# Savitribai Phule Pune University, Pune

## Faculty of Science and Technology

Board of Studies

## Electrical Engineering

Syllabus

## Second Year Electrical Engineering

**(2019 Course)**

(w.e.f. AY: 2020-21)

# Savitribai Phule Pune University
# Syllabus: Second Year (SE) Electrical Engineering (2019 Course)
# w.e.f. AY:2020-2021

## SEMESTER-I

| Course Code | Courses Name | Teaching Scheme | | | Examination Scheme and Marks | | | | | | Credits | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | TH | PR | TUT | ISE | ESE | TW | PR | OR | Total | TH | PR | TUT | Total |
| 207006 | Engineering Mathematics-III | 03 | -- | -- | 30 | 70 | -- | -- | -- | **100** | 03 | -- | -- | **03** |
| 203141 | Power Generation Technologies | 03 | -- | -- | 30 | 70 | -- | -- | -- | **100** | 03 | -- | -- | **03** |
| 203142 | Material Science | 03 | 04# | -- | 30 | 70 | 25 | -- | 25 | **150** | 03 | 02 | -- | **05** |
| 203143 | Analog and Digital Electronics | 03 | 02 | -- | 30 | 70 | -- | 50 | -- | **150** | 03 | 01 | -- | **04** |
| 203144 | Electrical Measurement & Instrumentation | 03 | 04# | -- | 30 | 70 | 25 | 25 | -- | **150** | 03 | 02 | -- | **05** |
| 203150 | Applications of Mathematics in Electrical Engineering | -- | 02* | -- | -- | -- | 25 | -- | -- | **25** | -- | 01 | -- | **01** |
| 203151 | Soft Skill | -- | 02 | -- | -- | -- | 25 | -- | -- | **25** | -- | 01 | -- | **01** |
| 203152 | Audit Course-III | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **Grade: PP/NP** | | | |
| **Total** | | **15** | **14** | **--** | **150** | **350** | **100** | **75** | **25** | **700** | **15** | **07** | **--** | **22** |

## SEMESTER-II

| Course Code | Courses Name | Teaching Scheme | | | Examination Scheme and Marks | | | | | | Credits | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | TH | PR | TUT | ISE | ESE | TW | PR | OR | Total | TH | PR | TUT | Total |
| 203145 | Power System-I | 03 | -- | -- | 30 | 70 | -- | -- | -- | **100** | 03 | -- | -- | **03** |
| 203146 | Electrical Machines-I | 03 | 02 | -- | 30 | 70 | -- | 50 | -- | **150** | 03 | 01 | -- | **04** |
| 203147 | Network Analysis | 03 | 02 | -- | 30 | 70 | 25 | -- | -- | **125** | 03 | 01 | -- | **04** |
| 203148 | Numerical Methods & Computer Programming | 03 | 02 | -- | 30 | 70 | -- | 25 | -- | **125** | 03 | 01 | -- | **04** |
| 203149 | Fundamental of Microcontroller and Applications | 03 | 04$ | -- | 30 | 70 | 25 | -- | 25 | **150** | 03 | 02 | -- | **05** |
| 203152 | Project Based Learning | -- | 04 | -- | -- | -- | 50 | -- | -- | **--** | -- | 02 | -- | **--** |
| 203153 | Audit Course-IV | -- | -- | -- | -- | -- | -- | -- | -- | **--** | **Grade: PP/NP** | | | |
| **Total** | | **15** | **14** | **--** | **150** | **350** | **100** | **75** | **25** | **700** | **15** | **07** | **--** | **22** |

* - Lab sessions on application of Mathematics in Electrical Engineering using professional software.

# - Practical section will comprises of two Part : a) PART A : 2 hours per week : Regular curriculum listed practical total 12 numbers out of which conduction of 8 numbers will be mandatory b) PART B : 2 Hours a week :Practical/case studies/assignments to enable active learning based on advances related to subject to bridge gap between curriculum and enhance practical knowledge required in field .

$ - Practical section will comprises of two Part : a) PART A : 2 hours per week : Regular curriculum listed practical total 12 numbers out of which conduction of 8 numbers will be mandatory b) PART B : 2 Hours a week : IOT application in Electrical Engineering using microcontroller and GSM module to bridge gap between curriculum and enhance application knowledge.

**Abbreviation**: TH: Theory, PR: Practical, TUT:Tutorial, ISE: Insem Exam, ESE: End Sem Exam, TW: Term Work, OR: Oral

# 207006: Engineering Mathematics-III

| Teaching Scheme | Credits | Examination Scheme [Marks] |
|---|---|---|
| **Lecture** : 03 Hrs/ Week | **Th**: 03 | **In Sem** : 30 Marks<br>**End Sem** : 70 Marks |

**Prerequisites: -** Differential & Integral calculus, Taylor series, Differential equations of first order and first degree, Fourier series, Collection, classification & representation of data, Vector algebra and Algebra of complex numbers.

**Course Objectives:**

To make the students familiarize with concepts and techniques in Ordinary differential equations, Laplace transform, Fourier transform & Z-transform, Statistics & Probability, Vector Calculus and functions of a Complex Variable. The aim is to equip them with the techniques to understand advanced level mathematics and its applications that would enhance analytical thinking power, useful in their disciplines.

**Course Outcomes:**At the end of this course, students will be able to:

**CO1**:Solve higher order linear differential equation using appropriate techniques to model and analyze electrical circuits.

**CO2**: Apply Integral transforms such as Laplace transform, Fourier transform and Z-Transform to solve problems related to signal processing and control systems.

**CO3**: Apply Statistical methods like correlation, regression and Probability theory as applicable to analyze and interpret experimental data related to energy management, power systems, testing and quality control.

**CO4**: Perform Vector differentiation and integration, analyze the vector fields and apply to wave theory and electro-magnetic fields.

**CO5**: Analyze Complex functions, conformal mappings, and perform contour integration in the study of electrostatics, signal and image processing.

**Unit I:** Linear Differential Equations (**LDE**) and Applications (08 Hours)

LDE of $n^{th}$ order with constant coefficients, Complementary Function, Particular Integral, General method, Short methods, Method of variation of parameters, Cauchy's and Legendre's DE, Simultaneous and Symmetric simultaneous DE. Modeling of Electrical circuits.

**Unit II:** Laplace Transform (**LT**) (07Hours)

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 III:** Fourier and Z - transforms (08 Hours)

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

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

**Unit IV:** Statistics and Probability (07 Hours)

Measures of central tendency, Measures of dispersion, Coefficient of variation, Moments, Skewness and Kurtosis, Correlation and Regression, Reliability of Regression estimates.

Probability, Probability density function, Probability distributions: Binomial, Poisson, Normal, Test of hypothesis: Chi-square test.

**Unit V:** Vector Calculus (08 Hours)

Vector differentiation, Gradient, Divergence and Curl, Directional derivative, Solenoidal and Irrotational fields, Vector identities. Line, Surface and Volume integrals, Green's Lemma, Gauss's Divergence theorem and Stoke's theorem.

**Unit VI:** Complex Variables (08 Hours)

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

**Text Books:**

1. Higher Engineering Mathematics by B.V. Ramana (Tata McGraw-Hill).
2. Higher Engineering Mathematics by B. S. Grewal (Khanna Publication, Delhi).

**Reference Books:**

1. Advanced Engineering Mathematics, 10e, by Erwin Kreyszig (Wiley India).
2. Advanced Engineering Mathematics, 2e, by M. D. Greenberg (Pearson Education).
3. Advanced Engineering Mathematics, 7e, by Peter V. O'Neil (Cengage Learning).
4. Differential Equations, 3e by S. L. Ross (Wiley India).
5. Introduction to Probability and Statistics for Engineers and Scientists, 5e, by Sheldon M. Ross (Elsevier Academic Press).
6. Complex Variables and Applications, 8e, by J. W. Brown and R. V. Churchill (McGraw-Hill Inc.).

# 203141: Power Generation Technologies

| Teaching Scheme | Credits | Examination Scheme [Marks] |
|---|---|---|
| **Lecture** : 03 Hrs/ Week | **Th**: 03 | **In Sem** : 30 Marks<br>**End Sem** : 70 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:
**CO1**: Identify components and elaborate working principle of conventional power plants.
**CO2**: Recognize the importance and opportunities of renewable energies.
**CO3**: Calculate and control power output of wind solar, and hydro power plant.
**CO4**: Describe process of grid interconnection of distributed generation and requirements.
**CO5**: Interpret the environmental and social impact of various generation technologies.

**Unit 01: Thermal Power Plant (06 hrs)**

**Basic thermodynamic cycles:** Carnot cycle, Rankine cycle; Actual Rankine cycle; Reheat cycle (theoretical only); heat rate (Numerical on Heat rate).
**Thermal Power Plants**: Site selection, Main parts and its working. Types of boilers (FBC, Fire tube, and Water tube). Assessment of heat recovery systems Steam turbines Fuel Handling, Ash disposal and dust collection, Draught systems, electrostatic precipitator.

**Unit 02: Nuclear, Diesel, Gas Power Plant (6 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.
**B. Diesel Power Plants:** Main components and its working, Diesel plant efficiency and heat balance (Numerical), Site selection of diesel power plant.
**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, concept of heat to power ratio.

**Unit 03: Hydro Power Plant (6 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 hydro graphs and number of turbine required. Small, mini and micro hydro power plant (Introduction only).

**Unit 04: Wind Energy Systems (6 Hrs)**

Historical Development of Wind Power, Types of wind turbine, Impact of Tower Height, Power in the Wind. Maximum Rotor efficiency, Speed control for Maximum Power, Average Power in the wind (Numerical). Wind Turbine Generators (WTG) - Synchronous and Asynchronous (block diagrams only), 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 (6 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, Numerical on number of solar panel selection. 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.
[T8] Chetan singh solanki " Solar Photovotaics: Fundamentals, Technology and Application" PHI 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.
[R5] Robert Foster, Majid Ghassemi, Alma Cota "Solar Energy" CRC Press

| 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, T8 | R2, R3, R4, R5 |
| 6 | T5, T7 | R4 |

# 203142: Material Science

| Teaching Scheme | Credits | Examination Scheme [Marks] |
|---|---|---|
| **Lecture** : 03 Hrs/ Week<br>**Practical** : 04 Hrs/ Week | **Th**: 03<br>**PR**:02 | **In Sem** : 30 Marks<br>**End Sem** : 70 Marks<br>**Term Work**: 25 Marks<br>**Oral** : 25 Marks |

**Prerequisite:**

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

**Course Objectives:** The course aims to :

1. Explain classification,properties and characteristics of electrical engineering materials.
2. Describe applications and measuring methods for parameters of dielectric, insulating, magnetic, conducting and resistive materials.
3. Illustrate solving of simple problems based on dielectric, magnetic and conducting materials.
4. Impart knowledge of Nano-technology to electrical engineering.5. Demonstrate testing methods of dielectric, insulating, magnetic, conducting and resistive materials as per IS.
5. Enable students to create self learning resource material through active learning based on practical /case study/assignments.

**Course Outcomes:**

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

**CO1**: Discuss classification,properties and characteristics of different electrical engineering materials.

**CO2**: State various applications measuring methods for parameters of different classes of electrical engineering materials.

**CO3**: Solve simple problems based on dielectric, magnetic and conducting materials.

**CO4**: Apply knowledge of Nano-technology to electrical engineering.

**CO5**: Execute tests on dielectric, insulating, magnetic, conducting, resistive materials as per IS to decide the quality of the materials.

**CO6**: Create learning resource material ethically to demonstrate **self learning leading to** lifelong learning skills and usage of ICT/ online technology through collaborative/active learning activities.

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

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), Clausius Mossotti Equation, Piezo-Electric, Pyro-Electric & Ferro-Electric Materials, Dielectric loss and loss tangent, Concept of negative tan delta.

**Unit 02: A) 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 02: B) Testing of Materials: (4Hrs)**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.

**Unit 03 : Insulating Materials, Properties & Applications: (6 Hrs)**

Introduction, Characteristics of Good Insulating Material, Classification, Solid Insulating Materials-Paper, Press Board, Fibrous Materials, Ceramics, Mica, Asbestos, Resins, Liquid

Insulating Materials such as Transformer Oil, Varnish, Askarel. Insulating Gases like Air, $SF_6$. Insulating Materials for Power and Distribution Transformers, Rotating Machines, Capacitors, Cables, Line Insulators and Switchgears.

**Unit 04 : Magnetic Materials: (6 Hrs)**

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, 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.

**Unit 05 : Conducting Materials: (6 Hrs)**

General Properties of Conductor, Electrical Conducting Materials - Copper, Aluminum and its applications, Materials of High and Low Resistivity-Constantan, Nickel-Chromium Alloy, Tungsten, Kanthal, Silver and Silver alloys, Characteristics of Copper Alloys (Brass & Bronze), Electrical Carbon Materials. Materials used for Lamp Filaments, Solders, Metals and Alloys for different types of Thermal Bimetal and Thermocouples.

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

Introduction, Concepts of Energy bands and 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. Nano materials used in Batteries, Photovoltaic Cells and in Supercapacitors.

**Industrial Visit:**

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

***Guidelines for TW Assessment will be given later.**

There is **Term Work of 25 marks**for the subject.

Practical section will comprise of two parts: (Refer SE Structure 2019 Pattern)

**PART A:** 2 Hours per week:

Regular curriculum listed practical total 12 numbers out of which conduction of 8 numbers will be mandatory. Out of 25 marks of Term Work, **15 Marks** will be based on continuous assessment that 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.

**PART B:** 2 Hours a week:

Practical/case studies/assignments to enable active learning based on advances related to subject to bridge gap between curriculum and enhance practical knowledge required in field. **10 Marks**

**List of Experiments:**

**Part A:**Term Work **(TW): 15 Marks**

**List of total 12 numbers of experiments out of which conduction of 8 numbers of experiments will be mandatory.**

1. To measure dielectric strength of solid insulating material-IS 2584.
2. To measure dielectric strength of liquid insulating material-IS 6789.
3. To measure dielectric strength of gaseous insulating material as per IS using Sphere Gap-Unit.
4. To obtain hysteresis loop of the ferromagnetic material.
5. To understand the principle of thermocouple and to obtain characteristics of different thermocouples.
6. To measure insulation resistance and 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.

12. Write report on visit to an industry related to manufacturing of batteries, capacitors, cables, transformers (Any one industry).

**List of Experiments: Part B:Part B :**2 Hours per week (**Term Work(TW) : 10 Marks) (Total 6 activities from the list below are mandatory for evaluation of Term Work for Part B. Activity numbers 1, 4 and 6 are compulsory)**

Practical/case studies/assignments to enable self,active, collaborative **learning leading to** lifelong learning, based on advances related to subject to bridge gap between curriculum and enhance application knowledge of the subject.

Guidance/monitoring/assessment/presentation/field visits /expert sessions related activity can be carried out in **'Part B'** practical schedules .

1) Review of research/on line literature from latest journal papers /transactions related to different insulating, magnetic, semiconducting and conducting materials, advanced material developments and their applications. Draft of paper, presentation among students, in conference /publishing it.
2) Detailed case study of complete insulation system in transformer, comparison of various types of solid, liquid materials and study of recent advances related with major and minor insulating materials.
3) Detailed study of patents on caster oil used in transformer, its properties and comparison with other liquid insulating material.
4) Mini project on development of prototype of various electrical gadgets right from draft of specifications,design, selection of conducting, magnetic and insulating material.
5) Testing and diagnosis of induction motor, cable, transformer insulation by measurement of Polarization index, Dielectric Absorption Ratio, Step Voltage, dielectric discharge and ramp testing using 5/10KV IR Tester.
6) Laboratory visits/survey/role play/games/debates/any activity focusing collaborative, student centrist, active learning on Industrial/ Social/ Sustainability/ Public Health/ Safety/Ethical/Cultural/ Societal and Environmental aspects related to advanced materials Presentations of industrial case studies related with material science.
7) Two - Three household appliances like mixer -motor, ceiling fan- motor etc can be opened up by students either individually or by group of students and analyzed w.r.t. the materials found in it. Name each material used and to which category of materials does it belong, other applications of the same materials can be listed.
8) Detailed study of insulation system of resin casted transformer, comparison of various resins, study of testing of insulation system with applicable IS/IEC /IEEE standards
9) Visit to NABL accredited Laboratory to study testing of oil for DGA, furan analysis, study of equipment's used, test procedure and applicable IS/IEEE/IEC standard and recommended limits.
10) Discussions/Presentations/any activity using or related to IS/ IEC /IEEE standards/Recent Patents related with insulating, conducting and magnetic materials .
11) Case study on failure modes of various insulating materials and measures to reduce failure. Recent advancement in testing and diagnostic of solid and liquid insulating materials.
12) Case study on recent advancement of magnetic materials, high temperature superconductors and its applications.
13) Any activity using advanced ICT tool like Virtual Labs/animations/simulations/advanced software/on line certificate course like NPTEL/on line quiz etc related to curriculum.

**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 Journal should 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 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).

**Text Books:**

[T1] "A Course in Electrical Engineering Materials", by S.P. Seth, Dhanpat Rai and Sons publication.
[T2] A Textbook of "Electrical Engineering Materials" by R.K.Rajput, Laxmi Publications (P) Ltd.
[T3] "Electrical Engineering Materials", by T.T.T.I, Madras.
[T4] "Electrical Engineering Materials", by K. B. Raina and S. K. Bhattacharya, S. K. Kataria Sons.
[T5] "Material Science for Electrical Engineering", by P.K. Palanisamy, Scitech Pub. Pvt. Ltd., Chennai (India).
[T6] "Introduction to Nanotechnology" by Charles P. Poole, Jr. Frank & J. Ownes (Wiley Student Edition)

**Reference Books:**

[R1] "Electrical Power Capacitors-Design & Manufacture", by D. M. Tagare, Tata McGraw Hill Publication.
[R2] "Electrical Engineering Materials", by S. P. Chalotra and B. K. Bhattacharya, Khanna Publishers, Nath Market.
[R3] "Electrical Engineering Materials", by C. S. Indulkar and S. Thiruvengadam, S. Chand and Company Ltd.
[R4] "High Voltage Engineering" by Kamraju and Naidu, Tata McGraw Hill Publication.
[R5] "Introduction to Material Science for Engineering", Sixth Edition by James F. Shackelford & M. K. Muralidhara, Pearson Education.
[R6] "Insulation Technology Course Material" of IEEMA Ratner, Pearson Education.
[R7] "Materials Science for Engineering Students", by Traugott Fischer, Elsevier Publications.
[R8]"Energy Conversion Systems", by Rakosh Das Begamudre, New Age International Publishers.
[R9] "Advanced Nanomaterials and Their Applications in Renewable Energy", by Jingbo Louise Liu, Sajid Bashir, ELSEVIER Publications.

| Unit No. | Text Book | Reference Book |
|---|---|---|
| 1 | T1, T2 | R1, R3, R8 |
| 2 | T1, T2, T3 | R1, R2, R4 |
| 3 | T1, T2, T3, T4 | R1, R3, R4, R6 |
| 4 | T1, T2, T3, T4 | R3, R5 |
| 5 | T1, T2, T4 | R7, R8 |
| 6 | T6 | R9 |

# 203143: Analog And Digital Electronics

| Teaching Scheme | Credits | Examination Scheme [Marks] |
|---|---|---|
| **Lecture** : 03 Hrs/ Week<br>**Practical** : 02 Hrs/ Week | **Th**: 03<br>**PR**:01 | **In Sem** : 30 Marks<br>**End Sem** : 70 Marks<br>**Practical** : 50 Marks |

**Prerequisite**: Basic Electronics Engineering, Numbering system, Logic Gates and flip flops,Diode and BJT

**Course Objectives**:

1) To use K map for Boolean algebra reduction and design digital circuit
2) To introduce digital memories and logical families.
3) To construct sequential and combinational circuits using flip flops and K map
4) To develop the concept of basics of operational Amplifier and its applications.
5) To design uncontrolled rectifier

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

**CO1**: Design logical, sequential and combinational digital circuit using K-Map.
**CO2**: Demonstrate different digital memories and programmable logic families.
**CO3**: Apply and analyze applications of OPAMP in open and closed loop condition.
**CO4**: Design uncontrolled rectifier with given specifications

**Unit 01 : Design of combinational circuit:**(6 hrs)

Booleans algebra, De-Morgan theory etc, Karnaugh map: structure for two, three and four Variables, SOP and POS form reduction of Boolean expressions by K-map. Design of combinational circuits using Boolean expression and K-map, encoder, decoder, half and full adder.

**Unit 02: Design of sequential circuit:**(6 hrs)

Introduction to sequential circuit. Design of synchronous (K-map) and asynchronous counters. Up down counters, N modulo counters, Shift registers, ring and twisted ring counters

**Unit 03: Digital memories and logic families:**(6 hrs)

**A) Digital memories:** SRAM, DRAM, ROM, EPROM
B) **Digital logic families:** PAL,PLA, CPLD, FPGA

**Unit 04: Operational Amplifier Applications:** (6 hrs)

Open loop and close loop configuration of Op-Amp. Applications of Op- Amp- zero crossing detectors, Comparator, Schmitt trigger, V-I and I-V converters, Instrumentation amplifier, peak detector, Waveform generation using Op-amp - sine, square, saw tooth and triangular generator,

**Unit 05: Other Analog circuits:**(6 hrs)

Active filters-Its configuration with frequency response, Analysis of first order low pass and high pass filters using OPAMP, IC 555 –construction, working and modes of operation- astable and monostable multi vibrators, Sequence generator, voltage regulators using IC78xx, 79xx, LM 317

**Unit 06: Diode rectifier:**(6 hrs)

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.

**List of Experiments:**

Perform any **eight (three experiment should be on bread board/trainer kit)** experiment from following list:

1. Design of logical circuit for display of decimal number on seven segment display. **(Hardware)**
2. Deign 3:8 decoder for binary to octal decoding.**(Hardware)**
3. Design four bit full adder using any open source software. **(Software)**
4. Design logical circuit to convert binary to octal number system. **(Hardware)**
5. Design digital clock or stop watch using decade counter.(IC74192) **(Hardware)**
6. Find phase angle difference between same frequency signal using ZCD and AND gate. **(Hardware)**
7. Design of comparator and schmitt trigger. **(Hardware)**
8. Study of Instrumentation amplifier using three Op-amp, CMRR measurement **(Hardware)**

9. Design sine, and triangular wave generator. **(Hardware)**
10. Design first order high pass and low pass filter using OPAMP in any open source software. (For this provide one statement to each of four students to perform with desired cut-off frequency. Each group will demonstrate their result and prepare documentation) **(Software)**
11. Design of monostable mutivibrator using IC555 and digital circuit to count number of pulses. **(Hardware)**
12. Design astable multivibrator using IC-555. **(Hardware)**
13. Design of single phase bridge rectifier with output voltage and specified ripple.(this practical should be design by each students, perform in simulation and demonstrate with hardware in laboratory with design documents) **(Software and Hardware)**

**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 (10 marks) List of components required with their specifications .

**Guidelines for Student's Lab Journal**

The student'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,

**Guidelines for Lab Assessment**

- There should be continuous assessment.
- 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 or trainer kit (**ready made set up is not allow**)

**Books & Other Resources:**

**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.
[T8] Fundamental of digital circuits, 4th Edition, by A Anand Kumar, PHI learning private limited publication

**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.
[R7] NPTEL course on Digital Electronics Circuit, IIT, Kharagpur.
https://nptel.ac.in/courses/108105132/
[R8] NPTEL course on Integrated circuit, MOSFET, OPAMP and there applications IISC Banglore. https://nptel.ac.in/courses/108/108/108108111/
[R9] NPTEL course on power electronics by IIT Kharagpur.
https://nptel.ac.in/courses/108/105/108105066/

| Unit 01 | Test Books | References |
|---|---|---|
| 1 | T1, T2, T8 | R1, R7 |
| 2 | T1, T2, T3, T8 | R2, R7 |
| 3 | T8 | R7 |
| 4 | T4, T5 | R3, R4, R8 |
| 5 | T4, T5 | R3, R4, R8 |
| 6 | T7 | R6, R9 |

# 203144: Electrical Measurements and Instrumentation

| Teaching Scheme | Credits | Examination Scheme [Marks] |
|---|---|---|
| **Lecture** : 03 Hrs/ Week<br>**Practical** : 04 Hrs/ Week | **Th**: 03<br>**PR**:02 | **In Sem** : 30 Marks<br>**End Sem** : 70 Marks<br>**Term Work**: 25 Marks<br>**Oral** : 25 Marks |

**Course Objectives:**

1. To understand the necessity and importance of measurement and instrumentation.
2. To know about various types of measurement techniques, instruments and sensors.
3. To learn to apply proper methods of measurement and use of sensors in instrumentation.

**Course Outcomes:**

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

**CO1**: Define various characteristic and classify measuring instruments along with range extension techniques.

**CO3**: Apply measurement techniques for measurement of resistance, inductance and capacitance.

**CO4**: Demonstrate construction, working principle of electrodynamo type and induction type instruments for measurement of power and energy.

**CO5**: Make use of CRO for measurement of voltage, current and frequency.

**CO6**: Classify transducer and apply it for measurement of physical parameters in real time.

**Unit 01: (7 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) instruments (attraction and repulsion). block diagram and operation of digital ammeter & voltmeter.

**B. Range Extension:** Instrument Transformers : Construction, connection of CT & PT in the circuit, advantages of CT / PT for range extension of MI Instruments, transformation ratio, turns ratio, nominal ratio, burden, ratio and phase angle error.(descriptive treatment only)

**Unit 02: (6 Hrs)**

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

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

**Unit 03: (6 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.

**Unit 04: (5 Hrs)**

**Measurement of Energy**: Construction, working principle, torque equation of single phase conventional (induction type) energy meter. Block diagram and operation of single phase and three phase static energy meter. Calibration of static energy meter. TOD meter.

**Unit 05: (6 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. 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: (6 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, applications, 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; their construction, working, advantages and disadvantages.

## Industrial Visit(s)

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.

## List of Experiments

**Practical section will comprise of two part; part A and part B.**

**Practical examination will be conducted on Part A.**

**Distribution of term works marks; Part A : 10 Marks, Part B : 15 Marks.**

**Part A:** Minimum eight experiments are to be conducted from the following experiments:

1. Extension of ammeter range using CT, voltmeter range using PT and watt meter range using CT / PT.
2. i) Measurement of medium resistance by Ammeter- Voltmeter method.
   ii) Measurement of low resistance using Kelvin's Double Bridge.
3. Measurement of inductance using Anderson's bridge / Maxwell's bridge.
4. Measurement of active & reactive power in three phase balanced circuit using one wattmeter method with two way switch.
5. Measurement of reactive power by one wattmeter with all possible connections of current coil and pressure coil.
6. Measurement of three phase active & reactive power by two wattmeter method procedure.
7. Measurement of active power in three phase, four wire system using three CTs & two wattmeter.
8. Calibration of single phase wattmeter at different power factors.
9. Calibration of single phase static energy meter at different power factors.
10. Measurement of voltage, current, time period, frequency & phase angle using CRO.
11. To study and plot the characteristics of LVDT.
12. Electrical methods for measurement of liquid level.

**Part B:** Minimum eight experiments / case studies are to be conducted from the following:

1. Study of various standards (IS/IEC) related to calibration process of various instruments and NABL accredited Test Laboratory visit.
2. Measurement of soil resistivity using four pin wenner method.
3. Study of programmable LCR meter; Measure L, C, R, Q, dissipation factor and power factor of given component.
4. Demonstration of Power analyser and multifunction meter for measurement of various

electrical quantities.

5. Study of Digital Storage Oscilloscope:
   a) Different modes in DSO such as Roll, Average, Peak detection.
   b) Capture transients
   c) FFT analysis
   d) Various MATH operations
6. Study and demonstration of net meter and four quadrant TOD Meter.
7. Detailed study of various temperature transducers, their selection procedure, specifications, characteristics and comparison, calibration process of temperature transducer.
8. Determination of polarities and ratio, phase angle and ratio error of various CTs and PTs.
9. Study and demonstration of DIAF / Woodward alternator synchronization relay used in industrial power system for synchronization of DG sets and Alternators.
10. Detailed study of on line Energy Monitoring System, various parameters, EMS software capabilities, trending with IOT applications. Demonstration of EMS system by inviting Expert.
11. Virtual instrument modeling using software like LABVIEW.
12. Study of advanced metering infrastructure in smart grid.

## 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 and 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.

**Text Books**

[T1] A. K. Sawhney, “A Course in Electrical and Electronic Measurements & Instrumentation”, Dhanpat Rai & 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", PHI Publication.

| Unit | Text Books | Reference Books |
|---|---|---|
| I | T1,T2,T3,T4 | R1,R2,R3,R4 |
| II | T1,T2 | R1,R4 |
| III | T1,T2 | R1,R2 |
| IV | T1,T2 | R1,R2 |
| V | T1,T2,T3,T4 | R2,R3,R4 |
| VI | T1,T2,T3 | R2,R3 |

# 203150: Applications of Mathematics in Electrical Engineering

| Teaching Scheme | Credits | Examination Scheme [Marks] |
|---|---|---|
| **Practical** : 02 Hrs/ Week | **Pr**:01 | **Term Work**: 25 Marks |

**Prerequisite:** Basic mathematics, Engineering Mathematics-I, II

**Course Objective**: Course Objectives are:

- To relate mathematics and electrical problems.
- To introduce software solution
- To develop mathematical and complex problem solving skill.

**Course Outcome**: At the end of this course, learner will be able to

**CO1**: Apply fundamentals of mathematics in solving electrical engineering problem

**CO2**: Analyze complex electrical engineering problem using mathematical techniques.

**CO3**: Implement program and simulation for problems in electrical engineering.

**CO4**: Demonstrate self lifelong learning skills with applications of mathematics in electrical engineering through software.

Perform any **Eight** experiments from following list using any professional software:

1. To solve ordinary differential equations in electrical circuits or DC motors:
2. To apply Laplace Transform for solving ordinary differential equations in electrical circuits or DC motors:
3. To analyze the waveform generated using Fourier series.
4. To solve difference equations using z-Transform:
5. To Perform convolution of two discrete signal using software programming:
6. To solve linear simultaneous equations from electrical network (KVL/KCL) using software programming:
7. To determine a phasor of AC signal using Discrete Fourier Transform.
8. To perform mathematical addition, subtraction, multiplication and division of electrical signals.
9. To calculate rms and average values of given waveform using software programming.
10. To calculate electrical power under sinusoidal and non sinusoidal voltage and current

Perform any **Two** experiments from following list using any professional software:.

1. To determine maxima and minima of single/two variable problem.
2. To convert three phase electrical signal quantities dq0 transformation.
3. To apply partial difference equation in Electromagnetic (Maxwell equation)
4. To apply graph theory in network analysis
5. To calculate poles and zeros in complex electrical network.

**Guidelines for Instructor's Manual Practical Sessions**

The Instructor Manual should contain following related to every program

- Theory related to the method
- Algorithm
- Three to four different sets of problem statement
- Solve numerical using appropriate method
- Ten questions based on experiment
- Expected Output

**Guidelines for Student's Lab Journal**

The student's Lab Journal should contain following related to every experiment:

- Theory related to the method
- Algorithm
- Problem statement
- Solve numerical using appropriate method
- Program printout with output
- Conclusion
- Ten questions based on experiment

**Guidelines for Lab Assessment**

- There should be continuous assessment
- Assessment must be based on understanding of theory, attentiveness during practical session, how efficiently the student is able to do programming
- Timely submission of journal

**Guidelines for Laboratory Conduction**

- Detail theory and numerical related to the method should be taken 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

# 203151: Soft Skill

| Teaching Scheme | Credits | Examination Scheme [Marks] |
|---|---|---|
| **Practical** : 02 Hrs/ Week | **Pr**:01 | **Term Work**: 25 Marks |

**Course Objective**: The course aims to:-

- To possess knowledge of the 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, etiquette 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 :-

**CO1**: DoSWOC analysis.
**CO2**: Develop presentation and take part in group discussion.
**CO3**: Understand and implement etiquette in workplace and in society at large.
**CO4**: Work in team with team spirit.
**CO5**: 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 is the 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 Etiquette: (2 Hrs)**

Corporate grooming & dressing, Email & telephone etiquette, etiquette in social & office setting: Understand the importance of professional behavior at the work place, Understand and Implement etiquette in workplace, presenting oneself with finesse and making others comfortable in a business setting. Importance of first impression, Grooming, Wardrobe, Body language, Meeting etiquette (targeted at young professionals who are just entering business environment), Introduction to Ethics in engineering and ethical reasoning, rights and responsibilities.

