Experiments

Minimum 8 experiments are to be performed from the following list:

1) Digital I/O: Learn and understand how to configureMSP-EXP430G2553 / MSP-EXP430F5529 digital I/O pins. Write a C program for configuration of GPIO ports for MSP430 (blinking LEDs, push buttons interface).
   Exercises: a) modify the code to make the green and red LEDs blink: Together and alternatively
   b) Modify the delay with which the LED blinks: Together and alternatively
   c) Modify the code to make the green LED blink: Together and alternatively

2) Timer/Interrupt: Learn and understand GPIO based Interrupt programming in MSP-EXP430G2553 / MSP-EXP430F5529. 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.
   b) Write the code to turn on interrupts globally.
   c) LED Blink using timer instead of software delay.

3) PWM: Implement Pulse Width Modulation to control the brightness of the on-board, green LED. Exercises:
   a) Observe the PWM waveform using CRO / DSO.
   b) What is the maximum resolution of PWM circuitry in MSP-EXP430G2553 / MSP-EXP430F5529?
   c) Change the above code to create a PWM signal of 75% duty cycle on PWM pin.

4) PWM (Continued): Implement Advanced Pulse Width Modulation techniques
   Exercises:
   a) Edge-Aligned and Center Aligned PWM.
   b) Sine-PWM generation.

5) ADC: Learn and understand how to configure the ADC module to control the brightness of LED.
   Exercises:
   a) Read ADC value and observe in Watch window
   b) Change PWM duty cycle based on ADC value and control brightness of LED using a pot connected to ADC pin.

6) Configure of Universal Serial Communication Interface (USCI) module ofMSP-EXP430G2553 / MSP430F5529 for UART based serial communication. The main objective of this experiment is to use UART of the MSP-EXP430G2553 / MSP430F5529 to communicate with the computer.
   Exercise:
   a) Modify the above code to transmit the set of strings to the serial terminal via UART as shown below:
      char str1[]=”MSP-EXP430G2553 / MSP430F5529 MCU”
      char str2[]= “Ultra low power mixed signal processing applications”

7) Capacitive I/O interface: Understand and interface a Capacitive Booster pack with MSP430.
   Exercise:
   a) Implementing Capacitive Booster Pack Demo

8) On chip temperature Sensor and ADC interface demo: To implement the on-chip temperature sensor demo.
   Exercise:
   a) Implementing Temperature Sensor and ADC interface Demo

9) Bluetooth Interface: Transmit Data wirelessly over Bluetooth for any chosen IoT application
   Examples:
   a) Temperature Sensor
   b) Humidity Sensor
   c) Position Sensor
   d) Proximity Sensor
   e) Current Sensor
   f) Voltage Sensor
   g) Pressure Sensor
   h) Or any other sensor interfaced with MSP430.

10) Closed loop temperature/speed control system using MSP430.

Lab Manual:

1) www.ti.com/lab-maunals

Embedded System Design using MSP430 Launchpad Development Kit – Lab Manual

Text Books:

[T1] Getting Started with the MSP430 Launchpad by Adrian Fernandez, Dung Dang, Newness publication ISBN-13: 978-0124115880

[T2] MSP430 microcontroller basics 1st Edition by John H. Davies (Author), Newnes Publication ISBN- 13: 978-0750682763

Other References:

[R1] http://www.ti.com/lit/ds/symlink/msp430g2553.pdf

[R2] http://www.ti.com/lit/ug/tidu520/tidu520.pdf

[R3] http://processors.wiki.ti.com/index.php/MSP430_LaunchPad_Low_Power_Mode

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

Elective I: 403143 (B) : Power Quality

Teaching Scheme		Credits	Examination Scheme [125 Marks]		
Theory	: 03 Hr/Week	03	In Sem	:	30 Marks
Practical	: 02 Hr/Week	01	End Sem	:	70 Marks
			Term work	:	25 Marks

Prerequisite:
Fundamentals of Power system and Power electronics.

Course Objective: The course aims to:-
- Develop ability to identify various power quality issues, its sources and effects on various equipments.
- Monitor and analyze various power quality problems
- Describe and selection of cost effective power quality mitigation solutions.
- Explain use of power quality standards

Course Outcome: Upon successful completion of this course, the students will be able to:-
1. Identify importance of various power quality issues.
2. Carry out power quality monitoring
3. List and explain various causes and effects of power quality problems
4. Analyze power quality parameters and carry out power quality analysis
5. Select cost effective mitigation technique for various power quality problems
6. Use IEEE 519-2014 power quality standard for harmonic compliance

Unit 01 : Basics of power quality (06 Hrs)
Introduction and importance of power quality, symptoms of poor power quality. Classification of power quality events, power quality definition as per IEEE 1159.Grounding of sensitive electronic equipments and guidelines of IEEE std 1100.Long duration RMS voltage variations, its sources, effects and solutions.

Unit 02 : Voltage Sag (06 Hrs)
Sources of voltage sags, classification of voltage sags, factors governing severity of voltage sag. Area of vulnerability, critical distance. Voltage sag characteristics. Classification of equipments based on its sensitivity to various characteristics of voltage sag. Effect of voltage sag on various equipments. Voltage tolerance curve, ITIC and SEMI F47 curve, investigation of sensitivity of equipments to voltage sags. Voltage sag mitigation techniques at equipment level, LT power entrance and medium voltage. Voltage sag indices. Study of important provisions in IEEE Std 1346.

Unit 03 : Transient Overvoltage and Flicker (06 Hrs)
Sources of transient over voltages, Impulsive and oscillatory transients. Magnification of capacitor switching transients, pre insertion reactors to control capacitor switching transients, ferroresonance, principle of over voltage protection. Devices for over voltage protection. Voltage flicker, its sources. Factors governing severity of flicker. Flicker measurement, Pst and Plt. Flicker mitigation solutions.

Unit 04 : Fundamentals of Harmonics (06 Hrs)
Waveform Distortion, Harmonics, Harmonic phase sequences. Classification of harmonics harmonic, Voltage Verses Current distortion, AC quantities under non-sinusoidal conditions, Voltage and current harmonic indices, Sources of harmonics, General and special Effects of Harmonics on Electrical Equipments, cables, switchgears, Meters and Communications.

Unit 05 : Harmonic Mitigation Techniques (06 Hrs)

System behaviour to harmonics, location of harmonic sources, Series and parallel resonance, Harmonic mitigation, passive tuned and detuned filters, design of tuned filters, Active Filter, Sizing and location of active filters, Advantages of active filters over passive filters, Hybrid filters. IEEE 519-2014 standard.

Unit 06 : Power Quality Monitoring (06 Hrs)

Objectives of Power quality monitoring. Types of power quality monitoring, Power quality monitoring equipments, Power quality analyser specification requirement as per EN50160 Standard. Selection of power quality equipments for cost effective power quality monitoring, selection of voltage and current transducers. Power quality indices. IEEE 1159 standard and important provision related with power quality monitoring. Computer Tools for analysis of power quality.

Guidelines for Instructor's Manual

Instructor's Manual shall have

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

Guidelines for Student's Lab Journal

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

9. Theory related to the experiment.
10. Apparatus with their detailed specifications.
11. Connection diagram /circuit diagram.
12. Observation table/ simulation waveforms.
13. Sample calculations for one/two reading.
14. Result table.
15. Graph and Conclusions.
16. Few short questions related to the experiment.

Guidelines for Laboratory conduction

- Read and understand power quality analyzer manual completely.
- Make sure that connections of power analyzer are done as per manual.
- Follow safety protocols while doing power quality audit.

List of Experiments

Minimum 8 experiments are to be performed from the following list:

Compulsory experiments:

1. Study of power quality analyzer and measurement of voltage, current, power and power factor using it.
2. Measurement of harmonic distortion of various Equipments such as UPS /AC/DC drive
3. Harmonic compliance of institute as per IEEE 519-2014 standard and sizing of active filter.
4. Power quality audit of institute or department.

Any 4 experiments from following list:

1. Harmonic analysis of transformer for various conditions (no load, inrush, full load etc.)
2. Analysis of performance of induction motor/transformer operated with sinusoidal supply and under distorted supply conditions supplied by 3 phase inverter.
3. Measurement of voltage sag magnitude and duration by using digital storage oscilloscope/ power quality analyzer.
4. Design of 7% detuned Passive Filter
5. Simulation study of transient and/or flicker measurement.
6. Simulation studies of harmonic generation sources such as VFD, SVC, STATCOM and FACTS devices and harmonic measurement (THD) by using professional software like MATLAB.
7. Harmonic load flow analysis by using professional software such as ETAP, PSCAD, ATP etc.

Text Books:

[T1] R. C. Dugan, Mark F. McGranghan, Surya Santoso, H. Wayne Beaty, "Electrical Power System Quality", 2nd Edition, McGraw Hill Publication.

[T2] M. H. J. Bollen, "Understanding Power Quality Problems, Voltage Sag and Interruptions", New York: IEEE Press, 2000, Series on Power Engineering.

[T3] C.Sankaran "Power quality", CRC Press

[T4] Arrillaga, M. R. Watson, S. Chan, "Power System Quality Assessment", John Wiley and Sons.

Reference Books:

[R1] Enriques Acha, Manuel Madrigal, "Power System Harmonics: Computer Modeling and Analysis", John Wiley and Sons Ltd.

[R2] Ewald F. Fuchs, Mohammad A. S. Masoum, "Power Quality in Power Systems and Electrical Machines" Elsevier Publication.

[R3] G. J. Heydt, "Electric Power Quality", Stars in Circle Publications

[R4] EN50160and IEEE 1100, 1346,519 and 1159 standards

[R5] Arrillaga, M. R. Watson, "Power System Harmonics", John Wiley and Sons

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

403143 (C) : Renewable Energy Systems

Teaching Scheme		Credits	Examination Scheme [125 Marks]		
Theory	: 03 Hr/Week	03	In Sem	:	30 Marks
Practical	: 02 Hr/Week	01	End Sem	:	70 Marks
			Term work	:	25 Marks

Prerequisite: Knowledge of basic renewable technologies like solar, wind, biogas, fuel cell, Knowledge of conventional grid

Course Objective: The course aims:-

- To develop fundamental understanding about Solar Thermal and Solar Photovoltaic systems.
- To provide knowledge about development of Wind Power plant and various operational as well as performance parameter/characteristics.
- To explain the contribution of Biomass Energy System in power generation.
- To describe different Storage systems, Integration and Economics of Renewable Energy System.

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

1. Describe various renewable energy sources such as Solar Photovoltaic, Biomass, Wind, Fuel cell and Solar thermal.
2. Explain different renewable energy sources as an alternate for conventional power sources in any application of energy.
3. Identify and locate the use of renewable energy sources as per the requirement of the location.
4. Analyze, assess and design renewable energy systems such as solar and wind sources.
5. Compare the various storage sources for electrical energy.
6. Describe the standards for renewable energy source integration and evaluate economics related to these sources.

Unit 01 : Solar Thermal (06 Hrs)

Solar radiation at the Earth's surface, solar constant, spectral distribution, Extra-terrestrial radiation, solar terrestrial radiation, solar radiation geometry, Introduction to the concept of monthly average daily and hourly global and diffuse radiation, beam and diffuse radiation under cloudless skies, solar radiation on tilted surfaces: a) beam radiation, b) diffuse radiation, c) reflected radiation, d) flux on tilted surface.

Instruments for measuring solar radiation, Basics of flat plate collector, concepts of solar water heating system and space heating system, solar dryer, introduction to Concentrating Solar Power (CSP) plants using technologies like a) parabolic troughs b) linear Fresnel reflector c) paraboloid dish

Unit 02 : Solar PV (06 Hrs)

Introduction to various solar PV technologies, Single c-Si, Poly c-Si, thin film PV Cell, Module and Array, factors influencing the electrical design of the solar system: a) Sun Intensity b) Sun Angle c) Shadow Effect d) Temperature Effect e) Effect of Climate f) Electrical Load Matching g) Sun Tracking; Peak Power Point Operation, Electrical characteristics of Silicon PV Cells and Modules, PV System Components, Efficiency of PV system.

Design of typical solar PV system with and without battery backup for applications such as homes, commercial complex, agriculture etc.

Unit 03 : Wind Energy System (06 Hrs)

Types of wind turbine, Site selection, Power Contained in Wind, Aerodynamics of Wind Energy, Efficiency Limit for Wind Energy Conversion, Maximum Energy obtained for a Thrust-operated converter (Efficiency limit), Introduction to the Design of Wind Turbine Rotor, Power-Speed Characteristics, Wind Turbine Control Systems: a) Pitch Angle Control b) Stall Control c) Power Electronics Control d) Yaw Control; Control Strategy, Introduction to Offshore Wind Energy System and its comparison with on grid Wind Energy System

Unit 04 : Biomass Energy System (06 Hrs)

Biomass Classification, Biomass Resources and their Energy Potential, Biomass Conversion Technologies: Anaerobic Digestion, Ethanol Fermentation, Biomass Gasification: Gasifiers, Fluidized Bed Gasifier, Biogas Technologies and their factor affecting Biogas Production, Biogas Plants: Floating and Fixed Dome type, Introduction to other bio-reactors such as CSTR and UASB, designing of biogas plant. Power Generation from Municipal Solid Waste (MSW), Land Fill Gas, Liquid Waste. Introduction to organic fertilizers from digest state.

Unit 05 : Fuel cell and Storage Systems (06 Hrs)

a) Fuel Cells: Introduction to Fuel Cell Technology; type of fuel cells, Operating principles of Fuel Cell, Fuel and Oxidant Consumption, Fuel Cell System Characteristics, application and limits.

b) Energy Storage systems: Hydrogen storage: Hydrogen production, relevant properties, Hydrogen as an Engine Fuel, methods of Hydrogen storage.

Batteries: Introduction to Batteries, Elements of Electro Chemical Cell, Battery classification, Battery Parameters, Factors affecting battery performance.

Grid scale storage, various options available (pumped storage, SMES, compressed air storage, fly wheels, etc.), requirements, future trends, Introduction to the concepts of round trip efficiency and cost of storage.

Unit 06 : Integration and Economics of Renewable Energy Systems (06 Hrs)

a) Integration of RES with grid, standards., Introduction to hybrid systems

b) Economics of RES: Simple payback, Internal Rate of Return (IRR), time value, Net present value (NPV), Life cycle costing, Effect of fuel cost Escalation, Annualized and levelized cost of energy

Guidelines for Instructor's Manual

Manual must have assignment related to theory of each experiment.

Guidelines for Student's Lab Journal

A separate notebook/file is required for experiments. Top of the page must have experiment number, title of experiment, date of experiment. It is to be followed by observations, calculations and results. The laboratory notebook must be checked by the staff in-charge of the experiment. Journal must have observations and conclusions written neatly. The experiments must be assessed by the proper authority before submission.