**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

**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 minute search) 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. McGraw, “Basic Managerial Skills for all”, Eastern Economy Edition, Prentice hall
[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, ISBN139780743409384. S.E. Electrical Engineering (2015 course) – Savitribai Phule Pune University 25
[R7] Wayne Dyer, “Change Your Thoughts, Change Your Life”, Hay House India, ISBN-139788189988050.
[R8] Stephen Covey, “Habits of Highly Effective People”, Pocket Books, ISBN139781416502494.
[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] Shiv Khera, “You can win”, Macmillan, ISBN-139789350591932.
[R14] Gopalaswamy Ramesh, Mahadevan Ramesh, “The Ace of Soft Skills: Attitude, Communication and Etiquette for Success”

# 203152 : Audit Course-III

**List of three audit course is provided. Students can choose any one from 203152(A) 203152(B) and 203152(C)**

## 203152 (A) : Solar Thermal System

| Teaching Scheme<br>Lectures: 2hrs/week | Credits<br>No credit | Examination Scheme [Marks]<br>Grade: PP/NP<br>Quiz and 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 first-hand 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

**CO1**: Differentiate between types of solar Concentrators

**CO2**: Apply software tool for solar concentrators

**CO3**: 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

**Assignment**

- Design of solar thermal system for residential/ commercial building.

**References:**

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

# 203152 (B) : C Language Programming

| Teaching Scheme<br>Lectures: 2hrs/week | Credits<br>No credit | Examination Scheme [Marks]<br>Grade: PP/NP<br>Quiz and term paper |
|---|---|---|

**Course Objective:**

- To give basic idea about C programming language
- To prepare students for writing algorithm, draw flow chart and program in C language
- To learn data types and syntax in C language.

**Course Outcome:** Student will be able to

**CO1**: Elaborate data types, arithmetic, logical and conditional operators

**CO2**: Apply control and looping statements in C programming

**CO3**: Write programming using C language with functions, arrays and pointers.

**Course Contents:**

**Unit 01**: The language of C : Phases of developing a running computer program in C, Data concepts in C :Constants, Variables, Expressions, Operators, and operator precedence in C., Statements : Declarations, Input-Output Statements, Compound statements, Selection Statements. Conditions, Logical operators, Precedence. Repetitive statements, While construct, Do-while Construct, For construct., Data types, size and values. Char, Unsigned and Signed data types. Number systems and representations. Constants, Overflow., Arrays. Strings. Multidimensional arrays and matrices.

**Unit 02**: Functions :The prototype declaration, Function definition. Function call : Passing arguments to a function, by value, by reference. Pointers : Pointer variables. Declaring and dereferencing pointer variables. Pointer Arithmetic. Examples. Accessing arrays through pointers. Pointer

**Assignment**

- Write C program for arithmetic operations such as +,-,*,/,%.
- Write C program for decision making statements such as if, else-if etc.
- Write C program for Representative statements such as for, while, do-while.
- Write C program to determine roots of an quadratic equation using functions.
- Write C program to enter matrix data and printing its inverse.
- Write C program to demonstrate use of pointers.

**References:**

1. A.R. Bradley, "Programming for Engineers", Ringer, 2011
2. Hankering and Chitchat, "The C Programming Language", (2nd ed.) Prentice Hall, 1988

## 203152(C) Japanese Language-I

| Teaching Scheme<br>Lectures: 2hrs/week | Credits<br>No credit | Examination Scheme [Marks]<br>Grade: PP/NP<br>Quiz and term paper |
|---|---|---|

**Course Objective:**

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

**Course Outcome:** On completion of the course student

- Will have ability of basic communication.
- Will have the knowledge of Japanese script.
- Will get introduced to reading , writing and listening skills
- Will develop interest to pursue professional Japanese Language course.

**Course Contents:**

**Unit 1:** Introduction to Japanese Language. Hiragana basic script, colors, Days of the week

**Unit 2:** Hiragana: modified Kana, double consonant, Letters combined with ya, yu, yo Long vowels, Greetings and expressions

**Unit 3:** Self Introduction, Introducing other person, Numbers, Months, Dates, Telephone numbers, Stating one's age.

**References:**

1. Minna No Nihongo, "Japanese for Everyone", Elementary Main Text book 1-1 (Indian Edition), Goyal Publishers & Distributors Pvt. Ltd.

**Guidelines for Conduction**

(Any one or more of following but not limited to)

- Guest Lectures
- Visiting lectures
- Language Lab

**Guidelines for Assessment** (Any one of following but not limited to)

- Written Test
- Practical Test
- Presentation
- Paper
- Report

# 203145: Power System-I

| Teaching Scheme | Credits | Examination Scheme [Marks] |
|---|---|---|
| **Lecture** : 03 Hrs/ Week | **Th**: 03 | **In Sem** : 30 Marks<br>**End Sem** : 70 Marks |

**Prerequisite courses if any:** Power Generation, Various insulating materials and properties, Knowledge of fundamentals of electrical circuit components and engineering mathematics.

**Course Objectives:**

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

**Course Outcomes:**

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

**CO1:** Recognize different patterns of load curve and calculate associated different factors with it and tariff.

**CO2:** Draft specifications of electrical equipment in power station.

**CO3:** Design electrical and mechanical aspects in overhead transmission and underground cables.

**CO4:** Evaluate the inductance and capacitance of different transmission line configurations.

**CO5:** Analyse the performance of short and medium transmission lines

**Unit 01: Structure of Electrical Power Systems and Tariff [6Hrs]**

**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, Advantages of interconnected grid system, Fitting of available generating station into the area load duration curve. **[4 Hrs]**

**B) Tariff:** Introduction of Tariff, Tariff setting principles, desirable characteristics of tariff, various consumer categories and implemented tariff such as two part tariff, three part tariff(Numerical on two part and three part tariff), Time of day tariff for H.T and L.T industrial and commercial consumers, Introduction to Availability based tariff (ABT), kVAh tariff(Descriptive treatment only).[**2 Hrs**]

**Unit 02 Major Electrical Equipment's in Power Station & Underground Cables [ 6Hrs]**

**A) Major Electrical Equipment's in Power Station:** 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, Power transformers, voltage regulators, bus-bars, current limiting reactors, circuit breakers, protective relays. Current transformers, potential transformers, Lightning arresters, Earthing switches, isolators, Carrier current equipment's (P.L.C.C), Control panels, battery rooms, metering and other control room equipment in generating station**. [3Hrs]**

**B)Underground Cables:** Construction of Cables, Classification of cables, XLPE cables, Capacitance of single core and three core cable, Dielectric stresses in single core cable, Grading of cables, inter sheath grading, capacitance grading. **[3Hrs]**

**Unit 03: Mechanical Design of Overhead lines and Insulators: [6Hrs]**

**A) Mechanical Design of Overhead lines:** Main components of overhead lines, Various types of line supports, Conductor spacing, Length of span, Calculation of sag for equal and unequal supports and effect of ice and wind loading. **[3Hrs]**

**B) Overhead Line Insulators:** Types of insulators, its construction and their applications such as Pin type, Suspension type, Strain type, Shackle type, Post insulators, bushing. Potential distribution over suspension insulators, String efficiency, (Numerical on string efficiency and up to four discs only), Methods of improving string efficiency (Descriptive treatment only). **[3Hrs]**

**Unit 04:Resistance and Inductance of Transmission Line: [6Hrs]**

Resistance of transmission line, Skin effect and proximity effect, Factors responsible for production of these effects, Internal and external flux linkages of single conductor, Inductance of single phase two wire line, Necessity of transposition, Inductance of three phase line with symmetrical and unsymmetrical spacing with transposition, Concept of G.M.R and G.M.D, Inductance of bundled conductors.

**Unit 05: Capacitance of Transmission Line: [6Hrs]**

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, need of transposition for capacitance calculations, Capacitance of three phase line with symmetrical and unsymmetrical spacing with transposition. Capacitance of single circuit and double circuit three phase line with symmetrical and unsymmetrical spacing considering transposition (without considering earth effect).

**Unit 06: Performance of Transmission Line [6Hrs]**

Classification of lines based on length and voltage levels such as short, medium and long lines, Performance of short transmission lines with voltage current relationship and phasor diagram, Representation of medium lines as 'Nominal Π' and 'Nominal T' circuits using R,L and C parameters, Ferranti effect, Representation of 'T' and 'Π' models of lines as two port networks, Evaluation and estimation of generalized circuit constants (ABCD) for short and medium lines, Estimation of efficiency and regulation of short and medium lines**.**

**Industrial Visit**: Compulsory one visit to EHV substation is recommended

**Text Books:**

[T1] V.K.Meheta, Rohit Mehta, "Principles of Power System", S. Chand Publication.
[T2] J.B.Gupta, "Transmission and Distribution", S.K.Kataria and Sons, New Delhi.
[T3] J.B.Gupata,"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] M.V.Deshpande," Elements of Power Station Design", Wheeler Publishing.
[R5] I.J. Nagrath and D.P.Kothari," Modern Power System Analysis", Tata McGraw Hill
[R6] NPTEL course on Power System Engineering, IIT Kharagpur
https://nptel.ac.in/courses/108/105/108105104/
[R7] NPTEL course on Power System Analysis, IIT Kharagpur
https://nptel.ac.in/courses/108/105/108105067/
[R8] NPTEL Power System Analysis, IIT Kharagpur
https://www.youtube.com/playlist?list=PLRWKj4sFG7-6gWwDMLI0Wy5DDRqyKP1uQ
[R9] MAHADISCOM Website for tariff:
https://wss.mahadiscom.in/wss/wss?uiActionName=getEnergyBillCalculator
[R10] Maharashtra Electricity Regulatory Commission www.merc.gov.in

| Units | Text Books | Reference Books |
|---|---|---|
| 1 | T1,T3,T6 | R1,R3,R4,R8,R9,R10 |
| 2 | T1,T4 | R4,R6 |
| 3 | T1,T5 | R4,R6 |
| 4 | T1,T2,T5,T6 | R1,R7,R8 |
| 5 | T1,T2,T5,T6 | R1,R7,R8 |
| 6 | T1,T2,T5 | R3,R5,R7,R8 |

# 203146: Electrical Machines-I

| Teaching Scheme | Credits | Examination Scheme [Marks] |
|---|---|---|
| **Lecture** : 03 Hrs/ Week<br>**Practical** : 02 Hrs/ Week | **Th**: 03<br>**PR**:01 | **In Sem** : 30 Marks<br>**End Sem** : 70 Marks<br>**Practical** : 50 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 understand the construction, principle of operation of transformers, DC Machine & Induction Machine.
- To test & analyse the performance of machine.

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

**CO1**: Evaluate performance parameters of transformer with experimentation and demonstrate construction along with specifications as per standards.

**CO2**: Distinguish between various types of transformer connections as per vector groups with application and to perform parallel operation of single/three phase transformers.

**CO3**: Select and draft specifications of DC machines and Induction motors for various applications along with speed control methods.

**CO4**: Justify the need of starters in electrical machines with merits and demerits.

**CO5**: Test and evaluate performance of DC machines and Induction motors as per IS standard.

**Unit 01: Transformers: (6 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. Auto transformers, their ratings and applications. Comparison with two winding transformers with respect to saving of copper and size.

**Unit 02: (6 Hrs)**

**Transformers:**

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 (Part-1): (6 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 (Part-2): (6 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, different form

of commutations, causes of bad commutation and its remedies (Descriptive treatment only)

**Unit 05: Three Phase Induction Motor: (6 Hrs)**

Construction: Stator, Squirrel cage & wound rotors. Production of rotating mmf. 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: (6 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, comparison of various starters. Testing of three phase induction motor as per IS 325 & IS 4029.

**Industrial Visit:**

Minimum One visit to above machines manufacturing industry (mentioned in syllabus) is recommended.

**List of Experiments:**

**Compulsory Experiments:**

1. O.C. and S.C. test on single phase Transformer
   a. Determination of equivalent circuit parameters from the test data
   b. Determination of voltage regulation and efficiency
2. Parallel operation of two single phase transformers and study of their load sharing under various conditions of voltage ratios and leakage impedance.
3. Speed control of D.C. Shunt motor and study of starters.
4. Load test on 3-phase induction motor.

**Any four experiments are to be conducted of following experiments:**

1. Polarity test on single phase and three phase transformer.
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. No load & blocked-rotor test on 3-phase induction motor:

a) Determination of parameters of equivalent circuit.
b) Plotting of circle diagram.

6. Calculation of motor performance from (a) & (b) above.
7. Determination of sequence impedance of the transformer
8. To study Sumpner's test.
9. Measurements of non-sinusoidal current waveform of transformer at no load
10. Swinburne Test on DC shunt Motor.

**Text Books:**

[T1] Edward Hughes "Electrical Technology", ELBS, Pearson Education.
[T2] Ashfaq Husain, "Electrical Machines", Dhanpat Rai& 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", TataMcGraw

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] Smarajit Ghosh, "Electrical Machines", Pearson Education, New Delhi.
[R6] Charles I Hubert, "Electrical Machines Theory, Application, & Control", Pearson Education, New Delhi, Second Edition.

| Unit No. | Text Book | Book Reference |
|---|---|---|
| I | T1, T2, T3, T4 | R2, R4, R5 |
| II | T1, T2, T3, T4 | R2, R4, R5 |
| III | T2, T3, T4 | R1, R3, R5 |
| IV | T2, T3, T4 | R1, R3, R5 |
| V | T1, T3, T4, T5, T6 | R4, R5, R6 |
| VI | T1, T3, T4, T5, T6 | R4, R5, R6 |

# 203147: Network Analysis

| Teaching Scheme | Credits | Examination Scheme [Marks] |
|---|---|---|
| **Lecture** : 03 Hrs/ Week<br>**Practical** : 02 Hrs/ Week | **Th**: 03<br>**PR**:01 | **In Sem** : 30 Marks<br>**End Sem** : 70 Marks<br>**Term Work**: 25 Marks |

**Prerequisite:**

Terminology of electrical networks, series and parallel combinations of resistance, Laplace transforms , linear differential equations.

**Course Objective:**

1. To develop the strong foundation for Electrical Networks.
2. To develop analytical qualities in Electrical circuits by application of various theorems.
3. To understand the behavior of circuits by analyzing the transient response using classical methods and Laplace Transform approach.
4. To apply knowledge of laws and 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 :-

**CO1**: Calculate current/voltage in electrical circuits using simplification techniques, Mesh, Nodal analysis and network theorems.

**CO2**: Analyze the response of RLC circuit with electrical supply in transient and stead state.

**CO3**: Apply Laplace transform to analyze behaviour of an electrical circuit.

**CO4**: Derive formula and solve numerical of two port network and Design of filters

**CO5**: Apply knowledge of network theory to find transfer function, poles and zeroes location to perform stability analysis and parallel resonance

**Unit 1 Types of Network, Mesh and Nodal analysis** [6 Hrs]

Lumped and Distributed, Linear and Nonlinear, Bilateral and Unilateral, Time-variant and Time-invariant. Independent and Dependent (controlled) voltage and current sources. Concept of voltage and current divider, Source transformation and shifting. Network Equations: Network equations on Loop basis and Node basis, choice between Loop analysis and Nodal analysis. Concept of super node and super mesh, mutual inductance, Dot convention for coupled circuits, Concept of duality and dual networks.

**Unit 2: Network Theorem**:[6 Hrs]

Superposition, Thevenin, Norton, Maximum Power Transfer Theorem, Reciprocity, Millman theorems applied to electrical networks with all types of sources.

Graph Theory : Tree ,Co-tree, Incidence matrix ,F-cutest Matrix, Tie set B Matrix

**Unit 3: Transients in RLC circuit**[6 Hrs]

Solutions of differential equations and network equations using classical method for R-L, R-C and R-L-C circuits, Initial and Final Condition (series and parallel).

**Unit 4: Laplace Transform**[6 Hrs]

Basic Properties of Laplace Transform, Laplace Transform of Basic R, L and C components, Solutions of differential equations and network equations using Laplace transform method for RL, R-C and R-L-C circuits (series and parallel), Inverse Laplace transforms, transformed networks with initial conditions. Analysis of electrical circuits with applications of step, pulse, impulse & ramp functions, shifted & singular functions the convolution integral,application of initial and final value theorem.

**Unit 5 Two port network and Filters** [6 Hrs]

Two Port Network: Z, Y, H and transmission parameters, Interrelations between parameters. Introduction to passive filters, low pass filters, high pass filters and m-derived LPF and HPF filters and design.

**Unit 6 Network Functions:** [6 Hrs]

Poles and Zeros: Terminal pairs or ports, network functions for the one port and two ports, the calculation of network functions, general networks. Poles and zeros of network functions, Restrictions on poles and zeros locations for transfer functions and driving point function, Time

–domain behavior from the pole and zero plot. Stability of active networks. Parallel Resonance, Resonance frequency, Quality factor, Current and resonance.

**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 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. Determination of current under parallel Resonance condition .
11. Determination of Resonance, Bandwidth and Q factor of R-L-C series circuit.

**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 formula 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.
- Students should get the assignment and lab write up checked within 1 week after performing the experiment.

**Guidelines for Lab**

- TW 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.

**Text Book:**

[T1] Network Analysis Third Edition by M. E. Van Valkenburg, Prentice Hall of India Private Limited.
[T2] Network Analysis & Synthesis by G. K. Mittal, Khanna Publication.
[T3] Network Analysis and Synthesis by Ravish R Singh, McGraw Hill.
[T4] Introduction to Electric Circuits by Alexander & Sadiku, McGraw Hill.
[T5] Introduction to Electric Circuits by S. Charkarboorty, Dhanpat Rai & Co.
[T6] Fundamentals of Electrical Networks by B.R.Gupta & Vandana Singhal- S.Chand Publications 8. Electrical Circuit Analysis 2nd Edition by P. Ramesh babu, Scitech Publication India Pvt Ltd.

**Reference Books:**

[R1] Network Analysis by Cramer , McGraw Hill Publication.
[R2] Engineering Circuit Analysis by William H. Hayt, Jr. Jack E. Kemmerly, McGraw Hill Publication.
[R3] Schaum's Outline of Electric Circuits, McGraw-Hill Education; 7 edition

| Unit | Text book | Reference |
|---|---|---|
| 1 | T1,T2, T3 T5 | R1,R3 |
| 2 | T1,T2, T3, T4 | R1,R3 |
| 3 | T2, T3,T5 | R2,R3 |
| 4 | T2, T3,T5 | R2,R3 |
| 5 | T2, T3, T4 | R3 |
| 6 | T5,T6 | R3 |

# 203148: Numerical Methods and Computer Programming

| Teaching Scheme | Credits | Examination Scheme [Marks] |
|---|---|---|
| **Lecture** : 03 Hrs/ Week<br>**Practical** : 02 Hrs/ Week | **Th**: 03<br>**PR**:01 | **In Sem** : 30 Marks<br>**End Sem** : 70 Marks<br>**Practical** : 25 Marks |

**Prerequisite:**

1. Differentiation and integration of a single real variable, ordinary differential equations.
2. Programming and Problem solving.
3. Linear Algebra.

**Course Objectives:**

1. To emphasize the need of computational techniques and analyze errors involved in the computation.
2. To provide sound knowledge of various numerical methods.
3. 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.
4. To impart skills to develop algorithms and programs for various numerical methods.

**Course Outcomes:**

On completion of the course, student will be able to

**CO1:**Demonstrate types of errors in computation and their causes of occurrence.

**CO2:** Calculate root of algebraic and transcendental equations using various methods.

**CO3:** Apply numerical methods for various mathematical problems such as interpolation, numerical differentiation, integration and ordinary differential equation.

**CO4**: Solve linear simultaneous equation using direct and indirect method.

**CO5:**Develop algorithms and write computer programs for various numerical methods.

**Unit 01 : Numerical Computations, Errors and Concept of root of equation (6hrs)**

**A)** Basic principle of numerical computation. 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 (Derivation and Numerical )

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

**Unit 02: Solution of Transcendental and polynomial equation and Curve Fitting: (6hrs)**

**A)** Solution of Transcendental and polynomial equation using Bisection, Regula- Falsi, Newton-Raphson method for single variable and two variables.

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

**Unit 03: Interpolation (6hrs)**

Forward, Backward, Central and Divided Difference operators, Introduction to interpolation.

**A)Interpolation with equal Intervals** - Newton's forward, backward interpolation formula (Derivations and numerical), Stirling's and Bessel's central difference formula (Only numericals)

**B) Interpolation with unequal Intervals**- Newton's divided difference formula and Lagrange's interpolation (Derivations and numerical).

**Unit 04: Numerical Differentiation and Integration (6hrs)**

A) **Numerical Differentiation** using Newton's forward and backward interpolation formula (Derivation and numerical).

**B) Numerical Integration:** Trapezoidal and Simpson's rules as special cases of Newton-Cote's quadrature technique for single integral. Numerical on double integrals using Trapezoidal and Simpson's 1/3 $^{rd}$ rule.

**Unit 05:Solution of linear simultaneous equation (6hrs)**

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

**B)Matrix Inversion** using Gauss Jordan method

**Unit 06: Solution of Ordinary Differential Equation(ODE) (6hrs)**

**A) Solution of First order Ordinary Differential Equation** (ODE) using Taylor's series method, Euler's method, Modified Euler's method (Derivation and numerical). Runge-Kutta fourth order method (Numerical).

**B)Solution of Second order ODE** using 4th order Runge-Kutta method (Numerical)

**List of Experiments:**

Develop computer program using **Python language**

**Compulsory Experiments-1,2,3,4,7,10**

**Any one from 5 or 6 and any one from 8 or 9**

1. Develop algorithm, draw flow chart and write a program to implement following:
   (a) for loop and while loop-- application in Descarte's rule of sign.
   (b) if-else and functions-- application in Intermediate value theorem.
   (c) 2DArray formation-- application in matrix data entry, transposition and printing matrix.
2. Develop algorithm, draw flow chart and write a program to implement Birge-Vieta method.
3. Develop algorithm, draw flow chart and write a program to implement Bisection/Regula falsi /Newton-Raphson method (single variable) in following applications (formulate problem statement in any one of following area(but not limited to))
   (a) Finding critical clearing angle in power system stability (give equation directly)
   (b) Relation between voltage and current in solar PV.
4. Develop algorithm, draw flow chart and write a program to implement curve fitting using least square approximation in following applications (formulate problem statement in any one of following area(but not limited to))
   (a) Voltage across capacitor during charging.
   (b) Relate temperature and resistance in thermocouple.
   (c) Current through inductor during excitation.
5. Develop algorithm, draw flow chart and write a program to apply Newton's forward/backward interpolation method in following applications (formulate problem statement in any one of following area(but not limited to))
   (a) Voltage across capacitor during charging
   (b) Relation of speed and armature voltage in DC motor.
   (c) Relation of breakdown voltage and thickness of insulation
6. Develop algorithm, draw flow chart and write a program to apply Newton's divided difference/Lagrange's interpolation method in following applications (formulate problem statement in any one of following area(but not limited to))
   (a) Power transfer equation to find power at particular angle
   (b) Transformer efficiency at particular loading (data of % loading and efficiency in known at a particular power factor)
   (c) Growth of electricity consumption in India (year Vs. Per capita electrical consumption).
7. Develop algorithm, draw flow chart and write a program to implement trapezoidal/ Simpson (1/3)rd rule in following applications (formulate problem statement in any one of following area(but not limited to))
   (a) RMS/Average value of given waveform.
   (b) Finding current through first order circuit (RL series)
   (c) kWh consumption from load curve
   (d) Magnetic field intensity in overhead transmission line
8. Develop algorithm, draw flow chart and write a program to implement Gauss elimination/Jordan in following applications (formulate problem statement in any one of following area(but not limited to))
   (a) Electrical network using KVL
   (b) Electrical Network using KCL
9. Develop algorithm, draw flow chart and write a program to implement Gauss Jacobi/Seidel in following applications (formulate problem statement in any one of following area(but not limited to))
   (a) Electrical network using KVL
   (b) Electrical Network using KCL
10. Develop algorithm, draw flow chart and write a program to implement Modified Euler's/$4^{th}$ order RK method in following applications (formulate problem statement in any one of following area(but not limited to)
   (a) Response of RC series circuit with DC
   (b) Response of RL circuit with DC
   (c) Deflection angle in MI type instrument

**Guidelines for Instructor's Manual Practical Sessions**

The Instructor Manual should contain following related to every program

- Theory related to the method
- Algorithm and Flowchart of the method
- Three to four different sets of problem statement for numerical method

- Solve numerical using appropriate method
- Ten questions based on method and related Python commands
- Expected Output

**Guidelines for Student's Lab Journal**

The student's Lab Journal should contain following related to every experiment:

- Theory related to the method
- Algorithm and Flowchart of the method
- Problem statement for numerical method
- Solve numerical using appropriate method
- Program printout with output
- Conclusion
- Ten questions based on method and related Python commands

**Guidelines for Lab Assessment**

- There should be continuous assessment
- Assessment must be based on understanding of theory, attentiveness during practical session, how efficiently the student is able to do programming
- Timely submission of journal

**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

**Books & Other Resources:**

**Text Books:**

[T1] M. K. Jain, S.R.K. Iyangar, R. K. Jain, "Numerical Methods for Scientific and Engineering Computations", New Age Publications.
[T2] Dr. B. S. Grewal, "Numerical Methods in Engineering & Sciences", Khanna Publishers.
[T3] P.P. Gupta & G.S Malik, "Calculus of Finite Difference and Numerical Analysis", Krishna Prakashan Media Ltd, Meerut**.**
[T4] T. Veerarajan and T. Ramchandran, "Numerical Methods with Programs in C and C++", Tata McGraw Hill Publication.
[T5] S Arumugam, "Numerical Methods" Scitech 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] S.S. Sastry, "Introductory methods of Numerical Analysis", PHI Learning Private Ltd.
[R4] P. Thangaraj, "Computer oriented Numerical Methods", PHI Learning Private Ltd.
[R5] Yashwant Kanitkar, "Let us Python", pbp publications
[R6] NPTEL course on Numerical Analysis, IIT, Roorkee.
https://nptel.ac.in/courses/111107062/
[R7] NPTEL course on MATLAB Programming on Numerical Computation, IIT Madras
https://nptel.ac.in/courses/103106118/
[R8] NPTEL course on Python for Data Science, IIT Madras
https://nptel.ac.in/courses/106106212/
[R9]Jaan Kiusalaas, "Numerical methods in Engineering with Python", Cambridge University Press

| Unit No | Text Books | References |
|---|---|---|
| 1 | T5, T4 | R2, R3, R6 |
| 2 | T1, T5 | R2, R3, R6 |
| 3 | T3, T4, T5 | R4, R2, R1, R6, R7 |
| 4 | T2, T3,T5 | R2, R3, R7 |
| 5 | T2, T3,T5 | R2, R3, R7 |
| 6 | T2, T3,T5 | R2, R3, R6, R7 |
| Python | -- | R5, R8,R9 |

# 203149: Fundamental of Microcontroller and Applications

| Teaching Scheme | Credits | Examination Scheme [Marks] |
|---|---|---|
| **Lecture** : 03 Hrs/ Week<br>**Practical** : 04 Hrs/ Week | **Th**: 03<br>**PR**:02 | **In Sem** : 30 Marks<br>**End Sem** : 70 Marks<br>**Term Work**: 25 Marks<br>**Oral** : 25 Marks |

**Prerequisite:**

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

**Course Objective:** Objectives of the course are to

- Explain the microcontroller architecture & describe the features of a typical microcontroller.
- To use the 8051 addressing modes and instruction set and apply this knowledge to develop programs in assembly language and C language.
- To define the protocol for serial communication and understand the microcontroller development systems.
- Explain the interrupt structure of the microcontroller and to develop programs related to interrupt handling
- To introduce students to Global System for Mobile Communication (GSM)
- To provide students with interfacing concepts and develop interfacing circuits for simple devices.

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

**CO1**: Describe the architecture and features of various types of the microcontroller.

**CO2**: Illustrate addressing modes and execute programs in assembly language for the microcontroller.

**CO3**: Write programs in C language for microcontroller 8051.

**CO4**: Elaborate interrupt structure of 8051 and program to handle interrupt and ADC809

**CO5**: Define the protocol for serial communication and understand the microcontroller development systems.

**CO6**: Interface input output devices and measure electrical parameters with 8051 in real time.

**Unit 01 :** **(6 Hrs)**

Introduction to concept of microcontroller, Intel 8051 Functional block diagram, Functions of pins of 8051, Memory organization of 8051, PSW and Flag Bits, Stack and Stack pointer. Overview of special function registers,Data transfer instructions and programs in assembly language.

**Unit 02 :** **(6 Hrs)**

Arithmetic and logical instructions and programs in assembly language.Boolean and Program Branching instructions and programs in assembly language.Addressing modes of 8051.

**Unit 03 :** **(6 Hrs)**

8051 Programming in C , Data types in C . Ports of 8051, their use, and programming in C (Byte Level and Bit-level). Time delay programming in C.

Timers and counters in 8051, Timer modes 0,1,2 and its programming in C and counter-programming.

**Unit 04 :** **(6 Hrs)**

Interrupt structure of 8051 and SFR associated with interrupts Programming of External hardware interrupts in C. Interfacing of ADC 0809 with 8051.

**Unit 05 :** **(6 Hrs)**

Serial port Structure in 8051. Programming of Serial port for transferring and receiving data in C in mode 1.

Introduction to GSM module, AT commands, Programming to send and read SMS.

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

Measurement of electrical parameters such as voltage, current (Theoretical Treatment only).

Interfacing of Stepper motor with 8051 and its programming in C. Interfacing and programming of single Key, LED, and Relay with 8051 in C.

**Guidelines for Instructor's Manual**

1. Commands to be followed to operate the 8051 microcontroller kit.
2. The architecture of the 8051 microcontroller kit-Functional block diagram & its explanation.
3. Pin Diagram of 8051 microcontrollers with a 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 an 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 a 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. A faculty member has to check the result of all the groups after the execution of the program.

**List of Experiments:**

**PART A: [TW: 15 Marks]**

**Compulsory Experiments:**

1. Study and use of 8051 Microcontroller trainer kit.
2. Assembly Language Program for the arithmetic operation of 8-bit numbers.
3. Assembly Language Program for finding the largest number and smallest number from a given an array of 8-bit numbers.
4. Assembly Language program to arrange 8-bit numbers stored in an array in ascending order and descending order.

**Any four experiments are to be conducted of the following experiments using embedded C :**

1. Implementation of Serial Communication by using 8051 serial ports.
2. Programming using a cross-assembler.
3. The blinking display of LED's interfaced with 8051.
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 the relay with 8051.
7. Stepper motor control by 8051 Microcontroller.
8. Interfacing of matrix keyboard/ 7 segment display with 8051.
9. Interfacing of LCD with 8051.

**PART B: [TW: 10 Marks]**

**Prerequisite: Programming exercises of C language.**

**Compulsory Experiments:**

1. Study of GSM Module SIM800/SIM900/QUECTEL M95 and AT Commands
2. Study of IoT system
3. Interfacing of GSM with a computer through COM port to Send and Receive SMS.
4. Interfacing GSM with 8051 trainer kit and develop a program to send AT commands.

**Any two experiments are to be conducted of the following experiments:**

1. Develop a program in C to read and send SMS from the GSM module.
2. Measurement of physical parameters (Temperature/Pressure/Humidity) using 8051 and send value to GSM after an interval of the specified interval.
3. Measurement of electrical parameters (Voltage/Current) using 8051 and send value to the GSM module after an interval of 10min.
4. Develop a program to turn on and turn off induction Motor using 8051 and GSM module.
5. Development of mobile app for various applications in electrical engineering.

**Text Books:**

[T1] Muhammad Ali Mazidi, J.G. Mazidi, "The 8051 Microcontroller and Embedded Systems", Pearsons Publishers.
[T2] V Udayashankara and M S MallikarjunaSwamy, "8051 Microcontroller, Hardware, software and applications", TATA McGraw Hill.
[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.
[T7] Han-Way Huang," Embedded System Design with C8051", Cengage Learning

**Reference Books:**

[R1] Scott Mackenzie, "8051 Microcontroller", Pearson Education.
[R2] Intel Microcontroller data book.
[R3] Intel Corporation 1990- 8 bit embedded controller handbook.

# 203152: Project Based Learning

| Teaching Scheme | Credits | Examination Scheme [Marks] |
|---|---|---|
| **Practical** : 04 Hrs/ Week | **PR**:02 | **Term Work**: 50 Marks |

**Preamble**: For better learning experience, along with traditional classroom teaching and laboratory learning, project-based learning has been introduced to motivate students to learn by working in a group cooperatively to solve a problem. Project-Based Learning (PBL) is a student-centered and experimental approach to education promoting 'deeper learning' through active exploration of real-world problems and challenges. A central goal of PBL is to facilitate the deeper learning process and support students' acquisition of complex cognitive competencies, e.g., rigorous content knowledge and critical thinking skills. The PBL engages students in the problem definition, design process, contextual understanding, and systems thinking approaches. In the PBL approach, learning based on memorization is de-emphasized and more emphasis is given on understanding and application of engineering design principles. Because of frequent assessments throughout the course, plagiarism can be more easily controlled.

**Course Objectives**: Objectives of this course are to

1. Impart technical knowledge and skills, and develop deeper understanding to integrate knowledge and skills from various areas.
2. Build critical thinking, problem-solving, communication, collaboration and creativity, and innovation amongst students
3. Make students aware of their own academic, personal, and social developments.
4. Develop habits of self-evaluation and self-criticism, against self-competency and trying to see beyond own ideas and knowledge

**Course Outcomes**: At the end of this project-based learning, students will be able to

**CO1:** Identify, formulate, and analyze the simple project problem.

**CO2:** Apply knowledge of mathematics, basic sciences, and electrical engineering fundamentals to develop solutions for the project.

**CO3:** Learn to work in teams, and to plan and carry out different tasks that are required during a project.

**CO4:** Understand their own and their team-mate's strengths and skills.

**CO5:** Draw information from a variety of sources and be able to filter and summarize the relevant points.

**CO6:** Communicate to different audiences in oral, visual, and written forms.

**Procedure:** A group of 4-5 students will be assigned to a faculty member called a mentor. Based on the engineering knowledge of a group and societal and industry problems, the mentor has to guide a group to identify project problems and plan the work schedule. Here, the expected outcomes of the project must be noted. The complete work-plan should be divided in the form of the individual tasks to be accomplished with targets. Weekly review of the completed task should be taken and further guidelines are to be given to a group. The final activity will be presenting the work completed and submitting the report. A group should be promoted to participate in a competition or write a paper.

A problem needs to refer back to a particularly practical, scientific, social, and/or technical domain. The problem should stand as one specific example or manifestation of more general learning outcomes related to knowledge and/or modes of inquiry. There are no commonly shared criteria for what constitutes an acceptable project. Projects vary greatly in the depth of the questions explored, the clarity of the learning goals, the content, and the structure of the activity. It may have

- ✓ A few hands-on activities that may or may not be multidisciplinary.
- ✓ Use of technology in meaningful ways to help them investigate, collaborate, analyze, synthesize, and present their learning.
- ✓ Activities on solving real-life problems, investigation /study, and writing reports of in-depth study, fieldwork.

**Assessment:**

The department/mentor is committed to assess and evaluate both students' performance and course effectiveness. The progress of PBL is monitored regularly every week. During the process

of monitoring, continuous assessment and evaluation the individual and team performances are to be measured by supervisor /mentor and authorities.

Students must maintain an institutional culture of authentic collaboration, self-motivation, peer-learning, and personal responsibility. The institution/department should support students in this regard through guidance/orientation programs and the provision of appropriate resources and services. Supervisor/mentor and students must actively participate in the assessment and evaluation processes. Groups may demonstrate their knowledge and skills by developing a solution to the problem, public product, and/or report and/or presentation.

- ✓ Individual assessment for each student (Understanding individual capacity, role, and involvement in the project)
- ✓ Group assessment (roles defined, distribution of work, intra-team communication and togetherness)
- ✓ Documentation and presentation

**Evaluation and Continuous Assessment:**

It is recommended that all activities are to be recorded in a PBL workbook regularly, regular assessment of work to be done and proper documents are to be maintained at the department level by both students as well as a mentor. Continuous Assessment Sheet (CAS) is to be maintained by all mentors/department. Recommended parameters for assessment, evaluation, and weightage are as follows.

- ✓ Idea Inception **(5%)**
- ✓ Outcomes of PBL/ Problem Solving Skills/ Solution provided/ Final product **(50%)** (Individual assessment and team assessment)
- ✓ Documentation (Gathering requirements, design and modeling, implementation/execution, use of technology and final report, other documents) **(25%)**
- ✓ Demonstration (Presentation, User Interface, Usability, etc.) **(10%)**
- ✓ Contest Participation/ publication **(5%)**
- ✓ Awareness /Consideration of -Environment/ Social /Ethics/ Safety measures/Legal aspects **(5%)**
- ✓ PBL workbook will serve the purpose and facilitate the job of students, mentors, and project coordinator. This workbook will reflect accountability, punctuality, technical writing ability and work flow of the work undertaken

# 203153: Audit Course-IV

**List of three audit course is provided. Students can choose any one from 203153(A) 203153(B) and 203153(C)**

## 203153(A): Solar Photovoltaic Systems

| Teaching Scheme<br>Lectures: 2hrs/week | Credits<br>No credit | Examination Scheme [Marks]<br>Grade: PP/NP<br>Quiz and term paper |
|---|---|---|

**Prerequisite**: Completion of FE or equivalent

**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

**CO1**: design of Solar PV system for small and large installations

**CO2**: 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 modelling 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

**Assignment**

- Design of solar PV system for department / college.

**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

# 203153(B) Installation & Maintenance of Electrical appliances

| Teaching Scheme<br>Lectures: 2hrs/week | Credits<br>No credit | Examination Scheme [Marks]<br>Grade: PP/NP<br>Quiz and term paper |
|---|---|---|

**Prerequisite:** Completion of FE/DEE or equivalent

**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

# 203153(C) Japanese Language-II

| Teaching Scheme<br>Lectures: 2hrs/week | Credits<br>No credit | Examination Scheme [Marks]<br>Grade: PP/NP<br>Quiz and term paper |
|---|---|---|

**Course Objective:**

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

**Course Outcome:** On completion of the course student

- Will have ability of basic communication.
- Will have the knowledge of Japanese script.
- Will get introduced to reading , writing and listening skills
- Will develop interest to pursue professional Japanese Language course.

**Course Contents:**

**Unit 1:** Katakana basic Script, Denoting things (nominal & prenominal demonstratives) Purchasing at the Market / in a shop / mall (asking & stating price)

**Unit 2:** Katakana: Modified kana, double consonant, letters with ya, yu, yo, Long vowels Describing time, describing starting & finishing time (kara ~ made) Point in time (denoting the time when any action or the movement occurs)

**Unit 3:** Means of transport (Vehicles), Places, Countries, Stating Birth date, Indicating movement to a certain place by a vehicle

**References:**

1. Minna No Nihongo, “Japanese for Everyone”, Elementary Main Text book 1-1 (Indian Edition), Goyal Publishers & Distributors Pvt. Ltd.

**Guidelines for Conduction**

(Any one or more of following but not limited to)

- Guest Lectures
- Visiting lectures
- Language Lab

**Guidelines for Assessment** (Any one of following but not limited to)

- Written Test
- Practical Test
- Presentation
- Paper
- Report

# Savitribai Phule Pune University, Pune

## Faculty of Science and Technology

Board of Studies

## Electrical Engineering

Syllabus

## Third Year Electrical Engineering (2019 course)

**(w.e.f. 2021-22)**

# Savitribai Phule Pune University, Pune
# Syllabus: Third Year (TE) Electrical Engineering (2019 course)
# (w.e.f 2021-22)

## SEMESTER-I

| Course code | Course Name | Teaching Scheme | | | | Examination Scheme | | | | | | Credit | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Th | Pr | Tu | SEM /PW /IN | ISE | ESE | TW | PR | OR | Total | Th | Pr | Tu | SEM /PW /IN | Total |
| 303141 | Industrial and Technology Management | 3 | 0 | 0 | 0 | 30 | 70 | 0 | 0 | 0 | 100 | 3 | 0 | 0 | 0 | 3 |
| 303142 | Power Electronics | 3 | 4# | 0 | 0 | 30 | 70 | 0 | 50 | 0 | 150 | 3 | 2 | 0 | 0 | 5 |
| 303143 | Electrical Machines-II | 3 | 2 | 0 | 0 | 30 | 70 | 25 | 25 | 0 | 150 | 3 | 1 | 0 | 0 | 4 |
| 303144 | Electrical Installation Design and Condition Based Maintenance | 3 | 4# | 0 | 0 | 30 | 70 | 25 | 0 | 25 | 150 | 3 | 2 | 0 | 0 | 5 |
| 303145 | Elective-I | 3 | 0 | 0 | 0 | 30 | 70 | 0 | 0 | 0 | 100 | 3 | 0 | 0 | 0 | 3 |
| 303146 | Seminar | 0 | 0 | 0 | 1 | 0 | 0 | 50 | 0 | 0 | 50 | 0 | 0 | 0 | 1 | 1 |
| 303147 | Audit course-V | 2* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | GRADE: PP/NP | | | | 0 |
| **Total** | | **15** | **10** | **0** | **1** | **150** | **350** | **100** | **75** | **25** | **700** | **15** | **5** | **0** | **1** | **21** |

| **303145: Elective-I** | **303147 : Audit Course-V** |
|---|---|
| 303145A : Advanced Microcontroller and Embedded System | 303147A : Energy storage systems |
| 303145B : Digital Signal Processing | 303147B : Start-up & Disruptive innovation |
| 303145C : Open Elective | |

## SEMESTER-II

| Course code | Course Name | Teaching Scheme | | | | Examination Scheme | | | | | | Credit | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Th | Pr | Tu | SEM /PW /IN | ISE | ESE | TW | PR | OR | Total | Th | Pr | Tu | SEM /PW /IN | Total |
| 303148 | Power System-II | 3 | 2 | 1 | 0 | 30 | 70 | 25 | 50 | 0 | 175 | 3 | 1 | 1 | 0 | 5 |
| 303149 | Computer Aided Design of Electrical Machines | 3 | 4# | 0 | 0 | 30 | 70 | 50 | 0 | 25 | 175 | 3 | 2 | 0 | 0 | 5 |
| 303150 | Control System Engineering | 3 | 2$ | 1$ | 0 | 30 | 70 | 25 | 0 | 25 | 150 | 3 | 1 | 0 | 0 | 4 |
| 303151 | Elective-II | 3 | 0 | 0 | 0 | 30 | 70 | 0 | 0 | 0 | 100 | 3 | 0 | 0 | 0 | 3 |
| 303152 | Internship | 0 | 0 | 0 | 4 | 0 | 0 | 100 | 0 | 0 | 100 | 0 | 0 | 0 | 4 | 4 |
| 303153 | Audit Course VI | 2* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | GRADE: PP/NP | | | | 0 |
| Total | | 12 | 8 | 2 | 4 | 120 | 280 | 200 | 50 | 50 | 700 | 12 | 4 | 1 | 4 | 21 |

| **303151: Elective-II** | **303153 : Audit Course-VI** |
|---|---|
| 303151A : IoT and its Applications in Electrical Engineering | 303153A: Ethical Practices for Engineers |
| 303151B : Electrical Mobility | 303153B :Project Management |
| 303 151C: Cybernetic Engineering | |
| 303151D: Energy Management | |

#Practical consists of Part A & part B. PART A; Regular experiments & part B; to bridge the gap between theory & actual industrial practices. For subject 303144; there will be auto cad drawing on Electrical installation, Electrical wiring, cabling etc. For 303149, Part A, Regular drawing by hand & part B same drawing by AutoCAD.
$ tutorial credit merged with Practical.
* Conduct over and above these lectures.

Savitribai Phule Pune University
सावित्रीबाई फुले पुणे विद्यापीठ

# 303141: Industrial and Technology Management

| Teaching Scheme | | | Credits | | Examination Scheme | |
|---|---|---|---|---|---|---|
| **Theory** | 03 | Hr/Week | **TH** | 03 | **ISE** | 30 Marks |
| | | | | | **ESE** | 70 Marks |

## Course Objectives: This course aims to

- Possess knowledge of types of business organizations.
- Explore the fundamentals of Industrial economics and Management.
- Understand the basic concepts of Technology management and Quality management.
- Analyze and differentiate between marketing management and financial management.
- Recognize the importance of Motivation, Group dynamics, Teamwork, 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.
- Software programming to construct and use simple mathematical model.
- Ability to carry out basic manufacturing and testing procedure.

## Course Outcomes: At the end of this course, student will be able to

| | |
|---|---|
| **CO1** | Differentiate between different types of business organizations and discuss the fundamentals of economics and management. |
| **CO2** | Explain the importance of technology management and quality management. |
| **CO3** | Explain the importance of IPR and role of Human Resource Management. |
| **CO4** | Understand the importance of Quality and its significance. |
| **CO5** | Describe the characteristics of marketing & its types and overview of financial Management. |
| **CO6** | Discuss the qualities of a good leader and road map to Entrepreneurship. |

## Unit 01 Introduction to Management and Economics — 07 hrs

**A) Management:** Meaning, scope, function, and importance of management. Difference between administration and management.

**B) Industrial Economics:** Definition of economics, Demand and Supply concept, Demand Analysis. Types of Demand, Determinants of Demand, Law of demand and supply, Elasticity of demand and supply, Law of Diminishing Marginal utility, Demand forecasting: Meaning and methods.

**C) Business Organizations:** Line organization, Staff organization and Functional Organization, (Project, Matrix, Committee Organization.)

**D) Business Ownership and its Types:** Types of business ownership, Sole proprietorship, Partnership (Act 1934), LLP (Limited Liability Partnership) (Act 2008). One person company, Joint Stock Company: Public Limited and Private Limited, Public Sector Undertaking (PSU).

## Unit 02 Technology Management — 05 hrs

**A) Technology Management:** Definition of technology Management and its relation with society, development, application and its scope.

**B) Classification of Technology Management:** Classification of technology management at various levels- its importance on National Economy, Ethics in technology management, Critical factors in technology management.

## Unit 03 Intellectual Property Rights (IPR) & Human Resource Management (HRM) — 06 hrs

**A) Introduction to Intellectual Property Rights (IPR):** Meaning of IPR, Different forms of IPR, Patents, Criteria for securing Patents. Patent format and structure, Copy rights and trademark (Descriptive treatment only).

**B) Human Resource Management:** Introduction, importance, scope, HR planning, Recruitment, selection, training and development, Performance management.

| Unit 04 | Quality Management | 06 hrs |
|---|---|---|

**A) Quality Management:** Definition of quality, continuous improvement, Types of quality, Quality of design, Seven QC Tools, Poka Yoke (Mistake Proofing), Quality circles, Kaizen. TQM, 5S (Case study of Toyota, descriptive treatment). Six-Sigma.
Basic software used for inventory management and quality management like Zoho inventory, Oracal, Netsuite, Vyapar, Quick book commerce.

**B) Quality Management Standards (Introductory aspects only):-** The ISO9001:2000 Quality Management System Standard-The ISO14001:2004, ISO26000, ISO 10004:2012, ISO 9001:2012 ISO 9001:2016, Environmental Management System Standard.

| Unit 05 | Marketing and Financial Management | 06 hrs |
|---|---|---|

A) **Marketing Management**: Meaning of Market, Marketing strategy, motives, market characteristics and its types, Perfect Competition, Monopoly, Monopolistic completion and Oligopoly. New product development, Product life cycle, Marketing and selling, methods of selling, marketing planning. Market survey and market research, Online Marketing (Digital Marketing).

B) **Financial Management:** Definition of financial management, cost Concept, Types of costs (Fixed, Variable, average, marginal, and total cost) and methods of costing price, capital. Debit, credit, Profit and loss statement, Balance sheet, Depreciation Analysis, causes and significance, methods of calculation of depreciation, Taxation system, and type of taxes.

| Unit 06 | Motivational Theory and Entrepreneurship | 06 hrs |
|---|---|---|

**A) Motivation:** Introduction to Motivation, theories of work motivation, Content Theories: Maslow's Hierarchy of Needs, Herzberg's Two factor theory, McClelland's Three Needs Theory, McGregor's Theory X and Theory Y.
Process Theories: Adam's Equity Theory, Vroom's Expectancy Theory, Taylor's Motivation Theory

**B) Leadership:** Importance of Leadership, Types of Leadership: Autocratic, Democratic and Laissez-Faire Leadership, qualities of good Leader. Group dynamics: Types and interactions of groups, stages of group dynamics: Norming, Storming, Forming, Performing and Adjourning.

**C) Entrepreneurship**: 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.

## Test Books:


| | |
|---|---|
| **[T1]** | O. P. Khanna, industrial engineering and management, Dhanpat Rai and sons, New Delhi. |
| **[T2]** | E. H. McGraw, S. J. Basic managerial skill for all. |
| **[T3]** | Tarek Khalil, Management of Technology Tata McGraw Hill Publication Pvt. Ltd. |
| **[T4]** | Prabuddha Ganguli Intellectual Property rights Tata McGraw Hill Publication Company |
| **[T5]** | Management Accounting and financial management by M. Y.Khan and P.K. Jain, Tata 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 OD'onnel–Management. Tata McGraw Hill Publication1980. |
| **[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. Bester field and Carol Bester field 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, Deepak |

| | |
|---|---|
| | Bhivpathki. |
| **[R11]** | Financial Management by I. M. Pandey, Vikas Publishing House Pvt. Ltd., Delhi Philip Kotler-Marketing Management. |

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

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# 303142: Power Electronics

| Teaching Scheme | | | Credits | | Examination Scheme | |
|---|---|---|---|---|---|---|
| **Theory** | 03 | Hr/Week | **TH** | 03 | **ISE** | 30 Marks |
| **Practical** | 04 | Hr/Week/batch | **PR** | 02 | **ESE** | 70 Marks |
| | | | | | **PR** | 50 Marks |

**Prerequisite:**

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

**Course Objectives:** The course aims :-

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

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

**Course Outcomes: At the end of this course, student will be able to**

| | |
|---|---|
| **CO1** | Develop characteristics of different power electronic switching devices. |
| **CO2** | Reproduce working principle of power electronic converters for different types of loads. |
| **CO3** | Choose the appropriate converter for different applications. |

| | | |
|---|---|---|
| **Unit 01** | **Power Semi-Conductor Devices** | **06 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), TRIAC- four mode operation, triggering of TRIAC using DIAC, Application-light dimmer.

| | | |
|---|---|---|
| **Unit 02** | **Transistor based Devices and DC-DC converter** | **06 hrs** |

**Transistor based Devices:** MOSFET & IGBT- Construction, working, Static and Dynamic Characteristics

**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. Buck Boost Chopper (Descriptive Treatment), Applications- Chargers for Battery operated vehicles.

| | | |
|---|---|---|
| **Unit 03** | **Single Phase AC-DC Converter** | **06 hrs** |

**Single phase Converter:** Fully controlled converter, 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, Single phase dual converter (Descriptive treatment only), Application-Speed control of DC motor.

| | | |
|---|---|---|
| **Unit 04** | **Three Phase Converter and AC Voltage Regulator** | **06 hrs** |

**Three phase converters:** Fully controlled converter, Half controlled converter (Semi converter)- Operation of all converters with R, RL load, derivation of Average and RMS output voltage. Numerical based on output voltage and current calculations.

**AC voltage regulator**: Single phase AC Voltage regulator; operation with R and RL Load, derivation of Average and RMS output voltage. Concept of two stage AC voltage regulator (Descriptive treatment only).

| | | |
|---|---|---|
| **Unit 05** | **Single phase DC-AC Converter (Transistor based)** | **06 hrs** |

Full bridge VSI, derivation of output voltage and current, Numerical, current source inverter with ideal switches and load commutated CSI, Voltage control techniques, Application- UPS.

| **Unit 06** | **Three phase DC-AC Converter (Transistor based)** | **06 hrs** |
|---|---|---|

Three phase VSI for $120^0$ and $180^0$ modes of operation and their comparison, PWM based VSI, voltage control and harmonic elimination techniques (Single Pulse Modulation, Multilevel Control), Multilevel Converter concept its classification (Neutral Point Clamped Converter, Flying Capacitor Converter, cascaded multilevel converter) and their comparison, Application- Speed control of 3 phase Induction motor.

## Test Books:

| | |
|---|---|
| **[T1]** | M. H. Rashid - Power Electronics 2nd Edition, Pearson publication. |
| **[T2]** | Ned Mohan, T.M. Undel and, W.P. Robbins - Power Electronics, 3rd Edition, John Wiley and Sons. |
| **[T3]** | B.W. Williams: Power Electronics 2nd edition, John Wiley and sons. |
| **[T4]** | Ashfaq Ahmed- Power Electronics for Technology, LPE Pearson Edition. |
| **[T5]** | Dr. P.S. Bimbhra, Power Electronics, Third Edition, Khanna Publication. |
| **[T6]** | K. Hari Babu, Power Electronics, Scitech Publication. |

## Reference Books:

| | |
|---|---|
| **[R1]** | Vedam Subramanyam - Power Electronics , New Age International , New Delhi |
| **[R2]** | Dubey, Donalda, Joshi, Sinha, Thyristorised Power controllers, Wiley Eastern New Delhi. |
| **[R3]** | M. D. Singh and K. B. Khandchandani, Power Electronics, Tata McGraw Hill. |
| **[R4]** | Jai P. Agrawal, Power Electronics systems theory and design LPE, Pearson Education, Asia. |
| **[R5]** | L. Umanand, Power Electronics – Essentials and Applications Wiley Publication. |
| **[R6]** | J. Michael Jacob – Power Electronics Principal and Applications. |
| **[R7]** | M. H. Rashid - Power Electronics Handbook, Butterworth-Heinemann publication, 3 edition |
| **[R8]** | V.R. Moorthi, Power Electronics Devices, circuits, and Industrial applications, Oxford University Press. |

## Online Resources:

| | |
|---|---|
| **[O1]** | NPTEL Web course and video course on Power Electronics by Dr. B. G. Fernandis, IIT, Mumbai. |

| **Unit** | **Text Books** | **Reference Books** |
|---|---|---|
| **Unit 1** | T5, T6 | R3, R8, O1 |
| **Unit 2** | T4, T5, T6 | R3, R5, R6, R9, O1 |
| **Unit 3** | T1, T5 | R3, O1 |
| **Unit 4** | T5, T6 | R1, R7, O1 |
| **Unit 5** | T1, T2, T3 | R3, O1 |
| **Unit 6** | T1, T2, T3 | R3, O1 |

## List of Experiments

**Part A:**

**Minimum 8 hardware experiments to be conducted**

1. Static VI characteristic of SCR / GTO.
2. Static VI characteristic of TRIAC.
3. Study of Gate firing circuits of SCR (R, RC & UJT).
4. Single phase Half controlled converter with R and RL load.
5. Single phase fully controlled converter with R load.
6. Single Phase fully controlled converter with and without Free Wheeling diode with RL load.

7. Three phase AC-DC fully controlled bridge converter R and RL load.
8. Study of DC step down chopper.
9. Single phase A.C. voltage regulator with R and RL load.
10. Output and Transfer Characteristic of MOSFET and IGBT (Both).
11. Three phase voltage source inverter using $120^0$ and $180^0$mode
12. Study of three phase inverter (VSI).

**Part B:**

**Any 8 experiments to be conducted (either hardware or simulation)**

1. Fabrication of buck converter/inverter/ac voltage regulator. (compulsory)
2. Study of 1-ø bridge inverter SPWM.
3. Study of Forced commutation circuits of SCR (Class C and Class D).
4. Study and design of SMPS.
5. Study of PWM controls of a single-phase inverter.
6. Power Quality Analysis (Harmonic and PF measurement) at AC side of Single phase controlled Converter.
7. Power Quality Analysis (Harmonic and PF measurement) at AC side of Three phase controlled Converter.
8. Performance analysis of three phase diode clamped Multilevel inverter.
9. Performance analysis of three phase cascaded H-Bridge Multilevel inverter.
10. Study of three phase Active power filter.
11. Study of Standalone/ Grid connected converters for interfacing of renewable energy sources.
12. Industrial Visit to Power Electronics manufacturing unit/Renewable energy power plant.

## 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.
- Equipment 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.
- Analyze 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 must check the result of all the groups.

# 303143: Electrical Machines-II

| Teaching Scheme | | | Credits | | Examination Scheme | |
|---|---|---|---|---|---|---|
| **Theory** | 03 | Hr/Week | **TH** | 03 | **ISE** | 30 Marks |
| **Practical** | 02 | Hr/Week/batch | **PR** | 01 | **ESE** | 70 Marks |
| | | | | | **PR** | 25 Marks |
| | | | | | **TW** | 25 Marks |

## Prerequisite:

- Magnetic circuits, Force on current carrying conductor placed in magnetic field, Fleming Right Hand & Left Hand Rule.
- Working principle and construction DC Machines, transformer & 3-ph induction motor.
- Phasor diagram and equivalent circuit of single phase transformer.

## Course Objectives: The course aims to:

- Learn construction & working principle of three phase synchronous machines and 1-ph induction motors.
- Calculate voltage regulation of Alternator by different methods.
- Study the applications of different machines in industrial, commercial & social sectors.
- Determine the performance indices of AC series & single phase motors by experimentation.

## Course Outcomes: At the end of this course, student will be able to

| | |
|---|---|
| **CO1** | Learn construction, working principle of three phase Synchronous Machines, Induction Motors, A.C. Series Motor and Special Purpose Motors. |
| **CO2** | Understand characteristics of three phase Synchronous Machines, Induction Motors, A.C. Series Motor and Special Purpose Motors. |
| **CO3** | Select the above machines in Power System, industrial, household & Military Engineering applications. |
| **CO4** | Testing of machines to evaluate the performance through experimentation. |

| **Unit 01** | **Three phase Synchronous machines.** | **06 hrs** |
|---|---|---|

**Three phase Synchronous machines:**
Construction, rotating-field type and rotating-armature type, salient-pole 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 (No derivation), 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** | **06 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 (Descriptive treatment only). Process of synchronizing alternator with infinite bus-bar by lamp method (one dark & two equally

bright lamp method) and by the use of synchroscope, Synchronizing current, power and torque (no numerical).

| **Unit 03** | **Three phase synchronous motor** | **06 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 load and variable excitation ('V' curves and 'inverted V' curves). Phenomenon of hunting and its remedies. Applications of 3-phase synchronous motors. Comparison of 3 phase synchronous motor with 3-phase induction motor.

| **Unit 04** | **3-ph induction motor, Induction generator and special purpose motors** | **06 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 :** Construction, principle of working, characteristics, ratings and applications of Brush less D.C. motors, Stepper motors (permanent magnet and variable reluctance type only), Permanent Magnet motor (A.C. & D.C.).

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| **Unit 05** | **A.C. series motor** | **06 hrs** |
|---|---|---|

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

**Compensated series motor:** Compensating winding, conductively and inductively compensated motor. Approximate phasor diagram. 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** | **06 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). Comparison of 1-phase induction motor with 3-phase induction motor.

## Test 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]** | B. L Theraja –Electrical Technology, Vol II , S. Chand publication. |
| **[T7]** | V. K. Mehta and Rohit Mehta, Principles of Electrical Machines, S Chand Publication |
| **[T8]** | Krishna Reddy –Electrical Machines Vol.II and III, SCITECH publications. |
| **[T9]** | Ashfaq Husain, Electrical Machines, Dhanpat Rai and Co. |
| **[T10]** | M V Deshpande, Electrical Machines, Prentice Hall of India |

## Reference Books:


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


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

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## Industrial Visit:

**Compulsory visit to Synchronous Machines / Induction motor manufacturing company.**

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

**Compulsory experiments:**

1. Determination of voltage regulation of cylindrical rotor alternator by a) EMF method b) MMF method.
2. Determination of voltage regulation of cylindrical rotor alternator by Potier method.
3. Determination of voltage 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 voltage 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. Synchronization of three phase alternator by Lamp and Synchroscope methods.
7. Simulation of three phase induction motor on MATLAB to obtain its performance.
8. Speed control of three phase induction motor by rotor resistance control method.
9. Speed control of BLDC 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 the whether the MCB / main switch is off.
2. Students should go through the name plates of machines.
3. 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.
4. Perform the experiment only in presence of teacher or Lab Assistant.
5. Do the calculations and get it checked from the teacher.
6. After completion of experiment, switch off the MCB / main switch.
7. Write the experiment in the journal and get it checked within week.

# 303144: Electrical Installation, Design and Condition Based Maintenance

| Teaching Scheme | | | Credits | | Examination Scheme | |
|---|---|---|---|---|---|---|
| **Theory** | 03 | Hr/Week | **TH** | 03 | **ISE** | 30 Marks |
| **Practical** | 04 | Hr/Week/batch | **PR** | 02 | **ESE** | 70 Marks |
| | | | | | **OR** | 25 Marks |
| | | | | | **TW** | 25 Marks |

**Prerequisite:**

Basic Electrical Engg, Power System 1, Electrical Machines I and Electrical Machines II.

**Course Objectives:** The course aims: -

1. To classify different types of distribution supply system and determine economics of distribution system.
2. To compare and classify various substations, bus-bars and Earthing systems.
3. To demonstrate the importance and necessity of maintenance.
4. To analyze and test different condition monitoring methods.
5. To carry out estimation and costing of internal wiring for residential and commercial installations.
6. To apply electrical safety procedures.

**Course Outcomes: At the end of this course, student will be able to**

| | |
|---|---|
| **CO1** | Classify different types of distribution supply system and determine economics of distribution system. compare and classify various substations, bus-bars and Earthing systems. |
| **CO2** | Demonstrate the importance and necessity of maintenance. |
| **CO3** | Analyse and test different condition monitoring methods. |
| **CO4** | Carry out estimation and costing of internal wiring for residential and commercial installations. |
| **CO5** | Apply electrical safety procedures. |

| **Unit 01** | **Economics of 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 equipment 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 80-2013.

| **Unit 03** | **Maintenance and Condition Monitoring** | **08 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 equipment. Advance tools and techniques of condition monitoring, Thermography. 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.<br>Hot Line Maintenance - Meaning and advantages, special types of non-conducting Materials used for tools for hot line maintenance. | | |
| **Unit 04** | **Basics of Estimation and Costing** | **04 hrs** |
| Purpose of estimating and costing, qualities of good estimator, essential elements of estimating and costing, tender, guidelines for inviting tenders, quotation, price catalogue, labor rates, schedule of rates and estimating data (only theory), | | |
| **Unit 05** | **Installation and estimation of distribution system** | **06 hrs** |
| Introduction cable sizing, Estimation and conductor size calculations of internal wiring for Residential and Commercial (Numerical) installations and estimate for underground LT service lines. | | |
| **Unit 06** | **Testing and Electrical Safety** | **06 hrs** |
| Understanding CAT Ratings & Using CAT rated Instrument, Electrical Installation Testing Procedures- Insulation resistance test between installation and earth, Insulation resistance test between conductors (use of GUARD Terminal in IR test & Application) (methods used for IR Testing) Testing of polarity, Testing of earth continuity paths (Applications of PAT Tester "Portable Appliance Tester" in commercial like hotels, hospital & Industry also) and Earth resistance test (methods for earth testing 2-pole, 3-pole new methods clamp on type where we can performs test in Live)<br>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. *( Introduction to OSHA )* | | |
| **Test 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 . | |
| **[R8]** | Power Equipment Maintenance and Testing (Power Engineering Book 32) by Paul Gill | |

| Unit | Text Books | Reference Books |
|---|---|---|
| **Unit 1** | T1, T3 | R1, R7 |
| **Unit 2** | T1, T2, T3 | R1, R4, R6 |
| **Unit 3** | T2, T4, T5, T6 | R6, R7, R8 |
| **Unit 4** | -- | R2, R3, R4, R5 |
| **Unit 5** | T1, T3 | R2, R3, R4, R5 |
| **Unit 6** | T7 | R8 |

## List of Experiments

**Part-A: (Any Eight of the following)**

1) Measurement of Dielectric Absorption Ratio and Polarization Index of insulation.
2) Study of thermograph images and analysis based on these images.
3) Practice of Earthing and Measurement of Earth resistance of Campus premises by using 4 Pole, 3 Pole, new technology practicing in industry clamp on method.
4) Single Line diagram of 132 or 220 or 400 kV substation (based on actual field visit) Symbols, Plate or Pipe Earthing. (Drawing sheets 1 using AutoCAD or other CAD software)
5) Assignment on design of Earthing grid for 132/220 kV substation.
6) Design and estimation of light and power circuit of labs/industry.
7) Measurement of insulation resistance of motors and cables.
8) Precautions from Electric shock and method of shock treatment.
9) Using of Installation Multifunction Testers for RCD testing, Phase Sequence Indication, Insulation resistance measurement, Continuity testing.
10) Use REVIT / any BOQ (Bill of Quantity) estimation software for estimation and costing
11) Design and estimation of light and power circuit of residential wiring.