Guidelines for Laboratory conduction

Minimum 08 experiments should be conducted from the list given below:

List of Experiments

1. To identify and measure the parameters of a Solar PV Module with Series and/or Parallel combination.
2. To plot I-V and P-V characteristics with series and parallel combination of Solar PV Modules for different Insolation and temperature effects.
3. To evaluate effect of Shading and Tilt Angle on I-V and PV characteristics of Solar Module.
4. To estimate effect of sun tracking on energy generation by Solar PV Module.
5. To estimate efficiency of standalone Solar PV Module.
6. To evaluate performance of Solar flat plate collector.
7. To plot characteristics of lead-acid battery for various source and load condition.
8. To analyze effect of blade angles on performance of wind turbine.
9. To evaluate performance of horizontal axis wind turbine.
10. To evaluate performance evolution of vertical axis wind turbine.
11. To study synchronization of wind electric generator.
12. Wind generation analysis using Matlab for variable wind speeds.
13. To evaluate efficiency of DFIG System (Hardware setup only).

Industrial Visit: Field visit to Renewable Energy Sources locations or Manufacturing Industry

Text Books:

[T1] S.P. Sukhatme, "Solar Energy," Tata McGraw Hill

[T2] Mukund R. Patel, "Wind and Power Solar System", CRC Press

[T3] Chetan Singh Solanki, "Solar Photovoltaics-Fundamentals, Technologies and Applications", PHI Second Edition

[T4] H. P. Garg, J. Prakash, "Solar Energy-Fundamentals and Applications", Tata McGraw hill Publishing Co.ltd., First Revised Edition

[T5] Tony Burton, Nick Jenkins, David Sharpe, "Wind Energy Hand Book-Second Edition", John Wiley & Sons, Ltd., Publication

[T6] Godfrey Boyle, "Renewable Energy", Third edition, Oxford University Press

[T7] S. Rao, Dr. B. B. Parulekar, "Energy Technology – Non Conventional, Renewable and Conventional", Khanna Publication

Reference Books:

[R1] D. P. Kothari, K. C. Singal, Rakesh Rajan, "Renewable Energy Sources and Emerging Technologies", PHI Second Edition

[R2] Donald L.Klass, "Biomass for Renewable Energy, Fuels, and Chemicals, Elsevier, Academic Press

[R3] B T.Nijaguna, "Biogas Technology", New Age International Publishers

[R4] Tapan Bhattacharya, "Terrestrial Solar Photovoltaics", Narosa Publishing House

[R5] Thomas Ackermann, "Wind Power in Power Systems", Wiley Publications

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

Elective I: 403143 (D): Digital Signal Processing

Teaching Scheme		Credits	Examination Scheme [125 Marks]		
Theory	: 03 Hr/Week	03	In Sem	:	30 Marks
Practical	: 02 Hr/Week	01	End Sem	:	70 Marks
			Term work	:	25 Marks

Prerequisite:
Knowledge of basic signals and systems

Course Objective: The course aims:-
- To elaborate Sampling theorem
- To classify discrete signals and systems
- To analyze DT signals with Z transform, inverse Z transform and DTFT
- To describe Frequency response of LTI system
- To introduce Digital filters and analyze the response
- To demonstrate DSP Applications in electrical engineering

Course Outcome: Upon successful completion of this course, the students will be able to :-
1. Sample and reconstruct any analog signal
2. Construct frequency response of LTI system
3. Evaluate Fourier Transform of discrete signals
4. Design IIR filter and its implementation
5. Design FIR filter and implementation
6. Develop block diagram for DSP applications to electrical engineering

Unit 01 : Classification of Signals: (06 Hrs)
Analog, Discrete-time and Digital signals, Basic sequences and sequence operations, Discrete-time systems, Properties of D. T. Systems and Classification, Linear Time Invariant Systems, impulse response, linear convolution and its properties, properties of LTI systems: stability, causality, parallel and cascade connection, Linear constant coefficient difference equations, Periodic Sampling, Sampling Theorem, Frequency Domain representation of sampling, reconstruction of a band limited Signal, A to D conversion Process: Sampling, quantization and encoding.

Unit 02 : Z-transform, Inverse Z-transform and its properties: (06 Hrs)
Unilateral Z-transform, Z transform properties: Linearity, time shifting, multiplication by exponential sequence, differentiation, conjugation, time reversal, convolution, initial value theorem, Inverse z transform by inspection, partial fraction, power series expansion and complex inversion, solution of difference equation

Unit 03 : Discrete Time Fourier Transform (06 Hrs)
Representation of Sequences by Fourier Transform, Symmetry properties of D. T., F. T. theorems: Linearity, time shifting, frequency shifting, time reversal, differentiation, convolution theorem, Frequency response analysis of first and second order system, steady state and transient response

Unit 04 : Discrete Fourier Transform (06 Hrs)
Sampling theorem in frequency domain. The Discrete Fourier Transform, Relation with z transform Properties of DFT: Linearity, circular shift, duality, symmetry, Circular Convolution, Linear Convolution using DFT, Effective computation of DFT and FFT, DIT FFT, DIF FFT, Inverse DFT using FFT

Unit 05 : Frequency Response of LTI Systems: (06 Hrs)

Ideal frequency selective filters, Concept of filtering, specifications of filter, IIR filter design from continuous time filters: Characteristics of Butterworth, and Cheybyshev low pass filter, impulse invariant and bilinear transformation techniques, Design examples, Basic structures for IIR Systems: direct form, cascade form

Unit 06 : FIR filter design using windows: (06 Hrs)

specifications of properties of commonly used windows, Design Examples using rectangular, and hanning windows. Basic Structures for FIR Systems: direct form. Comparison of IIR and FIR Filters Applications: Measurement of magnitude and phase of voltage, current, power, frequency and power factor correction, harmonic Analysis and measurement, applications to machine control, DSP based protective relaying.

Guidelines for Instructor's Manual

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

- Theory related to the experiment.
- Basic MATLAB instructions for DSP/ 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
- Circuit diagram/Simulink diagram/MATLAB program
- 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: :

[Minimum eight experiments are to be performed]

Note: Perform the practical using C language or any other professional software for group A and B

GROUP-A (Any Three)

1. Plotting of discrete time waveforms (a) Sin, (b) Unit Step, (c) Exponential.
2. Find Linear convolution
3. Plot frequency response of given system function (Magnitude and Phase)
4. Verification of Z-transform properties (any two)

GROUP-B (Any Four)

1. Find DFT and IDFT of sequence
2. Find Circular convolution Using DFT IDFT method and linear convolution using Circular convolution.

3 DIT- FFT or DIF-FFT algorithm

4. Design of IIR filter (Butterworth method).
5. Design of FIR filter (window (any one) method).

Group-C (Any one)

1. Study of DSP starter kit and generation of Sine wave.
2. Discrete implementation of FIR Filter using PIC18F/DSP kit.
3. Discrete implementation of IIR Filter using PIC18F/DSP kit.
4. Harmonic analysis of any non-sinusoidal signal using DSP.

Text Books:

[T1] Proakis J., Manolakis D., "Digital signal processing", 3rd Edition, Prentice Hall, ISBN 81- 203-0720-8

[T2] P. Ramesh Babu, "Digital Signal Processing", 4th Edition Scitech Publication

[T3] Dr.S. D. Apte,"Digital Signal Processing",2nd Edition Wiley India Pvt. Ltd ISBN: 978-81-265-2142-5

[T4] W.Rebizant, J.Szafran, A.Wiszniewski, "Digital Signal Processing in Power system Protection and Control", Springer 2011 ISBN 978-0-85729-801-0

Reference Books:

[R1] Mitra S., "Digital Signal Processing: A Computer Based Approach", Tata McGraw-Hill, 1998, ISBN 0-07-044705-5

[R2] A.V. Oppenheim, R. W. Schafer, J. R. Buck, "Discrete Time Signal Processing", 2nd Edition Prentice Hall, ISBN 978-81-317-0492-9

[R3] Steven W. Smith, "Digital Signal Processing: A Practical Guide for Engineers and Scientists",1st Edition Elsevier, **ISBN:** 9780750674447

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

Elective II : 403144 (A) : Restructuring and Deregulation

Teaching Scheme	Credits	Examination Scheme [100Marks]
Theory : 03 Hr/Week	03	In Sem : 30 Marks
		End Sem : 70 Marks

Prerequisites: Knowledge in power system analysis and power system generation, transmission and distribution.

Course Objective: The course aims:-

- To educate students about the process and operation of restructuring of power system.
- To familiarize students about the various power system restructuring models.
- To elaborate students pricing of electricity.
- To explain fundamental concept of congestion, its management and transmission pricing.

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

1. Enlist the functions of various key entities in India and explain the implications of various policies and acts on restructuring and deregulation.
2. Describe the regulatory process in India along with various methods of regulations.
3. List the components involved in tariff determination.
4. Explain different power sector restructuring models
5. Explain different types of electricity markets.
6. State different transmission pricing methods and discuss congestion management

Unit 01 : Power Sector Reforms in India (06 Hrs)

Need of Regulation. Institutional structure before reforms and after reforms. Roles of various key entities like Ministry of Power, CEA, Planning Commission, CERC and SERC in India. Electricity Act 2003 and 2010 and its implications for Restructuring and Deregulation. National Energy policy. Critical issues and challenges before the Indian power sector.

Unit 02 : Power Sector Regulation (06 Hrs)

Regulatory process in India, Principles of Tariff setting, Phases of Tariff determination, types and methods of Regulation, cost plus, performance-based regulation, price cap, revenue cap, rate of return regulation, benchmarking or yardstick regulation. Considerations of socio economic aspects in regulation.

Unit 03 : Power Sector Economics (06 Hrs)

Introduction to various concepts such as capital cost, debt and equity, depreciation, fixed and variable costs, working capital. Typical cost components of utilities such as return in equity, depreciation, interest and finance charges, O and M expenses etc. Key Indices for assessment of utility performances (Generation, transmission and distribution). Financial tools to compare investment options.

Unit 04 : Power Sector Restructuring Models and Introduction to energy Markets (06 Hrs)

Introduction, models based on energy trading or structural models – monopoly, single buyer, wholesale competition, retail competition. Models based on contractual arrangements – pool model, bilateral dispatch, pool and bilateral trades, multilateral trades. ISO models. Introduction to Energy Exchange, Day ahead market (DAM) and Term ahead market (TAM) procedure adopted in Energy exchanges and trading of Renewable Energy Credits and Carbon Credits.

Unit 05 : Electricity Markets (06 Hrs)

Rules that govern electricity markets, peculiarity of electricity as a commodity. Various electricity markets such as spot markets, forward contracts and forward markets, future contracts and future markets, day ahead market, reserve market, ancillary services market, market for differences, Options contracts. Market operation- settlement process, Market Clearing Price (MCP), Market efficiency, Market power.

Unit 06 : Transmission Pricing and Transmission Congestion issues (06 Hrs)

Cost components of transmission system, Cost allocation of Transmission system, Transmission pricing methods, physical transmission rights, Open Access, Role of Load Dispatch centers (SLDC, RLDC and NLDC). Congestion in power network, reasons for congestion, congestion management.

Text Books:

[T1] Know Your Power: A citizen Primer on the electricity Sector, Prayas Energy Group, Pune

[T2] Daniel S. Kirschen, Goran Strbac, "Power System Economics" John Wiely and Sons Publication Ltd. August 2006.

[T3] Mohammad Shahidehpour, Muwaffaq Alomoush, "Restructured Electrical Power Systems: Operation Trading and Volatility" CRC Press, 06-Jun-2001

Reference Books:

[R1] Steven Stoft, "Power System Economics: Designing Markets for Electricity", John Wiley and Sons, 2002

[R2] Sally Hunt, "Making Competition Work in Electricity", 2002, John Wiley Inc

[R3] Geoffrey Rothwell, Tomas Gomez, "Electricity Economics Regulation and Deregulation" A John Wiley and Sons Publication 2003

[R4] Mohammad Shahidehpour, Hatim Yamin, Zuyi Li, "Market operations in Electric Power System" A John Wiley and Sons Publication.

[R5] Deregulation in Power Industry – A course under continuing Education Program, Department of Electrical Engineering , IIT , Bombay

Websites:

1 http://www.cercind.gov.in/Function.html
2 www.cercind.gov.in/serc.html
3 http://www.power.gov.ng/index.php/about-us/our-functions
4 http://www.cea.nic.in/functions.html
5 http://planningcommission.nic.in/reports/genrep/arep9920/ar9920role.htm

Unit	Text Books	Reference Books
1	T1	Websites 1-5
2	T1	R3
3	T1	R1
4	T2	R5
5	T2	R5, R2, R4
6	T3	R1

Elective II : 403144 (B) : Electromagnetic Fields

Teaching Scheme		Credits	Examination Scheme [100 Marks]		
Theory : 03 Hr/Week		03	In Sem	:	30 Marks
			End Sem	:	70 Marks

Prerequisite: Coordinate system, Vector algebra, Electric field intensity, Magnetic field intensity, Fundamental relations for electrostatic and magnetostatic fields

Course Objective: The course aims:-

- To impart knowledge on the basics of electric and magnetic fields and their applications for utilization in the development of the theory for power transmission lines and electrical machines.
- To describe how materials affect electric and magnetic fields
- To discuss the boundary conditions
- To analyze the relation between the fields under time varying situations
- To give insight to Maxwell's equations in different form and media

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

1. Describe time varying Maxwell's equations and their applications in electromagnetic problems
2. Interpret electric and magnetic field with the help of associated laws
3. Solve simple electrostatic and magnetic boundary conditions
4. Determine the relationship between time varying electric and magnetic fields and electromotive force
5. Solve electromagnetic problems with the help of mathematical tools

Unit 01 : Introduction (06 Hrs)

Sources and effects of Electro-Magnetic Fields, Scalar and vector, Unit vector, Mathematical operations of Vector, Scalar and vector fields, Different Co-ordinate System, Operator Del, Physical interpretation of gradient, divergence and curl, Conversion between coordinate system, Expression for gradient, divergence and curl in three coordinate system.

Unit 02 : Basic Electrostatics (06 Hrs)

Coulomb's law, Electric field, Electric Field Intensity (EFI), EFI due to - point charge, line charge, surface charge and volume charge, Electric displacement, Electric flux density, Gauss's law (scalar and vector form), Applications of Gauss law, Electric field due to – point charge, infinite long straight conductor and infinite plane sheet of charge, Divergence theorem, Stoke's theorem.

Unit 03 : Applied Electrostatics (06 Hrs)

Electric Potential, Relationship between E and V, Equipotential surfaces, Electric dipole and flux lines, Electric field due to dipole, Energy density in electrostatic field, Energy stored in terms of D and E, Convection and Conduction currents, Current and current density, Continuity equation for current, Poisson's and Laplace's equations, Capacitor and its capacitance, Parallel plate capacitor, Capacitors with multiple dielectrics, Spherical capacitor, Coaxial capacitor.