**Part-B:(Any 4 out of these)**

1) Estimation and costing for 11 kV feeders and substation. (voltage drop calculation, SLD, substation layout)
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. Trouble shooting of household equipment – Construction, working and troubleshooting of any two household Electrical equipment's (Fan, Mixer, Electric Iron, Washing Machines, Electric Oven, Microwave - Limited to electrical faults) (Here we perform Practical by using PAT Testers)
4) Design, Estimation and costing of Earthing pit and Earthing connection for computer lab, Electrical Machines Lab.
5) Wiring installation and maintenance of pump motor.
6) Activity: Interview of Electrical maintenance personnel/Technician/Electrician.
7) Activity: Safety awareness for housing societies/schools/Junior colleges.
8) Activity: Preparation of Tender notice and studying the Tender notices published in newspapers.
9) Any innovative activity related to EIDCBM syllabus.

Industrial Visit ( if any): Visit to substation/ installation sites.

# 303145A: Elective-I: Advanced Microcontroller and Embedded System

| Teaching Scheme | | | Credits | | Examination Scheme | |
|---|---|---|---|---|---|---|
| **Theory** | 03 | Hr/Week | **TH** | 03 | **ISE** | 30 Marks |
| | | | | | **ESE** | 70 Marks |

**Prerequisite:**

1. Knowledge of Number system and Basic logic components.
2. Programming basics of C language.
3. Advantage of Microcontroller over Microprocessor.

**Course Objectives:** The course aims to:

1. Help Students understand Architecture of PIC 18F458 microcontroller.
2. Create and enhance ability to write and Interpret Assembly and C language for PIC 18F458.
3. Make students understand procedure to interface peripherals with PIC 18F458 for various Applications.

**Course Outcomes: At the end of this course, student will be able to**

| | |
|---|---|
| **CO1** | Explain architecture of PIC 18F458 microcontroller, its instructions and the addressing modes. |
| **CO2** | Use Ports and timers for peripheral interfacing and delay generation. |
| **CO3** | Interface special and generate events using CCP module. |
| **CO4** | Effectively use interrupt structure in internal and External interrupt mode. |
| **CO5** | Effectively use ADC for parameter measurement and also understand LCD interfacing. |
| **CO6** | Use Serial Communication and various serial communication protocols. |

| | | |
|---|---|---|
| **Unit 01** | **PIC Architecture and Embedded C** | **07 hrs** |

Comparison of CISC and RISC Architectures, Data and Program memory organization, Program Counters, Stack pointer, Bank Select Register, Status register, Embedded C concepts, Header and source files and pre-processor directives, Data types, data structures, Control loops, functions, bit operations.

| | | |
|---|---|---|
| **Unit 02** | **Port and Timer 0 Programming** | **05 hrs** |

I/O Ports and related SFRs, I/O port programming in C. PIC 18 Timer 0 Programing in C. Delay programming (with and without Timer0). LED Interfacing and its programming.

| | | |
|---|---|---|
| **Unit 03** | **CCP Module and its applications** | **06 hrs** |

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

| | | |
|---|---|---|
| **Unit 04** | **Interrupt structure and its Programming** | **05 hrs** |

Interrupt Programming, Programming of Timer0 interrupts, Programming of External interrupts INT0.

| | | |
|---|---|---|
| **Unit 05** | **ADC structure and LCD interfacing** | **07 hrs** |

PIC ADC, Programming of ADC using interrupts, Measurement of temperature and Power. Using PIC microcontroller. Interfacing of LCD (16x2) in 4 bit mode.

| | | |
|---|---|---|
| **Unit** | **Serial Communication and its protocols** | **06 hrs** |

| **06** | | |
|---|---|---|
| Serial Communication structure and its programming (Data transmit and Receive), Introduction to Communication protocols as SPI and MODE BUS | | |
| **Test 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 Myke Predko, 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 |
|---|---|---|
| **Unit 1** | T1,T2,T3,T4 | R1 |
| **Unit 2** | T1, T2,T3,T4,T5 | R1,R2 |
| **Unit 3** | T1,T4,T5 | R1 |
| **Unit 4** | T1,T2,T3,T4 | R1 |
| **Unit 5** | T1,T2,T3,T4 | R1 |
| **Unit 6** | T1,T2,T3,T4 | R1,R3 |

# 303145B: Elective-I: Digital Signal Processing

| Teaching Scheme | | | Credits | | Examination Scheme | |
|---|---|---|---|---|---|---|
| **Theory** | 03 | Hr/Week | **TH** | 03 | **ISE** | 30 Marks |
| | | | | | **ESE** | 70 Marks |

**Prerequisite:**

Knowledge of basic signals and systems

**Course Objectives:** The course aims:

1. To introduce discrete signals and systems.
2. To ability to analyse DT signals with Z transform, DTFT and DFT.
3. To introduce Digital filters and analyze the response.
4. To explore DSP Applications in electrical engineering.

**Course Outcomes: At the end of this course, student will be able to**

| | |
|---|---|
| **CO1** | Analyse discrete time signals and systems. |
| **CO2** | Construct frequency response of LTI system using Fourier Transform. |
| **CO3** | Design and realize IIR and FIR filters. |
| **CO4** | Apply concepts of DSP in applications of electrical engineering. |

| | | |
|---|---|---|
| **Unit 01** | **Discrete time signal and system** | **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, 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 and Inverse Z transform** | **06 hrs** |

Revision of Z-transform, Numerical of Z transform, Inverse Z transform using partial fraction and power series method, Linear constant coefficient difference equations, solution of difference equation, stability and causality using ROC of Z-transform.

| | | |
|---|---|---|
| **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 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.

| | | |
|---|---|---|
| **Unit 05** | **Design of IIR filter** | **06 hrs** |

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

| | | |
|---|---|---|
| **Unit 06** | **Design of FIR Filter and DSP Applications** | **06 hrs** |

**A)** 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. B) 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.

**Test 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: 97881-265-2142-5 |
| **[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 |
|---|---|---|
| **Unit 1** | T1,T2 | R1, R2, R3 |
| **Unit 2** | T1,T2 | R2, R3 |
| **Unit 3** | T1,T2 | R2, R3 |
| **Unit 4** | T1,T2 | R2, R3 |
| **Unit 5** | T1,T2,T3 | R1,R2,R3 |
| **Unit 6** | T2, T4 | R3 |

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# 303146: Seminar

| Teaching Scheme | | | Credits | | Examination Scheme | |
|---|---|---|---|---|---|---|
| **SEM** | 01 | Hr/Week | **SEM** | 01 | **TW** | 50 Marks |

## Course Objectives:

1. Gaining of actual knowledge (terminology, classification, methods and advanced trends)
2. Learning fundamental principles, generalization or theories.
3. Discussion and critical thinking about topics of current intellectual importance.
4. 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 course, student will be able to

| | |
|---|---|
| **CO1** | Relate with the current technologies and innovations in Electrical engineering. |
| **CO2** | Improve presentation and documentation skill |
| **CO3** | Apply theoretical knowledge to actual industrial applications and research activity. |
| **CO4** | 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 student 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. Content. 2. Presentation 3. Report

## Rubrics for assessment

| | Does not meet criterion | Meets criterion somewhat | Meets criterion fully |
|---|---|---|---|
| **Content** | | | |
| Background/Intro is sufficient to understand how this project fits into larger field | 0 | 1 | 2 |
| Description of methodology is sufficient for audience to understand the procedure | 0 | 1 | 2 |
| Explanations are understandable/clear | 0 | 1 | 2 |
| Conclusions stated are supported to topic | 0 | 1 | 2 |
| References/Sources are cited correctly | 0 | 1 | 2 |
| Audience questions are answered honestly (i.e. no bluffing or guessing) | 0 | 1 | 2 |
| **Presentation Quality** | | | |
| Speaking is understandable/clear | 0 | 1 | 2 |
| Speaker can answer questions professionally | 0 | 1 | 2 |
| Speaker makes eye contact with audience | 0 | 1 | 2 |
| Speaker uses professional body language | 0 | 1 | 2 |
| Visuals/PPT are clear and readable | 0 | 1 | 2 |
| Visuals/PPT have appropriate amount of text, diagrams | 0 | 1 | 2 |
| Visuals/PPT are free of errors/typos | 0 | 1 | 2 |
| **Report Writing** | | | |
| Abstract is meaningful | 0 | 1 | 2 |
| Graphs/diagrams are labeled completely | 0 | 1 | 2 |
| References/Sources are cited correctly | 0 | 1 | 2 |
| At least one reference is from a journal | 0 | 1 | 2 |
| Grammar is correct | 0 | 1 | 2 |
| Spelling is correct | 0 | 1 | 2 |
| Report format is clear | 0 | 1 | 2 |
| Total | _____/40 (convert to 50) | | |

# 303147A: Audit Course V: Energy Storage System

| Teaching Scheme | | | Credits | | Examination Scheme | |
|---|---|---|---|---|---|---|
| **Theory** | 02 | Hr/Week | **TH** | 00 | **GRADE** | PP/NP |

**Prerequisite:**

Batteries, Inductor and Capacitor.

**Course Objectives:**

To elaborate various energy storage systems
To be familiar with various aspects such as hybridization, selection of storage system.

**Course Outcomes: At the end of this course, student will be able to**

| | |
|---|---|
| **CO1** | Explain and differentiate various types of energy storage for suitable applications |
| **CO2** | Understand battery recycling techniques |

**Unit 01** **Energy Storage Fundamentals** **12 hrs**

(A) Battery: Energy Density, Power Density, Cycle life, C-rate, State of Charge (SoC), State of Health (SoH), Depth of Discharge (DoD), Characteristic.
(B) Types of Batteries: Nickel Metal Hydrate, Nickel Cadmium, Lithium ion, Lithium Polymer, Flow Batteries (Vanadium, Zinc, Manganese)
(C) Super capacitor, Superconducting Magnetic Energy Storage, Compressed Air Energy Storage, Flywheel storage
(D) Hybridization of energy storage

Energy storage sizing, Selection of storage as per application

**Unit 02** **Recent Trends in Storage** **12 hrs**

Solid state batteries, Aluminum air and Aluminum ion batteries, Lithium ion Capacitor, Advances in Thermal energy storage systems. Batteries recycling techniques and policies, Case studies.

**Reference Books:**

| | |
|---|---|
| **[R1]** | Handbook of Energy Storage: Demand, Technologies, Integration Michael Sterner, Ingo Stadler. |
| **[R2]** | Energy Storage: Fundamentals, Materials and Applications, Robert Huggins. |

**Industrial Visit:** Manufacturing industry of battery or Capacitor.

# 303147B: Start-up and Disruptive Innovations

| Teaching Scheme | | | Credits | | Examination Scheme | |
|---|---|---|---|---|---|---|
| **Theory** | 02 | Hr/Week | **TH** | 00 | **GRADE** | PP/NP |

**Prerequisite:**

**Course Objectives:**

To learn fundamentals related to Start-up and initiatives taken by government along with policies.
To understand Disruptive technologies.

**Course Outcomes: At the end of this course, student will be able to**

| | |
|---|---|
| **CO1** | Describe role of incubation for Startup and recent national policy. |
| **CO2** | Identify various types of Startups. |
| **CO3** | Explain impacts of disruptive innovation and Differentiate between disruptive innovation and disruptive technology |

## Unit 01 Start-up — 12 hrs

**Startup Fundamentals**

Startup: Stages of startup life cycle, business model, business plan, Business incubation, Startup financing life cycle, Funding options for startup, Market, Market Segments.

Entrepreneurship: Types of Entrepreneurship: Social, Rural, Women, Agri-preneurship. Factors affecting Entrepreneurship Growth

**Government Initiatives and Policies**

Initiatives taken by the government, Startup India Scheme, National Innovation and Startup Policy 2019, Approvals and other regulatory processes, Challenges faced by startups in India, Students Startup, Faculty Startup.

**Types of Startups and Case Studies**

Types of Startups: E-commerce Startups, EdTech Startups, FinTech Startups, Food and Beverages Startups, Health Care Startups, Block chain Startups etc.

Case study : Airbnb, Paytm, Byju, Zomato, Red bus, Ola, Razorpay

## Unit 02 Disruptive Technologies — 12 hrs

**Disruptive Innovation Fundamental**

What is invention? What is innovation? Defining Disruptive Innovation, Sustaining Innovation, Disruptive Innovation Theory, Disruptive innovation model, Disruptive strategy, Impact of Disruptive Innovation, Requirements of Disruptive Innovation, Types of Disruptive Innovations.

Inventor vs. Entrepreneur vs. Manager: Schumpeter's Trumpeters

Schumpeter's "creative destruction"

Maslow's Hierarchy of Needs Revisited, Disrupting Brands, Disrupting Religion.

**Disruptive Technologies**

Agricultural Revolution, Scientific Revolution, Industrial Revolution, Digital Revolution

Disruptive Innovation Vs Disruptive Technology

IoT, AI, Cloud Computing, Digital Twin, CRISPR, Block chain, 3D printing, Advanced Energy Storage, Hyperloop, Autonomous Vehicles, Nano technology, Industrial Automation (Industry 4.0)

**Reference Books:**


| | |
|---|---|
| **[R1]** | The $100 Startup : Reinvent the Way you Make a Living, Do What You Love and Create a New Future, Chris Guillebeau |
| **[R2]** | Creating a Successful Business Plan, Entrepreneur Magazine |
| **[R3]** | Thomas Kuhn and The Theory of Scientific Revolutions revisited, CRC Press |
| **[R4]** | P. Armstrong. Disruptive Technologies: Understand, Evaluate, Respond Kogan Page Publishers. (2017) |
| **[R5]** | Innovator's Solution: Creating and Sustaining Successful Growth – Clayton Christensen, 16 December 2013 |
| **[R6]** | Digital Disruption: Unleashing the Next Wave of Innovation – James McQuivey, 26 |

| | |
|---|---|
| | February 2013 |
| **Online Resources:** | |
| **[O1]** | https://ipindia.gov.in/ |
| **[O2]** | https://www.wipo.int/about-ip/en/ |
| **[O3]** | https://www.weforum.org/agenda/2016/06/what-is-disruptive-innovation/ |

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# 303148: Power System-II

| Teaching Scheme | | | Credits | | Examination Scheme | |
|---|---|---|---|---|---|---|
| **Theory** | 03 | Hr/Week | **TH** | 03 | **ISE** | 30 Marks |
| **Practical** | 02 | Hr/Week/batch | **TU** | 01 | **ESE** | 70 Marks |
| **Tutorial** | 01 | Hr/Week/batch | **PR** | 01 | **PR** | 50 Marks |
| | | | | | **TW** | 25 Marks |

**Note: TW marks: 15 for Tutorial and 10 for continuous assessment of lab work**

## Prerequisite:

Power Generation Technology, Power System-I, Electrical machine I and II

## Course Objectives:

1) Develop analytical ability for Power system.
2) Introduce concept of EHVAC and HVDC System.
3) Demonstrate different computational methods for solving problems of load flow.
4) Analyze the power system under symmetrical and Unsymmetrical fault conditions.

## Course Outcomes: At the end of this course, student will be able to

| | |
|---|---|
| **CO1** | Solve problems involving modelling, design and performance evaluation of HVDC and EHVAC power transmission lines. |
| **CO2** | Calculate per unit values and develop Y bus for solution power flow equations in power transmission networks |
| **CO3** | 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** | **06 hrs** |

Evaluation of ABCD constants and equivalent circuit parameters of Long transmission line. Concept of complex power, power flow using generalized constants, surge impedance loading, Line efficiency, Regulation and compensation, basic concepts. Numerical based on: ABCD constants of Long transmission line, Power flow.

| | | |
|---|---|---|
| **Unit 02** | **EHVAC Transmission** | **05 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** | **07 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 bus incidence matrix method, Numerical based on Y bus Matrix, power- flow equations generalization to n bus systems, classification of buses, Newton- Raphson method (polar method) Decoupled and Fast decoupled load flow (descriptive treatment only).

| | | |
|---|---|---|
| **Unit 04** | **Symmetrical Fault Analysis** | **06 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** | **07 hrs** |
| Symmetrical components, transformation matrices, sequence components, power in terms of symmetrical components, sequence impedance 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** | **05 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. | | |

**Test 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. Chandana, Power Systems, Cyber tech Publications. |
| **[R10]** | P. Kundur, Power System Stability And Control, McGraw Hill |

**Online Resources:**

| | |
|---|---|
| **[O1]** | NPTEL Course on power system engineering:Debpriya Das https://nptel.ac.in/courses/108/105/108105104/ |
| **[O2]** | NPTEL Course on power system analysis By Dr. A.K. Sinha https://nptel.ac.in/courses/108/105/108105067/ |
| **[O3]** | NPTEL Course on power system analysis By Dr. Debpriya Das https://nptel.ac.in/noc/courses/noc20/SEM2/noc20-ee72/ |

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

## Industrial Visit:

Compulsory visit to EHV-AC substation/ HVDC substation

## List of Tutorial: **(Minimum 10 Tutorial should be conducted) (Maintain Record in file or separate notebook)**

**(Such types of numerical also in INSEM and ENDSEM examination)**

**1)** ABCD parameters of long transmission line--(3 numerical)
**2)** power flow using generalized constant--(3 numerical)
**3)** power flow and losses in EHVAC transmission line for specified ratings. --(3 numerical)
**4)** Determination of Y-bus for three, four and five bus system--(3 numerical)
**5)** Load flow analysis using NR method for three bus system (1 numerical)
**6)** Calculation of symmetrical fault current and determine value of current limiting reactor suitable for given circuit breaker rating (2 numerical)
**7)** Determination of line/phase current, voltage and power calculation using symmetrical component. (4 numerical)
**8)** Calculation of unsymmetrical fault current (4 numerical)
**9)** Write a report on different HVDC project in India / world wide
**10)** Solve challenging questions related to syllabus (5 numerical)
**11)** Receiving end Power Circle diagram (1 Numerical)

## List of Experiments

**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. Solution of a load flow problem using Newton-Raphson method using software.
3. Simulation of Symmetrical fault of single machine connected to infinite bus.
4. Simulation of Unsymmetrical fault of single machine connected to infinite bus.
5. Simulation of HVDC system.

## Guidelines for Instructor's Manual:

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

**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 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.

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# 303149: Computer Aided Design of Electrical Machines

| Teaching Scheme | | | Credits | | Examination Scheme | |
|---|---|---|---|---|---|---|
| **Theory** | 03 | Hr/Week | **TH** | 03 | **ISE** | 30 Marks |
| **Practical** | 04 | Hr/Week/batch | **TU** | 00 | **ESE** | 70 Marks |
| **Tutorial** | 00 | Hr/Week/batch | **PR** | 02 | **OR** | 25 Marks |
| | | | | | **TW** | 50Marks |

**Prerequisite:**

1. Knowledge of fundamentals of electrical engineering.
2. Knowledge of various materials used in electrical machines.
3. Knowledge of types, construction and working of transformer.
4. Knowledge of types, construction and working of three phase induction motor.

**Course Objectives:** The course aims to:-

1. Design of transformer based on specifications.
2. Determine performance based on the parameters of transformer.
3. Design of Induction motor based on specifications.
4. Determine performance based on the parameters of Induction motor.
5. Apply computer aided design techniques to transformer and induction motor design.

**Course Outcomes: At the end of this course, student will be able to**

| | |
|---|---|
| **CO1** | Summarize temperature rise, methods of cooling of transformer and consider IS 2026 in transformer design. |
| **CO2** | Design the overall dimensions of the transformer. |
| **CO3** | Analyze the performance parameters of transformer. |
| **CO4** | Design overall dimensions of three phase Induction motor |
| **CO5** | Analyze the performance parameters of three phase Induction motor. |
| **CO6** | Implement and develop computer aided design of transformer and induction motor. |

| **Unit 01** | **Transformer Design: Part 1** | **06 hrs** |
|---|---|---|

Modes of heat dissipation. Heating and cooling curves. Calculations of heating and cooling time constants. Methods of cooling of transformer. 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). Introduction to computer aided design

| **Unit 02** | **Transformer Design: Part 2** | **06 hrs** |
|---|---|---|

Output equation with usual notations, optimum design of transformer for minimum cost and loss. Design of core, estimation of overall dimensions of frame and windings of transformer. Design of tank with cooling tubes.

| **Unit 03** | **Performance parameters of Transformer** | **06 hrs** |
|---|---|---|

Estimation of resistance and leakage reactance of transformer. 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. Computer aided design of transformer, generalized flow chart for design of transformer.

| **Unit 04** | **Three phase Induction Motor Design:Part1** | **06 hrs** |
|---|---|---|

Specifications and constructional features. Types of ac windings. Specific electrical and magnetic loadings, ranges of specific loadings. Output equation with usual notations. Calculations for main dimensions, turns per phase and number of stator slots.

| **Unit 05** | **Three phase Induction Motor Design:Part2** | **06 hrs** |
|---|---|---|

Suitable combinations of stator and rotor slots. Selection of length of air gap, factors affecting length of air gap. Design of rotor slots, size of bars and end rings for cage rotor. Conductor size, turns and area of rotor slots for wound rotor.

| **Unit 06** | **Performance parameters of Three Phase Induction motor** | **06 hrs** |
|---|---|---|

Leakage flux and leakage reactance: Slot, tooth top, zig - zag, overhang. 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. Computer aided design of induction motor, generalized flow chart for design of induction motor.

## Test 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, -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, Satya Prakashan, New Delhi. |
| **[R2]** | A Shanmuga sundaram,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. |

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

## Industrial Visit:

Industrial visit to a transformer and Induction motor manufacturing/repairing unit.

## List of Experiments

1. Details and assembly of transformer with design report. (Sheet in CAD)
2. Details and layout of single layer three phase winding with design report. (Sheet in CAD)
3. Details and layout of double layer three phase winding with design report. (Sheet in CAD)
4. Details and layout of three phase mush winding with design report. (Sheet in CAD)
5. Assembly of three phase induction motor. (Sheet in CAD)
6. 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/Heat distribution.
c. Analysis by variation of design parameters.

7. Report based on transformer manufacturing/repairing unit.
8. Report based on induction motor manufacturing/repairing unit.

## Guidelines for Instructor's Manual:

Theinstructor'smanualshouldcontainfollowingrelatedtoeverydrawingsheet-

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.
7. A3 size sheet to be used for CAD drawing.

## Guidelines for Student's Lab Journal

TheStudent'sLabJournalshouldcontainfollowingrelatedtoeverydrawingsheet-

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.
7. A3 size sheet to be used for CAD drawing.

## Guidelines for Laboratory conduction

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.

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# 303150: Control System Engineering

| Teaching Scheme | | | Credits | | Examination Scheme | |
|---|---|---|---|---|---|---|
| **Theory** | 03 | Hr/Week | **TH** | 03 | **ISE** | 30 Marks |
| **Practical** | 02 | Hr/Week/batch | **TU** | 01 | **ESE** | 70 Marks |
| **Tutorial** | 01 | Hr/Week/batch | **PR** | | **OR** | 25 Marks |
| | | | | | **TW** | 25 Marks |

**Prerequisite:**

Laplace Transform, Ordinary differential equations.

**Course Objectives:** 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 Outcomes: At the end of this course, student will be able to**

| | |
|---|---|
| **CO1** | Construct mathematical model of Electrical and Mechanical system using differential equations and transfer function and develop analogy between Electrical and Mechanical systems. |
| **CO2** | Determine time response of systems for a given input and perform analysis of first and second order systems using time domain specifications. |
| **CO3** | Investigate closed loop stability of system in s-plane using Routh Hurwitz stability criteria and root locus. |
| **CO4** | Analyze the systems in frequency domain and investigate stability using Nyquist plot and Bode plot |
| **CO5** | Design PID controller for a given plant to meet desired time domain specifications. |

| | | |
|---|---|---|
| **Unit 01** | **Basics of Control System** | **07 hrs** |

Basic concepts of control system, classification of control systems, types of control system: feedback, tracking, regulator system, feed forward system, transfer function, concept of pole and zero, modeling of Electrical and Mechanical systems (Only series linear and rotary motion) using differential equations and transfer function , analogy between electrical and mechanical systems, block diagram algebra, signal flow graph, Mason's gain formula.

| | | |
|---|---|---|
| **Unit 02** | **Time domain analysis** | **06 hrs** |

Concept of transient and steady state response, standard test signals: 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, time domain specifications of second order systems, derivation of time domain specifications for second-order under-damped system for unit step input, steady state error and static error coefficients.

| | | |
|---|---|---|
| **Unit 03** | **Stability analysis and Root Locus** | **05 hrs** |

Concept of stability: BIBO, nature of system response for various locations of poles in S-plane. Routh's-Hurwitz criterion. Root Locus: Angle and magnitude condition, Basic properties of root locus. Construction of root locus, Stability analysis using root locus.

| | | |
|---|---|---|
| **Unit 04** | **Frequency domain analysis-I** | **06 hrs** |

Introduction, Frequency domain specifications, correlation between time and frequency domain specifications, polar Plot, Nyquist plot, stability analysis using Nyquist plot.

| | | |
|---|---|---|
| **Unit** | **Frequency domain analysis-II** | **06 hrs** |

| 05 | | |
|---|---|---|
| Introduction to Bode plot, Asymptotic approximation: sketching of Bode plot, stability analysis using Bode plot. | | |
| **Unit 06** | **PID controllers and Control system components** | **06 hrs** |
| 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 using Ziegler-Nichol Methods Control System Components: Working principle and transfer function of Lag network, lead network, potentiometer, DC servo motors. | | |

## Test Books:

| | |
|---|---|
| **[T1]** | I.J. Nagrath, M. Gopal, "Control System Engineering", New Age International Publishers, 6th edition, 2017. |
| **[T2]** | Katsuhiko Ogata, "Modern control system engineering", Prentice Hall, 2010. |
| **[T3]** | Nise N. S. "Control Systems Engineering", John Wiley & Sons, Incorporated, 2011 |
| **[T4]** | R. Anandanatrajan and P. Ramesh Babu, "Control Systems Engineering", Scitech Publication,3rd edition, 2011 |
| **[T5]** | C. D. Johnson, "Process Control Instrumentation Technology, 8th edition, PHI Learning Pvt. Ltd., 2013 |

## 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. |
| **[R4]** | B. Wayne Bequette, "Process Control: Modeling, Design and Simulation", PHI, 2003. |

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

## List of Tutorial:

**Tuto**rial (Minimum ten tutorials should be conducted)

1. Reduce the given block diagram and determine overall transfer function.
2. Determine transfer function of the system represented by signal flow graph using Mason's gain formula.
3. Determine time domain specifications of given second order systems.
4. Determine static error constants and steady state error for the given systems.
5. Investigate closed loop stability of a given systems using Routh Hurwitz stability criterion.
6. Sketch the root locus of a given systems and comment on stability.
7. Sketch the polar plot of given systems.
8. Sketch the Nyquist plot of a given system, determine stability margins and comment on stability.
9. Sketch the Bode plot of a given systems, determine stability margins and comment on stability.
10. Determine the tuning parameters of PID controller using open loop step response and closed loop ultimate cycle methods of Ziegler and Nichol.
11. Design the PID controller for desired specifications using root locus approach.

## List of Experiment

**A) Minimum five experiments should be conducted.**

1. Experimental determination of DC servo motor parameters for mathematical modeling and transfer function
2. Experimental study of time response characteristics of R-L-C second order system. Validate the results using software simulation.
3. Experimental determination of frequency response of Lead compensator.
4. Experimental determination of frequency response of Lag compensator.
5. PID control of level/ Temperature/speed control system.
6. Experimental determination of transfer function of any one physical systems (AC Servomotor/ Two Tank System/ Temperature control/ Level control)
7. Experimental analysis of D.C. Motor Position control System.

**B) Minimum three experiments should be conducted (perform using software)**

1. Stability analysis using a) Bode plot, b) Root locus and c) Nyquist plot.
2. Effect of P, PI and PID controllers on time response of second order system.
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.
5. Effect of addition of dominant and non-dominant poles on step response of second order system.
6. PID controller for speed/position control of DC servomotor.

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## 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
- Software program and result (if applicable)
- 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

# 303151A: Elective II: IoT and Its Applications in Electrical Engineering

| Teaching Scheme | | | Credits | | Examination Scheme | |
|---|---|---|---|---|---|---|
| **Theory** | 03 | Hr/Week | **TH** | 03 | **ISE** | 30 Marks |
| | | | | | **ESE** | 70 Marks |

**Prerequisite:**

Basics of Electrical generation, transmission, distribution and utilization, Fundamentals of logic circuits, C, C+.

**Course Objectives:** The course aims to

1. Understand the architecture of Internet of Things
2. Evaluate the electrical systems for making them IoT enable
3. Assess the automated processes and retrofit it for enhancement is user accessibility.

**Course Outcomes: At the end of this course, student will be able to**

| | |
|---|---|
| **CO1** | Build circuits for signal acquisition and conditioning |
| **CO2** | Experiment with sensors and actuators and choose the right sensor for application |
| **CO3** | Determine the performance of IoT based automated process |
| **CO4** | Design and develop IoT based applications |

| | | |
|---|---|---|
| **Unit 01** | **Introduction to IoT** | **06 hrs** |

Fundamental components of IoT, Evolution of Connected Devices, Basic Architecture of IoT, ISO and IEC Standards, IoT categories, IoT gateways, challenges, Security concerns and hurdles, Overview of applications - home automation, agriculture, Industrial, health care, Smart Grid.

| | | |
|---|---|---|
| **Unit 02** | **IoT Development platforms** | **06 hrs** |

Basics of Microcontroller and Microprocessor, Introduction to Edge devices e.g. Arduino, Node MCU, Raspberry Pi. Comparative analysis of the Platforms.

| | | |
|---|---|---|
| **Unit 03** | **Programming the hardware** | **06 hrs** |

Introduction to Integrated Development Environment, Overview of different IDE's, Example of programs using Arduino IDE, Basics of Python, Example of programs using Python.

| | | |
|---|---|---|
| **Unit 04** | **Sensing and Actuation** | **06 hrs** |

Sensors, Types of sensors – Digital and Analog, characteristics, choosing right sensor for Application, Interfacing Sensor with Node MCU, Reading data from Sensors like LM35, DHT 11, Ultrasonic Sensor, IR Sensor, sound sensor, touch sensor, LDR, Potentiometer, Current and voltage Sensor, Connecting actuators - relay, stepper motor.

| | | |
|---|---|---|
| **Unit 05** | **Communication Technologies and Cloud** | **06 hrs** |

Introduction to communication Technologies like Wi-Fi, Bluetooth, RFID, Z-Wave, Zigbee, 6LoWPAN, LORA, Wireless HART, MQTT, Introduction to cloud platforms.

| | | |
|---|---|---|
| **Unit 06** | **Development of IoT based Application** | **06 hrs** |

Reading sensor data and sending it to cloud platform, Visualization and analysis of the data on cloud, actuation and control, case study – Home automation

**Test Books:**

| | |
|---|---|
| **[T1]** | Daniel Minoli, "Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications", ISBN: 978-1-118-47347-4, Willy Publications |
| **[T2]** | Bernd Scholz-Reiter, Florian Michahelles, "Architecting the Internet of Things", ISBN 978-3-642-19156-5 e-ISBN 978-3-642-19157-2, Springer |
| **[T3]** | Parikshit N. Mahalle & Poonam N. Railkar, "Identity Management for Internet of Things", River Publishers, ISBN: 978-87-93102-90-3 (Hard Copy), 978-87-93102-91-0 (e-book). |
| **Reference Books:** | |
| **[R1]** | Hakima Chaouchi, " The Internet of Things Connecting Objects to the Web", ISBN : 978-1-84821-140-7, Willy Publications |
| **[R2]** | Olivier Hersent, David Boswarthick, Omar Elloumi, The Internet of Things: Key Applications and Protocols, ISBN: 978-1-119-99435-0, 2nd Edition, Willy Publications. |
| **[R3]** | Daniel Kellmereit, Daniel Obodovski, "The Silent Intelligence: The Internet of Things". Publisher: Lightning Source Inc; 1st edition (15 April 2014). ISBN-10: 0989973700, ISBN-13: 978-0989973700. |
| **[R4]** | Fang Zhaho, Leonidas Guibas, "Wireless Sensor Network: An information processing approach", Elsevier, ISBN: 978-81-8147-642-5. |
| **[R5]** | Michael Margolis, Arduino Cookbook, 2nd Edition, O'Reilly Media, Inc, 2011. |
| **[R6]** | Alex Bradbury & Ben Everard, Learning Python with Raspberry Pi, 1st Edition, John Wiley & Sons, Feb 2014. |
| **[R7]** | Charles Bell, Beginning Sensor Networks with Arduino and Raspberry Pi, 1st Edition, Apress, 2014. |


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# 303151B: Elective-II: Electric Mobility

| Teaching Scheme | | | Credits | | Examination Scheme | |
|---|---|---|---|---|---|---|
| **Theory** | 03 | Hr/Week | **TH** | 03 | **ISE** | 30 Marks |
| | | | | | **ESE** | 70 Marks |

**Prerequisite:**

Basic concept of Batteries, Electrical Motors, Power Electronics

**Course Objectives: This course aims to**

1. To make students understand the need & importance of Electric & Hybrid Electric vehicles.
2. To differentiate and analyze the various energy storage devices.
3. To impart the knowledge about architecture and performance of Electric and Hybrid Vehicles
4. To classify the different drives and controls used in electric vehicles.