Unit 04 : Magnetostatics and Applications (06 Hrs)

Magnetic flux density, Magnetic field intensity (MFI), Magnetic permeability, Biot-Savart's law, Applications of Biot-Savart's law, MFI due to - infinite long straight filament, finite length element, on the axis of circular loop, Ampere's Circuital law, Field due to – infinite line current, coaxial cable, uniform current sheet density, Magnetic flux density, Scalar magnetic potential, Vector magnetic potential, Poisson's Equations for Magnetostatic field, Derivations of Biot-Savart law and Ampere's law based on magnetic potential, Forces due to magnetic field, Magnetic dipole.

Unit 05 : Boundary Conditions and Analysis. (06 Hrs)

Conductors, Ohm's law employing mobility, Dielectrics, Polarization in Dielectrics, Dielectric constants and strength, Relaxation time, Boundary conditions : Dielectric-Dielectric boundary conditions, Conductor – Dielectric boundary conditions, Conductor – Free space boundary conditions, Boundary conditions for Magnetostatic fields

Unit 06 : Time Varying Fields and Maxwell's equations (06 Hrs)

Faraday's law, Transformer and motional EMFs – stationary loop in time varying B field, moving loop in static B field and moving loop in time varying field, Displacement current, Maxwell's equations in point form and integral form, Power and Poynting theorem, Time varying potentials, Time Harmonic Field, Maxwell's equations in point form and integral form for harmonic field, Concept of uniform plane wave.

Text Books:

[T1] W. H. Hayt and J. A. Buck, "Engineering Electromagnetics", Tata McGraw Hill

[T2] Mathew Sadiku, "Elements of Electromagnetics", Oxford University Press

Reference Books:

[R1] R. K. Shevgaonkar, "Electromagnetic Waves", Tata McGraw Hill

[R2] Liang Chi Shen, Jin Au Kong, Amalendu Patnaik, "Engineering Electromagnetics", CENGAGE Learning

[R3] K. B. Madhu Sahu, "Electromagnetic Fields", SciTech Publication

[R4] N. N. Rao, " Elements of Engineering Electromagnetics", Pearson Education

[R5] Edminister J. A., " Electromagnetics", Tata McGraw Hill

Unit	Text Books	Reference Books
1	T2	R2, R3, R4
2	T1, T2	R1,R2, R3
3	T1, T2	R2, R3, R4, R5
4	T1, T2	R2, R3
5	T2	R1, R4, R5
6	T1, T2	R2, R3, R4

Elective II : 403144 (C) : EHV AC Transmission

Teaching Scheme		Credits	Examination Scheme [100Marks]		
Theory : 03 Hr/Week		03	In Sem	:	30 Marks
			End Sem	:	70 Marks

Prerequisite : Fundamental course in Power System

The course aims:-

- To explain the need of EHV and UHV systems.
- To describe the impact of such voltage levels on the environment
- To identify problems encountered with EHV and UHV transmissions
- To describe methods of governance on the line conductor design, line height and phase etc.

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

1. Highlight need for EHV ac transmission.
2. Calculate line and ground parameters.
3. Enlist problems encountered in EHV transmission.
4. Describe effect of electric and magnetic field on human being
5. Express issues related to UHV transmission discussed

Unit 01 : EHV ac transmission lines (06 Hrs)

Need for EHV transmission lines, Power handling capacity and line loss, Mechanical considerations in line performance, Vibrations.

Travelling wave equations, transmission reflection attenuation and distortion of travelling waves, transmission and reflection coefficients and examples.

Unit 02 : Calculation of line and ground parameters (06 Hrs)

Resistance of conductors, effect of temperature on overhead conductors, temperature rise of conductors and current carrying capacity, Properties of bundled conductors, Inductance of current carrying single conductor, Inductance of EHV line configurations, Line capacitance calculations

Unit 03 : Voltage gradient of conductors (06 Hrs)

Electrostatic Field of a point charge and its properties, Field of sphere gap, Field of line charges and their properties, charge potential relations for multi-conductor lines, Maximum charge condition on three phase line.

Surface voltage gradient on conductors-single conductor, two conductors and multi-conductor bundle, Maximum surface voltage gradient, Mangoldt formula, design of cylindrical cage for corona gradients

Unit 04 : Electrostatic and magnetic fields of EHV lines (06 Hrs)

Electric shock and threshold currents, Effects of high electrostatic fields on humans, animals and plants, Calculation of electrostatic field of single circuit of three phase line, Profile of electrostatic field of line at ground level.

Electrostatic induction on un-energized circuit of a double circuit line. Insulated ground wire and induced voltage in insulated ground wires.

Magnetic field calculation of horizontal configuration of single circuit of three phase lines, Effects of power frequency magnetic fields on human health.

Unit 05 : Corona and its effects (06 Hrs)

Corona formation, corona inception voltage, visual corona voltage, critical field for corona inception and for visual corona under standard operating condition and conditions other than standard operating conditions.

Power loss due to corona, corona loss formulae, corona current waveform, charge-voltage diagram and corona loss. Audible noise operation and characteristics limits for audible noise, AN measurement and meters, microphone, weighting networks.

Unit 06 : (06 Hrs)

A) **Design of EHV line**

Design of EHV lines based upon steady state limits and transient over voltages, design factors under state. Design examples: steady state limits. Line insulation design based on transient over voltages

B**) Extra high voltage cable transmission**

Classification of cables, Electrical characteristics of EHV Cables, Properties of cable insulation materials.

Text Books:

[T1] Rakosh das Begamudre "Extra high voltage transmission", New Age International publishers

Reference Books:

[R1] S. Rao , "EHV AC and DC Transmission" Khanna publication.

Unit	Text Books	Reference Books
1	T1	R1
2	T1	--
3	T1	--
4	T1	R1
5	T1	R1
6	T1	R1

Elective II : 403144 (D) : Electric and Hybrid Vehicles

Teaching Scheme		Credits	Examination Scheme [100 Marks]		
Theory : 03 Hr/Week		03	In Sem	:	30 Marks
			End Sem	:	70 Marks

Prerequisite: Basic concept of Batteries, Electrical motors, Power electronic conversion

Course Objective: The course aims:-

- To make students aware the need and importance of Electric, Hybrid Electric Vehicles and Fuel cell vehicle.
- To differentiate and analyze the various energy storage devices and battery charging and management systems.
- To impart knowledge about architecture and performance of Electric and Hybrid Vehicles
- To classify the different drives and controls used in electric vehicles.

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

1. Review history, Social and environmental importance of Hybrid and Electric vehicles.
2. Describe the performance and selection of energy storage systems and Analyze battery management system.
3. Distinguish between the performance and architecture of various drive trains.
4. Describe the different Instrumentation and Control used for electric vehicles.
5. Differentiate between Vehicle to Home, Vehicle to Vehicle and Vehicle to Grid energy systems concepts.

Unit 01 : Introduction (05 Hrs)

Conventional Vehicle: Basic of Vehicle performance, vehicle power source characterization, transmission characterization. Need and importance of transportation development.
History of Electric Vehicle, Hybrid Electric Vehicle and Fuel cell Vehicle. Social and environmental importance of Hybrid and Electric vehicles. Impact of modern drive-trains on energy supplies.

Unit 02 : Energy Storage Systems (07 Hrs)

Introduction to energy storage requirements in Hybrid and Electric vehicles, battery-based energy storage and its analysis, Fuel cell based energy storage and its analysis, Ultra capacitor based energy storage and its analysis, flywheel based energy storage and its analysis.
Hybridization of energy sources for Hybrid and Electric vehicle: - Hybridization of drive trains in HEVs, Hybridization of energy storage in EVs.
Selection of energy storage technology.

Unit 03 : Battery charging and Management systems (06 Hrs)

Introduction, charging algorithm, balancing method for battery pack charging.
Battery management system representation: - battery module, measurement unit block, battery equalization balancing unit, MCU estimation unit, display unit, fault warning block.
SoC and SoH, estimation of SoC, battery balancing, Thermal monitoring of Battery unit.

Unit 04 : Hybrid and Electric vehicles (05 Hrs)

Electric vehicles: - Components, configuration, performance, tractive efforts in normal driving, Advantages and challenges in EV design.
Hybrid Electric vehicles: - Concept and architecture of HEV drive train (Series, parallel and series-parallel).Energy consumption of EV and HEV

Unit 05 : Drives and control systems (07 Hrs)

Drives: - Application of BLDC drives and Switched reluctance motor drive for HEV and EV, performance characteristics of drives.

Instrumentation and control system related to Hybrid and Electric vehicles, speed control, acceleration characteristics, Electric steering, motion control, braking mechanism, Vehicle tracking through GPS, over speed indicating systems, Auto-parking systems

Unit 06 : Vehicle to Home, Vehicle to Vehicle and Vehicle to Grid energy systems (06 Hrs)

Vehicle to Home(V2H): PHEV control Strategies to V2H applications, V2H with demand response.

Vehicle to Vehicle(V2V): - Concept and structure of EV aggregator, control method for EV aggregator for dispatching a fleet of EV.

Vehicle to Grid(V2G): - planning of V2G infrastructure in the smart grid, ancillary services provided by V2G, cost emission optimization.

Text Books:

[T1] James Larminie and John Lowry, "Electrical Vehicle", John Wiley and Sons, 2012.

[T2] Ronald K. Jurgen, "Electric and Hybrid-Electric Vehicles", SAE InternationalPublisher**.**

[T3] K T Chau, "Energy Systems for Electric and Hybrid Vehicles", The institution of Engineering and Technology Publication

[T4] D.A.J Rand, R Woods, R M Dell, "Batteries for Electric Vehicles", Research studies press Ltd, New York, John Willey and Sons

[T5] Electric and Hybrid Vehicles-Design Fundamentals, CRC press

[T6] Mark Warner, The Electric Vehicle Conversion handbook –HP Books, 2011.

Reference Books:

[R1] Mehrdad Ehsani, Yimin Gao and Ali Emadi, "Modern Electrical Hybrid Electric and Fuel Cell Vehicles: Fundamental, Theory and design", CRC Press, 2009.

[R2] Junwei Lu, Jahangir Hossain,"Vehicle-to-Grid: Linking Electric Vehicles to the Smart Grid", IET Digital Library.

[R3] "Automobile Electrical and Electronic systems", Tom Denton, SAE International publications.

[R4] "Automotive handbook 5th edition", Robert Bosch, SAE international publication.

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

Elective II : 403144 (E) : Special Purpose Machines

Teaching Scheme	Credits	Examination Scheme [100 Marks]
Theory : 03Hr/Week	03	In Sem : 30 Marks
		End Sem : 70 Marks

Prerequisite:

- Basic concepts of different electric motors
- Laws related to energy conversion in electrical machines
- Knowhow of D-Q axis theory related to electrical machines

Course Objective: The course aims:-

1. To explain operation and performance of synchronous reluctance motors.
2. To describe operation and performance of stepping motors.
3. To elaborate operation and performance of switched reluctance motors.
4. To familiarize with operation and performance of permanent magnet brushless D.C. motors.
5. To illustrate operation and performance of permanent magnet synchronous motors.

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

1. Reproduce fundamentals of magnetic circuits
2. Reproduce principal of operation of PMSM, Stepper motor, SRM, Switch reluctance and linear motors.
3. Derive basic transformations used in machine modeling and control
4. Develop torque speed and performance characteristics of above motors
5. Enlist application of above motors
6. Demonstrate various control strategies.

Unit 01 : Generalised Machine Theory (06 Hrs)

Energy in singly excited magnetic field systems, determination of magnetic force and torque from energy. Determination of magnetic force and torque from co-energy, Forces and torques in systems with permanent magnets. MMF of distributed winding, Magnetic fields production of EMFs in rotating machines.

Unit 02 : Permanent Magnet Synchronous and brushless D.C. Motor Drives (06 Hrs)

Synchronous machines with PMs, machine configurations. Types of PM synchronous machines Sinusoidal and Trapezoidal. EMF and torque equations Torque speed characteristics Concept of electronic commutation, Comparative analysis of sinusoidal and trapezoidal motor operations. Applications

Unit 03 : Control of PMSM Machine (06 Hrs)

abc-αβ and αβ-dq transformations, significance in machine modelling, Mathematical Model of PMSM (Sinusoidal), Basics of Field Oriented Control (FOC), Control Strategies: constant torque angle, unity power factor.

Unit 04 : Reluctance Motor (06 Hrs)

Principle of operation and construction of Switch Reluctance motor, Selection of poles and pole arcs, Static and dynamics Torque production, Power flow, effects of saturation, Performance, Torque speed characteristics, Synchronous Reluctance, Constructional features; axial and radial air gap motors; operating principle; reluctance torque; phasor diagram; motor characteristics Introduction to control of Reluctance Drive. Applications.

Unit 05 : Stepper Motor (06 Hrs)

Construction and operation of stepper motor, hybrid, Variable Reluctance and Permanent magnet, characteristics of stepper motor; Static and dynamics characteristics, theory of torque production, figures of merit; Concepts of lead angles , micro stepping , Applications selection of motor.

Unit 06 : Linear Electrical Machines (06 Hrs)

Introduction to linear electric machines. Types of linear induction motors, Constructional details of linear induction motor, Operation of linear induction motor. Performance specifications and characteristics Applications.

Text Books:

[T1] K. Venkatratnam, 'Special Electrical Machines', University Press

[T2] A.E. Fitzgerald Charles Kingsley, Stephen Umans, 'Electric Machinery', Tata McGraw Hill Publication

[T3] T.J.E. Miller, 'Brushless Permanent magnet and Reluctance Motor Drives' Clarendon Press, Oxford 1989.

[T4] V. V. Athani, 'Stepper Motors: Fundamentals, Applications and Design', New age International, 1997

Reference Books:

[R1] R Krishnan, 'Permanent Magnet Synchronous and Brushless D.C. Motor Drives' CRC Press.

[R2] Ion Boldea, 'Linear Electric Machines, Drives and maglevs' CRC press

[R3] Ion Boldea S. Nasar, 'Linear Electrical Actuators and Generators', Cambridge University Press.

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

403145: Control System II

Teaching Scheme	Credits	Examination Scheme [150 Marks]		
Theory : 03 Hr/Week	03	In Sem	:	30 Marks
Practical : 02 Hr/Week	01	End Sem	:	70 Marks
		Oral	:	25 Marks
		Term work	:	25 Marks

Prerequisite: Basic concepts of Control System, Transfer Function, Pole zero plot.

Course Objective: The course aims to:-

- Explain the basic digital control system and the concept of sampling and reconstruction.
- Elaborate the concept of state and to be able to represent a system in the state space format.
- Solve the state equation and familiarize with STM and its properties.
- Design a control system using state space techniques including state feedback control and full order observer.