**Course Outcomes: At the end of this course, student will be able to**

| | |
|---|---|
| **CO1** | Analyze the concepts of Hybrid and Electric vehicles. |
| **CO2** | Describe the different types of energy storage systems |
| **CO3** | Comprehend the knowledge of the battery charging and management systems. |
| **CO4** | Classify the different mode of operation for hybrid vehicle. |
| **CO5** | Apply the different Charging standards used for electric vehicles. |
| **CO6** | Differentiate between Vehicle to home & Vehicle to grid concepts. |

| | | |
|---|---|---|
| **Unit 01** | **Introduction to Hybrid and Electric vehicles** | **06 hrs** |

Need and importance of Electric Vehicle and Hybrid Electric Vehicles, Environmental importance of Hybrid and Electric vehicles. Hybrid Electric vehicles: Concept and architecture of HEV drive train (Series, parallel and series-parallel). Micro Hybrid, Mild Hybrid, Full Hybrid, Plug-in Hybrid, Electric vehicles: Components, configuration, performance, tractive effort, Advantages and challenges in EV.

| | | |
|---|---|---|
| **Unit 02** | **Energy Storage Systems** | **06 hrs** |

Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery specifications, Battery based energy storage and its analysis, Classification of lithium-ion batteries, Aluminum Air and Aluminum ion battery. Fuel Cell based energy storage, Super Capacitor based energy storage, Hybridization of Ultra capacitor and Battery. Selection methodology for the energy storage.

| | | |
|---|---|---|
| **Unit 03** | **Battery Charging and Management Systems** | **06 hrs** |

introduction: Different Charging algorithms and Charging method, Cell Balancing methods.
Battery Management System: Functions of BMS, Block diagram of BMS. SoC Estimation methods, Thermal Management of Battery.

| | | |
|---|---|---|
| **Unit 04** | **Hybrid Power Train and mode of operation** | **06 hrs** |

Control Strategies and Design of the Major Components: Series and Parallel Hybrid Electric Drive Train. Energy Consumption in Braking, Braking Power and Energy on Front and Rear Wheels, Brake System of EVs and HEVs, Regenerative braking

| | | |
|---|---|---|
| **Unit 05** | **Drives and Charging Infrastructure** | **06 hrs** |

Selection of drives for Electric vehicle: PMSM drive and BLDC drive, Sizing of motor, Charging Levels: 01,02 and 03, Charging Standards: CCS, CHAdeMO, SAE J1772, IEC 60309, Bharat DC 001, Bharat AC 001, Electric Vehicle Supply Equipment (EVSE).

| | | |
|---|---|---|
| **Unit 06** | **Vehicle to Home, Vehicle to Vehicle and Vehicle to Grid** | **06 hrs** |

Vehicle to Home: Introduction, applications, V2H with demand response, Case Study of V2H.
Vehicle to Grid: Introduction of V2G, V2G infrastructure in the smart grid, Role of aggregator for V2G, Case study of V2G, Vehicle to Vehicle: Introduction of V2V, Concept & structure.

**Test Books:**


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

| | |
|---|---|
| **[T2]** | "Electric and Hybrid-Electric Vehicles", Ronald K. Jurgen, SAE International Publisher. |
| **[T3]** | "Energy Systems for Electric and Hybrid Vehicles", K T Chau, The institution of Engineering and Technology Publication |
| **[T4]** | "Batteries for Electric Vehicles", D.A.J Rand, R Woods & R M Dell ,Research studies press Ltd, New York, John Willey & Sons |
| **[T5]** | Electric & Hybrid Vehicles-Design Fundamentals, CRC press |
| **Reference Books:** | |
| **[R1]** | "Modern Electrical Hybrid Electric and Fuel Cell Vehicles: Fundamental, Theory and design", Mehrdad Ehsani, Yimin Gao and Ali Emadi. CRC Press, 2009. |
| **[R2]** | "Vehicle-to-Grid: Linking Electric Vehicles to the Smart Grid", Junwei Lu & Jahangir Hossain et al (eds), IET Digital Library. |
| **[R3]** | "Automobile Electrical and Electronic systems", Tom Denton, SAE International publications. |
| **[R4]** | "Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives", C. Mi, M. A. Masrur and D. W. Gao, John Wiley & Sons, 2011. |
| **[R5]** | The Electric Vehicle Conversion handbook –Mark Warner, HP Books, 2011. |
| **Online Resources:** | |
| **[O1]** | https://www.theiet.org/resources/books/transport/vehicle2grid.cfm? |
| **[O2]** | https://www.sae.org/publications/books/content/pt-143.set/ |
| **[O3]** | http://nptel.ac.in/courses/108103009/ |

सावित्रीबाई फुले पुणे विद्यापीठ

# 303151C:Elective-II: Cybernetics Engineering

| Teaching Scheme | | | Credits | | Examination Scheme | |
|---|---|---|---|---|---|---|
| **Theory** | 03 | Hr/Week | **TH** | 03 | **ISE** | 30 Marks |
| | | | | | **ESE** | 70 Marks |

## Prerequisite:

Laplace transform, basics of matrices, computer programming and fundamentals.

## Course Objectives: This course aims to

1. Introduce the concept of engineering cybernetics.
2. Give basic knowledge of key topics in cybernetics, such as system theory, control engineering, embedded computer systems, mathematical modeling, simulation, and optimization.

## Course Outcomes: At the end of this course, student will be able to

| | |
|---|---|
| **CO1** | Define cybernetics in terms of control and how is it used in controlling technical, biological, and other processes. |
| **CO2** | Understand various matrix operations. |
| **CO3** | Describe different types of control system configurations and their applications. |
| **CO4** | Carry out mathematical modeling and simulation of simple processes. |
| **CO5** | Appreciate the essential requirements for computers and computer equipment that are intended to operate in dedicated applications and industrial environments. |
| **CO6** | Know intelligent optimization techniques. |

| | | |
|---|---|---|
| **Unit 01** | **Introduction to Cybernetics** | **06 hrs** |

History of Cybernetics, various definitions of cybernetics, Control or regulation in machines, Control or regulation in human affairs.

| | | |
|---|---|---|
| **Unit 02** | **Linear system theory** | **06 hrs** |

Vector Spaces, Bases, Coordinate Transformation, Invariant Subspaces, Inner product, Norms, Rank, Types of Matrices, Eigenvalues, Eigenvectors, Diagonalization, Matrix Factorization.

| | | |
|---|---|---|
| **Unit 03** | **Control Engineering** | **06 hrs** |

Introduction to control systems, basic terminologies, Linearization. Laplace transform and transfer functions, types of control systems, introduction of nonlinear control system, adaptive control system, optimal control system, multivariable control system and their examples and applications.

| | | |
|---|---|---|
| **Unit 04** | **Mathematical Modeling and Simulation** | **06 hrs** |

Mathematical modeling of physical processes, Differential equations of physical systems, such as electrical, mechanical, fluid, linear approximation, solution of ordinary differential equations using ODE solvers.

| | | |
|---|---|---|
| **Unit 05** | **Embedded computer systems** | **06 hrs** |

Design of embedded computer systems. Computer architectures and system components for embedded and industrial applications. Microcontrollers and specialized microprocessors. Parallel and serial bus systems. Data communication in industrial environments. Analog/digital interfaces.

| | | |
|---|---|---|
| **Unit 06** | **Modern Optimization Methods** | **06 hrs** |

Definition, applications, types of methods for optimization, Introduction to modern optimization techniques, Genetic algorithm, Simulated Annealing method, Particle Swarm Optimization, Ant Colony method.

## Test Books:


| | |
|---|---|
| **[T1]** | https://asc-cybernetics.org/foundations/history.htm [Online available on 30.05.2021] |
| **[T2]** | Dan C. Marinescu, "Complex Systems and Clouds A Self-Organization and Self-Management Perspective", Elsevier, United States, 2017 |
| **[T3]** | C-T Chen, "Linear System Theory and Design", Oxford University Press, 1999 |
| **[T4]** | Richard C. Dorf, Robert H. Bishop, "Modern Control System", Pearson Education Limited, 2011 |
| **[T5]** | Hassan K. Khalil, "Nonlinear Control", Pearson Education Limited, 2011 |

| | |
|---|---|
| **[T6]** | Karl Johan Astrom, Bjorn Wittenmark, "Adaptive Control", Dover Publications Inc., New York 2008 |
| **[T7]** | Y. S. Apte, "Linear Multivariable Control Systems", McGraw-Hill, 1981 |
| **[T8]** | Nirmala Sharma, "Computer Architecture", Laxmi Publication, 2009 |
| **[T9]** | Soliman Abdel- Hady Soliman, Abdel-Aal Hassan Mantawy, "Modern Optimization Techniques with Applications in Electric Power Systems" Springer |


Savitribai Phule Pune University
सावित्रीबाई फुले पुणे विद्यापीठ

# 303151D:Elective-II Energy Management

| Teaching Scheme | | | Credits | | Examination Scheme | |
|---|---|---|---|---|---|---|
| **Theory** | 03 | Hr/Week | **TH** | 03 | **ISE** | 30 Marks |
| | | | | | **ESE** | 70 Marks |

**Prerequisite:**

Various electrical equipment and specifications, Construction and operation of different equipment/process like HVAC, Pumps, Compressors etc.

**Course Objectives:** The course aims to:-

1. Understand importance of energy Conservation and energy security and impact of energy use on environment.
2. Follow format of energy management, energy policy.
3. Understand demand side management tools and impact of tariff on demand management.
4. Importance of Data Analytics in Energy audit and audit process.
5. Calculate energy consumption and saving options with economic feasibility.
6. Use of appropriate energy conservation measure in field applications or industry.

**Course Outcomes: At the end of this course, student will be able to**

| | |
|---|---|
| **CO1** | Describe BEE Energy policies, Energy ACT. |
| **CO2** | List and apply demand side management measures for managing utility systems. |
| **CO3** | Explore and use simple data analytic tools. |
| **CO4** | Use various energy measurement and audit instruments. |
| **CO5** | Evaluate economic feasibility of energy conservation projects. |
| **CO6** | Identify appropriate energy conservations methods for electric and thermal utilities. |

**Unit 01** **Energy Scenario** **06 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, introduction to CDM, UNFCCC, Paris treety, emission check standard, salient features of Energy Conservation Act 2001 and Electricity Act 2003. Latest amendments in Electricity Act. Indian and Global energy scenario. Introduction to IE Rules. Study of Energy Conservation Building Code (ECBC).

**Unit 02** **Energy Management** **06 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 the latest Act. Energy Efficiency Programs. Energy monitoring systems.

**Unit 03** **Demand Management** **06 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 ISO 50001- Energy Management.

**Unit 04** **Energy Audit** **06 hrs**

Definition, need of energy audits, types of audit, procedures to follow, data and information analysis, Introduction to Data Analytics, data quality processing, clustering techniques, pattern mining, regression and classification. Relevance of Data Analytics in Audit, energy audit instrumentation,

energy consumption – production relationship, pie charts. Sankey diagram, Cusum technique, least square method and numerical based on it. Outcome of energy audit and energy saving potential, action plans for implementation of energy conservation options. Bench- marking energy performance of an industry. Energy Audit reporting format – Executive Summary , Detailing of report.

| **Unit 05** | **Financial Analysis** | **06 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 of energy, cost of generation Energy Audits case studies – Sugar Industry, Steel Industry, Paper and Pulp industry.

| **Unit 06** | **Energy Conservation** | **06 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) and Performance Assessments.

## Test 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. |
| **[R6]** | A General Introduction to Data Analytics by Andre Carvalho and Tomáš Horváth Wiley Inc First Edition 2019. |

## Online Resources:

| | |
|---|---|
| **[O1]** | www.energymanaertraining.com |
| **[O2]** | www.em-ea.org |
| **[O3]** | www.bee-india.org |
| **[O4]** | https://www.iso.org/iso-50001-energy-management.html |

| **Unit** | **Text Books** | **Reference Books** |
|---|---|---|
| **Unit 1** | T1 | O1, O2 |
| **Unit 2** | T1 | O1, O2 |
| **Unit 3** | T1 | R4, O4 |
| **Unit 4** | T1 | R4, R5 and O1 and O2, R6 |
| **Unit 5** | T1 and T4 | R1, R2, R3, R5 O1 and O2 |
| **Unit 6** | T2, T3 and T4 | R1, R5 and O1 and O2 |

# 303152: Internship

| Teaching Scheme | | | Credits | | Examination Scheme | |
|---|---|---|---|---|---|---|
| **IN** | 04 | Hr/Week | **IN** | 04 | **TW** | 100 Marks |

## Preamble

Internship is a short-term industrial working experience for the students. The internship aims at providing entry-level exposure to a particular industry. It is expected that students should spend time working on relevant projects or part of the project and acquire learning about the field, along with developing industry connections, and employability skills.

## Course Objectives:

1. Encourage and provide opportunities to the students to acquire professional learning experiences.
2. Empower students to relate and then apply the theoretical knowledge in real-life industrial situations.
3. Provide exposure for handing and using various tools, measuring instruments, meters, and technologies used in industries.
4. Enable students to develop professional and employability skills and expand their professional network.
5. Empower students to apply the internship learnings to the academic courses and project completions.
6. Impart professional and societal ethics in students through the internship.
7. Make students aware of social, economic, and administrative aspects influencing the working environment of the industry.

## Course Outcomes: At the end of this course, student will be able to

| | |
|---|---|
| **CO1** | Understand the working culture and environment of the Industry and get familiar with various departments and practices in the industry. |
| **CO2** | Operate various meters, measuring instruments, tools used in industry efficiently and develop technical competence. |
| **CO3** | Apply internship learning in other course completions and final year project management, i.e. topic finalization, project planning, hardware development, result interpretations, report writing, etc. |
| **CO4** | Create a professional network and learn about ethical, safety measures, and legal practices. |
| **CO5** | Appreciate the responsibility of a professional towards society and the environment. |
| **CO6** | Identify career goals and personal aspirations. |

**Guidelines:** The guidelines related to the internship are given below.

**Duration:** Guidelines related to duration are as follows.

1. The internship should be started after semester 5 and should be completed before the commencement of semester 6.
2. It should be for at least 4 to 6 weeks.
3. It should be assessed and evaluated in semester 6.

**2. Internship Identification:**

A student may choose to undergo an Internship at Industries, Government organizations, NGOs, Micro-Small-Medium enterprises, startups, Innovation and Incubation Centers, Institutes of National interests, organizations working for rural development, organizations promoting IPR and Entrepreneurship, etc. Approaching various industries for Internships and finalizing the same should be initiated in the 5$^{th}$ semester in consultation with Institute's Training and Placement Cell, Industry-Institute Cell, or Internship Cell. This will help students to start their internship work on time. Also, it will allow students to work in a vacation period after their 5$^{th}$-semester examination and before the start of the 6$^{th}$ semester. Student can take internship work in the form of Online/Onsite work from any

of the following but not limited to:

1. Working for consultancy or the funded research project of the institute/Department.
2. Contributing at Incubation, Innovation, Entrepreneurship Cell, Institutional Innovation Council, Start-up Cell of Institute where students will get learning opportunities on projects.
3. Learning at Departmental Lab leading to lab development and modernization, Tinkering Lab, Institutional workshop for prototyping and model development, etc.
4. Working at Industry or Government Organization on project or part of the project.
5. Internship through Internshala, AICTE, Government initiatives, etc.
6. In-house product or working model development, intercollegiate, inter-department research under research lab or research group, etc.
7. Working at micro-small-medium enterprises on solving their specific problems.
8. Research internship under professors at IISc, IIT's, NIT's, Research organizations, etc.
9. Working with NGOs or Social Internships, Rural Internship, etc.

Further, other internship opportunities should be discussed and finalized in consultation with Department/Institute constituted committees for Internship.

**3. Internship Record Book:**
Students must maintain an Internship record book. The main purpose of maintaining a record book is to nurture the habit of documenting and keeping records by students. The students should maintain the record of daily activities completed which may include, field visits, important discussions, observations, project work completed, suggestions received, etc. The record book should be signed every day by the supervisor or in-charge where the student is undergoing an internship. The internship record book and well-drafted Internship Report should be submitted by the students to the department faculty coordinator within a week after the completion of the internship.

**4. Internship Evaluation:**
The evaluation of activities recorded in the Internship Record Book will be done by Program Head, Cell In-charge, Project Head, faculty mentor, or Industry Supervisor based on the overall compilation of internship activities, sub-activities, the level of achievement expected, and the duration for certain activities. Assessment and Evaluation are to be done in consultation with the internship supervisors (Internal from the institute and External from industry).

**5. Evaluation and Assessment of Internship:**
Internship Record Book – 25 Marks + Internship Report - 25 Marks + Post Internship Internal Evaluation-50 Marks = Total 100 Marks

**5.1 Internship Record Book:** The attendance record of the student along with the evaluation sheet, duly signed and stamped by the industry should be submitted by the industry Supervisor or Mentor to the Institute/Department after the completion of the internship. The internship record book may be evaluated based on the following criteria:

- Proper and timely documented entries
- Adequacy and quality of information
- Data, observations, discussions recorded
- Thought process and recording techniques used
- Organization of the information

**5.2 Internship Report:** After completion of the Internship, the student should prepare a comprehensive report to indicate what he/she has observed and learned in the internship period. The report shall be presented covering the following recommended fields but not limited to:

- Title/Cover Page
- Internship certificate with details like company name, location, duration, supervisor, etc.
- Institute Certificate
- Declaration
- Abstract
- Index/Table of Contents
- List of Figures/Tables
- **Chapter 1:** Introduction: Brief about company, industry or organization, objectives, motivation, organization of the report
- **Chapter 2:** Problem Identification/Problem statement/objectives and scope/expected outcomes
- **Chapter 3:** Methodological details
- **Chapter 4:** Results / Analysis /inferences and conclusion
- **Chapter 5:** Suggestions/Recommendations for improvement to industry, if any
- Attendance Record
- Acknowledgement
- List of reference (Library books, magazines, and other sources)

**5.3 Post Internship Internal Evaluation:** The student will give a presentation based on his Internship report before an expert committee constituted by the concerned department as per norms of the institute. The evaluation will be based on the following criteria:

1. Internship Identification and Selection
2. Problem Studied with objectives and expected outcomes
3. Consideration of Environment/ Social /Ethics/ Safety measures/Legal aspects.
4. Methodology/System/Procedure Q&A
5. Block-diagram, flow-chart, algorithm, system description Q&A
6. Final results, discussions, suggestions, comments, etc. Q&A
7. Presentation and Communication

**6. Feedback from internship supervisor (External and Internal)**

Post internship, the faculty Internship coordinator should collect feedback about the student on the following suggested parameters from Industry Supervisor.

- Technical knowledge,
- Discipline and Punctuality,
- Work Commitment,
- Willingness to do the work,
- Communication skills, etc.

| 303153A: Audit Course IV: Ethical Practices for Engineers | | | | | | |
|---|---|---|---|---|---|---|
| **Teaching Scheme** | | | **Credits** | | **Examination Scheme** | |
| **Theory** | 02 | Hr/Week | **TH** | 00 | **GRADE** | PP/NP |
| **Prerequisite:** | | | | | | |
| Basic understanding of business management | | | | | | |
| **Course Objectives: This course aims to** | | | | | | |
| Create awareness to serve the public by strictly adhering to codes of conduct and placing paramount the health, safety and welfare of public. | | | | | | |
| **Course Outcomes: At the end of this course, student will be able to** | | | | | | |
| **CO1** | Understand for their professional responsibilities as Engineers. | | | | | |
| **CO2** | Recognize and think through ethically significant problem situations that are common in Engineering. | | | | | |
| **CO3** | Evaluate the existing ethical standards for Engineering Practice. | | | | | |
| **Unit 01** | **Introduction: Justice and Moral** | | | | | **12 hrs** |
| Introduction to Ethical Reasoning and Engineer Ethic, Professional Practice in Engineering, Ethics as Design - Doing Justice to Moral Problems, Central Professional Responsibilities of Engineers. | | | | | | |
| **Unit 02** | **Rights and Responsibility** | | | | | **12 Hrs** |
| Computers, Software, and Digital Information, Rights and Responsibilities Regarding Intellectual Property, Workplace Rights and Responsibilities, Responsibility for the Environment. | | | | | | |
| **Test Books:** | | | | | | |
| **[T1]** | Ethics in Engineering practice and Research (2nd Edition) by Caroline Whitbeck Cambridge | | | | | |
| **[T2]** | Ethics in Engineering MW Martin and R Schinzinger MC Graw Hill | | | | | |
| **[T3]** | Engineering Ethics and Environment P a Vesilind and AS Gunn Cambridge | | | | | |
| **Online Resources:** | | | | | | |
| **[O1]** | NPTEL course on “Ethics in Engineering Practice”, By Prof. Susmita Mukhopadhyay, IIT Kharagpur https://onlinecourses.nptel.ac.in/noc19_hs35/preview | | | | | |

| 303153B:Audit Course VI: Project Management | | | | | | |
|---|---|---|---|---|---|---|
| **Teaching Scheme** | | | **Credits** | | **Examination Scheme** | |
| **Theory** | 02 | Hr/Week | **TH** | 00 | **GRADE** | **PP/NP** |

**Prerequisite:**

**Course Objectives: This course aims to**

1. Plan a successful project through project management.
2. Select the right members of a team for a project.

**Course Outcomes: At the end of this course, student will be able to**

| | |
|---|---|
| **CO1** | Elaborate importance of project management and its process. |
| **CO2** | Learn about the role of high performance teams and leadership in project management. |

| **Unit 01** | **Basics of Project Management:** | **12 hrs** |
|---|---|---|

Introduction, Need for Project Management, Project Management Knowledge Areas and Processes, The Project Life Cycle, The Project Manager (PM), Phases of Project Management Life Cycle, Project Management Processes, Impact of Delays in Project Completions, Essentials of Project Management Philosophy, Project Management Principles

| **Unit 02** | **Project Identification, Selection, planning:** | **12 hrs** |
|---|---|---|

Project Identification, Selection Introduction, Project Identification Process, Project Initiation, Pr-Feasibility Study, Feasibility Studies, Project Break-even point

Project Planning: Introduction, Project Planning, Need of Project Planning, Project Life Cycle, Roles, Responsibility and Team Work, Project Planning Process, Work Breakdown Structure (WBS)

**Test Books:**

| | |
|---|---|
| **[T1]** | Project Management: A Systems Approach to Planning, Scheduling, and Controlling by Harold Kerzner. |
| **[T2]** | Guide to Project Management: Getting it right and achieving lasting benefits by Paul Roberts. |

**Online Resources:**

| | |
|---|---|
| **[O1]** | https://www.coursera.org/learn/project-planning?specialization=project-management |
| **[O2]** | Project management for managers By Prof. Mukesh Kumar Barua, IIT Roorkee https://onlinecourses.nptel.ac.in/noc20_mg48/preview |

# SAVITRIBAI PHULE PUNE UNIVERISTY, PUNE

## Faculty of Science and Technology

### Board of Studies

## Electrical Engineering

### Syllabus

## Final Year Electrical Engineering (2019 Course) (w.e.f. 2022-2023)

# BE Electrical (2019 Course)

## SEM-I

| Course Code | Course Name | Teaching Scheme | | | | Examination Scheme | | | | | | Credit | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Th | Pr | Tu | PW | ISE | ESE | TW | PR | OR | Total | Th | Pr | Tu | PW | Total |
| 403141 | Power System Operation & Control | 3 | 2 | – | – | 30 | 70 | 25 | – | 25 | 150 | 3 | 1 | – | – | 4 |
| 403142 | Advanced Control System | 3 | 2 | – | – | 30 | 70 | – | – | 50 | 150 | 3 | 1 | – | – | 4 |
| 403143 | Elective-I | 3 | 2 | – | – | 30 | 70 | – | – | 25 | 125 | 3 | 1 | – | – | 4 |
| 403144 | Elective-II | 3 | – | 2* | – | 30 | 70 | 25 | – | – | 125 | 3 | – | 1 | – | 4 |
| 403145 | Project Stage-I | – | – | – | 4 | – | – | 50 | – | 50 | 100 | – | – | – | 2 | 2 |
| 403146 | MOOCs | – | – | – | – | – | – | 50 | – | – | 50 | – | – | – | 2 | 2 |
| 403147 | Audit Course-VII | 2# | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **Total** | | **12** | **6** | **2** | **4** | **120** | **280** | **150** | **–** | **150** | **700** | **12** | **3** | **1** | **4** | **20** |

| 403143: Elective-I | 403144: Elective-II | 403147: Audit Course-VII |
|---|---|---|
| 403143A: PLC and SCADA<br>403143B: Power Quality Management<br>403143C: High Voltage Engineering<br>403143D: Robotics and Automation | 403144A : Alternate Energy System<br>403144B : Electrical & Hybrid Vehicle<br>403144C : Special-purpose Machines<br>403144D: HVDC & FACTS | 403147 A: German Language I<br>403147B: Engineering Economics I<br>403147C: Sustainability(IGBC) |

## SEM-II

| Course Code | Course Name | Teaching Scheme | | | | Examination Scheme | | | | | | Credit | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Th | Pr | Tu | PW | ISE | ESE | TW | PR | OR | Total | Th | Pr | Tu | PW | Total |
| 403148 | Switchgear and Protection | 3 | 2 | – | – | 30 | 70 | 25 | – | 50 | 175 | 3 | 1 | – | – | 4 |
| 403149 | Advanced Electrical Drives & Control | 3 | 2 | – | – | 30 | 70 | 25 | 50 | – | 175 | 3 | 1 | – | – | 4 |
| 403150 | Elective-III | 3 | – | – | – | 30 | 70 | – | – | – | 100 | 3 | – | – | – | 3 |
| 403151 | Elective-IV | 3 | – | – | – | 30 | 70 | – | – | – | 100 | 3 | – | – | – | 3 |
| 403152 | Project stage II | – | – | – | 12 | – | – | 100 | – | 50 | 150 | – | – | – | 6 | 6 |
| 403153 | Audit course VIII | 2# | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **Total** | | 12 | 4 | – | 12 | 120 | 280 | 150 | 50 | 100 | 700 | 12 | 2 | – | 6 | 20 |

| 403150: Elective-III | 403151: Elective-IV | 403153: Audit Course-VIII |
|---|---|---|
| 403150 A : Digital Control System<br>403150 B : Restructuring and Deregulation<br>403 150 C: Smart Grid<br>403150 D: SensorTechnology (Open Elective) | 403151A: EHV AC Transmission<br>403151B : Illumination Engineering<br>403151C: Electromagnetic Fields<br>403151D: AI and ML (Open Elective) | 403153A: German Language II<br>403153B: Engineering Economics II<br>403153C: Green Building |

*** For the tutorial, one credit is given. # Audit Course: Conduct over and above these lectures.**

# 403141: Power System Operation and Control

| Teaching Scheme | | | Credits | | Examination Scheme | |
|---|---|---|---|---|---|---|
| Theory | 03 | Hrs/Week | Theory | 03 | ISE | 30 |
| Practical | 02 | Hrs/Week/Batch | Practical | 01 | ESE | 70 |
| | | | | | Oral | 25 |
| | | | | | Term work | 25 |

==========

## Course Objectives:

This course aims to:

1. Study the different types of angle, voltage and frequency stability of the power system and methods to improve the stability of the power system.
2. Impart knowledge about various advanced controllers such as FACTs controllers with its evolution, principle of operation, circuit diagram and applications.
3. Introduce frequency control in a single area and two area system.
4. Understand the formulation of unit commitment and economic load dispatch.
5. Illustrate various ways of interchange of power between interconnected utilities.

## Course Outcomes:

At the end of this course, students will be able to:
CO1: Summarize angle, voltage and frequency stability in the power system control (UN).
CO2: Illustrate various ways of interchange of power between interconnected utilities (AP).
CO3: Analyze stability and optimal load dispatch using different techniques (AN).
CO4: Select appropriate FACTS devices for stable operation of the system (EV).
CO5: Evaluate the stability of the system and suggest the methods to improve it (EV).

| | | |
|---|---|---|
| Unit 01 | **Power System Stability (Angle Control):**<br>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 ), methods to improve steady state and transient stability, numerical based on equal area criteria. | 08 hrs |
| Unit 02 | **Reactive Power Control:**<br>The necessity of reactive power control, production and absorption of reactive power, reactive power requirements for power factor control and voltage regulation and the loading capability curve of a synchronous generator, types of FACTS controller.<br>**Series compensation:** reactor and capacitor, TCSC, SSSC.<br>**Shunt compensation:** reactor and capacitor, STATCOM, FC-TCR.<br>**Series and shunt compensation:** UPFC.<br>(FACTS devices: working principle, circuit diagram, VI characteristics, applications) | 08 hrs |
| Unit 03 | **Automatic Generation Control (Frequency Control):**<br>Introduction to the concept of AGC; complete block diagram representation of load-frequency control of an isolated power system; steady state and dynamic response; | 08 hrs |

| | | |
|---|---|---|
| | control area concept; two-area load-frequency control; Schematic and block diagram of the alternator voltage regulator scheme. | |
| Unit 04 | **Economic Load Dispatch and Unit Commitment (Cost Control):**<br>● **Part A: Economic load dispatch:** Introduction, revision of cost curve, incremental cost curve of thermal, method of Lagrange multiplier, exact coordinate equation (penalty factor), economic scheduling of thermal plant considering effect of transmission losses using Bmn coefficient.<br>(Numerical on method of Lagrange multiplier, penalty factor, Bmn coefficient)<br>● **Part B: Unit commitment:** Concept of unit commitment, constraints in unit commitment – spinning reserve, thermal and hydro constraints, methods of unit commitment – priority list and dynamic programming, Numerical on priority list and dynamic programming method. | 08 hrs |
| Unit 05 | **Energy Control:** Interchange of power between interconnected utilities (numerical), economic interchange evaluation, interchange evaluation with unit commitment, types of interchange, capacity and diversity interchange, energy banking, emergency power interchange, inadvertent power exchange, power pools. | 06 hrs |
| Unit 06 | **Voltage Stability:**<br>Basic concepts related to voltage stability: transmission system characteristics (PV curve), generator characteristics (QV curve), and load characteristics.<br>Voltage collapse, classification of voltage stability, static and dynamic stability, analysis techniques for dynamic voltage stability, voltage stability indexing. | 07 hrs |

## Text Books:


| | |
|---|---|
| [T1] | I. J. Nagrath, D. P. Kothari, "Modern Power System Analysis", 4th Edition, Tata McGraw Hill Publishing Co. Ltd. (Edition 2) |
| [T2] | T. J. E. Miller, "Reactive power control in electric systems," Willey. |
| [T3] | Hadi Saadat, "Power System Analysis," Tata McGraw's Hill |
| [T4] | S. Sivanagaraju, G. Sreenivasan, "Power System Operation and Control," Pearson Education India, 2009. |
| [T5] | P. S. R. Murthy, "Power System Operation and Control," Tata McGraw-Hill Publishing Co., Ltd. |
| [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. |
| [T8] | Dr. B.R. Gupta, "Power System-Analysis and Design", S. Chand Publication. |


## Reference Books:


| | |
|---|---|
| [R1] | Allen J. Wood and Bruce F. Wollenberg, "Power Generation, Operation, and Control," Wiley India Edition. |
| [R2] | R. Mohan Mathur, Rajiv K. Varma, "Thyristor based FACTS controller for electrical transmission systems", by John Wiley and Sons, Inc. |

| | |
|---|---|
| [R3] | Olle I. Elgerd, "Electrical Energy System Theory", 2nd Edition, Tata McGraw-Hill Publishing Co. Ltd. |
| [R4] | Dr. K. Uma Rao, "Power System Operation and Control," Wiley India |
| [R5] | Prabha Kundur, "Power System Stability and Control," Tata McGraw's Hill |
| [R6] | "Electrical Power System Handbook", IEEE Press |
| [R7] | James Momoh, "Smart Grid: Fundamentals of design and analysis," Wiley, IEEE Press |

Online Resources:

| | |
|---|---|
| [O1] | https://www.youtube.com/playlist?list=PL86E9AC8CFBA00ADB |
| [O2] | https://onlinecourses.nptel.ac.in/noc19_ee62/preview |
| [O3] | https://www.youtube.com/watch?v=uy9lZCdkQIM&list=PLD4ED2FAF3C155625 |
| [O4] | http://nptel.ac.in/courses/108101040/ (PSOC webcourse) |
| [O5] | https://nptel.ac.in/courses/108101004 |
| [O6] | https://onlinecourses.nptel.ac.in/noc21_ee16/preview |

Mapping:

| Unit | Text Books | Reference Books |
|---|---|---|
| 01 | T1, T3, T6, T8 | R4, R5 |
| 02 | T2, T4, T7 | R2, R4 |
| 03 | T1, T3, T4, T5 | R1, R3, R4, R5 |
| 04 | T1, T3, T4 | R1, R4 |
| 05 | T1 | R1 |
| 06 | T8 | R4, R5, R7 |

**List of Experiments:**

A)The following experiments are ***compulsory***:

1. To apply equal area criteria for stability analysis under a fault condition (three-phase fault at the middle point of a parallel transmission line).
2. To study the Lagrange multiplier technique for economic load dispatch (to find the optimal loading of generators).
3. To study load frequency control using an approximate and exact model.
4. To study reactive power compensation using STATCOM.