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

1. Recognize the importance of digital control system.
2. Derive pulse transfer function.
3. Analyze digital controllers.
4. Convert system in state space format.
5. Solve state equation.
6. Design observer for system.

Unit 01 : Digital Control System (06 Hrs)

Introduction, Configuration of the basic digital control system. Advantages and limitations of digital control; data conversion and quantization, Sampling and Reconstruction processes, Shannon's Sampling theorem, practical aspects of choice of sampling rate. Zero order hold (ZOH) and it's transfer function, Basic concepts and transfer function of first order hold.

Unit 02 : Z-transform and Pulse-transfer-function (06 Hrs)

Review of z-transform, Inverse z-transform, difference equations and solution using z transform method. Pulse transfer function and Z-transfer function, General procedure for obtaining Pulse-transfer-function, pulse transfer function of ZOH.

Unit 03 : Stability Analysis (06 Hrs)

Sampled data closed loop systems, characteristic equation, causality and physical realizability of discrete data system, realization of digital controller by digital programming, direct digital programming, cascade digital programming, parallel digital programming. Mapping between S-plane and Z-plane, stability analysis of closed loop system in z-plane using Jury's test, Bilinear Transformation.

Unit 04 : Introduction to state space analysis (06 Hrs)

Important definitions – state, state variable, state vector, state space, state equation, output equation. State space representation for electrical and mechanical system, n^{th} order differential equation and transfer function. Conversion of transfer function to state model and vice versa. State model of armature control DC motor

Unit 05 : Solution of state equations (06 Hrs)

Concept of diagonalization, eigen values, eigenvectors, diagonalization of system matrices with distinct and repeated eigen values, Vandermonde matrix.

Solution of homogeneous and non-homogeneous state equation in standard form, state transition matrix, its properties, Evaluation of STM using Laplace transform method and infinite series method Cayley Hamilton theorem.

Unit 06 : Design of Control System Using State Space Technique: (06 Hrs)

Concept of controllability and observability, controllability and observability Tests, condition for controllability and observability from the system matrices in Canonical form, Jordan canonical form, effect of pole zero cancellation on the controllability and observability of the system, duality property. Pole placement design by state variable feedback. Necessity of an observer, design of full order observer.

Guidelines for Instructor's Manual

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

- Theory related to the experiment.
- 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.
- 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

Any 8 experiments out of the list given below:

1. Plotting of discrete time wave forms a) sin, b)Unit step c) Exponential
2. Effect of sampling and verification of sampling theorem
3. Software programming for determination of STM of Discrete Time system.
4. Design and analysis of digital position control system.
5. Software programming for determination of state space representation for given transfer function and vice versa.
6. Check for observability and controllability in MATLAB
7. Verify State Feedback control using pole placement.
8. Convert a continuous time system to digital control system and check response using software.
9. Design state observer and validate it by software.
10. Software programming for determination of STM.

Text Books:

[T1] K. Ogata, "Discrete Time Control System", 2nd Edition, PHI Learning Pvt. Ltd. 2009
[T2] Benjamin C. Kuo "Digital Control System", Prentice Hall of India Pvt. Ltd.
[T3] J. Nagrath, M. Gopal "Control System Engineering", 5th Edition. New Age International Publishers
[T4] R.Anandanatarajan and P.Ramesh Babu "Control System Engineering",4th Edition, SCITECH Publications, India Pvt. Ltd.

Reference Books:

[R1] K. Ogata, "Modern Control Engineering", Prentice Hall of India Pvt. Ltd.
[R2] M. Gopal, "Digital Control and State Variable Methods", Tata McGraw-Hill.
[R3] M. N. Bandyopadhyay, "Control Engineering – Theory and Practice", Prentice Hall of India Ltd. Delhi.

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

403146 : Project I

Teaching Scheme	Credits	Examination Scheme [50 Marks]
Tutorial : 02 Hr/Week	02	Oral : 50 Marks

The student shall take up a project in the field closely related to Electrical Engineering. Preferably, group of 3/4 students should be formed for project work.

The project work should be based on the knowledge acquired by the student during the graduation and preferably it should meet and contribute towards the needs of the society. The project aims to provide an opportunity of designing and building complete system or subsystems based on area where the student likes to acquire specialized skills.

Project work in this semester is an integral part of the complete project. In this, the student shall complete the partial work of the project which will consists of problem statement, literature review, project overview and scheme of implementation. As a part of the progress report of project work, the candidate shall deliver a presentation on the advancement in Technology pertaining to the selected project topic.

Guidelines for VIIth Semester for Project work:

1. To identify the problems in industry and society.
2. Perform Literature survey on the specific chosen topic through research papers, Journals, books etc. and market survey if required.
3. To narrow down the area taking into consideration his/her strength and interest. The nature of project can be analytical, simulation, experimentation, design and validation.
4. Define problem, objectives, scope and its outcomes.
5. Design scheme of implementation of project.
6. Data collection, simulation, design, hardware if any, needs to be completed.
7. Presentation based on partially completed work.
8. Submission of report based on the work carried out.
9. Student should maintain Project Work Book.

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Audit Course V (A) : 403152: Hydro Energy Systems

Teaching Scheme
Theory : 02 Hr/Week
Field visit : 1 Day

Examination Schemes: Audit (P/F)
Written / MCQ / Term paper

Course Objectives:

- To elaborate various hydro electric generators
- To be familiar with basic operation and various elements of hydro electric systems

Course Outcomes:

On completion of the course, students will be able to:-

- Explain and differentiate various types of hydro electric generators; pico, micro and small hydro

Description:
The following topics may be broadly covered in the classroom. The course will introduce the basics of: hydro energy, availability, introduction to hydraulic machines, turbines, basics of design of hydro electric generators, pico, micro and small hydro, grid interaction, advantages and limitations of the technology, environmental impact, and 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 water
- Basic hydro energy conversion
- Types of turbines and their applications
- Decentralized hydroelectric plants
- Pico, Micro, small and large hydroelectric power plants
- Energy conversion calculations
- Hydro turbine basics and design
- Generator designs for hydro power
- Controllers for hydroelectric power
- Site requirements for hydro power
- Grid integration of micro-hydro
- Operation and maintenance of hydro power plants
- Financial modeling of hydro power
- Software tools for simulation, validation and economics of hydro power
- Environmental impact of various capacity hydroelectric plants
- Manufacturing and assembly
- Quality assurance and standards
- Standards and certification for hydroelectric power plants

Field Trip:

- Visit to Pico, Micro or Small hydroelectric plant

Audit Course V (B) : 403152
Foreign language- German

Teaching Scheme
Theory : 02 Hr/Week

Examination Schemes: Audit (P/F)
Written / MCQ / Term paper

Course Objectives:

- To meet the needs of ever growing industry with respect to language support
- To get introduced to German society and culture through language

Course Outcomes:

On completion of the course, students will be able to:-

- Comprehend everyday expressions and very simple sentences
- Read, write, listen and grasp German Language
- Develop interest to pursue professional German language

Description:

On a professional level, speaking and understanding another language opens many career opportunities. Knowing more than one language enhances employment opportunities in business, teaching, technology, communications, social service, etc.

In an increasingly globalized world, knowledge of German gives students access to the language, culture, and marketplace of few leading nations.

Speaking German gives significant advantages in the world of business since many companies nowadays would choose a competent German speaker over an equally qualified candidate for a job. A proficiency in German prepares you to function productively on behalf of a multinational employer who wants to capitalize on business.

Course Contents:

- Introduction to alphabets, numbers, months, days of the week and time of the day
- Pronouns, Modal and normal verbs, W/V questions
- Bestimmt, Unbestimmt Artikel, Akkusative and Akkusative prepositions
- Hobbies and Freizeit activities, Perfekt tense, basic adjectives and conjunctions.

References:

- Netzwerk Deutsch als Fremdsprache A1, Langenscheidt, First Indian Edition 2015
- www.dw.de

403147: Switchgear and Protection

Teaching Scheme		Credits	Examination Scheme [175Marks]		
Theory	: 3 Hrs./Week	03	In Sem	:	30 Marks
Practical	: 2 Hrs./Week	01	End Sem	:	70 Marks
			Oral	:	25 Marks
			Term work	:	50 Marks

Prerequisite:

- Different type of faults in power system
- Various switchgears and their use in substation
- Principle and working of rotating machines and transformer with vector groups

Course Objective: The course aims to:-

1. Acquaint about construction and working principle of different types of HVCBs
2. Elaborate the Need of protective Relaying and operating principles of different types of relays.
3. Explain different type of faults in transformer, alternator and 3 phase Induction motor and various protective schemes related to them.
4. Impart knowledge about transmission line protection schemes and characteristics of different types of distance relays

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

1. Describe arc interruption methods in circuit breaker.
2. Derive expression for restriking voltage and RRRV in circuit breaker
3. Explain construction and working of different high voltage circuit breakers such as ABCB, SF_6 CB, and VCB.
4. Classify and Describe different type of relays such as over current relay, Reverse power relay, directional over current relay, Differential relay, Distance relay, Static relay and numerical relay
5. Describe various protection schemes used for transformer, alternator and busbar
6. Describe transmission line protection schemes.

Unit 01 : Fundamentals of protective relaying (08 Hrs)

Need for protective system, nature and causes of fault, types of faults, effects of faults, evolution of protective relaying, classification of relays, zones of protection, primary and backup protection, essential qualities of protective relaying. Trip circuit of circuit breaker, zone of protection. Various basic operating principles of protection- over current, (current graded and time graded), directional over current, differential, distance, induction type relay, torque equation in induction type relay, current and time setting in induction relay, Numericals on TSM , PSM and operating time of relay

Unit 02 : Fundamentals of arc interruption (06 Hrs)

Ionization of gases, deionization, Electric arc formation , Current interruption in AC circuit breaker, high and low resistance principles, arc interruption theories, arc voltage, recovery voltage, derivation and definition of restriking voltage and RRRV, current chopping, interruption of capacitive current, resistance switching, Numerical on RRRV, current chopping and resistance switching.

Unit 03 : Circuit Breaker (05 Hrs)

Different ratings of circuit breaker (like rated voltage, rated current, rated frequency, rated breaking capacity – symmetrical and unsymmetrical breaking, making capacity, rated interrupting duties, rated operating sequence, short time rating). Classification of high voltage circuit breaker. Working and constructional features of ACB, SF_6 VCB- advantages, disadvantages and applications. Auto reclosing.

Unit 04 : (05 Hrs)

A) Static and Digital Relaying

Overview of Static relay, block diagram, operating principal, merits and demerits of static relay. Numerical Relays :-Introduction and block diagram of numerical relay, Sampling theorem, Anti –Aliasing Filter, Block diagram of PMU

B) 3 Phase Induction Motor Protection

Abnormal conditions and causes of failures in 3 phase Induction motor, single phasing protection, Overload protection, Short circuit protection.

Unit 05 : (06 Hrs)

A) Transformer Protection

Types of faults in transformer, Percentage differential protection in transformers, Restricted E/F protection, incipient faults, Buchholz relay, protection against over fluxing, protection against inrush current,

B) Alternator Protection

Various faults in Alternator, abnormal operating conditions- stator faults, longitudinal percentage differential scheme and transverse percentage differential scheme. Rotor faults-abnormal operating conditions, inter turn fault, unbalance loading, over speeding, loss of excitation, protection against loss of excitation using offset Mho relay, loss of prime mover.

Unit 06 : Transmission line protection (06 Hrs)

Over current protection for feeder using directional and non directional over current relays, Introduction to distance protection, impedance relay, reactance relay, mho relay and Quadrilateral Relays, Introduction to PLCC, block diagram, advantages, disadvantages, three stepped distance protection, Effect of arc resistance, and power swing on performance of distance relay. Realization of distance relays(impedance, reactance, and mho relay) using numerical relaying algorithm(flowchart, block diagram), Introduction to Wide Area Measurement (WAM) system.

Guidelines for Instructor's Manual

Prepare 3/4 sets of standard experiments. It must contain title of the experiment, Aim, Apparatus

- **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.
- **Specifications of Switchgear:**
- **Observation table:**
- **Graph:**
- **Detailed constructional diagram with nomenclature:**
- **Conclusion:**

Guidelines for Student's Lab Journal

- Students should write the journal in his own hand writing using A4 size both side ruled paper.
- Circuit / Connection diagram or construction diagram must be drawn either manually or using software. [Do not use Photo copy of standard journal] on A4 size blank/graph paper.
- Hand writing must be neat and clean.
- 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.
- Index must contain sr. number, title of the experiment, page number, and the signature of staff along with date.
- (Use black or blue ink pen for writing.)

Guidelines for Laboratory conduction

- Check whether the MCB / main switch is off.
- Make connections as per circuit diagram. Do not keep loose connection. Get it checked from teacher / Lab Assistant.
- Perform the experiment only in presence of teacher or Lab Assistant.
- After completion of experiment, switch off the MCB / main switch.
- Write the experiment in the journal and get it checked within a week

List of Experiments :

A) Compulsory Experiments

1. Study of switchgear testing kit.
2. Study of bus-bar protection schemes.

B) Minimum 6 Experiments to be performed from the following list:

1. Study of Fuse, MCB and MCCB
2. Testing of MCB and MCCB.
3. Study and testing of contactors.
4. Study and testing of ACB.
5. Study and testing of thermal overload relay for Induction Motor protection.
6. Study and plot Characteristics of IDMT type Induction over current relay
7. Study and plot Characteristics of digital over current relay
8. Percentage differential protection of transformer.
9. Protection of alternator.
10. Protection of Transmission line using Impedance relay
11. Study of various LT switchgears like RCCB, timers.

Industrial Visit:

A compulsory industrial visit to switchgear training centre /or switchgear/relay manufacturing unit/ or 220 kV substation visit and report to be submitted as a part of term-work.

Assignments:

Minimum 3 assignments (at least 4 to 6 questions in each) to be submitted as a part of term-work.

Text Books:

[T1] S. Rao, "Switchgear Protection and Power Systems", Khanna Publications

[T2] Y. G. Paithankar, S. R. Bhide, "Fundamentals of Power System Protection", Prentice Hall of India

[T3] Bhavesh Bhalja,R.P. Maheshwari, N.G. Chothani," Protection and Switchgear", Oxford University Press, 2011 Edition.

[T4] J.B.Gupta " Switchgear and Protection", S.K. Kataria and Sons.

Reference Books:

[R1] Badri Ram, D. N. Vishwakarma, "Power System Protection and Switchgear", Tata McGraw Hill Publishing Co. Ltd.

[R2] J Lewis Blackburn , "Protective Relaying- Principles and Applications", Dekker Publications.

[R3] Prof. Dr S.A. Soman, IIT Mumbai, A Web course on "Digital Protection of power System"
http://www.cdeep.iitb.ac.in/nptel/Electrical%20Engineering/Power%20System%20Protection/Course_home_L27.html

[R4] A.G. Phadke, J.S. Thorp ,Computer relaying for Power System , Research Studies Press LTD, England.(John Willy and Sons Inc New York)

[R5] Mason C.R., "Art and Science of Protective Relaying", Wiley Eastern Limited.

[R6] Arun Ingole, "Switchgear and Protection", Pearson.

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

403148: Power Electronic Controlled Drives

Teaching Scheme		Credits	Examination Scheme [175 Marks]		
Theory	: 4 Hrs./Week	04	In Sem	:	30 Marks
Practical	: 2 Hrs./Week	01	End Sem	:	70 Marks
			PR	:	50 Marks
			Term work	:	25 Marks

Prerequisite:
1. Construction, working and characteristic of different electrical motors and soft starting methods.
2. Power Electronic Applications such as converter, inverter, chopper etc.
3. Basic concept of control system

Course Objective: The course aims to
- To understand motor load dynamics.
- To analyze the operation of the converter fed and chopper fed dc drives.
- To elaborate braking methods of D.C. and Induction motor drive.
- To explain vector control of induction motor.
- To differentiate synchronous and BLDC motor drive.
- To identify classes and duty of motor.
- To describe the modes of operation of drive in various applications.

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

1. Explain motor load dynamics and multi quadrant operation of drives
2. Analyze operation of converter fed and chopper fed DC drives.
3. Describe braking methods of D.C. and induction motor drive.
4. Explain vector control for induction motor drives
5. Describe synchronous motor drive.
6. Identify classes and duty cycles of motor and applications of drives in industries.

Unit 01 : Electrical Drives (08 Hrs)

A. Definition, Advantages of electrical drives, Components of Electric drive system, Types of Electrical Drives (DC and AC).

B. Motor-Load Dynamics, Speed Torque conventions and multi quadrant operation, Equivalent values of drive parameters. Load Torque Components, Nature and classification of Load. Constant Power operation of a Drive. Steady state stability, Numerical based on motor load dynamics.

Unit 02 : DC Motor Drives (08 Hrs)

A. Braking methods: Rheostatic, Plugging, and Regenerative. Closed loop control of drives: current limit control, torque control and speed control.

B. Single phase and three phase fully controlled converter drives and performance of converter fed separately excited DC Motor for speed control operations.

Chopper controlled drives for separately excited and series DC Motor operations.

Numerical based on above. Closed loop speed control of DC motor below and above base speed.

Unit 03 : Induction motor Drives I (08 Hrs)

Braking methods: DC Dynamic Braking, AC Rheostatic braking, Plugging, Regenerative Braking, V/f control and comparison with stator voltage control, voltage source inverter (VSI) control, Steady State Analysis. Current source inverter (CSI) control-open and closed loop, Regenerative braking and multiquadrant operation of Induction motor drives, relative merits and demerits of VSI and CSI for induction motor drives, Numerical on VSI and CSI fed I.M. drives

Unit 04 : Induction Motor Drives II (08 Hrs)

A. Principle of vector control, Block diagram of Vector control of induction motor. Servo mechanism in drives and block diagram for position control (Descriptive treatment only).
B. Thermal model of motor for heating and cooling, classes of motor duty, types of enclosures for motor.

Unit 05 : Synchronous motor Drives (08 Hrs)

Types of motor, cylindrical rotor wound field motor, equivalent circuit, speed torque characteristics and effect of power factor, salient pole wound field motor, phasor diagram, simple numerical based on above, closed loop speed control of self controlled synchronous motor drives fed from VSI and CSI.
BLDC drives, block diagram and speed torque characteristics.

Unit 06 : Industrial application (08 Hrs)

A. Specific requirement and choice of drives for following applications.
1. Machine tools
2. Textile mills
3. Steel rolling mills
3. Sugar mills
4. Traction drives
5. Crane and hoist drives
6. Solar and battery powered drives

Guidelines for Instructor's Manual

- Title and circuit diagram of power electronic controlled drives/ electrical machine circuit.
- Working operation and output characteristics / output waveforms of power electronic switching device /converter circuit used to control the electric motor.
- 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 and expected machine performance with speed torque characteristics.
- 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 guidance of the staff member.
- Staff member has to check the result of all the groups.

List of Experiments: Minimum eight experiments are to be performed out of the list mentioned as below:

GROUP A: Any FIVE Experiment (Hardware)

1. Study of Electrical braking of D.C. Shunt motor (Rheostatic, Plugging).
2. Study speed control characteristics of single phase fully converter fed separately excited D.C. motor
3. Study speed control characteristics of 3-ph fully converter fed separately excited D.C. motor
4. Study of Chopper fed D.C. series/separately motor speed control characteristics.
5. Study of electrical braking of 3 phases Induction Motor (DC Dynamic Braking, Plugging).
6. Study of VSI fed 3 phase Induction motor (using V/f control PWM inverter) speed control characteristics.
7. Study of Solid state stator voltage control of 3 phase Induction motor (Using AC voltage Regulator).
8. Study of constant torque and constant power characteristic of induction motor.

GROUP B: Any THREE Experiment (Software)

1. Simulation of starting characteristics of D.C. motor.
2. Simulation of starting characteristics of 3 phase Induction motor.
3. Study of Closed loop speed control of separately excited D.C. motor/ Induction Motor.
4. Simulation of an electric drive system for steady state and transient analysis.
5. Simulation of closed loop control of synchronous motor
6. Simulation of chopper controlled DC series motor.

Industrial Visit:

Minimum one industrial visit must be organized for drives application in industry such as railways, sugar mill, machine shop, textile mill, paper mill etc.

Text Books:

[T1] G. K. Dubey, "Fundamentals of Electric Drives", 2nd Edition, Narosa Publishing House

[T2] N. K. De, P. K. Sen, "Electric Drives", Prentice Hall of India Eastern Economy Edition

[T3] S. K. Pillai, "Analysis of Thyristor Power Conditioned Motors", University Press

[T4] R. Krishnan, "Electric Motor Drives – Modeling Analysis and Control", PHI India

[T5] G.K. Dubey, "Power Semiconductor controlled drives", PHI publication

Reference Books:

[R1] B. K. Bose, "Modern Power Electronics and AC Drives", Pearson Education

[R2] Malcolm Barnes, "Practical Variable Speed Drives and Power Electronics", Elsevier Newnes Publications

[R3] V. Subrahmanyam, "Electric Drives: Concepts and Application", Tata Mc-Graw Hill (An imprint of Elsevier)

[R4] M.D. Singh and Khanchandani "Power Electronics", Tata Mc-Graw Hill

[R5] Austin Huges, "Electrical motor and drives: Fundamental, types and applications", Heinemann Newnes, London

[R6] Tyagi MATLAB for engineers oxford (Indian Edition)

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

Elective –III : 403149 (A): High Voltage Engineering

Teaching Scheme	Credits	Examination Scheme [150 Marks]
Theory : 03 Hrs./Week	03	In Sem : 30 Marks
Practical : 02 Hrs./Week	01	End Sem : 70 Marks
		Oral : 25 Marks
		Term work : 25 Marks

Prerequisite: Atomic and molecular structure of gaseous and solid materials, basic properties of conductors and insulators, knowledge of material science.

Course Objective: The course aims to:-

- To enable students to know and compare the various processes of breakdown in solid, liquid and gaseous dielectric materials
- To enable students understand and apply various methods of generation and measurement of DC, AC, impulse voltage and current.
- To enable students to know the charge formation and separation phenomenon in clouds, causes of overvoltage and lightening phenomenon
- To develop ability among learners to execute testing on various high voltage equipments as per standards
- To introduce students to the design, layout, safety precautions, earthing, and shielding of HV laboratory.

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

1. Identify, describe and analyze the breakdown theories of solid, liquid and gaseous materials
2. Describe as well as use different methods of generation of high AC, DC, impulse voltage and current.
3. Demonstrate and use different methods of measurement of high AC, DC, impulse voltage and current.
4. Identify the occurrence of overvoltage and to provide remedial solutions
5. Demonstrate an ability to carry out different tests on high voltage equipment and devices as well as ability to design the high voltage laboratory with all safety measures

Unit 01 : Breakdown in Gases (06 Hrs)

Ionization process in gas, Townsend's Theory, current growth equation in presence of primary and secondary ionization processes, Townsend's breakdown criterion, primary and secondary ionization coefficients, limitations of Townsend's theory, Streamer mechanism of breakdown, Paschen's Law and its limitations, Corona discharges for point plane electrode combination with positive and negative pulse application, time lag and factors on which time lag depends. (Numerical on Townsend's theory and Paschen's law).

Unit 02 : (06 Hrs)

1. **Breakdown in Liquid Dielectrics:** Pure and commercial liquids, Different breakdown theories: Breakdown in Pure liquid and breakdown in commercial liquids: Suspended Particle theory, Cavitations and bubble theory, Thermal mechanism of breakdown and Stressed Oil volume theory

2. Breakdown in Solid Dielectrics: Intrinsic breakdown: electronic breakdown, avalanche or streamer breakdown, electro-mechanical breakdown, thermal breakdown, treeing and tracking phenomenon, Chemical and electrochemical breakdown, Partial discharge(Internal discharge),Composite dielectric material, Properties of composite dielectrics, breakdown in composite dielectrics. (Numerical on theories of liquid and solid dielectric materials)

Unit 03 : Generation of High Voltages and Current (06 Hrs)

a)Generation of high ac voltages-Cascading of transformers, series and parallel resonance system, Tesla coil

b)Generation of impulse voltages and current-Impulse voltage definition, wave front and wave tail time, Multistage impulse generator, Modified Marx circuit, Tripping and control of impulse generators, Generation of high impulse current

Unit 04 : Measurement of High Voltage and HighCurrents: (06 Hrs)

Sphere gap voltmeter, electrostatic volt meter, generating voltmeter, peak reading voltmeter, resistive, capacitive and mixed potential divider , capacitance voltage transformer, cathode ray oscilloscope for impulse voltage and current measurement, measurement of dielectric constant and loss factor, partial discharge measurements. Measurement of high power frequency a.c. using current transformer with electro-optical signal converter, Radio interference measurements.

Unit 05 : Lightning and Switching Over Voltages (06 Hrs)

Causes of over voltages, lightning phenomenon, Different types of lightening strokes and mechanisms of lightening strokes, Charge separation theories, Wilson theory, Simpson theory, Reynolds and Mason theory, Over voltage due to switching surges and methods to minimize switching surges. Statistical approach of insulation coordination

Unit 06 : High Voltage Testing of Electrical Apparatus and H V Laboratories: (06 Hrs)

a)Testing of insulators and bushings, Power capacitors and cables testing, testing of surge arresters.

b) Design, planning and layout of High Voltage laboratory:-Classification and layouts, earthing and shielding of H.V. laboratories.

Guidelines for Instructor's Manual

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

- Brief theory related to the experiment.
- Circuit diagram and apparatus with their detail specification as per IS code.
- Students should be encouraged to visit industries/HV laboratories/HV installations.
- Students should be encouraged to use virtual labs.
- Few short questions related to each practical.

Assignments based on use of IS and IEC

Guidelines for Student's Lab Journal

The Students lab journal should contain:

- Brief theory related to the experiment.
- Circuit diagram and apparatus with their detail specification as per IS code.
- Observations, result tables and proper inferences/ conclusion from each experiment conducted.
- Reports on visit to industries/HV laboratories/HV installations.
- Simulations and print outs of use of virtual labs.
- Few short questions and answers related to each practical.
- Assignments based on use of IS and IEC.

Guidelines for Laboratory conduction

- 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.

List of Experiments

1. To find the constants of breakdown equation of transformer oil.(Analytical and graphical method)
2. Measurement of unknown high a.c. voltage using sphere gap
3. To obtain breakdown strength of composite insulation system, and observe the effect of parameter like no. of layers, thickness of layer, effect of interfacing.
4. To find out the breakdown of air in uniform and non uniform field and compare it.
5. To study surface flashover on corrugated porcelain/polymeric insulation system.
6. To understand basic principle of corona and obtain audible and visible corona inception and extinction voltage under non uniform field.
7. To perform experiment on horn gap arrestor and understand arc quenching phenomenon.
8. To observe development of tracks and trees on polymeric insulation system.
9. Parametric analysis of Impulse current generator using virtual Laboratory.
10. To perform experiment on rod gap arrestor.
11. To Study effect of barrier on breakdown voltage of air/ transformer oil.
12. Simulation of lightening and switching impulse voltage generator using any simulation software.
13. To perform various HV insulation tests on cables as per IS.
14. Study of layout /earthing/safety of HV installation /lab in any industry by visit /virtual lab
15. Study of any IS for any power apparatus (Power Transformer/Induction Motor/ Alternator etc)

Industrial Visit: Industrial visit to high voltage equipment manufacturing industry/EHV substation/High Voltage Testing Unit.

Text Books:

[T1] M. S. Naidu, V. Kamaraju, "High Voltage Engineering", Tata McGraw Hill Publication Co. Ltd. New Delhi

[T2] C. L. Wadhwa, "High Voltage Engineering", New Age International Publishers Ltd.

Reference Books:

[R1] E. Kuffel, W. S. Zaengl, J. Kuffel, "High Voltage Engineering Fundamentals", Newnes Publication

[R2] Prof. D. V. Razevig Translated from Russian by Dr. M. P. Chourasia, "High Voltage Engineering", Khanna Publishers, New Delhi

[R3] Ravindra Arora, Wolf Gang Mosch, "High Voltage Insulation Engineering", New Age International

[R4] High Voltage Engineering Theory and Practice by M. Khalifa Marcel Dekker Inc. New York and Basel.

[R5] Subir Ray, "An Introduction to High voltage Engineering" PHI Pvt. Ltd. New Delhi

[R6] NPTEL lectures

[R7] IS 731-1971:Porcelain insulator for overhead power lines with nominal voltage > 1000 Volt

[R8] Bushings :IS2099-1986,specification for bushings for A.C. Voltages > 1000 Volts

[R9] Pollution test :IEC 60507-1991 on external and internal insulator

[R10] High voltage test techniques, general definitions and test requirements: IS 2071(part 1) 1993,IEC Pub 60-1(1989)

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

Elective –III : 403149 (B): HVDC and FACTS

Teaching Scheme	Credits	Examination Scheme [150 Marks]
Theory : 03Hrs./Week	03	In Sem : 30 Marks
Practical : 02Hrs./Week	01	End Sem : 70 Marks
		Oral : 25Marks
		Term work: : 25 Marks

Prerequisite:
1. Fundamental knowledge of Power Electronics and power controllers
2. Fundamentals of Power system Operation of three phase converters
3. Inverter topologies
3. Operation of VSI

Course Objective: The course aims to:-
- To provide students knowledge about modern trends in Power Transmission Technology
- To make students describe applications of power electronics in the control of power transmission.
- To educate students for utilization of software such as PSCAD, MATLAB for power transmission and control.