B) From the following list, perform ***any four*** experiments.

5. To solve the Unit Commitment problem by priority list method/ dynamic programming (DP) approach
6. Plot a swing curve using the point-by-point/4th order Runge-Kutta method.

7. To apply equal area criteria for analysis stability under a sudden rise in mechanical power input.
8. To study load frequency control with proportional and integral control.
9. To study the two area of load frequency control.
10. To study reactive power compensation using simulation of TCR or TCSC.
11. To study the optimum loading of generators considering transmission losses (penalty factor).

**Guidelines for the Instructor's Manual:**

- The Instructor's Manual should contain the following things related to every experiment:
- Specify prerequisite and objective(s) of experiment
- Include a circuit diagram with specifications (for hardware experiments).
- A 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/EMTP, the Simulink diagram with proper details must be included in the write up. For programming, take a printout of the program and the result.
- A conclusion based on calculations, results, and graphs (if any) should be written.

**Industrial Visit:**

An industrial visit is mandatory to the Load Dispatch Center/Power Station Control Room.

**Guidelines for Students' Lab Manual:**

- Students should write the journal in their own handwriting, particularly the results, diagrams, conclusions, questions, answers, etc.
- A circuit or connection diagram or construction diagram must be drawn either manually using or using software on graph paper.
- Handwriting and figures must be neat and clean.

**Guidelines for Laboratory Conduction:**

- Do the continuous assessment. The experiments performed in a particular week must be checked in the next turn in next week.
- During assessment, the teacher should make the remark by writing the word "Complete" and not simply "C". Put the signature along with the date at the end of the experiment and in the index.

# 403142: Advanced Control System

| Teaching Scheme | | | Credits | | Examination Scheme | |
|---|---|---|---|---|---|---|
| Theory | 03 | Hrs/Week | Theory | 03 | ISE | 30 |
| Practical | 02 | Hrs/Week/Batch | Practical | 01 | ESE | 70 |
| | | | | | Oral | 50 |

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## Prerequisite:

Control System Engineering, Matrix Algebra, Z-transform, and Laplace transform.

## Course Objectives:

This course aims to:

1. Introduce concepts of modern control theory, analysis, and design.
2. Provide an overview of the digital control system and nonlinear control system.
3. Explore advanced control techniques at an introductory level.

## Course Outcomes:

At the end of this course, students will be able to:
CO1: Explain compensation networks, common nonlinearities, the concept of state, sampling and reconstruction, and concepts of advanced controls (Understanding)
CO2: Determine transfer function from state model (Applying)
CO3: Test controllability and observability properties of the system (Evaluating)
CO4: Design compensators, state feedback controls, and observers for the system (Creating)

| | | |
|---|---|---|
| Unit 01 | Compensator Design in Frequency Domain | 06 hrs |

approach to control system design, cascade compensation networks, phase-lead and phase-lag compensator designs using bode plot, physical realization of compensators.

| | | |
|---|---|---|
| Unit 02 | Nonlinear Control Systems | 07 hrs |

introduction to nonlinear systems, common nonlinearities, describing function method, describing function of an ideal relay, stability analysis with describing function, introduction to Lyapunov stability analysis (basic concepts, definitions, and stability theorem)

| | | |
|---|---|---|
| Unit 03 | Introduction to State-Space | 08 hrs |

Concept of state, state-space representation of dynamical systems in physical variable form, phase variable forms and Jordon / diagonal canonical form, conversion of the transfer function to state-space model and vice versa, state equation and its solution, state transition matrix and its properties, computation of state transition matrix by Laplace transform and Caley Hamilton method.

| | | |
|---|---|---|
| Unit 04 | State-Space Design | 08 hrs |

| | | |
|---|---|---|
| The concept of controllability and observability, Kalman's and Gilbert's tests for controllability and observability, effect of pole-zero cancellation, duality property, control system design using pole-placement using transformation matrix, direct substitution, and Ackermann's formula, State observers, design of a full-order observer. | | |
| Unit 05 | Introduction to Digital Control System | 08 hrs |
| Basic block diagram of the digital control system, sampling and reconstruction, Shannon's Sampling theorem, zero-order hold and its transfer function, First-order hold (no derivation), characteristics equation, mapping between s-plane and z-plane, stability analysis in z-plane. | | |
| Unit 06 | Advanced control system topics | 08 hrs |
| Concept of sliding mode control, equivalent control, chattering, sliding mode control based on reaching law, Introduction to adaptive control, adaptive schemes, and control problems Optimal control-linear quadratic regulator problem. | | |

## Text Books:

| | |
|---|---|
| [T1] | Norman S. Nise, *Control System Engineering*, Sixth Edition, John Wily and Sons, Inc. 2011. |
| [T2] | Richard C. Dorf, Robert H. Bishop, *Modern Control Systems*, Twelfth Edition, Pearson Education. |
| [T3] | Benjamin C. Kuo, *Digital Control System*, Second Edition, Oxford University Press, 2003. |
| [T4] | I. J. Nagarath, M. Gopal, *Control System Engineering*, Fourth Edition, New Age International (P) Limited, Publishers |
| [T5] | A. Nagoor Kani, *Advanced Control Theory*, Third Edition, CBS Publishers and Distributes, 2020. |

## Reference Books:

| | |
|---|---|
| [R1] | Katsuhiko Ogata, *Modern Control Engineering*, Fifth Edition, Prentice-Hall, 2010. |
| [R2] | M. Gopal, *Digital Control and State Variable Methods*, Tata McGraw-Hill. |
| [R3] | K. Ogata, *Discrete-Time Control System*, Second Edition, PHI Pvt. Ltd. 2006 |
| [R4] | M. Gopal, *Modern Control Systems Theory*, Second Edition, New Age International (P) Limited, Publishers |
| [R5] | Karl J. Åström, Björn Wittenmark, *Adaptive Control*, Second Edition, Dover Publications, Inc. New Yark |
| [R6] | C Edwards, Sarah K. Spurgeon, S Spurgeon, *Sliding Mode Control: Theory And Applications*, Taylor and Francis, 1998 |
| [R7] | Jean-Jacques E. Slotine, Jean-Jacques E.. Slotine, Weiping Li, *Applied Nonlinear Control*, Prentice Hall, 1991. |

## Online Resources:

| | |
|---|---|
| [O1] | https://nptel.ac.in/courses/108102043 |
| [O2] | https://nptel.ac.in/courses/108102113 |

Mapping:

| Unit | Text Books | Reference Books |
|---|---|---|
| 01 | T1 | R1 |
| 02 | T4, T5 | R4 |
| 03 | T2 | R1 |
| 04 | T2 | R1 |
| 05 | T3 | R2,R3 |
| 06 | T2,T3 | R4,R5,R6 |

## List of Experiments:

[Perform any 8 experiments using any simulation software]

1. Simulation of a lead or lag compensator for a given system and comparison of compensated and uncompensated systems responses.
2. Simulation of the closed-loop system with ideal real as a nonlinearity.
3. Software program for determining a state-space model for a given transfer function and vice versa.
4. Software program for determining the state transition matrix.
5. Software program for checking the observability and controllability of a given system.
6. Simulation of state feedback control design using software.
7. Simulation of a full-order observer-based state feedback control system.
8. Effect of sampling and verification of sampling theorem by simulation.
9. Converting a continuous-time system to a discrete-time system and checking the response using the software.
10. Design of a linear quadratic regulator for a given system using simulation.

## Industrial Visit:

Industrial visit to a process industry or control and automation industry

## Guidelines for the instructor's manual:

Guidelines for the instructor’s manual are given below:

- It should have a title, learning outcomes, aim, software requirement, theory, the problem with the solution, simulation results, comparison (result table, if any), and conclusion.
- All the experiments should have at least one numerical problem, which should be solved analytically, then it should be verified by the simulation. For that matter, theory can be restricted to only definitions and concepts (no detailed explanation).
- Simulation printouts should have readable and self-explanatory block diagrams and figures.
- To develop a proper understanding of all the experiments, it is suggested to take figures with the same physical system (or numerical problem) for all the experiments.

## Guidelines for Student’s Lab Manual:

Guidelines for the students' lab manual are given below.

- Students should write the theory, the problem with a solution, and the conclusion on their own in their own handwriting.
- Students should write a program on their own and should compare analytical and simulated results.
- Students should try using different values of the parameters in the numerical problem and should observe the changes in the results.
- Hand writing must be clean and neat.

## Guidelines for Laboratory Conduction:

Guidelines for laboratory conduction are as follows:

- At the beginning, the instructor should state the learning outcomes of the experiment and should provide a problem statement to the students.
- Students should solve the problem and then simulate the experiment.
- To have variations in the numerical problem, different parameters can be set for different students.

# 403143A: PLC and SCADA

| Teaching Scheme | | | Credits | | Examination Scheme | |
|---|---|---|---|---|---|---|
| Theory | 03 | Hrs/Week | Theory | 03 | ISE | 30 |
| Practical | 02 | Hrs/Week/Batch | Practical | 01 | ESE | 70 |
| | | | | | Oral | 25 |

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## Course Objectives:

This course aims to:

1. To make the students understand the fundamentals of automation and various automation systems used in the industry, such as PLC.
2. To provide knowledge levels needed for PLC programming and operating.
3. To develop the architecture of SCADA, explaining each unit in detail.
4. To apply knowledge gained about PLCs and SCADA systems to real-life industrial applications.

## Course Outcomes:

At the end of this course, students will be able to:
CO1:Develop and explain the working of a PLC with the help of a block diagram.
CO2:Classify input and output interfacing devices with PLC.
CO3:Design PLC based application by proper selection criteria, developing GUI and ladder program.
CO4:Execute, debug, and test the programs developed for digital and analog operations.
CO5:Develop the architecture of SCADA and explain the importance of SCADA in critical infrastructure.
CO6:Describe the SCADA protocols and digital control systems, along with their architecture for automation.

| | | |
|---|---|---|
| Unit 01 | Introduction to PLC | 07 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

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|---|---|---|
| Unit 03 | Programming of PLC | 08 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

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|---|---|---|
| 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 systems using Proportional, Integral and Derivative (PID), PID modules, PID tuning, tuning methods including the "Adjust and observe" method<br>AC Motor Controls: AC Motor Starter, AC Motor Overload Protection, DC Motor Controller, Variable Speed (Variable Frequency) AC Motor Drive.<br>PLC Applications in developing systems- Tank level controller using analog signals, temperature controller using RTD, speed control of electric motor. | | |
| Unit 05 | SCADA Systems | 07 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 the SCADA system, advantages, disadvantages, and applications of SCADA.<br>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 systems in critical infrastructure: Petroleum Refining Process, Conventional electric power generation, Water Purification System, Chemical Plant. | | |
| Unit 06 | SCADA Protocols and Distributed Control Systems | 07 hrs |
| Open systems interconnection (OSI) Model, TCP/IP protocol, Modbus model, DNP3 protocol, IEC 60870-5-101 (IEC101), Control and Information Protocol (CIP), Ether 01111111111111Net/IP, Flexible Function Block process (FFB), Process Field bus (Profibus).<br>Distributed Control System: Introduction to DCS- its working & operation, Architecture , Features, Advantages & Applications of DCS, Comparison between DCS & PLC. | | |
| 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 Systems," Wiley Publishing. | |
| [T4] | Stuart A. Boyer, "SCADA supervisory control and data acquisition", ISA, 4th Revised edition. | |
| [T5] | Gary Dunning, "Introduction to Programmable Logic Controllers", Thomson, 2nd Edition. | |
| [T6] | Curtis Johnson, "Process Control Instrumentation Technology," Prentice-Hall of India. | |
| Reference Books: | | |
| [R1] | Gordan Clark, Deem Reynders, "Practical Modern SCADA Protocols," ELSEVIER | |
| [R2] | Batten G. L., "Programmable Controllers," McGraw Hill Inc., Second Edition | |

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|---|---|
| [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 |
| [R6] | Distributed Computer Control systems in Industrial Automation, D Popovic & Vijay Bhatkar. |

## Online Resources:

| | |
|---|---|
| [O1] | NPTEL Course: Electrical Measurement And Electronic Instruments By Prof. Avishek Chatterjee, Dept. of Electrical Engineering, IIT Kharagpur:- Web link https: // nptel.ac.in /courses /108 /105 / 108105153/ |
| [O2] | NPTEL Course: Industrial Instrumentation By Prof. Alok Barua, IIT Kharagpur:-Web linkhttps://nptel.ac.in/courses/108/105/108105064/ |

Mapping:

| Unit | Text Books | Reference Books |
|---|---|---|
| 01 | T1 | R1 |
| 02 | T1, T2, T6 | R3, R4 |
| 03 | T1, T5 | R5 |
| 04 | T1, T2, T6 | R2, R5 |
| 05 | T3, T4 | R1 |
| 06 | T3 | R1, R6 |

## 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 the 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.

## Guidelines for Instructor's Manual:

- Specify objective(s) of the experiment.
- Include a 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 conclusions.

## Guidelines for Student's Lab Manual:

Students are expected to write the journal in the following sequence:

- Aim –
- Ladder diagram –
- Theory –
- Conclusions
- Students are expected to draw the ladder diagrams on 1mm graph paper.
  - ➢ They should take the print out or draw SCADA HMI.
  - ➢ Students should write conclusions.
  - ➢ 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 to perform 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 an instructor.
- Verify the results obtained.

# 403143B: Power Quality Management

| Teaching Scheme | | | Credits | | Examination Scheme | |
|---|---|---|---|---|---|---|
| Theory | 03 | Hrs/Week | Theory | 03 | ISE | 30 |
| Practical | 02 | Hrs/Week/Batch | Practical | 01 | ESE | 70 |
| | | | | | Oral | 25 |

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## Prerequisite:

Fundamentals of Power Systems and Power Electronics

## Course Objectives:

This course aims to:

1. Develop understanding of power quality attributes.
2. Make students describe problems associated with poor power quality.
3. Make students describe mitigation techniques for improving power quality.
4. Learn various equipment of monitoring and assessment.

## Course Outcomes:

Student will be able to

CO1: Understand power quality and attribute of power quality

CO2: Describe voltage flicker and mitigation of it

CO3: Analyze the effect of power system events on voltage sag and its characteristics.

CO4: Identify the sources of harmonics and harmonics produced

CO5: Select proper method for harmonic mitigation along with methods of power quality monitoring.

CO6: Carry out power quality monitoring using power quality analyzers.

| Unit 01 | Basics of Power Quality | 07 hrs |
|---|---|---|

Importance of power quality, terms and definitions of power quality as per IEEE std. 1159-2019 such as transients, short and long duration voltage variations, interruptions, short and long voltage fluctuations, imbalance, flickers and transients. Symptoms of poor power quality. Definitions and terminology of grounding. Purpose of groundings. Good grounding practices and problems due to poor grounding, grounding and power quality, recommended grounding practices for noise and power quality control.

| Unit 02 | RMS Voltage variations, Flickers and Transient Over-Voltages | 07 hrs |
|---|---|---|

RMS voltage variations in power system and voltage regulation per unit system, complex power. Principles of voltage regulation. Basic power flow and voltage drop. Various devices used for voltage regulation and impact of reactive power management. Various causes of voltage flicker and their effects. Short term and long term flickers. Ferro-resonance Various means to reduce flickers. Flicker meter and monitoring. Transient over voltages, sources, impulsive transients, switching transients, Effect of surge impedance and line termination, control of transient voltages.

| | | |
|---|---|---|
| Unit 03 | Voltage Sag, Swell and Interruption | 07 hrs |
| Definitions of voltage sag and interruptions. Voltage sags versus interruptions. Economic impact of voltage sag, Major causes and consequences of voltage sags. Voltage sag characteristics. Voltage sag assessment. Influence of type of fault, fault location and fault level on voltage sag. Phase angle jumps. Types of sags ( Type 1 to type 7). Areas of vulnerability. Assessment of equipment sensitivity to voltage sags. Voltage sag limits for computer equipment, CBEMA, ITIC, SEMI F 42 curves. Measurement of voltage sag half cycle RMS, one cycle rms methods. Representation of the results of voltage sags analysis. Voltage sag indices. Mitigation measures for voltage sags, such as UPS, DVR, SMEs, CVT etc., utility solutions and end user solutions. | | |
| Unit 04 | Harmonics-I | 07 hrs |
| Definition of harmonics, inter-harmonics, sub-harmonics. Causes and effects of harmonics. Voltage versus current distortion. Overview of Fourier analysis. Harmonic indices and other indices for assessing impacts of harmonics. A.C. quantities under non-sinusoidal conditions. Triplen harmonics characteristics and non characteristics harmonics. Power assessment under waveform distortion conditions. Harmonic sources and harmonic generation from lighting loads, Computer and allied load including SMPS, household equipment, Office automation devices, Utility equipment like transformer, synchronous machines and FACTS devices. Industrial equipment – induction machines, AC and Dc drives, Arc Furnaces. | | |
| Unit 05 | Harmonics-II | 7 hrs |
| Harmonics resonances - series and parallel resonances. Consequences of harmonic resonance. Principles for controlling harmonics. Reducing harmonic currents in loads. K-rated transformer. Harmonic study procedure. Computer tools for harmonic analysis. Locating sources of harmonics. Modifying the system frequency response. Harmonic filtering, IEEE 1531 standard for key design criteria for filters. Passive filters, Notch filter, Tuned filters, Broadband filters and active filters. IEEE Standard 519-2014 for Harmonic control. | | |
| Unit 06 | Power Quality Monitoring & Assessment | 07 hrs |
| Need of power quality monitoring and approaches followed in power quality monitoring. Power quality monitoring objectives and requirements. Initial site survey. Power quality instrumentation. Power quality analyser specification requirement as per EN50160 Standard. Selection of power quality equipment for cost effective power quality monitoring, Selection of power quality monitors, selection of monitoring location and period. Selection of transducers. Harmonic monitoring, Transient monitoring, event recording and flicker monitoring. Power Quality assessment, Power quality indices and standards for assessment disturbances, waveform distortion. | | |
| Text Books: | | |
| [T1] | R. C. Dugan, Mark F. McGranaghan, Surya Santoso, and H. Wayne Beaty, “Electrical Power System Quality”, 2nd Edition, McGraw-Hill Publication. | |
| [T2] | C.Sankaran, “Power Quality”, CRC Press. | |
| [T3] | M. H. J. Bollen, “Understanding Power Quality Problems, Voltage Sag and Interruptions”, New York: IEEE Press, 2000, Series on Power Engineering. | |
| [T4] | Arrillaga, M. R. Watson, and 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] | Arrillaga, M. R. Watson, “Power System Harmonics”, John Wiley and Sons. |
| [R4] | G. J. Heydt, “Electric Power Quality”, Stars in Circle Publications. |
| [R5] | EN50160 and IEEE 1100, 1346, 519, and 1159 standards. |

Mapping:

| Unit | Text Books | Reference Books |
|---|---|---|
| 01 | T1,T2, T3,T4 | R1,R2,R4, R5 |
| 02 | T1,T2 | R2, R4, R5 |
| 03 | T1,T2, T3 | R2, R4, R5 |
| 04 | T1,T2 | R1, R2, R3, R4, R5 |
| 05 | T1,T2 | R1, R2, R3, R4, R5 |
| 06 | T1,T2,T5 | R1, R2, R3, R4, R5 |

## List of Experiments:

***A minimum of 9 experiments are to be performed from the following list:***
***Compulsory experiments:***

1. Study of the power quality analyzer and measurement of various power quality parameters.
2. Measurement of harmonic distortion of various non linear loads.
3. Harmonic analysis of SMPS based Equipment such as UPS /AC/DC drive.
4. Harmonic compliance of institute as per IEEE 519-2014 standard and sizing of hybrid ( Active + detuned filter).
5. 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. Harmonic analysis of UPS/ DC Drive/AC Drive.
3. Analysis of performance of induction motor/transformer operated with sinusoidal supply and under distorted supply conditions supplied by 3 phase inverter.
4. Measurement of voltage sag magnitude and duration by using digital storage oscilloscope/ power quality analyzer.
5. Design of 7% detuned Passive Filter.
6. Simulation study of transient and/or flicker measurement.
7. Simulation studies of harmonic generation sources such as VFD, SVC, STATCOM and FACTS devices and harmonic measurement (THD) by using professional software like MATLAB.
8. Harmonic load flow analysis by using professional software such as ETAP, PSCAD, ATP.

## Guidelines for the Instructor’s Manual:

The Instructor's Manual shall have

- Brief relevant theory.

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

## Guidelines for Students' Lab Manual:

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

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

## Guidelines for Laboratory Conduction:

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

# 403143C: High Voltage Engineering

| Teaching Scheme | | | Credits | | Examination Scheme | |
|---|---|---|---|---|---|---|
| Theory | 03 | Hrs/Week | Theory | 03 | ISE | 30 |
| Practical | 02 | Hrs/Week/Batch | Practical | 01 | ESE | 70 |
| | | | | | Oral | 25 |

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## Course Objectives:

This course aims:

- To make students to know and compare the various processes of breakdown in solid, liquid and gaseous dielectric materials.
- To make students understand and apply various methods of generation and measurement of DC, AC, impulse voltage and current.
- To enable students to understand the charge formation and separation phenomena in clouds, the causes of overvoltage and lightning phenomena,
- To develop the ability among learners to execute testing on various high-voltage equipment as per standards.
- To introduce students to the design, layout, safety precautions, earthing, and shielding of HV laboratory.

## Course Outcomes:

At the end of this course, students will be able to:
CO1: Identify, describe and analyze the breakdown theories of gaseous, solid and liquid materials.
CO2: Analyze the occurrence of over voltage and to provide remedial solutions
CO3: Describe and use of various methods of generation of high AC, DC, impulse voltage and current.
CO4: Demonstrate the methods of measurement of high AC, DC, impulse voltage and current, tests on high voltage equipment and devices
CO5: Study design of high voltage laboratory with all safety measures.

| Unit 01 | Breakdown in Gas | 07hrs |
|---|---|---|

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 for and factors on which time lag depends. (Numerical on Townsend's theory and Paschen's law).

| Unit 02 | Breakdown in Liquid and Solid Dielectrics | 07 hrs |
|---|---|---|

- **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.
- **Breakdown in Solid Dielectrics:** Intrinsic breakdown: electronic breakdown, avalanche or streamer breakdown, electromechanical breakdown, thermal breakdown, treeing and tracking phenomenon, Chemical and electrochemical breakdown, Partial discharge,Composite dielectric material,

| | | |
|---|---|---|
| | Properties of composite dielectrics, breakdown in composite dielectrics. (Numerical on theories of liquid and solid dielectric materials) | |
| Unit 03 | Lightning and Switching Over Voltages | 07 hrs |
| Lightning phenomenon, Different types of lightning strokes and mechanisms of lightning strokes, Charge separation theories, Wilson theory, Simpson theory, Reynolds and Mason theory.<br>Causes of over voltages and its effects on power systems, Over voltage due to switching surges and methods to minimize switching surges. Statistical approach of insulation coordination. | | |
| Unit 04 | Generation of High Voltages and Current | 07 hrs |
| Generation of high ac voltages-Cascading of transformers, series and parallel resonance system, Tesla coil. 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 05 | Measurement of High Voltage and High Currents | 07 hrs |
| Sphere gap voltmeter, electrostatic voltmeter, 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 06 | High Voltage Testing of Electrical Apparatus and EHV Laboratories | 07 hrs |
| Testing of insulators and bushings, Power capacitors and cables testing, testing of surge arresters.<br>Design, planning and layout of High Voltage laboratory:-Classification and layouts, earthing and shielding of H.V. laboratories. | | |
| Text Books: | | |
| [T1] | C. L. Wadhwa, “High Voltage Engineering”, New Age International Publishers Ltd. | |
| [T2] | M. S. Naidu, V. Kamaraju, “High Voltage Engineering”, Tata McGraw Hill Publication Co. Ltd. New Delhi | |
| 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 Delh | |
| [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] | IS 731-1971:Porcelain insulator for overhead power lines with nominal voltage > 1000 Volt |
| [R7] | Bushings :IS2099-1986,specification for bushings for A.C. Voltages > 1000 Volts |
| [R8] | Pollution test :IEC 60507-1991 on external and internal insulator |
| [R9] | High voltage test techniques, general definitions and test requirements: IS 2071(part 1) 1993,IEC Pub 60-1(1989) |

## Online Resources:

| | |
|---|---|
| [O1] | https://nptel.ac.in/courses/108104048 |

Mapping:

| Unit | Text Books | Reference Books |
|---|---|---|
| 01 | T1,T2 | R1,R2,R3,R6 |
| 02 | T1,T2 | R1,R2,R3,R5,R6 |
| 03 | T1,T2 | R1,R2,R3,R5,R6 |
| 04 | T1,T2 | R1,R2,R3,R4,R5,R6 |
| 05 | T1,T2 | R1,R2,R3,R4,R5,R6 |
| 06 | T1,T2 | R1,R2,R3,R7,R8,R9 |

## List of Experiments:

[Minimum eight experiments to be conducted from the given list]

1. To find the constants of the 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 systems, and observe the effect of parameters like no. of layers, thickness of layer, effect of interfacing.
4. To find out the breakdown of air in uniform and non uniform fields and compare it.
5. To study surface flashover on corrugated porcelain/polymeric insulation systems.
6. To understand the basic principle of corona and obtain audible and visible corona inception and extinction voltage under non uniform field.
7. To perform an experiment on horn gap arrester and understand arc quenching phenomenon.
8. To observe development of tracks and trees on polymeric insulation systems.
9. Parametric analysis of Impulse current generator using virtual Laboratory.
10. To perform an experiment on rod gap arresters.
11. To Study effect of barrier on breakdown voltage of air/ transformer oil.
12. Simulation of lightning 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.

**Industrial Visit:** Industrial visit to high voltage equipment manufacturing industry/EHV substation/High Voltage Testing Lab.

## 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 Manual:

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/ conclusions 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 practicals.
- Session, how efficiently the student is able to do connections and get the results.
- Timely submission of journal.

# 403143D: Robotics and Automation

| Teaching Scheme | | | Credits | | Examination Scheme | |
|---|---|---|---|---|---|---|
| Theory | 03 | Hrs/Week | Theory | 03 | ISE | 30 |
| Practical | 02 | Hrs/Week/Batch | Practical | 01 | ESE | 70 |
| | | | | | Oral | 25 |

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## Course Objectives:

This course aims to:

- To know the basic parts of a typical industrial robot system with its anatomy similar to the human body.
- To analyze mathematically the 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 Outcomes:

At the end of this course, students will be able to:
CO1: differentiate between types of robots based on configuration, method of control, types of drives, sensors used, etc.
CO2: apply mathematical modeling of a robot for a specific application with given specifications.
CO3: analyze the robot arm dynamics for calculation of torques and forces required for different joints of robots for control of the robot arm.
C04 : apply knowledge of Robot for their various applications

| Unit 01 | Robotics fundamentals | 07 hrs |
|---|---|---|

historical development of robotics, Definitions of Industrial Robot, Types of Robots, Asimov's Laws of Robotics, robot components, Robot specifications: repeatability, spatial resolution, compliance, degree of freedom, load carrying capacity, speed of response, work volume, work envelope, reach, etc,Robot configurations, Classification of Robots: Control Method: Servo controlled and non-servo controlled, their comparative study, form of motion: P-T-P (point to point), C-P (continuous path), pick and place etc. and their comparative study.

| Unit 02 | Mathematical Modeling and Dyanamics of Robots | 07 hrs |
|---|---|---|

Direct Kinematics, Coordinate and vector transformations using matrices, Rotation matrix, Inverse Transformations, Composite Rotation matrix, Homogeneous Transformations, The Robotic Manipulator Joint Coordinate System, inverse, Jacobian Transformation in Robotic Manipulation. **Robot Dynamics:** Lagrange's Equation, Kinetic and potential energy Equations, and Euler-Lagrange analysis for a single prismatic joint working against gravity and a single revolute joint. equation of motion.

| Unit 03 | Forward and Inverse Kinematics | 07 hrs |
|---|---|---|

Denavit-Hartenberg (D-H) representation of kinematic chains. Rules for establishing link coordinate frames.

Forward solution of robotic manipulator for SCARA Robot and PUMA Robot. Forward 67i solution for simple robot systems. **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.

| Unit 04 | Robotics Sensors | 07hrs |
|---|---|---|

Transducers and sensors, Sensors in robotics, Principles and applications of the following types of sensors- Proximity Sensors, Photo Electric Sensors, Laser Scanners, Position sensors – Piezo Electric Sensor, LVDT, Resolvers. Encoders: Absolute and Incremental: - Optical, Magnetic, Capacitive, pneumatic Position Sensors Range Sensors: Range Finders, Laser Range Meters, Touch Sensors, Force and torque sensors.

Safety Sensor: Light Curtain, Laser Area Scanner, Safety Switches; Machine vision

| Unit 05 | Differential motion and control | 07 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 | Various applications of Robots | 07 hrs |
|---|---|---|

Pick and place the robot, Application of Robots in Arc Welding Robots, assembly and mega-assembly Robots perform continuous arc welding, spot welding, spray painting, and assembly operations. Robots for Inspection: Robotic vision systems, image representation, object recognition and categorization, depth measurement. Other industrial applications: coating, deburring, cleaning, Die Casting, Molding, Material handling, Picking, palletizing, packaging, hospitals and patient care, F&B industry, sports and recreation, defense and surveillance industry, home automation, mining industry. A robot-based manufacturing system, robot cell design considerations and the selection of robots, Robot Economics, Functional Safety in Robotic Applications

## Text Books:


| | |
|---|---|
| [T1] | Mikell P. Groover, Mitchell Weiss, Roger N. Nagel, Nicholas G. Odrey, and 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 Economic 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, and 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. |

## Online Resources:

| | |
|---|---|
| [O1] | NPTEL Course on “Robotics”: https://nptel.ac.in/courses/112/105/112105249/ |
| [O2] | NPTEL Course on “Introduction to Robotics”: https://nptel.ac.in/courses/107/106/107106090/ |

Mapping:

| Unit | Text Books | Reference Books |
|---|---|---|
| 01 | T1,T2 | R3 |
| 02 | T1,T2,T3 | R1, R2,R3,R4 |
| 03 | T1,T2,T3 | R1,R3,R4 |
| 04 | T1,T2,T3 | R1,R3,R4 |
| 05 | T2, T3 | R1,R2, R3 |
| 06 | T2 | R1 |

## A List of Experiments:

Experiment 9 is compulsory.