Course Outcome: Upon successful completion of this course, the students will be able to :-
1. Compare HVDC and EHV AC systems for various aspects
2. Reproduce the layout of HVDC system with various components including protective devices
3. Differentiate VSC HVDC and conventional HVDC system
4. Differentiate various types of Power Electronic Controllers
5. Analyze modeling of FACTs Controllers
6. Simulate various controllers and HVDC systems using softwares

Unit 01 : (06 Hrs)
EHVAC versus HVDC transmission, power flow through HVDC link, Graetz circuit, equation for HVDC power flow bridge connection, control of DC voltage and power flow, effects of angle of delay and angle of advance commutation, CIA, CC and CEA control.

Unit 02 : (06 Hrs)
Twelve pulse converter operation, Harmonics in HVDC systems. HVDC system layout and placement of components, HVDC protection, grounding, multi terminal HVDC systems, configurations and types.

Unit 03 : VSC HVDC Technology (06 Hrs)
Introduction to VSC transmission, power transfer characteristics, structure of VSC link, VSC DC system control, HVDC light technology. HVDC plus, introduction, construction, operation and applications to renewable energy sources

Unit 04 : Power Electronic Controllers (06 Hrs)
Basics, Challenges and needs, Review of rectifiers and inverters, back to back converter, dc link converter, static Power converter structures, AC controller based structures, DC link converter topologies, converter output and harmonic control, power converter control.

Unit 05 : Shunt and Series Compensation (06 Hrs)

Operation and control of SVC, STATCOM configuration and control, characteristics and applications of SVC and STATCOM, TCSC layout and modes of operation, layout, operation and characteristics of Static Synchronous Series Compensator (SSSC).

Unit 06 : Unified Power Flow Controller (06 Hrs)

UPFC configuration, steady state operation, control and characteristics, operational constraints of UPFC, Power flow studies in UPFC embedded systems.

Guidelines for Instructor's Manual

- Title and circuit diagram of experiment (block diagram) /power network.
- Working operation and output characteristics / output waveforms of power electronic Controllers/FACTS devices /converter circuit used to control.
- Procedure to carry out the experiment
- For simulation experiments print out of model and simulation results

Guidelines for Student's Lab Journal

- Title, aim, circuit diagram, procedure and theory of power electronic switching device or converter circuit and expected machine performance with speed torque characteristics.
- Equipment along with the specifications needed to carry out the experiment.
- Circuit diagram, observation table, calculations if any.
- Analyse and interpret the experimental results and write the conclusions appropriately.

Guidelines for Laboratory conduction

- Minimum eight experiments are to be performed out of the list mentioned as below:
- Out of which at least two experiments shall be conducted on hardware setups.
- For simulation experiment ready models/demo models can be used. However study should simulate models for different conditions and attached prints of simulation models and test results.
- Term work should be assessed continuously.
- Term work marks are based on quality of work, initiative, timely submission

List of Experiments

Minimum eight experiments are to be performed out of the list mentioned as below:

A) Hardware experiments

1. Study effects of angle of delay and angle of advance commutation, CIA, CC and CEA control on single bridge converter
2. Study of Single Phase Thyristor Control Reactor(A) Study of Voltage and Current Waveforms with different delay angles (B) harmonic analysis (C) Basic control law (D) V-I characteristics
3. Single Phase TCR with fixed capacitor and filter.
4. Complete characteristics of a three phase voltage source converter, constant alpha and extinction angle control.

B) Simulation Experiments

1. Study and simulation of Three phase TCR with and without shunt capacitor
2. Study and simulation of resonance in electrical Power systems
3. Application study of SVC in Power System.
4. Application study of TCSC in Power System
5. Study and simulation of 6 pulse HVDC system
6. Study of 12 pulse or 24 pulse or 48 pulse inverter
7. Application study of DSTATCOM in Power System
8. Study and simulation of Power Flow control in a five bus system using any one of the following FACTS Controllers: (i) SVC (ii) STATCOM (iii) SSSC (iii) UPFC

Industrial Visit: Desirable visit to nearest HVDC substation

Text Books:

[T1] E. Acha, V.A. Agelidis, O.Anaya-lara and TJE Miller, "Power Electronic control in Electrical Systems" Newnes, Oxford.

[T2] J. Arrillaga, "High Voltage Direct Current Transmission" Peter Peregrinus Ltd., London, UK.

[T3] N.G. Hingorani and L.Gyugi, "Understanding FACTS" IEEE Press[Indian Edition], New York.

[T4] J. Arrillaga, Y.H.Liu and N.R.Watson, "Flexible Power Transmission The HVDC Options", John Wiley and sons Ltd., New York.

[T5] Erich Uhlmann, "Power Transmission by Direct Current" Springer International.

Reference Books:

[R1] Yong Hua Song and Allan T Johns, "Flexible ac transmission systems(FACTS), Published by The Institution of Electrical Engineers, London.

[R2] K.R.Padiyar, "FACTS controllers in transmission and Distribution" New Age Publications, New Delhi.

[R3] K.R.Padiyar , "HVDC Power Transmission Systems", New Age Publications, New Delhi, (2nd Edition)

[R4] M.H.Rashid , "Power Electronics Handbook", Academic Press.

[R5] PrabhaKundur, "Power System Stability and Control", McGraw Hill

[R6] S Kamakshaiah, V Kamaraju, "HVDC Transmission", McGraw Hill

Unit	Text Books	Reference Books
1	T2,T4,T5	R3,R6
2	T1, T3	R3, R4,R7
3	T1, T2	R1, R6
4	T2	R5, R8
5	T6	R2
6	T2, T3	R6

Elective –III : 403149 (C) : Digital Control Systems

Teaching Scheme		Credits	Examination Scheme [150 Marks]	
Theory	: 03 Hrs./Week	03	In Sem	: 30 Marks
Practical	: 02Hrs./Week	01	End Sem	: 70 Marks
			Oral	: 25Marks
			Term work	: 25 Marks

Prerequisite : Z-Transform, Basics of discrete systems.

Course Objective: The course aims to:-

- Make students elaborate basic concepts of discrete signals and systems.
- Educate students to analyze the stability of discrete systems.
- Explain formulation of state space discrete model and design the digital controllers.
- Elaborate digitize analog controllers using various numerical methods.
- Explore application of the theory of digital control to practical problems.

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

1. Analyze digital control system and its stability.
2. Differentiate between various control systems
3. Present system in state space format.
4. Design observer for system.
5. Understand digital controllers
6. Elaborate applications such as digital temperature control and position control

Unit 01 : Discrete systems and Signals (06 Hrs)

Standard discrete test signals, Basic operations on signals. Classification of discrete systems. Detail analysis of frequency aliasing and quantization, Brief review of Sampling theorem, Ideal low pass filter. Transfer function of ZOH, Frequency domain characteristics of ZOH, First order hold, frequency domain characteristics of first order hold.

Unit 02 : State - Space analysis (06 Hrs)

Conversion of Pulse transfer functions to State space model and vice a versa. Solution of LTI Discrete –time state equation; State Transition Matrix (STM) and properties of STM; Computation of STM by Z-transform method, by power series expansion method, by Cayley Hamilton theorem, by Similarity transformation method, Discretization of continuous time state space equation.

Unit 03 : Design using state space (05 Hrs)

Controllability and observability of linear time invariant discrete-data system, Tests for Controllability and observability; Principal of Duality; Effect of pole- zero cancellation; Relationship between controllability, observability and stability. Pole placement design using linear state-feedback.

Unit 04 : Design of State Observers (06 Hrs)

Full order state observer, reduced order state observer, State estimation and full order observer design. Ackermann's formula. Compensator design by the separation principle, State feedback with integral control, State regulator design.

Unit 05 : State space model and digitising analog controllers (07 Hrs)

State space model of digital systems: Transformation of state-space model to various forms (controllable, observable, diagonal and Jordan canonical forms). Numerical approximation of differential equations, Eulers foreword and backward method, Trapezoidal method, Bilinear transformation with frequency warping. Numerical differentiation, Matching step and other response. Pole-zero matching.

Unit 06 : Digital control system applications (0 6 Hrs)

Hybrid system simulation, Computer program structure for simulation of discrete time control of continuous time plant. Digital temperature control, position control, Stepper motor control, Block diagram presentation and control algorithms.

List of Experiments Perform any eight experiments using MATLAB

1. Design and analysis of digital temperature control system
2. Design and analysis of digital position control system.
3. Software programming for determination of STM of DT system.
4. Software programming to design DT system by pole placement through state feedback.
5. Software programming for determination of controllability and observability of DT System.
6. Software programming to observe effect of sampling on response of the system
7. Software programming to observe effect of sampling on stability of DT system.
8. Solution of state equation of L.T.I. systems by the use of digital computer.
9. Digital computer aided difference equation solution.
10. Conversion of continuous time state space model to discrete time state space model

Text Books:

[T1] K. Ogata, "Discrete Time Control System", 2nd Edition, PHI Learning Pvt. Ltd. 2009
[T2] B. C. Kuo, "Digital Control Systems", 2nd Edition, Oxford University Press
[T3] M. Gopal, "Digital Control Engineering", New Age International Publishers
[T4] M. Gopal, "Digital Control and State Variable Methods", 3rd Edition The McGraw Hill Co.

Reference Books:

[R1] Load D. Landau, Gianluca Zito, 'Digital Control Systems: design, Identification and Implementation' Springer.
[R2] Mohammed Santina, Allen Stubberud, Gene Hostetter 'Digital control System Design', Sanders College publishing
[R3] K.J. Astrom, B Wittenmark 'Computer Controlled Systems: Theory and Design' Prentice-Hall Inc New Jersey, 2011 Dover.

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

Elective – III : 403149 (D): Intelligent Systems and Applications in Electrical Engineering

Teaching Scheme		Credits	Examination Scheme [150 Marks]	
Theory	: 03 Hrs./Week	03	In Sem	: 30 Marks
Practical	: 02 Hrs./Week	01	End Sem	: 70 Marks
			Oral	: 25 Marks
			TW	: 25 Marks

Prerequisite: Knowledge of MATLAB, C- Programming

Course Objective: The course aims to:-

- To enhance knowledge of intelligence system to carry out power system problems.
- To impart knowledge about Artificial neural network and fuzzy logic programming for electrical engineering applications like load dispatch and load shedding.

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

1. Classify neural networks
2. Compare various AI tools
3. Develop algorithms for AI tools
4. Apply AI tools for Applications in electrical engineering

Unit 01 : Introduction to Artificial Neural Network (06 Hrs)

Organization of the Brain, Biological Neuron, Biological and Artificial Neuron Models, Historical Developments. Essentials of Artificial Neural Networks: Artificial Neuron Model, operations of Artificial Neuron, Types of Neuron Activation Function, ANN Architectures

Unit 02 : Classification Taxonomy of ANN (06 Hrs)

Connectivity, Neural Dynamics (Activation and Synaptic), Learning Strategy (Supervised, Unsupervised, Reinforcement), Learning Rules.
Perceptron Models: Training Algorithms: Discrete and Continuous Perceptron Networks, Perceptron Convergence theorem. Multilayer feed forward Neural Networks

Unit 03 : Memory (06 Hrs)

Associative Memory, Bi-directional Associative Memory (BAM) Architecture, BAM Training Algorithms: Storage and Recall Algorithm, BAM Energy Function, Self-Organizing Maps (SOM) and Adaptive Resonance Theory (ART).

Unit 04 : Introduction to Fuzzy Logic system (06 Hrs)

Fuzzy versus crisp, fuzzy sets: membership function, Basic fuzzy set operations, properties of fuzzy sets, fuzzy relations.

Unit 05 : Fuzzy Control (06 Hrs)

Predicate logic (Interpretation of predicate logic formula, Inference in predicate logic), fuzzy logic (Fuzzy quantifiers, fuzzy Inference), fuzzy rule based system, defuzzification methods

Unit 06 : Introduction to other Intelligent tools (06 Hrs)

Introduction to Genetic Algorithm: biological background, GA operators, selection, encoding, crossover, mutation, chromosome.
Expert System: software architecture, rule base system

List of Experiments
Minimum eight experiments are to be performed out of the list mentioned as below:

[Matlab Programming based experiments.]

1. Write program to evaluate output of any given architecture of neural network with different transfer functions such as linear logsig tanh, threshold function.
2. Verify the fault tolerant nature of neural network by disconnecting few weight link for a given architecture
3. Write program for perceptron learning algorithm.
4. To study some basic neuron models and learning algorithms by using ANN tool
5. Power system failure analysis using ANN tool
6. Predict power factor of four bus system using neural network
7. Predict system analysis for measurements like rms voltage using ANN tool
8. Write supervised and unsupervised ANN program for Signal Frequency Separation using Perceptron
9. Temperature monitoring using fuzzy logic
10. Speed control of DC motor using fuzzy logic
11. Fuzzy logic based washing machine control
12. Fuzzy logic based air conditioner
13. Design of a Fuzzy Multi-Objective Power System Stabilizer via Linear Matrix Inequalities

Text Books:

[T1] Simon Haykin, "Neural Networks: A Comprehensive Foundation", 2nd Edition, Pearson Education

[T2] S. Rajsekaram, G. A. Vijayalaxmi Pai, "Neural Networks, Fuzzy Logic and Genetic Algorithms Synthesis and Applications", Practice Hall India

[T3] James A. Anderson, "An Introduction to Neural Networks", Practice Hall India Publication

[T4] Mohamed H. Hassoun, "Fundamentals of Artificial Neural Network", Practice Hall India

Reference Books:

[R1] Kelvin Waruicke, Arthur Ekwlle, Raj Agarwal, "AI Techniques in Power System", IEE London, U.K.

[R2] S. N. Sivanandam, S. Sumathi, S. N. Deepa, "Introduction to Neural Network Using MATLAB 6.0", Tata McGraw Hill

[R3] Jacek Zurada, "Introduction to Artificial Neural Network", Jaico Publishing House India

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

Elective – III : 403149 (E): Analog Electronics and Sensing Technology [Open Elective]

Teaching Scheme	Credits	Examination Scheme [150 Marks]
Theory : 03 Hrs./Week	03	In Sem : 30 Marks
Practical : 02 Hrs./Week	01	End Sem : 70 Marks
		Oral : 25 Marks
		TW : 25 Marks

Course Objective: The course aims to:-

- Study operational amplifiers for various analog operations.
- Understand different types of analog filters and waveform generation techniques.
- Study advance applications such as mux/demux and multipliers.
- Understand various analog sensors for various applications.

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

1. Develop various analog circuits using operational amplifiers.
2. Design filters and waveform generators and various signal converter circuits.
3. Find characteristics of sensors used for system monitoring and protection.
4. Interface various position sensors to microcontrollers.
5. Find characteristics of sensors used for light and image sensing.

Unit 01 : Operational Amplifier & Applications (06 Hrs)

Study of Various types of Operational Amplifiers and their applications; Op-Amp: Block diagrams of LM741 and TL082, ideal and practical parameters, open loop and close loop configuration, Power supply configurations, DC and AC parameters.

Applications of Op- Amp- Comparator, zero crossing detectors, Voltage limiters, Integrator and Differentiator, V-I and I-V converters, V to f and f to V circuits using LM331, peak detector.

Unit 02 : Waveform generators, Filters & Regulators (06 Hrs)

Waveform generation using Op-amp - sine, square, saw tooth and triangular generator, Active filters-Its configuration with frequency response, Analysis of first order Butterworth low pass and high pass filters, bandpass and band-stop filters, notch filter, all pass filters, Universal Active filter design using UAF42.

OP-AMP Voltage regulator, Fixed and Adjustable Voltage Regulators, Basic Switching Regulator and characteristics of standard regulator ICs –TPS40200 and Low Drop out (LDO) Regulators ICs- TPS7250.

Unit 03 : Advanced applications (06 Hrs)

Introduction to analog multiplier e.g.MPY634, Basic application of Analog multiplier: AM, FM, FSK; Typical application using op-AMP and analog multipliers: Voltage Controlled Oscillator, Phase Locked Loop and its applications, self-tuned filters.

Analog Switches and Multiplexers Overview, MUX507 Multiplexer, SN74LV4051A-Q1 8-Channel Analog Multiplexer/Demultiplexer

Unit 04 : System monitoring & protection sensing (06 Hrs)

Principle of operation and application of following sensors for Real-time system protection, feedback control and high-accuracy system monitoring: LM35 Temperature Sensor, INA240 current sense amplifier, DRV5053 Hall Effect based current sensor, HDC1080 / HDC1010 / HDC2010 Humidity Sensor.

Unit 05 : Position Sensing (06 Hrs)

Absolute and relative position sensing solutions including: angular, presence, proximity, distance, flow, level, and velocity basics, DRV 5032 Hall Effect Sensor, mmWave Sensor, AFE5805 Ultrasonic sensor, Encoder, Resolver, Inductive position sensor, Capacitive Position Sensor, LVDT.

Unit 06 : Light & image sensing (06 Hrs)

Sensors and sensing AFEs for capturing a broad range of wavelengths introduction, 3D Depth Sensor, Near Infrared spectroscopy, OPT3007 Light Sensor, Optical Isolators.

Guidelines for Instructor's Manual

Instructor's Manual shall have

- Brief relevant theory of all analog and sensing devices.
- Equipment with specifications.
- Connection diagram/ methodology.

Format of observation table, analog device characteristics and sample results.

Guidelines for Student's Lab Journal

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

1. Theory related to the experiment.
2. Apparatus with their detailed specifications.
3. Connection diagram /circuit diagram.
4. Observation table/ simulation waveforms.
5. Sample calculations for one/two reading.
6. Result table.
7. Graph and Conclusions.
8. Few short questions related to the experiment.

Guidelines for Laboratory conduction

Lab Requirement: LM741, TL082, LM331 operational amplifiers, ICs – TPS40200,TPS7250,TPS 7A4901, TPS7A8300, UAF42, MPY634, MUX507 and SN74LV4051A-Q1;LM35, INA240, DRV5053, HDC1080 modules; Angular, Presence, Proximity, Distance, Flow, level and other position sensor modules and OPT3007 light sensor module with relevant power supply and DSO/CRO and other metering equipment for characterization of all analog devices.

List of Experiments

Minimum eight experiments are to be performed out of the list mentioned as below:

1. LM741 based comparator circuit.
2. LM318 based zero crossing detector.
3. LM331 based V to f and f to V converter.
4. LM741 based triangular, square and sinusoidal waveform generation.
5. Universal Active filter design using UAF42.
6. Voltage Regulators using TPS40200 and TPS7250.
7. Analog multiplier using MPY634
8. Analog Multiplexer using MUX507
9. Study characteristics of LM35 based temperature sensor module
10. Study characteristics of HDC 1080 based Humidity sensor module
11. Hall Effect based position sensing / Ultrasonic based distance sensing.
12. Study characteristics of OPT 3007 light sensor module.

Text Books:

[T1] HANDBOOK OF OPERATIONAL AMPLIFIER APPLICATIONS, http://www.ti.com/lit/an/sboa092b/sboa092b.pdf

[T2] Thomas L. Floyd, "Electronics Devices", Pearson Education.

[T3] Mottershed, "Electronics Devices & Circuits", PHI New Delhi

[T4] Muhammad H. Rashid, "Power Electronics: Circuits, Devices and Applications", 3rd edition, PearsonEducation.

[T5] Linear Integrated Circuits and its Applications: https://www.ti.com/seclit/ml/ssqu016/ssqu016.pdf

[T6] http://www.ti.com/lit/ds/symlink/tps40200.pdf

[T7] www.ti.com/lit/ds/symlink/lm35.pdf

[T8] AIP Handbook of Modern Sensors: Physics, Design and Applications, Jacob Fraden, American Institute of Physics.

Reference Books:

[R1] K. R. Botkar, "Integrated Circuits", Khanna Publication, New Delhi.

[R2] James, "Operational Amplifier and Linear Integrated Circuits Theory and Application." P John Paul, "Electronics Devices and circuits", New Age international Publications.

[R3] P. S. Bimbhra, "Power Electronics", Khanna Publications

[R4] http://www.ti.com/lit/an/sboa092b/sboa092b.pdf

[R5] The Signal e-Book, Texas Instruments

[R6] http://www.ti.com/lit/ds/symlink/uaf42.pdf

[R7] https://www.ti.com/lit/ds/symlink/mpy634.pdf

[R8] www.ti.com/lit/ds/symlink/mux506.pdf

[R9] www.ti.com/lit/ds/symlink/hdc1080.pdf

[R10] The fundamentals of millimeter wave, Texas Instruments

[R11] www.ti.com/lit/ds/sbos864/sbos864.pdf

Unit	Text Books	Reference Books
1	T1, T2, T3	R1, R2, R6
2	T4, T5, T6	R3, R4, R5, R6, R7
3	-	R6, R8, R9
4	T7, T8	R6, R10
5	T8	R6, R11
6	T8	R6, R12

Elective –IV : 403150 (A): Smart Grid

Teaching Scheme	Credit	Examination Scheme [100 Marks]
Theory : 03 Hrs / Week	03	In Sem : 30 Marks
		End Sem : 70 Marks

Prerequisite: Knowledge of power system and power electronics

Course Objective: The course aims:-

- To explain the concept of Smart Grid, compare with conventional grid, and identify its opportunities and barriers.
- To describe the concept of Smart Meter, Smart Appliances, Automatic Meter Reading, Outage Management System, Plug in Hybrid Electric Vehicles, Vehicle to Grid, Smart Sensors, Home and Building Automation, Phase Shifting Transformers.
- To elaborate the concept of Substation Automation, Feeder Automation. Intelligent Electronic Devices, Smart storage like Battery, Pumped Hydro, Compressed Air Energy Storage, Wide Area Measurement System, Phase Measurement Unit.
- To elaborate the concept of microgrid
- To acquaint Power Quality issues of Grid connected Renewable Energy Sources, Web based Power Quality monitoring, Power Quality Audit.

Course Outcome:

1. Apply the knowledge to differentiate between Conventional and Smart Grid.
2. Identify the need of Smart Grid, Smart metering, Smart storage, Hybrid Vehicles, Home Automation, Smart Communication, and GIS
3. Comprehend the issues of micro grid
4. Solve the Power Quality problems in smart grid
5. Apply the communication technology in smart grid

Unit 01 : Introduction to Smart Grid: (06 Hrs)

Concept of Smart Grid, Need of Smart Grid, Functions of Smart Grid, Opportunities and Barriers of Smart Grid, Drivers of SG in India, Functionalities and key components of smart grid, Difference between conventional and smart grid, Smart Grid Vision and Roadmap for India, Concept of Resilient and Self-Healing Grid, Present development and International policies in Smart Grid, Smart Cities, Pilot projects in India.

Unit 02 : Smart Grid Technologies (06 Hrs)

Remote Terminal Unit (RTU):Block diagram and function of each block, Intelligent Electronic Devices (IED), Phase Measurement Unit (PMU). Smart Substations, Substation and Feeder Automation, application for monitoring, protection and control, Plug in Hybrid Electric Vehicles(PHEV), Vehicle to Grid(V2G), Grid to vehicles(G2V), Smart storage technologies and applications – Battery(flow and advanced), SMES, Super Capacitors, Compressed Air Energy Storage(CAES) and its comparison, Optimal location of PMUs for complete Observability.

Unit 03 : Smart Meters and Advance Metering Infrastructure: (06 Hrs)

Introduction to Smart Meters, Advanced Metering Infrastructure (AMI), Real Time Prizing, Automatic Meter Reading (AMR), Outage Management System (OMS) Smart Sensors, Smart Appliances, Home and Building Automation, Geographic Information System (GIS).

Unit 04 : Microgrids: (06 Hrs)

Concept of Microgrid, need and applications of Microgrid, Microgrid Architecture, DC Microgrid, Formation of Microgrid, Issues of interconnection, protection and control ofMicrogrid, Integration of renewable energy sources, Smart Microgrid, Microgrid and Smart Grid Comparison, Smart Microgrid Renewable Green Energy System, Cyber Controlled Smart Grid.

Unit 05 : Power Quality Management in Smart Grid (06 Hrs)

Power Quality and EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring, Power Quality Audit.

Unit 06 : Communication Technology for Smart Grid (06 Hrs)

Communication Architecture of SG, Wide Area Measurement System (WAMS), Home Area Network (HAN), Neighbourhood Area Network (NAN), Wide Area Network (WAN)., ZigBee, GPS, Wi-Fi, Wi-Max based communication, Wireless Mesh Network, Basics of CLOUD Computing and Cyber Security for Smart Grid, Broadband over Power line (BPL).

Text Books:

[T1] Ali Keyhani, Mohammad N. Marwali, Min Dai “Integration of Green and Renewable Energy in Electric Power Systems”, Wiley

[T2] Clark W. Gellings, “The Smart Grid: Enabling Energy Efficiency and Demand Response”,CRC Press

[T3] Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama, “Smart Grid: Technology and Applications”, Wiley Publications.

[T4] Stuart Borlase, “Smart Grids-Infrastructure, Technology and Solutions”, CRC Press, Taylor and Francis group

[T5] James Momoh, “Smart Grid-Fundamentals of design and analysis”, Wiley Publications.

Reference Books:

[R1] Nikos Ziargyriour, “Micro grid, Architecture and Control”, IEEE Press, Wiley Publications.

[R2] Yang Xiao, “Communication and Networking in Smart Grids”, CRC Press, Taylor and Francis group

[R3] Lars T. Berger and Krzysztof Iniewski, “Smart Grid-Applications, Communications and Security”, Wiley Publications.

[R4] Mladen Kezunovic, Mark G. Adamiak, Alexander P. Apostolov, Jeffrey George Gilbert “Substation Automation (Power Electronics and Power Systems)”, Springer Publications.

[R5] Smart grid handbook for regulators and policy makers November 2017,ISGF

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

Elective – IV : 403150 (B): Robotics and Automation

Teaching Scheme	Credits	Examination Scheme [100Marks]
Theory : 03 Hrs./Week	03	In Sem : 30 Marks
		End Sem : 70 Marks

Course Objective: The course aims to:-

- To know basic parts of a typical industrial robot system with its anatomy with human body.
- To analyze mathematically kinematic and dynamic modeling of a typical robot manipulator.
- To select an appropriate type of robot with given specifications for different industrial applications.
- To know the basics of actuators, sensors and control of an industrial robot for different applications

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

1. Differentiate between types of robots based on configuration, method of control, types of drives, sensors used etc.
2. Choose a specific robot for specific application with given specifications.
3. Analyze the robot arm dynamics for calculation of torques and forces required for different joints of robots for control of robot arm.
4. Determine the D-H parameters for a robot configuration using concepts from robot arm kinematics which further leads to forward/inverse kinematics.
5. Calculate the Jacobian matrix for robot arm velocity and decide the singular positions.

Unit 01 : Introduction (06 Hrs)

Robot components, Degrees of freedom, Robot joints, Robot reference frames,Robot specifications: repeatability, spatial resolution, compliance, load carrying capacity, speed of response, work volume, work envelope, reach etc., end effectors (Wrist), concept of: yaw, pitch and roll. Robot classification: according to Co-ordinate system: Cartesian, cylindrical, spherical, SCARA, Articulated, Control Method: Servo controlled and non-servo controlled, their comparative study, formof motion: P-T-P (point to point), C-P (continuous path), pick and place etc. and their comparative study.

Unit 02 : Mathematical preliminaries (06 Hrs)

Homogeneous Coordinate, Translational Transformation, Rotational Transformation, coordinate reference frames, Effect of pre and post multiplication of transformation, Concept of Homogeneous transformation, Euler angles and singularities

Unit 03 : Forward Kinematics (06 Hrs)

Denavit-Hartenberg (D-H) representation of kinematic chains. Rules for establishing link co-ordinate frames. Forward solution of robotic manipulator for SCARA Robot and PUMA Robot. Forward solution for simple robot systems.

(06 Hrs)

Unit 04 :

Inverse Kinematics: Concept of Inverse Kinematics, general properties of inverse solution such as existence and uniqueness of solution, inverse solution by direct approach, Geometric approach, inverse solution for simple SCARA Robots, numericals for simple three axis robots based on direct approach.

Robot Dynamics: Lagrange's Equation, Kinetic and potential energy Equations, Euler-Lagrange analysis for a single prismatic joint working against gravity and single revolute joint. Equation of motion.

Unit 05 : Differential motion and Control (06 Hrs)

Manipulator Differential Motion: Concept of linear and angular velocity, Relationship between transformation matrix and angular velocity, manipulator Jacobian, Jacobian for prismatic and revolute joint, Jacobian Inverse, Singularities.

Control of Robot Arm: Modeling of DC motor and load, closed loop control in position servo, the effect of friction and gravity, control of a robotic joint, position velocity and acceleration profiles for trapezoidal velocity profile.

Control of Robot manipulator: joint position controls (JPC), resolved motion position controls (RMPC) and resolved motion rate control (RMRC).

Unit 06 : Actuators and Sensors (06 Hrs)

Drive Technology: Hydraulic, Pneumatic, Electric (stepper motor, D.C. servo motor, BLDC Motors) in detail with selection criteria. Sensors in servo control system: Resolver, rotary shaft encoders, potentiometers, tacho-generators.