List of Laboratory Experiments

1.Identify and selection of Sensors such as IR sensors, Proximity Sensor, Ultrasonic Sensor, White line sensor, Temperature Sensor, Touch sensor, Tilt Sensor, Accelerometer, Gyroscopic Sensor etc. based on given application

2. Identify and selection of Actuators and related hardware such as DC motor, Servo motor, Stepper Motor, Motor drivers based on application

3. Demonstration of various robotic configurations using industrial robot

4. Design and selection of Gripper / End effector

5. One Programming exercise on lead through programming

6. MATLAB program for simple and inverse kinematics of simple robot configuration

7. To demonstrate simple robotic system using Matlab/ MscAdam / RoboAnalyser software

8.Study of various applications of Robots

9. One Industrial visit for Industrial robotic application

## Guidelines for the Instructor’s Manual:

The Instructor's Manual should contain the following things related to every experiment:

- Specify prerequisite and objective(s) of experiment.
- A related theory of the experiment must be included.

- The circuit diagram of the experiment should be drawn at the beginning.
- For simulation experiments, the Simulink diagram with proper details must be included in the write up. For programming, take a printout of the program and the result.
- A conclusion based on calculations, results, and graphs (if any) should be written.

## Guidelines for Students' Lab Manual:

- Students should write the journal in their own handwriting, particularly the results, diagrams, conclusions, questions, answers, etc.
- A circuit or connection diagram or construction diagram must be drawn either manually using or using software on graph paper.
- Handwriting and figures must be neat and clean.

## Guidelines for Laboratory Conduction:

- Do the continuous assessment. The experiments performed in a particular week must be checked in the next turn in next week.
- During assessment, the teacher should make the remark by writing the word “Complete” and not simply “C”. Put the signature along with the date at the end of the experiment and in the index.

# 403144A: Alternate Energy System

| Teaching Scheme | | | Credits | | Examination Scheme | |
|---|---|---|---|---|---|---|
| Theory | 03 | Hrs/Week | Theory | 03 | ISE | 30 |
| Tutorial | 02 | Hrs/Week/Batch | Tutorial | 01 | ESE | 70 |
| | | | | | Term work | 25 |

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## Course Objectives:

This course aims to:

1. Develop a fundamental understanding of solar thermal and photovoltaic systems.
2. Provide the knowledge of development and operation of wind energy system
3. Discuss bio-energy resource assessment.
4. Introduce different storage systems, Integration and Economics of Renewable Energy Systems.

## Course Outcomes:

At the end of this course, students will be able to:
CO1:Analyze the performance of solar thermal and photovoltaic systems.
CO2:Determine wind turbine performance.
CO3:Explain and evaluate biomass resources in an Indian context.
CO4:Illustrate the importance of storage systems.
CO5:Analyze the economics of renewable energy sources.

| Unit 01 | Solar Energy-I | 08 hrs |
|---|---|---|

Solar radiation at the earth's surface, Solar constant, Spectral distribution, Extraterrestrial Radiation, Solar Terrestrial Radiation, Solar radiation geometry, Computation of cosθ for any location having any orientation, Empirical equations for predicting the availability of solar radiation: 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, Devices for thermal collection and storage, Thermal applications, Introduction to concentrating solar power (CSP) plants using technologies like a) Parabolic troughs b) Linear Fresnel reflector, c) Parabolic Dish, etc.

| Unit 02 | Solar Energy-II | 06 hrs |
|---|---|---|

Introduction to family of solar film technology, Single c-Si, Poly c-Si PV Cell, Module and Array, Array Design (factors influencing the electrical design of the solar array) : 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, MPPT of solar system, PV system design for various applications( residential, commercial and industrial)

| Unit 03 | Wind Energy | 08 hrs |
|---|---|---|

Power Contained in Wind, Thermodynamics of Wind Energy, Efficiency Limit for Wind Energy

Conversion, the maximum energy obtained for a Thrust-operated converter (Efficiency limit), Design of Wind Turbine Rotor, Power-Speed Characteristics, Torque-Speed Characteristics, Wind Turbine Control Systems: a) Pitch Angle Control, b) Stall Control, c) Power Electronics Control, d) Yaw Control, Control Strategy, Wind Speed Statistics, Statistical Wind Speed Distributions, Site and Turbine Selection, Extraction of wind energy and wind turbine power. Introduction to Offshore Wind Energy System and its comparison with Wind Energy System,

| Unit 04 | Biomass Energy | 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, designing of biogas plant, Introduction to Biodiesel**,** Power Generation from Municipal Solid Waste (MSW), Landfill Gas, Liquid Waste.

| Unit 05 | Fuel Cells and Storage Systems | 08 hrs |
|---|---|---|

A. Fuel Cells: Operating principles of Fuel Cell, Fuel and Oxidant Consumption, Fuel Cell System Characteristics, Introduction to Fuel Cell Technology and its type, application and limits.
B. 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. Introduction to other storage technologies: pump storage, SMES, compressed air storage.

| Unit 06 | Integration of RES | 06 hrs |
|---|---|---|

A. Integration of RES with grid, Grid codes.
B. Economics of RES: Simple, Initial rate of return, time value, Net present value, Internal rate of return, Life cycle costing, Effect of fuel Escalation, Annualized and levelized cost of energy.

## Text Books:

| | |
|---|---|
| [T1] | S.P. Sukhatme, “Solar Energy”, Tata McGraw Hill |
| [T2] | Chetan Singh Solanki, “Solar Photovoltaics-Fundamentals, Technologies and Applications”, PHI Second Edition |
| [T3] | Godfrey Boyle, “Renewable Energy”, Third edition, Oxford University Press |
| [T4] | H. P. Garg, J. Prakash, “Solar Energy-Fundamentals and Applications”, Tata McGraw hill Publishing Co. ltd., First Revised Edition. |
| [T5] | Mukund R. Patel, “Wind and Power Solar System”, CRC Press |
| [T6] | Gilbert M. Masters, “Renewable and Efficient Electrical Power Systems”, Wiley - IEEE Press, August 2004 |

## Reference Books:

| | |
|---|---|
| [R1] | D.P.Kothari, K.C.Singal, Rakesh Rajan,“Renewable Energy Sources and Emerging Technologies”, PHI Second Edition |
| [R2] | Tapan Bhattacharya, “Terrestrial Solar Photovoltaics”, Narosa Publishing House |
| [R3] | Paul Gipe, “Wind Energy Comes of Age”, John Wiley & Sons Inc. |

| | |
|---|---|
| [R4] | Donald L.Klass, “Biomass for Renewable Energy, Fuels, and Chemicals, Elsevier, Academic Press |
| [R5] | Thomas Ackermann, “Wind Power in Power Systems”, Wiley Publications. |
| [R6] | B T.Nijaguna, “Biogas Technology”, New Age International Publishers. |
| [R7] | Tony Burton, Nick Jenkins, David Sharpe, “Wind Energy HandBook-Second Edition”, John Wiley & Sons, Ltd., Publication |

## Online Resources:

| | |
|---|---|
| [O1] | A review on non-edible oil as a potential feedstock for biodiesel: physicochemical properties and production technologies. |
| [O2] | Fabrication and Design of Solar cooker. |

Mapping:

| Unit | Text Books | Reference Books |
|---|---|---|
| 01 | T1, T2 | R1, R2 |
| 02 | T2, T3, T4 | R1 |
| 03 | T5 | R3, R5,R7 |
| 04 | T6 | R4, R6 |
| 05 | T3,T6 | R1 |
| 06 | T6 | R1 |

## List of Tutorial:

It is expected to take ***minimum 8 tutorials*** from the following list:

1. Report on Renewable Energy Scenario in India/ across the Globe.
2. Designing of standalone Solar PV systems for various loads( 2 numericals).
3. Report on analysis of Indian solar radiation data/ Wind data.
4. Performance analysis of concentrating solar collector/ solar cooker/ solar air heaters
1. Study of Wind Electric Generators with Grid Integration.
2. Performance of Wind generation ( 2 or 3 numericals).
3. Design of a community biogas plant for a village in India( 1 or 2 numericals).
4. Analysis of Non Edible oil as an alternate energy source.
5. Performance of storage devices( 3/4 numericals).
6. Economics of renewable energy sources(2 or 3 numericals).
7. Design of Hybrid system using HOMER demo software

## Guidelines for Assessment of Tutorial:

- Maintain Record in file or separate notebook.
- Timely submission of tutorials.
- Assessment of the report must be based on understanding, presentation and contents.

# 403144B: Electric and Hybrid Vehicle

| Teaching Scheme | | | Credits | | Examination Scheme | |
|---|---|---|---|---|---|---|
| Theory | 03 | Hrs/Week | Theory | 03 | ISE | 30 |
| Tutorial | 02 | Hrs/Week/Batch | Tutorial | 01 | ESE | 70 |
| | | | | | Term work | 25 |

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## Course Objectives:

This course aims to:
1. To gain knowledge of Li-ion battery protection.
2. To learn HEV Subsystems and Configurations.
3. To understand Mathematical Model of Li-ion battery.
4. To familiarize with Hybridization of drivetrains.
5. To learn Star Labeling Schemes for Li-ion Packs.

## Course Outcomes:

At the end of this course, students will be able to:
CO1: Analyze the Life Cycle Assessment of Li-ion battery.
CO2 : Describe the different types of Li-ion charging methods
CO3 : Comprehend the knowledge of drivetrain hybridization.
CO4 : Evaluate EV motor sizing.
CO5 : Classify Battery Recycling methods.

| | | |
|---|---|---|
| Unit 01 | Li-ion Battery | 07 hrs |

Materials used for Li-ion battery, Nanostructured Electrode Materials for Li-Ion Batteries, Li-ion battery protection, Wireless charging of EV, Life Cycle Assessment of Li-ion battery, Solid-state Battery, Panasonic 18650 & 2170 cell,

| | | |
|---|---|---|
| Unit 02 | Battery Charging and Modelling | 07 hrs |

TSCC/CV charging and CVCC/CC charging of Li-Ion battery, BMS standards,
SoC Estimation methods (Kalman Filter, Neural Network, Fuzzy logic), Public EV charging stations, Solar Powered Charging Stations, Modeling of Lithium-ion batteries, Thermal Modeling of Li-ion battery.

| | | |
|---|---|---|
| Unit 03 | Electric Vehicle Technologies | 07 hrs |

Battery Swapping System, EV Fleet Management, Sensors for Electric Vehicles
Electric bus, Electric trucks, Fuel cell vehicles, Introduction of EV Subsystems and Configurations, Energy management strategies and its general architecture.

| | | |
|---|---|---|
| Unit 04 | Plug-In Hybrid Electric Vehicles | 07 hrs |

Hybridization of drivetrains in HEVs, Hybridization of energy sources in EVs, Power Flow control in hybrid drive train topologies, Power Management Strategies in HEV, Introduction of HEV Subsystems and Configurations, Vehicle Dynamics Fundamentals and HEV Modeling (Series Hybrid), Fuel

| | | |
|---|---|---|
| efficiency analysis. | | |
| Unit 05 | EV Components Design | 07 hrs |
| Criteria for battery selection , Forces on EV calculation, Power for EV calculation, Sizing the Power Converter, Sizing of Electric Machine for EVs and HEVs, Motor Torque Calculation, Induction motor control, PMSM motor control, Battery pack design, In vehicle networks- CAN | | |
| Unit 06 | Electric Vehicle Policies and Startups | 07 hrs |
| FAME-II Policy , Charging Infrastructure for Electric Vehicles - Revised Guidelines and Standards , Star Labeling Schemes for Li-ion Packs- BEE India, EV Tariff, EV Startup examples, Li-ion Battery Recycling Policy and Standards | | |

## Text Books:

| | |
|---|---|
| [T1] | Energy Systems for Electric and Hybrid Vehicles Edited by K.T. Chau |
| [T2] | Iqbal Hussain, "Electric & Hybrid Vehicles – Design Fundamentals", Second Edition, CRC Press, 2011 |
| [T3] | Electric and Hybrid Vehicles by Tom Denton |

## Reference Books:

| | |
|---|---|
| [R1] | Mehrdad Ehsani, Yimin Gao, Ali Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals", CRC Press, 2010 |
| [R2] | James Larminie, "Electric Vehicle Technology Explained", John Wiley & Sons, 2003.. |

## Online Resources:

| | |
|---|---|
| [O1] | NPTEL Course : Electric Vehicles - Part 1 by Prof. Amit |

## List of Tutorials:

Any 8 of the following

1. Introduction to battery modeling MATLAB Simulink
2. Introduction to BLDC motor control MATLAB Simulink
3. Introduction to Induction Motor control MATLAB Simulink
4. Power Converter selection in MATLAB Simulink
5. Study of EV subsidies in different states.
6. Visit to the Electric Vehicle Charging Station.
7. Study of Thermal Modeling in Ansys software
8. Study of Harmonics issues of EV charging.
9. Fuel efficiency evaluation of a series HEV in city and high-way.
10. Various strategies for improving vehicle energy/fuel efficiency regenerating braking.
11. Study of various Battery Recycling Methods.

## Guidelines for Assessment of Tutorial:

- Maintain Record in file or separate notebook.
- Timely submission of tutorials.
- Assessment of the report must be based on understanding, presentation and contents.

| 403144C: Special-Purpose Machines | | | | | | |
|---|---|---|---|---|---|---|
| **Teaching Scheme** | | | **Credits** | | **Examination Scheme** | |
| Theory | 03 | Hrs/Week | Theory | 03 | ISE | 30 |
| Tutorial | 02 | Hrs/Week/Batch | Tutorial | 01 | ESE | 70 |
| | | | | | Term work | 25 |

==========

## Course Objectives:

The course aims:-
1. To gain knowledge of operation and performance of synchronous reluctance motors.
2. To learn the operation and performance of stepping motors.
3. To understand 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 Outcomes:

At the end of this course, students will be able to:
CO1:Reproduce principal of operation of PMSM, Stepper motor, SRM, Switch reluctance and linear motors.
CO2: Develop torque - speed and performance characteristics of above motors.
CO3: Enlist application of above motors.
CO4: Demonstrate various control strategies.

| Unit 01 | **Generalized 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 modeling, 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. |
| [T5] | P.S. Bhimbra, Generalized Theory Of Electrical Machines |

## 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. |

## Online Resources:

| | |
|---|---|
| [O1] | NPTEL video lectures on all the special purpose machines can be observed. |

Mapping:

| Unit | Text Books | Reference Books |
|---|---|---|
| 01 | T2 | R1 |

| | | |
|---|---|---|
| 02 | T1, T3 | R1 |
| 03 | T1, T5 | R1 |
| 04 | T1 | R1 |
| 05 | T1, T4 | R1 |
| 06 | T5 | R2,R3 |

List of Tutorials: Minimum eight tutorials are to be performed out of the list mentioned as below:

1. Experimental analysis of PMSM motor drive
2. Experimental analysis of BLDC (Trapezoidal Motor) Drive
3. Experimental analysis of Switched Reluctance Motor Drive.
4. Experimental analysis of Synchronous Reluctance Motor Drive
5. Experimental analysis of Stepper Motor Drive.
6. Laboratory demonstration of Linear Induction Motor.
7. Simulation for the performance analysis of PMSM/BLDC drive. (Any software can be used)
8. Simulation of Switched Reluctance Drive.
9. Software programming for abc-αβ and αβ-dq transformations

Guidelines for Assessment of Tutorial:

- Maintain Record in file or separate notebook.
- Timely submission of tutorials.
- Assessment of the report must be based on understanding, presentation and contents.
- Prepare tutorial assessment sheet which may be used for the term work marks.

# 403144D: HVDC and FACTs

| Teaching Scheme | | | Credits | | Examination Scheme | |
|---|---|---|---|---|---|---|
| Theory | 03 | Hrs/Week | Theory | 03 | ISE | 30 |
| Tutorial | 02 | Hrs/Week/Batch | Tutorial | 01 | ESE | 70 |
| | | | | | Term work | 25 |

==========

## Course Objectives:

This course aims to:

1. To develop understanding of modern trends in power transmission.
2. To make students describe the operation of HVDC System and Control.
3. To make students describe applications of power electronics in the control of power transmission.
4. To understand fundamentals of FACTS Controllers.

## Course Outcomes:

At the end of this course, students will be able to:
CO1:Choose a proper FACTS controller for the specific application based on system requirements.
CO2:Analyze shunt, series, and combined controllers to explore different benefits.
CO3:Compare EHVAC and HVDC systems and to describe various types of DC links.
CO4:Describe various methods for the control of HVDC systems and to perform power flow analysis in AC/DC systems.

| | | |
|---|---|---|
| Unit 01 | HVDC -I | 07 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 | HVDC – II | 07 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 based HVDC System | 07 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 Principles of DC Link Control in a VSC based HVDC system: Power flow and dc voltage control. Reactive Power Control / AC voltage regulation using VSC. Real and Reactive power control using a VSC.

| | | |
|---|---|---|
| Unit 04 | Fundamentals of FACTS Controllers | 08 hrs |

Basics, Challenges and needs of Power Electronic Controllers, 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. Reactive power

control in electrical power transmission, principles of conventional reactive power compensators. Introduction to FACTS, flow of power in AC parallel paths, meshed systems, basic types of FACTS controllers, definitions of FACTS controllers, brief description of FACTS controllers.

| | | |
|---|---|---|
| Unit 05 | Shunt and Series Controllers | 08 hrs |

Shunt compensation – objectives of shunt compensation, methods of controllable VAR generation, static VAR compensators – SVC, STATCOM, SVC and STATCOM comparison. Series compensation – objectives of series compensation, thyristor switched series capacitors (TCSC), static series synchronous compensator (SSSC), power angle characteristics, and basic operating control schemes. Comparison between STATCOM and SVC, V –I and V –Q Characteristics, Transient stability, Response Time. Comparison between TSCS and SSSC

| | | |
|---|---|---|
| Unit 06 | Unified Power Flow Controller and advanced controllers | 08 hrs |

Unified power flow controller (UPFC) – Introduction, operating principle, independent real and reactive power flow controller and control structure. Interline power flow controller (IPFC), Introduction to Active power filtering, Concepts relating to Reactive power compensation and harmonic current compensation using Active power filters.

## Text Books:

| | |
|---|---|
| [T1] | S Kamakshaiah and V Kamaraju, “HVDC Transmission,” TMH Publications, 2011. |
| [T2] | K. R. Padiyar, “HVDC Power Transmission Systems”, New Age International Publishers, 2011 |
| [T3] | Hingorani ,L.Gyugyi, “Concepts and Technology of Flexible AC Transmission System”, IEEE Press, New York, 2000, ISBN –0780334588. |
| [T4] | Padiyar K.R., “FACTS Controllers for Transmission and Distribution systems”, New Age International Publishers, 1st Edition, 2007. |

## Reference Books:

| | |
|---|---|
| [R1] | Jos Arrillaga, “High Voltage Direct Current Transmission”, IET Power and Energy Series 29 |
| [R2] | Erich Uhlmann, “Power Transmission by Direct Current,” Springer International |
| [R3] | Song, Y.H. and Allan T. Johns, ‘Flexible AC Transmission Systems (FACTS)’, Institution of Electrical Engineers Press, London, 1999. |
| [R4] | Enrique Acha, Claudio R.Fuerte-Esqivel, Hugo Ambriz-Perez, Cesar Angeles-Camacho ‘FACTS" —Modeling and simulation in Power Networks, John Wiley & Sons, 2002. |
| [R5] | J. Arrillaga, “High Voltage Direct Current Transmission,” Peter Peregrinus Ltd., London, UK |

Mapping:

| Unit | Text Books | Reference Books |
|---|---|---|
| 01 | T1, T2 | R1, R2, R5 |
| 02 | T1, T2 | R1, R2, R5 |

| | | |
|---|---|---|
| 03 | T1, T2 | R1, R2, R5 |
| 04 | T3, T4 | R3, R4 |
| 05 | T3, T4 | R3, R4 |
| 06 | T3, T4 | R3, R4 |

## List of Tutorials:

1. Study of various HVDC transmission system components and its applications.
2. Study of AC/DC side voltage and current waveforms of a six-pulse converter system under variable RL load using simulation. (Hint: input PF, THD, converter efficiency, reactive power flow, etc.).
3. Study of AC/DC side voltage and current waveforms of a twelve-pulse converter system under variable R-L load using simulation. (Hint: input PF, THD, converter efficiency, reactive power flow, etc.).
4. Study of Reactive Power Control in an HVDC Transmission system
5. Study of various types of multi-terminal HVDC transmission systems
6. Study of DC link control in VSC-based HVDC transmission systems.
7. Study of various passive filters used in LCC-based HVDC transmission systems
8. Operation of VSC for power factor correction at AC side of HVDC system using sinusoidal pulse width modulation.

## Guidelines for Assessment of Tutorial:

- Maintain Record in file or separate notebook.
- Timely submission of tutorials.
- Assessment of the report must be based on understanding, presentation and contents.

# 403145: Project Stage I

| Teaching Scheme | | | Credits | | Examination Scheme | |
|---|---|---|---|---|---|---|
| SEM/PW/IN | 4 | Hrs./Week | SEM/PW/IN | 2 | ORAL | 50 |
| | | | | | Term work | 50 |

==========

## Preamble:

Project is an important part of the engineering curriculum covered in the final year. It is divided into Project Stage I and Project Stage II at Semesters I and II of the Final Year. This project is a substantial piece of work that will require creative activity and original thinking. The project aims to provide students with a transitional experience from the academic world to the professional world. The objectives, outcomes, and guidelines for Project Stage I are given below.

## Course Objectives:

The objectives of this course are to:

1. Provide an opportunity to learn new software, interdisciplinary theory, concepts, technology, etc. not covered in earlier subjects.
2. Empower students to use engineering knowledge and skills learned in previous courses to deliver a product that has passed through the design, analysis, testing, and evaluation.
3. Encourage multidisciplinary project work through the integration of knowledge.
4. Allow students to develop problem-solving, analysis, synthesis, and evaluation skills.
5. Encourage teamwork.
6. Improve students' communication skills by asking them to produce both a professional report and to give an oral presentation.

## Course Outcomes:

Course outcomes can be different for the different projects undertaken by the student groups. However, in general, the course outcomes for Project Stage-I can be stated as follows.
At the end of this course, students should be able to:
CO1:Define the project problem statement and identify the scope of the project.
CO2:Search the appropriate research papers, standards and e-resources and write a literature survey.
CO3:Identify tools, techniques, methods, concepts, measuring devices, and instruments required for the project to define the methodology of the project.
CO4:Justify the selection of electrical, electronic and mechanical components for the project prototyping
CO5:Simulate or develop a system for software or hardware verification.
CO6:Write a project report with proper interpretation of results.

**Guidelines for students:**

1. Form a group of 3-4 students.
2. Select a project problem statement based on an industrial or societal issue and ideate on it.
3. Research on the project topic through existing theories, literature, technology, patents, etc.
4. Define objectives, scope, and outcomes of the project in the 1st presentation.
5. Maintain a notebook to keep records of all the meetings, discussions, notes, etc. This is to be done by the individual student.
6. Some of the parameters mentioned in the above table will be evaluated and assessed at the group

level and some at an individual level.

## Guidelines:

Term work evaluation guidelines are given below.

| Sr. No. | Activity | Deadline (Semester I) | Parameters for Evaluation |
|---|---|---|---|
| 1. | Topic Approval Presentations | Up to 3rd Week | • Problem definition clearly stated (YES/NO)<br>• Objectives clearly defined (YES/NO)<br>• The overall project idea is feasible (YES/NO) |
| 2. | Progress Review-1 Presentation | Up to 8th Week | • Problem Definition (5)<br>• Scope & Objectives (10)<br>• Literature Review (10)<br>• Methodology (10)<br>• Block Diagram / Architecture (10)<br>• Project Planning (5)<br>• **Total Marks (50)** |
| 3. | Progress Review-2 Presentation | Up to 12th Week | • Requirement Specification (10)<br>• Literature Review (revised) (5)<br>• Detailed Design (10)<br>• Experimental Setup/Simulation (10)<br>• Performance Parameters (10)<br>• Partial Conclusion (5)<br>• **Total Marks (50)** |
| 4. | Submission of Project Stage –I Report | Up to 14th Week | • Timely submission (5)<br>• Formatting and Report Writing Style (5)<br>• Abstract, Literature Survey, Conclusion (5)<br>• Refereed References (5)<br>• Grammatical correctness in the report (5)<br>• **Total Marks (25)**<br><br>**(Review 1+ Review 2) conversion to 25 marks +Report (25 marks) = 50 Marks** |

# 403146: MOOCs

| Teaching Scheme | | | Credits | | Examination Scheme | |
|---|---|---|---|---|---|---|
| SEM/PW/IN | – | Hrs./Week | SEM/PW/IN | 2 | ORAL | – |
| | | | | | Termwork | 50 |

==========

## Preamble:

Massive Open Online Courses (MOOCs) is essentially an asynchronous teaching learning platform. To enhance the students learning and to motivate self learning, MOOCs have been added in the BE Electrical 2019 course. It is advised to students that they have to registers MOOCs courses thorough SWAYAM-NPTEL platform.

## Course Objectives:

The objectives of this course are to:

1. Provide an opportunity to learn new software, interdisciplinary theory, concepts, technology, etc. not covered in earlier subjects.
2. Make students employable in the industry or pursue a suitable higher education program.
3. Exposure to relevant tools and technologies.
4. Enrich the learning experience by using audio video and multimedia and state of the are pedagogy.

## Course Outcomes:

At the end of this course, students should be able to:
CO1:Enables the students to directly engage and learn from the best faculty in the country in order to strengthen the fundamentals.
CO2:Explore new areas of interest in a relevant field.
CO3:Enable self learning initiative in learners..
CO4:Develop critical thinking to solve complex problems in engineering, science and humanities.
CO5:Improve communication skills by interacting with peers and course teachers.

## Guidelines:

**Guidelines for students:**

1. Students have to register on the SWAYAM portal.
2. Through the SWAYAM portal, explore the courses available by NPTEL coordinator.
3. The minimum duration of the NPTEL course to be registered by the students has to be 8/12 weeks. (as per the course offered in the semester.)
4. Students can register the courses of engineering, science, humanities, management, and multidisciplinary in the NPTEL portal.
5. Students have to submit the assignments as per schedule given by NPTEL course structure and take part in a self assessment test.
6. Students have to register for the certificate examination of NPTEL by paying the required fees.
7. Students will be awarded credits of MOOCs only when they earn the certificate of the registered course.

7. Students have to submit proof (certificate) to the department in order to get credits.

**Guidelines for institute:**

1. It is advised that the institute should register for the NPTEL local chapter.
2. Keep the track of student registration in SWAYAM-NPTEL course.
3. Check the certificate authenticity submitted by student through online portal

**Guidelines for Assessment:**

1. The NPTEL will give percentage grades in certificates out of 100.
2. The percentage obtained needs to be converted to 50 marks and submitted as term work marks to university. (if someone got 75% marks then TW calculation will be 75/2=37.5=38 (out of 50) and round up the nearest integer.)
3. External examiner appointed by the university will assess certificates and marks obtained physically at the institute.

# 403147A: German Language-I

| Teaching Scheme | | | Credits | | Examination Scheme | | |
|---|---|---|---|---|---|---|---|
| Theory | 02 | Hrs/Week | Theory | – | ISE | | – |

==========

## Course Objectives:

This course aims to:

1. Get introduced to the Culture, Routine of the German Society through language.
2. Meet the needs of ever growing German industry with respect to language support.

## Course Outcomes:

At the end of this course, students:
CO1: Will have the ability of basic communication.
CO2: Will have the knowledge of German script.
CO3: Will get introduced to reading ,writing and listening skills
CO4: Will develop interest to pursue profession in Indo-German Industry.

| | | |
|---|---|---|
| Unit 01 | Introduction to the German Language-I | 06 hrs |

Introduction of German Alphabets, Spell the names, Addresses, Numbers, Telephone numbers, Ordinal Numbers, Pin code Numbers, Dates, Birthdates, Age, days of the week, Months.

| | | |
|---|---|---|
| Unit 02 | Introduction to the German Language-II | 06 hrs |

Basic Greetings, Personal Pronouns, Possessive Pronouns.

| | | |
|---|---|---|
| Unit 03 | Introduction to the German Language-III | 06 hrs |

Self-Introduction, Introducing other people, about family, friends, course mates, seasons, and seasons in Germany and in neighboring countries.

## Text Books:

| | |
|---|---|
| [T1] | Netzwerk A-1 (Deutsch als Fremdsprache) Goyal Publishers & Distributors Pvt. Ltd. |

## Reference Books:

| | |
|---|---|
| [R1] | Tipps und Uebungen A1 |

## Online Resources:

| | |
|---|---|
| [O1] | Practice Material like Listening Module, reading Texts |

# 403147B: Engineering Economics-I

| Teaching Scheme | | | Credits | | Examination Scheme | | |
|---|---|---|---|---|---|---|---|
| Theory | 02 | Hrs/Week | Theory | – | ISE | | – |

==========

## Course Objectives:

This course aims to:

1. Describe basics of economics and its application in engineering.
2. Explain the concept of Time value of Money and Cash flow

## Course Outcomes:

At the end of this course, students will be able to:
CO1:Discuss concepts related to business and its impact on enterprise.
CO2:Illustrate time value of money in economic analysis.

| | | |
|---|---|---|
| Unit 01 | Engineering Economics | 10 hrs |

Nature and scope, General concepts on micro & macro economics. The Theory of demand, Demand function, Law of demand and its exceptions, Elasticity of demand, Law of supply and elasticity of supply. Concept of Engineering Economics – Engineering efficiency, Economic efficiency, Scope of engineering economics – Element of costs, Marginal cost, Marginal Revenue, Sunk cost, Opportunity cost, Break-even analysis – V ratio, Elementary economic Analysis – Material selection for product, Design selection for a product, Process planning.

| | | |
|---|---|---|
| Unit 02 | Time Value of Money and Cash flow analysis | 10 hrs |

Time value of money: Simple and compound interest, Nominal Interest rate, Effective Interest rate, Principle of economic equivalence.
Cash Flow – Diagrams, Categories & Computation
Depreciation: Meaning Causes, Factors affecting depreciation, Methods of providing depreciation, Straight Line Method & Diminishing Balance Method

## Text Books:


| | |
|---|---|
| [T1] | Riggs, Bedworth and Randhwa, “Engineering Economics”, McGraw Hill Education India. |
| [T2] | D.M. Mithani, Principles of Economics. Himalaya Publishing House |


## Reference Books:


| | |
|---|---|
| [R1] | Sasmita Mishra, “Engineering Economics & Costing “, PHI |
| [R2] | Sullivan and Wicks, “ Engineering Economy”, Pearson |
| [R3] | R. Paneer Seelvan, “ Engineering Economics”, PHI |

# 403147C: Sustainability

| Teaching Scheme | | | Credits | | Examination Scheme | | |
|---|---|---|---|---|---|---|---|
| Theory | 02 | Hrs/Week | Theory | – | ISE | | – |

==========

## Course Objectives:

This course aims to:

- Increase awareness among students about sustainability.
- Understand role of engineering and technology within sustainable development.

## Course Outcomes:

At the end of this course, students will be able to:
CO1: Understand different types of environmental pollution problem.
CO2: Suggest solutions for sustainable development.
CO3: Develop a broader perspective in thinking for sustainable practices by utilizing engineering principle and knowledge

| | | | |
|---|---|---|---|
| Unit 01 | Sustainability Introduction | | 11 hrs |

Introduction, need and concept of sustainability, social, environmental and economical sustainability concepts, sustainable development, 17 goals defined by UN, Nexus between technology and sustatinable development and its challenges, multilateral environmental agreements and protocols-CDM, Environmental legislations in India-Water Act, Air Act.
Air, water and solid waste pollution sources and impacts, Sustainable water treatment. Zero waste concept. Global environmental issues, climate change, global warming, ozon layer depletion.

| | | | |
|---|---|---|---|
| Unit 02 | Sustainable Solution | | 11 hrs |

Carbon credits and trading, carbon foot print, Green engineering, sustainable urbanization, industrialization and poverty reduction, Industrial process: Material selection, pollution preventions, industrial ecology and symbiosis, Global institutions: UNEP, IPCC, UNDP, WHO, Kyoto protocols. Certification and labelling in energy and carbon: Energy Star, Compliance and voluntary carbon credits, Green-e. Tools and techniques: ISO 14001, ISO26000, ABCD planning method.Assessment measurement: Indicators, F2B2, LCA, LCC, ROI.