Industrial Applications of Robots: Welding, Spray-painting, Grinding, Handling of rotary tools, Parts handling/transfer, Assembly operations, parts sorting, parts inspection, Potential applications in Nuclear and fossil fuel power plant etc. (Details for the above applications are selection criterion of robots, sensors used, selection of drives and actuators, methods of control, peripheral devices used etc).

Industrial Visit: At least one industrial visit should be arranged supporting the classroom teaching and student should submit a report on that industrial robot application including type of robot, method of control, type of application, sensor interface, method of programming etc.

Text Books:

[T1] Mikell P. Groover, Mitchell Weiss, Roger N. Nagel, Nicholas G. Odrey, Ashish Dutta, "Industrial Robotics:Technology, Programming and Applications", Tata- McGraw Hill Education Private Limited, New Delhi, 2012.

[T2] Richard D. Klafter, Thomas A. Chemielewski, Michael Neign, "Robotic Engineering – An IntegralApproach", Prentice Hall of India Pvt. Ltd., New Delhi. Eastern Economy Edition.

[T3] Robert J. Schilling, "Fundamentals of Robotics: Analysis and Control", Prentice Hall of India, New Delhi

Reference Books:

[R1] K. S. Fu, R. C. Gonzalez, C. S. G. Lee, "Robotics: Control Sensing, Vision and Intelligence", International Edition, McGraw Hill Book Co.

[R2] John J. Craig, "Introduction to Robotics: Mechanics and Control", Pearson Education

[R3] R. K. Mittal, I. J. Nagrath, "Robotics and Control", Tata McGraw Hill Publishing Company Ltd., New Delhi.

[R4] Saeed b. Niku, "Introduction to Robotics: Analysis, Control, Applications", Wiley Publication, 2011.

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

Elective IV :403150 (C): Illumination Engineering

Teaching Scheme	Credits	Examination Scheme [100Marks]
Theory : 03 Hr/Week	03	In Sem : 30 Marks
		End Sem : 70 Marks

Prerequisite:
The working of the conventional lamps, generation of light and physics of light, techniques for natural and artificial lighting

Course Objective: The course aims :-
- To explain conventional and modern lamps and their accessories.
- To get detailed insight of indoor and outdoor illumination system components, control and design aspects.
- To know the requirements of energy efficient lighting.
- To introduce the modern trends in the lighting

Course Outcome: Upon successful completion of this course, the students will be able to :-
1. Define and reproduce various terms in illumination.
2. Identify various parameters for illumination system design.
3. Design indoor and outdoor lighting systems.
4. Enlist state of the art illumination systems.

Unit 01 : Importance of Lighting in Human Life (05 Hrs)
Optical systems of human eye, Dependence of human activities on light, performance characteristics of human visual system, External factors of vision-visual acuity, contrast, sensitivity, time illuminance, colour, visual perception, optical radiation hazards, Good and bad effects of lighting and perfect level of illumination, Artificial lighting as substitute to natural light, Ability to control natural light, Production of light, physics of generation of light, Properties of light, Quantification and Measurement of light.

Unit 02 : Light Sources and Electrical Control of Light Sources (08 Hrs)
(A) Light Sources- Lamp materials: Filament, glass, ceramics, gases, phosphors and other metals and non-metals. Discharge Lamps: Theory of gas Discharge phenomena, lamp design considerations, characteristics of low and high pressure mercury and Sodium vapour lamps, Low Vapour Pressure discharge lamps - Mercury Vapour lamp, Fluorescent Lamp, Compact Fluorescent Lamp (CFL)
High Vapour Pressure discharge lamps - Mercury Vapour lamp, Sodium Vapour lamp, Metal halide Lamps, Solid Sodium Argon Neon lamps, SOX lamps, Electro luminescent lamps, Induction lamps.
Ballast, ignitors and dimmers for different types of lamps

(B) Control of Light Sources
Photometric Control of Light Sources and their Quantification: Types of Luminaries, factors to be considered for designing luminaries Types of lighting fixtures.
Optical control schemes, design procedure of reflecting and refracting type of luminaries. Lighting Fixture types, use of reflectors and refractors, physical protection of lighting fixtures, types of lighting fixtures according to installation type, types of lighting fixtures according to photometric usages, luminaries standard (IEC-598-Part I).

Unit 03 : Design Considerations for illumination schemes (04 Hrs)

Zonal cavity method for general lighting design, determination for zonal cavities and different shaped ceilings using COU (coefficient of utilization), beam angles and polar diagrams. Factors to be considered for design of indoor illumination scheme

Unit 04 : Design of lighting schemes-I (06 Hrs)

Indoor illumination design for following installations-

Residential (Numerical)
Educational institute
Commercial installation
Hospitals
Industrial lighting
Special purpose lighting schemes
Decorative lighting
Theatre lighting
Aquarium, swimming pool lighting

Unit 05 : Design of lighting schemes-II (08 Hrs)

Factors to be considered for design of outdoor illumination scheme

Outdoor Lighting Design: Road classifications according to BIS, pole arrangement, terminology, lamp and luminaries' selection, different design procedures, beam lumen method, point by point method, isolux diagram, problems on point by point method.

Outdoor illumination design for following installations:

Road lighting (Numerical)
Flood lighting (Numerical)
Stadium and sports complex
Lighting for advertisement/hoardings

Unit 06 : Modern trends in illumination (05 Hrs)

LED luminary designs
Intelligent LED fixtures
Natural light conduiting
Organic lighting system
LASERS, characteristics, features and applications, non-lighting lamps
Optical fiber, its construction as a light guide, features and applications

Text Books:

[T1] H. S. Mamak, "Book on Lighting", Publisher International lighting Academy.
[T2] Joseph B. Murdoch, "Illumination Engineering from Edison's Lamp to Lasers" Publisher -York, PA : Visions Communications
[T3] M. A. Cayless, A. M. Marsden, "Lamps and Lighting", Publisher-Butterworth-Heinemann(ISBN 978-0-415-50308-2)
[T4] Designing with light: Lighting Handbook., Anil Valia; Lighting System 2002

Reference Books:

[R1] "BIS, IEC Standards for Lamps, Lighting Fixtures and Lighting", Manak Bhavan, New Delhi.

[R2] D. C. Pritchard, "Lighting", 4th Edition, Longman Scientific and Technical, ISBN 0-582-23422-0.

[R3] "IES Lighting Handbook", (Reference Volume 1984), Illuminating Engineering Society of North America.

[R4] "IES Lighting Handbook", (Application Volume 1987), Illuminating Engineering Society of
North America

[R5] IESNA lighting Handbook., Illuminating Engineering Society of North America 9th edition 2000

[R6] Applied Illumination Engineering, Jack L. Lindsey FIES (Author), Scott C. Dunning PHD PECEM (Author) ,ISBN-13: 978-0824748098 ISBN-10: 0824748093, 3rd Edition.

[R7] IS 3646: Part I: 1992, Code of practice for interior illumination.

[R8] Organic Light Emitting Diodes (OLEDs): Materials, Devices and Applications, Alastair Buckley,
University of Sheffieid, UK, ISBN: 978-0-85709-425-4.

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

403150 (D) : VLSI Design [Open Elective]

Teaching Scheme	Credits	Examination Scheme [100 Marks]
Theory : 03 Hrs. /Week	03	In Sem : 30 Marks
		End Sem : 70 Marks

Prerequisite : Concepts of Digital Electronics, Number systems, any programming language like C

Course Objective: The course aims to:-

- Develop Digital designing skills of Students
- Train the students for Hardware Description Language.
- Develop various applications using VHDL coding.

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

1. To understand Modeling of Digital Systems Domains for different combinational and sequential circuits
2. To understand Levels of Modeling using Modeling Language VHDL.
3. To Understand Modeling and programming Concepts by Learning a New Language
4. To develop of logic design and programming skills in HDL language.
5. To study HDL based design approach.
6. To learn digital CMOS logic design

Unit 01 : Overview of Digital Logic Circuits and Introduction to VLSI (06 Hrs)

Combinational circuits: Decoders, Multiplexer, ALU. Sequential circuits: latch, flip flop – RS, JK, D,T., shift registers ,Counters, Moore, Mealy Machines. Introduction to VLSI: complete VLSI design flow (with reference to an EDA tool), IEEE Standards ,VHDL Terms Definitions – Entity, architecture, Schematic, Components, Configuration.

Unit 02 : VHDL Modeling (06 Hrs)

Data objects, Data types, Entity, Architecture and types of modeling: Behavioral, data flow, and Structural with the help of digital functions like multiplexer, Shift Register, counter. Sequential statements, Concurrent statements. VHDL Test bench. VHDL modeling of Combinational, Sequential logics.

Unit 03 : VHDL and Finite State Machines (06 Hrs)

Synthesizable and non synthesizable statements, functions, procedures, attributes, configurations, packages. Synchronous and asynchronous machines, Finite State Machines (FSM), metastability, state diagrams and VHDL codes for FSMs.

Unit 04 : Programmable Logic Devices (PLDs) (06 Hrs)

Need of PLDs. Comparison with ASIC, general purpose processor, DSP processor, microcontroller, memories etc. Features, specifications, detail architectures, application areas, limitations of Complex Programmable Logic Device (CPLD) and Field Programmable Logic Devices (FPGA).

Unit 05 : Digital CMOS Design (06 Hrs)

CMOS INVERTER, CMOS NAND and CMOS NOR, voltage transfer curve, body effect, hot electron effect, velocity saturation. Static and dynamic dissipations. Power delay product. Noise margin. Combinational logic design, comparison of CMOS and NMOS. Comparative study of TTL, ECL, CMOS.

Unit 06 : VLSI Design Applications (06 Hrs)

Barrel shifter, signed and unsigned comparators, Carry ripple and carry look, Ahead address, Fixed- point division, serial data receiver, parallel to serial converter, playing with a seven segment display and key board, signal generators, memory design, Vending - Machine controller.

Text Books:

[T1] Douglas Perry, "VHDL", Tata McGraw Hill.
[T2] John F. Wakerly, "Digital Design, Principles and Practices", Prentice Hall Publication
[T3] Wolf, "Modern VLSI Design", Pearson Education.
[T4] R.P.Jain, "Modern Digital electronics", 3rd edition, Tata McGraw-Hill.
[T5] Donald P. Leach, Albert Paul Malvino, "Digital Principles and Applications", Glencoe Publisher.
[T6] Neil H. Weste and Kamran, "Principles of CMOS VLSI Design", Pearson Publication.

Reference Books:

[R1] Charles H. Roth, "Digital System Design Using VHDL", PWS Publishing Company (Thomson Learning) 2.
[R2] Sung-Mo(Steve) Kang, Yusuf Leblebici, "CMOS Digital Integrated Circuits", Tata McGraw Hill Publication.
[R3] J. Bhaskar, "VHDL Primer", 3rd Edition, Addison Wesley Longman Singapore Pte Ltd.
[R4] Volner A. Dedroni, "Circuit Design with VHDL", PHI Publications
[R5] Xilinx Data Manual "The Programmable Logic Data Book".
[R6] LizyKurian John, "Principles of Digital Systems Design and VHDL" Paperback – 2008 .
[R7] Peter J. Ashenden (Author), Jim Lewis, " VHDL-2008: Just the New Stuff", (Systems on Silicon) Paperback – Import, 7 Dec 2007.
[R8] Data Sheets of PLDs.

Unit	Text Books	Reference Books
1	T2,T4,T5	R3, R6
2	T1,T3	R3, R4, R7
3	T2,T1	R1, R6
4	T2	R5, R8
5	T6	R2
6	T2,T3	R6

403151: Project II

Teaching Scheme	Credits	Examination Scheme [150 Marks]
Tutorial : 06 Hrs./Week	06	Oral : 50 Marks Term work : 100 Marks

Course Objectives:

- To explore and to acquire specified skill in areas related to Electrical Engineering
- To develop skills for carrying literature survey and organize the material in proper manner.
- To provide opportunity of designing and building complete system/subsystem based on their knowledge acquired during graduation.
- To understand the needs of society and based on it to contribute towards its betterment and to learn to work in a team.
- To ensure the completion of given project such as fabrication, conducting experimentation, analysis, validation with optimized cost.
- Present the data and results in report form
- Communicate findings of the completed work systematically.

Course outcomes: Students will be able to

- Work in team and ensure satisfactory completion of project in all respect.
- Handle different tools to complete the given task and to acquire specified knowledge in area of interest.
- Provide solution to the current issues faced by the society.
- Practice moral and ethical value while completing the given task.
- Communicate effectively findings in verbal and written forms.

Guidelines :

The student shall complete the remaining part of the project which is an extension of the work carried out in VIIth Semester. For exceptional cases, change of topic has to be approved by Internal Assessment Committee consisting of Guide, Project Coordinator and Head of Department.
Student should incorporate suggestions given by examiner in project I.
The student shall complete the remaining part of the project which consists of design, simulation, fabrication of set up required for the project, analysis and validation of results and conclusions.
The student shall prepare duly certified final report of the project work in the standard format in MS Word / LaTex.
Student should maintain Project Work Book.

Audit Course VI : 403153: Energy Storage Systems

Teaching Scheme
Theory : 02 Hrs. / Week
Field visit : 1 Day

Examination Schemes: Audit (P/F)
Written / MCQ / Term paper

Course Objectives:

- To elaborate various energy storage systems
- To be familiar with various aspects such as hybridization, selection and sizing of energy storage systems

Course Outcomes:

On completion of the course, students will be able to:-

- Explain and differentiate various types of energy storage systems

Energy Storage Systems:

1. Introduction to Energy Storage System: need, its types and applications.

a) Battery as an energy storage device, its types, Basic terms related to battery Energy Storage System such as Energy Density, Power Density, Cycle Life, C_{10} Rating, State of Charge (SOC), Depth of Discharge (DOD), its characteristics and analysis of various batteries.

b) Types of Batteries: Characteristics, construction, economics, development status, future trends in batteries such as advanced lead-acid, lithium ion, polymer, Ni-Cd, metal hydride, sodium, and various types of flow batteries (vanadium, zinc, manganese, etc.).

c) Fuel Cell as an energy storage device and its analysis.

d) Supercapacitor as an energy storage device and its analysis.

e) Superconducting Energy Storage as an energy storage device and its analysis.

f) Flywheel as an energy storage device and its analysis.

Hybridization of different energy storage devices.

Sizing and selecting the energy storage technology and its supporting subsystems.

2. Case Studies: Design of a Hybrid Electric Vehicle (HEV), Design of a Battery Electric Vehicle (BEV) Introduction to energy management strategies used in hybrid and electric vehicles.

Experiments: There shall be a 3-4 exercises based on MATLAB and Simulink related to **Battery** energy storage, **Fuel Cell** energy storage and **Supercapacitor** energy storage.

Industrial Visit: Industrial visit to manufacturing industry of battery/ supercapacitor.