## Text Books:


| | |
|---|---|
| [T1] | Allen D. T. and Shonnard D. R. “Sustainable Engineering: Concept design and case studies”, Prentice hall |
| [T2] | Environmental Impact Assessment Guidelines, Notification of Government of India 2006 |
| [T3] | Mackenthun K. M. “Basic Concept of Environmental Management”, Lewis publication London 1998 |
| [T4] | ECBC code 2007, BEE, New Delhi, BEE publication, TERI publication |

| | |
|---|---|
| [T5] | Ni Bin Chang, “Systems Analysis for sustainable engineering: Theory and Applications ”, Mc-Graw-Hill Professional |
| Reference Books: | |
| [R1] | “Sustainable Excellence Associate: Study Guide” International society of sustainability professional, https://community.sustainabilityprofessionals.org/store/viewproduct.aspx?id=13043928 |
| Online Resources: | |
| [O1] | https://www.globalgoals.org/goals/ |

# 403148: Switchgear and Protection

| Teaching Scheme | | | Credits | | Examination Scheme | |
|---|---|---|---|---|---|---|
| Theory | 03 | Hrs/Week | Theory | 03 | ISE | 30 |
| Practical | 02 | Hrs/Week/Batch | Practical | 01 | ESE | 70 |
| | | | | | Oral | 50 |
| | | | | | Termwork | 25 |

==========

## Course Objectives:

This course aims to:

- Acquaint about construction and working principles of different types of HVCBs.
- Elaborate the need for protective relaying and the operating principles of different types of relays.
- Explain the different types of faults in the transformer, alternator, and 3-phase induction motor and the various protective schemes related to them.
- Impart knowledge about transmission line protection schemes and the characteristics of different types of distance relays.

## Course Outcomes:

At the end of this course, students will be able to:
CO1:Understand the fundamentals of protective relaying.
CO2:Demonstrate the arc interruption and analyze the RRRV in circuit breakers
CO3:Demonstrate the construction and working principle of air brake circuit breakers, SF6 circuit breakers, and a vacuum circuit breaker.
CO4:Explain the characteristics of static and digital relays and their applications in power systems.
CO5:Apply the differential protection scheme to large transformers, alternators, and induction motors.
CO6:Apply distance protection, three stepped protection for transmission line.

| | | |
|---|---|---|
| Unit 01 | Fundamentals of protective relaying | 08hrs |

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 | 07 hrs |

Ionization of gasses, 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 | 08 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 breakers. Working and constructional features of ACB, SF6 , VCB- advantages, disadvantages and applications. Auto reclosing, Testing of circuit breakers. Introduction to GIS , its advantages over conventional substation

| Unit 04 | Static and Digital Relaying | 06 hrs |
|---|---|---|

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

| Unit 05 | Equipment protection | 08 hrs |
|---|---|---|

I. Power 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.

II. 3 Phase Induction Motor Protection: Abnormal conditions and causes of failures in 3 phase Induction motor, single phasing protection, Overload protection, Short circuit protection.

III. Synchronous Generator (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 | 08 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, 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 PLCC, block diagram, advantages, disadvantages, Introduction to Wide Area Measurement (WAM) system.

**Text Books:**


| | |
|---|---|
| [T1] | Badri Ram, D. N. Vishwakarma, “Power System Protection and Switchgear”, Tata McGraw Hill Publishing Co. Ltd. |
| [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. |
| [T5] | Power system protection and switchgear by Oza, Nair, Mehta, Makwana |


**Reference Books:**


| | |
|---|---|
| [R1] | S. Rao, “Switchgear Protection and Power Systems”, Khanna Publications |

| | |
|---|---|
| [R2] | J Lewis Blackburn , “Protective Relaying- Principles and Applications”, Dekker Publications. |
| [R3] | A.G. Phadke, J.S. Thorp ,Computer relaying for Power System , Research Studies Press LTD, England.(John Willy and Sons Inc New York) |
| [R4] | Mason C.R., “Art and Science of Protective Relaying”, Wiley Eastern Limited. |
| [R5] | Arun Ingole, “Switchgear and Protection”, Pearson. |
| [R6] | Bhuvanesh Oza, “Power System Protection and Switchgear”, McGraw Hill Education. |

## Online Resources:

| | |
|---|---|
| [O1] | 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 |
| [O2] | NPTEL Course on power system protection. |

**Mapping:**

| Unit | Text Books | Reference Books |
|---|---|---|
| 01 | T1,T2,T4 | R1, R2, R6 |
| 02 | T1,T3,T4 | R1, R6 |
| 03 | T1,T4 | R1, R6 |
| 04 | T2,T3,T4 | R3, R4, R6 |
| 05 | T1 , T5 | R1 ,R5, R6 |
| 06 | T1,T4 | R1,R2, R5, R6 |

## List of Experiments:

**A) Compulsory Experiments**

1. Study of switchgear testing kit.
2. Protection of Transmission line using Impedance relay

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

1. Study and testing of fuse , MCB.
2. Study and testing of contactors.
3. Study and testing of ACB.
4. Study and testing of MCCB.
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 (Merz Price Protection).
9. Protection of alternators.

## Guidelines for Instructor's Manual:

Lab manual 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.
- Detailed constructional diagram with nomenclature:
- Procedure: Write down step by step procedure to perform the experiment.
- Specifications of Switchgear:
- Observation table:
- Graph:
- Conclusion:

## Guidelines for Student's Lab Manual:

- Students should write the journal in his own handwriting using A4 size both side ruled paper.
- Circuit / Connection diagram or construction diagram must be drawn either manually or using software. [Do not use Photocopy of standard journal] on A4 size blank/graph paper.
- Hand writing must be neat and clean.
- Journal must contain a certificate indicating the 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 connections. Get it checked by the teacher / Lab Assistant.
- Perform the experiment only in the presence of a teacher or Lab Assistant.
- After completion of the experiment, switch off the MCB / main switch.
- Write the experiment in the journal and get it checked within a week.

## Industrial Visit:

Industrial visit to switchgear training center /or switchgear/relay manufacturing unit/ or 220 kV substation visit and report to be submitted.

## Assignments:

Minimum 2 assignments (at least 4 to 6 questions in each) to be submitted as a part of term-work.

# 403149: Advanced Electrical Drives and Control

| Teaching Scheme | | | Credits | | Examination Scheme | |
|---|---|---|---|---|---|---|
| Theory | 03 | Hrs/Week | Theory | 03 | ISE | 30 |
| Practical | 02 | Hrs/Week/Batch | Practical | 01 | ESE | 70 |
| | | | | | Practical | 50 |
| | | | | | Termwork | 25 |

==========

## Course Objectives:

This course aims to:

- Understand motor load dynamics. ·
- Study and analyze the operation of the converter fed and chopper fed dc drives. ·
- Study and understand braking methods of D.C. and Induction motor drive.
- Study vector control of induction motors. ·
- Study synchronous and BLDC motor drive. ·
- Study classes and duty of motor. ·
- Understands the modes of operation of drive in various applications.

## Course Outcomes:

At the end of this course, students will be able to:
CO1: Explain motor load dynamics and multi quadrant operation of drives.
CO2: Analyze operation of converter fed and chopper fed DC drives.
CO3: Apply different braking methods of D.C. and induction motor drive.
CO4: Elaborate vector control for induction motor and BLDC drives.
CO5: Elaborate synchronous motor, reluctance motor drive.
CO6: Differentiate between classes and duty cycles of motors and select suitable drives in various industrial applications.

| | | |
|---|---|---|
| Unit 01 | Electrical Drives | 07 hrs |

A. Definition, components of electric drive system, types of electrical drives (DC and AC), selection of drive parameters, List of Industrial Applications
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.

| | | |
|---|---|---|
| Unit 02 | DC Motor Drives: | 08 hrs |

A. Single-phase and three-phase fully controlled converter drives and performance of converter fed separately excited DC Motor for speed control operations, 12 pulse converter drives.
B. Chopper controlled drives for separately excited and series DC Motor operations. Closed-loop speed control of DC motor below and above base speed for starting, speed control and braking

| | | |
|---|---|---|
| Unit 03 | Induction Motor Drives: | 08 hrs |

| | | |
|---|---|---|
| Regenerative braking, dynamic braking, Plugging, Numerical based on braking and speed control, voltage source inverter (VSI) control, Steady State Analysis. Current source inverter (CSI) control-open and closed loop, Regenerative braking and multi quadrant operation of Induction motor drives, Principle of vector control, Block diagram of Vector control of induction motor, Failure modes of Drives. | | |
| Unit 04 | BLDC drive: | 07 hrs |
| Construction (Block diagram) and working for motoring and regenerative braking, Speed and torque Characteristics, closed loop control of BLDC drive (PI controller) , vector control of BLDC drive, Applications in EV ( descriptive treatment) | | |
| Unit 05 | Synchronous Motor drives: | 08 hrs |
| A. PMSM Drive: Construction (Block diagram) and working for motoring and regenerative braking, Speed and torque Characteristics, closed loop control of PMSM drive (PI controller) , vector control of PMSM drive.<br>B. Synchronous Reluctance Motor -Introduction, working of SRM , application in EV (descriptive treatment) | | |
| Unit 06 | Drive Application | 07 hrs |
| A. Classes of motor duty, types of enclosures for motor.<br>B. Specific requirement and choice of drives for following applications: Machine tools , Textile mills, Steel rolling mills, Sugar mills, Traction drives, Crane and hoist drives, Solar and battery powered drives | | |
| 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] | G.K. Dubey, “Power Semiconductor controlled drives”, PHI publication | |
| [T5] | B. K. Bose, “Modern Power Electronics and AC Drives”, Pearson Education | |
| Reference Books: | | |
| [R1] | R. Krishnan, “Electric Motor Drives – Modeling Analysis and Control”, PHI India | |
| [R2] | B. K. Bose, “Modern Power Electronics and AC Drives”, Pearson Education | |
| [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) |
| [R7] | Malcolm Barnes, “Practical Variable Speed Drives and Power Electronics”, Elsevier Newnes Publications |

## Online Resources:

| | |
|---|---|
| [O1] | NPTEL online course on Fundamentals of Electric Drives, I.I.T. Kanpur by Dr. S.P. Das. |
| [O2] | NPTEL online course on advanced Electric Drives, I.I.T. Kanpur by Dr. S.P. Das. |
| [O3] | Allen Bradley Powerflex 700 AC Drives User manual. |

Mapping:

| Unit | Text Books | Reference Books |
|---|---|---|
| 01 | T1 | R3 |
| 02 | T1,T5 | R2,R4 |
| 03 | T1,T4 | R1,R5 |
| 04 | T1,T2,T5 | R1,R2 |
| 05 | T1,T3,T5 | R1,R6 |
| 06 | T1,T2 | R3,R5,R7 |

## List of Experiments:

Total 9 experiments to be conducted from the following list of practical.

A) Following 5 experiments are compulsory (Hardware based)

1. Electrical braking of D.C. Shunt motor (Rheostatic, Plugging).
2. Speed control characteristics of single phase fully converter fed separately excited D.C. motor
3. VSI fed 3 phase Induction motor (using V/f control PWM inverter) speed control characteristics.
4. Chopper fed D.C. series/separately motor speed control characteristics.
5. Electrical braking of 3 phases Induction Motor (DC Dynamic Braking, Plugging, Regenerative Braking).

B) Any 4 experiments from following (Hardware/software)

6. Speed control characteristics of 3-ph fully converter fed separately excited D.C. motor.
7. Simulation of Induction Motor Vector Control.
8. Study of constant torque and constant power characteristic of induction motor.
9. Study of speed control of BLDC / PMSM drive.
10. Simulation of closed loop control of BLDC / PMSM drive.
11. Simulation of vector control of PMSM/BLDC motor

## 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 Manual: |
| --- |
| ● Title, aim, circuit diagram, procedure and theory of power electronic switching device or converter circuit and expected machine performance with speed torque characteristics.<br>● Equipment along with the specifications needed to carry out the experiment.<br>● Circuit diagram, observation table, calculations must be written on the left side of the journal and aim, theory related to experiment and procedure must be written on the right side.<br>● Analyze 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. ·<br>● All the students in the group must do the connections and perform the practical under the guidance of the staff member. ·<br>● Staff member has to check the results of all the groups. |

# 403150A: Digital Control System

| Teaching Scheme | | | Credits | | Examination Scheme | |
|---|---|---|---|---|---|---|
| Theory | 03 | Hrs/Week | Theory | 03 | ISE | 30 |
| | | | | | ESE | 70 |

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## Course Objectives:

This 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 Outcomes:

At the end of this course, students will be able to:
CO1: Analyze digital control system and its stability.
CO2: Differentiate between various control systems
CO3: Present system in state space format.
CO4: Design observer for system.
CO5: Understand digital controllers
CO6: Elaborate applications such as digital temperature control and position control

| | | |
|---|---|---|
| Unit 01 | Discrete systems and Signals | 07 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 | 07 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 | 07 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 | 07 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 digitizing 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, Euler's forward 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 | 07 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.

## 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. |

Mapping:

| Unit | Text Books | Reference Books |
|---|---|---|
| 01 | T2, T2 | R3 |
| 02 | T2 | R3 |
| 03 | T1, T2 | R3 |
| 04 | T1,T2 | R1, R2 |
| 05 | T1,T3 | R1, R2 |
| 06 | T2,T4 | R3 |

## 403150B: Restructuring and Deregulation

| Teaching Scheme | | | Credits | | Examination Scheme | |
|---|---|---|---|---|---|---|
| Theory | 03 | Hrs/Week | Theory | 03 | ISE | 30 |
| | | | | | ESE | 70 |

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### Course Objectives:

This course aims to:

- Give brief introductions about the various institutions and their roles in the Indian Power sector and introduce the restructured power system .
- Introduce Fundamentals of Power Sector economics.
- Educate about the process and operation of restructuring of power systems and tariff setting principles.
- Explain Power Sector Restructuring Models and to introduction concept of energy trading
- Introduce the concept of electricity markets and various operations involved in the market .
- Explain the fundamental concept of congestion, its management and transmission pricing and concept of transmission pricing.

### Course Outcomes:

At the end of this course, students will be able to:
CO1: Identify the various institutions in the Indian power sector and explain their role in the Indian power sector .
CO2: Explain the various fundamentals of power sector economics
CO3: Describe the regulatory process in India and list the steps involved in tariff determination and explain the phases of tariff determination
CO4: Describe and explain different power sector restructuring models and explain the concept of energy trading
CO5: Explain the types of electricity markets and compare the types of electricity markets .
CO6: State different transmission pricing methods and describe and compare various congestion management methods.

| Unit 01 | Power Sector in India | 07hrs |
|---|---|---|

Introduction to various institutions in the Indian Power sector such as the Ministry of Power ,MNRE, CEA, Planning Commissions, PGCIL, PFC, CERC, SERC, Load dispatch centers (National, regional and state ) and their roles. Critical issues / challenges before the Indian power sector, Need of regulation and deregulation of the power industry. Conditions favoring deregulation in the power sector. An overview of the restructured power system, Difference between integrated power system and restructured power system

| Unit 02 | Fundamentals of Power Sector Economics | 07hrs |
|---|---|---|

Introduction, Consumer behaviour, Supplier behaviour, Short-run and Long-run costs, Various costs of production, Relationship between short-run and long-run average costs, Typical cost components and cost structure of the power sector, Concept of life cycle cost, annual rate of return .Elasticity of demand and

supply curve, Market equilibrium, Consumer and supplier surplus. Perfectly competitive market. Key Indices for assessment of utility performances.(Generation, transmission and distribution).Financial tools to compare investment options.

| | | |
|---|---|---|
| Unit 03 | Power Sector Regulation | 07hrs |

Regulatory process in India, types and methods of Regulation - rate of return regulation, benchmarking or yardstick regulation, performance-based regulation. Role of regulatory commission. Considerations of socio economic aspects in regulation. Principles of Tariff setting, Phases of Tariff determination. Consumer tariff structures and considerations, different consumer categories. Comparison of different tariff structures for different load patterns. The Electricity Act 2003, The Electricity Act 2010, National Electricity policy. Recently Amended Electrical policy.

| | | |
|---|---|---|
| Unit 04 | Introduction to Power Sector Restructuring Models and Introduction to energy trading | 07hrs |

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, ownership models, 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 | 07hrs |

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 .Market operation – settlement process , market clearing price (MCP) , Market efficiency . Market power Electricity markets under imperfect competition Sources of market power, Effect of market power, Identifying market power, HHI Index, Entropy coefficient, Lerner index, Market power mitigation, Effects of contract for differences.

| | | |
|---|---|---|
| Unit 06 | Transmission Pricing and Congestion Management | 07hrs |

Cost components of transmission system, cost allocation of transmission system, Transmission pricing methods, physical transmission rights, Open access.
Congestion in power networks, reasons for congestion, congestion management methods . Non-market methods, Market based methods. Definition of terms - Total transfer capability (TTC), Available transfer capability (ATC), Transmission Reliability Margin (TRM), Capacity Benefit Margin (CBM), Existing Transmission Commitments (ETC). Locational marginal Pricing (LMR), Firm Transmission Right (FTR)

## 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-J |


## 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 |

Online Resources:

| | |
|---|---|
| [O1] | http://www.cercind.gov.in/Function.html |
| [O2] | www.cercind.gov.in/serc.html |
| [O3] | http://www.power.gov.ng/index.php/about-us/our-functions |
| [O4] | http://planningcommission.nic.in/reports/genrep/arep9920/ar9920role.htm |
| [O5] | http://www.cea.nic.in/functions.html |
| [O6] | https://nptel.ac.in/courses/108101005 |
| [O7] | https://posoco.in/ |
| [08] | https://www.iexindia.com/ |

Mapping:

| Unit | Text Books | Reference Books |
|---|---|---|
| 01 | T1 | [O1]-[O6] |
| 02 | T1 | R3 |
| 03 | T1 | R1 |
| 04 | T2 | R5,[O8] |
| 05 | T2 | R5,R2,R4 |
| 06 | T3 | R1 |

# 403150C: Smart Grid

| Teaching Scheme | | | Credits | | Examination Scheme | |
|---|---|---|---|---|---|---|
| Theory | 03 | Hrs/Week | Theory | 03 | ISE | 30 |
| | | | | | ESE | 70 |

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## Course Objectives:

This course aims to:

- Explain the concept of Smart Grid, compare with conventional grid, and identify its opportunities and barriers.
- 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.
- 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.
- Elaborate the concept of microgrid.

## Course Outcomes:

At the end of this course, students will be able to:
CO1: Apply the knowledge to differentiate between Conventional and Smart Grid
CO2: Describe importance of Supercapacitors.
CO3: Identify the need of Smart metering.
CO4: Apply the communication technology in smart grid.
CO5: Comprehend the issues of micro grid.

| | | |
|---|---|---|
| Unit 01 | Introduction to Smart Grid | 07 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, Smart Grid National Policies, Smart Cities, Pilot projects in India

| | | |
|---|---|---|
| Unit 02 | Smart Grid Technologies | 07 hrs |

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), Energy Storage Technologies and applications – Battery (flow and advanced), SMES, Super Capacitors, Compressed Air Energy Storage (CAES) and its comparison.

| | | |
|---|---|---|
| Unit 03 | Smart Meters and Advanced Metering Infrastructure | 07 hrs |

Introduction to Smart Meters, Prepaid meters, Net Metering, Advanced Metering Infrastructure (AMI), Real Time Pricing, Automatic Meter Reading (AMR), Outage Management System (OMS), Smart Substation , IEC 61850, Smart Sensors, Geographic Information System (GIS), IS 16444, LowPAN RF meter

| | | |
|---|---|---|
| Unit 04 | Communication Technology for Smart Grid | 07 hrs |
| Communication Architecture of SG, Wide Area Measurement Protection and Control (WAMPAC), 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, LORaWAN, NB-IoT, SigFox. | | |
| Unit 05 | Microgrids | 07 hrs |
| Concept of Microgrid, need and applications of Microgrid, Microgrid Architecture, DC Microgrid, Hybrid Microgrid, Formation of Microgrid, Issues of interconnection, protection and control of Microgrid, Integration of renewable energy sources, Smart Microgrid, Microgrid and Smart Grid Comparison, Renewable Energy based Microgrid system | | |
| Unit 06 | Power Quality issues and Challenges | 07 hrs |
| Power Quality and EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources , Smart Grid data analytics, Distributed Generation, Reliability Indices (CAIDI, CAIFI, MAIDI, MAIFI), Load Forecasting Methods, Smart Appliances, Home and Building Automation. | | |
| Text Books: | | |
| [T1] | Clark W. Gellings, “The Smart Grid: Enabling Energy Efficiency and Demand Response”,CRC Press | |
| [T2] | Stuart Borlase, “Smart Grids-Infrastructure, Technology and Solutions”, CRC Press, Taylor and Francis group | |
| [T3] | Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama, “Smart Grid: Technology and Applications”, Wiley Publications. | |
| [T4] | Nikos Ziargyriour, “Micro grid, Architecture and Control”, IEEE Press, Wiley Publications. | |
| Reference Books: | | |
| [R1] | Yang Xiao, “Communication and Networking in Smart Grids”, CRC Press, Taylor and Francis group | |
| Online Resources: | | |

| 403150D: Sensor Technology (Open Elective) | | | | | | |
|---|---|---|---|---|---|---|
| **Teaching Scheme** | | | **Credits** | | **Examination Scheme** | |
| Theory | 03 | Hrs/Week | Theory | 03 | ISE | 30 |
| | | | | | ESE | 70 |

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## Course Objectives:

This course aims to:

## Course Outcomes:

At the end of this course, students will be able to:
CO1: Understand the characteristics of sensors used for system monitoring and protection.
CO2: Interface the various position sensors to microcontrollers.
CO3: Demonstrate the characteristics of sensors used for light and image sensing.

| | | |
|---|---|---|
| Unit 01 | Sensor fundamentals and characteristics | 06 hrs |

Sensor Classification, Performance and Types, Error Analysis characteristics

| | | |
|---|---|---|
| Unit 02 | Optical Sources and Detectors | 06 hrs |

Electronic and Optical properties of semiconductor as sensors, LED, Semiconductor lasers, Fiber optic sensors, Thermal detectors, Photo multipliers, photoconductive detectors, Photo diodes, Avalanche photodiodes, CCDs.

| | | |
|---|---|---|
| Unit 03 | 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.

| | | |
|---|---|---|
| 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 | Special Sensors - | 06 hrs |

GPS, Bluetooth, smart sensor - film sensor, MEMS and nano sensors, laser sensors, touch screen sensors, heading sensors - compass gyroscope inclinometer, application of sensors in drone.

## Text Books:

| | |
|---|---|
| [T1] | Jacob Fraden, “Hand Book of Modern Sensors: physics, Designs and Applications”, 2015, 3rd edition, Springer, New York. 2. Jon. S. Wilson, “Sensor Technology Hand Book”, 2011, 1st edition, Elsevier, Netherland. |
| [T2] | Jon. S. Wilson, “Sensor Technology Hand Book”, 2011, 1st edition, Elsevier, Netherland. |

## Reference Books:

| | |
|---|---|
| [R1] | Gerd Keiser,”Optical Fiber Communications”, 2012, 4th edition, McGraw-Hill Science, Delhi. |
| [R2] | John G Webster, “Measurement, Instrumentation and sensor Handbook”, 2014, 2nd edition, CRC Press, Florida. |
| [R3] | Eric Udd and W.B. Spillman, “Fiber optic sensors: An introduction for engineers and scientists”, 2013, 2nd edition, Wiley, New Jersey. |
| [R4] | Bahaa E. A. Saleh and Malvin Carl Teich, “Fundamentals of photonics”, 2012, 1st edition, John Wiley, New York. |

## Online Resources:

| | |
|---|---|
| [O1] | https://www.ti.com |
| [O2] | https://www.mouser.in/ |

Mapping:

| Unit | Text Books | Reference Books |
|---|---|---|
| 01 | [01] | [R1] |
| 02 | [02] | [R2],[R4] |
| 03 | [01],[02] | [R3] |
| 04 | [01],[02] | [01] Online |
| 05 | [01],[02] | [02] online |
| 06 | [01],[02] | [R2],[R4] |

# 403151A: EHV AC Transmission

| Teaching Scheme | | | Credits | | Examination Scheme | |
|---|---|---|---|---|---|---|
| Theory | 03 | Hrs/Week | Theory | 03 | ISE | 30 |
| | | | | | ESE | 70 |

==========

## Course Objectives:

This course aims to:

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

## Course Outcomes:

At the end of this course, students will be able to:
CO1:Highlight need for EHV ac transmission.
CO2:Calculate line and ground parameters.
CO3:Enlist problems encountered in EHV transmission.
CO4:Describe the effect of electric and magnetic fields on human beings.

| | | |
|---|---|---|
| Unit 01 | EHVAC Transmission | 07 hrs |

Need for EHV transmission lines, Power handling capacity and line loss, Mechanical considerations in line performance, Vibrations. Traveling wave equations, transmission reflection attenuation and distortion of traveling waves, transmission and reflection coefficients and examples.

| | | |
|---|---|---|
| Unit 02 | Calculation of line and ground parameters | 07 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 Conductor | 07 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 | 07hrs |

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 an 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 | 07 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 | | 07 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. |
|---|---|

Mapping:

| Unit | Text Books | Reference Books |
|---|---|---|
| 01 | T1 | R1 |
| 02 | T1 | – |
| 03 | T1 | – |
| 04 | T1 | R1 |
| 05 | T1 | R1 |
| 06 | T1 | R1 |

# 403151B: Illumination Engineering

| Teaching Scheme | | | Credits | | Examination Scheme | |
|---|---|---|---|---|---|---|
| Theory | 03 | Hrs/Week | Theory | 03 | ISE | 30 |
| | | | | | ESE | 70 |

==========

## Course Objectives:

This course aims to:

- 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 Outcomes:

At the end of this course, students will be able to:
CO1: Define and reproduce various terms in illumination.
CO2: Identify various parameters for illumination system design.
CO3: Design indoor and outdoor lighting systems.
CO4: Enlist state of the art illumination systems.

| Unit 01 | Importance of Lighting in Human Life | 07 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 |
|---|---|---|

**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

**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 | 07 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 | 07 hrs |
| Indoor illumination design for following installations<br>Residential (Numerical)<br>Educational institute<br>Commercial installation<br>Hospitals<br>Industrial lighting<br>Special purpose lighting schemes<br>Decorative lighting<br>Theatre lighting<br>Aquarium, swimming pool lighting | | |
| Unit 05 | Design of lighting schemes-II | 07 hrs |
| Factors to be considered for design of outdoor illumination scheme<br>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.<br>Outdoor illumination design for following installations:<br>Road lighting (Numerical)<br>Flood lighting (Numerical)<br>Stadium and sports complex<br>Lighting for advertisement/hoardings | | |
| Unit 06 | Modern trends in illumination | 07 hrs |
| LED luminary designs<br>Intelligent LED fixtures<br>Natural light conduiting<br>Organic lighting system<br>LASERS, characteristics, features and applications, non-lighting lamps<br>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 |

Mapping:

| Unit | Text Books | Reference Books |
|---|---|---|
| 01 | T1, T4 | R6 |
| 02 | T3, T4 | R1, R3, R4, R8 |
| 03 | T2, T4 | R2, R3, R7 |
| 04 | T3, T4 | R2,R3, R4, R5, R7 |
| 05 | T2, T3, T4 | R3, R4, R6, R7 |
| 06 | T1, T2, T4 | R2, R3, R5, R8 |

# 403151C: Electromagnetic Fields

| Teaching Scheme | | | Credits | | Examination Scheme | |
|---|---|---|---|---|---|---|
| Theory | 03 | Hrs/Week | Theory | 03 | ISE | 30 |
| | | | | | ESE | 70 |

==========

## Course Objectives:

This course aims to:

- 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 Outcomes:

At the end of this course, students will be able to:
CO1: Describe time varying Maxwell's equations and their applications in electromagnetic problems
CO2: Interpret electric and magnetic field with the help of associated laws
CO3: Solve simple electrostatic and magnetic boundary conditions
CO4: Determine the relationship between time varying electric and magnetic fields and electromotive force
CO5: Solve electromagnetic problems with the help of mathematical tools.

| | | |
|---|---|---|
| Unit 01 | Introduction | 07 hrs |

Sources and effects of Electro-Magnetic Fields, Scalar and vector, Unit vector, Mathematical operations of Vector, Scalar and vector fields, Different Coordinate 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 | 07 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 | 07 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 | 07 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 BiotSavart law and Ampere's law based on magnetic potential, Forces due to magnetic field, Magnetic dipole.

| Unit 05 | Boundary Conditions and Analysis | 07 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 | 07 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. |

Mapping:

| Unit | Text Books | Reference Books |
|---|---|---|
| 01 | T2 | R2, R3, R4 |
| 02 | T1, T2 | R1, R2, R3 |
| 03 | T1, T2 | R2, R3, R4, R5 |
| 04 | T1, T2 | R2, R3 |
| 05 | T2 | R1, R4, R5 |
| 06 | T1, T2 | R2, R3, R4 |

# 403151D: Artificial Intelligence and Machine Learning

| Teaching Scheme | | | Credits | | Examination Scheme | |
|---|---|---|---|---|---|---|
| Theory | 03 | Hrs/Week | Theory | 03 | ISE | 30 |
| | | | | | ESE | 70 |

==========

## Course Objectives:

This course aims to:

- Understand the basic concept of AI, strength and weakness of problem solving and search.
- Know about various Expert System tools and applications.
- Understand the basic concepts of machine Learning and apply different dimensionality reduction techniques.
- Optimize the different linear methods of regression and classification.
- Interpret the different supervised classification methods of support vector machine.
- Acquire the knowledge of different generative models through unsupervised learning.

## Course Outcomes:

At the end of this course, students will be able to:
CO1: Evaluate Artificial Intelligence (AI) and Machine Learning(ML) methods and describe their foundations.
CO2: Demonstrate knowledge of reasoning and knowledge representation for solving real world problems.
CO3: Illustrate the construction of learning and expert system Discuss current scope and limitations of AI and societal implications
CO4: Distinguish between different types of learning types.
CO5: Apply the different supervised, unsupervised and reinforcement learning methods.

| | | |
|---|---|---|
| Unit 01 | Introduction to AI | 07 hrs |

Definitions – Foundation and History of AI, Evolution of AI - Applications of AI, Classification of AI systems with respect to environment. Artificial Intelligence vs Machine learning, Statistical Analysis: Relationship between attributes: Covariance, Correlation Coefficient, Chi Square. Intelligent Agent: Concept of Rationality, nature of environment, structure of agents.

| | | |
|---|---|---|
| Unit 02 | Problem Solving | 07 hrs |

Heuristic Search Techniques: Generate-and-Test; Hill Climbing; Properties of A* algorithm, Bestfirst Search; Problem Reduction. Constraint Satisfaction problem: Interference in CSPs; Back tracking search for CSPs; Local Search for CSPs; structure of CSP Problem. Beyond Classical Search: Local search algorithms and optimization problem, local search in continuous spaces, searching with nondeterministic action and partial observation, online search agent and unknown environments.

| | | |
|---|---|---|
| Unit 03 | Knowledge and Reasoning | 07 hrs |

Knowledge and Reasoning: Building a Knowledge Base: Propositional logic, first order Logic, situation calculus. Theorem Proving in First Order Logic, Planning, partial order planning. Uncertain Knowledge and Reasoning, Probabilities, Bayesian Networks. Probabilistic reasoning over time: time and uncertainty, hidden Markova models, Kalman filter, dynamic bayesian network, keeping track of many objects

| | | |
|---|---|---|
| Unit 04 | Introduction to ML and Supervised Learning | 07 hrs |
| Introduction to Machine Learning, Examples of Machine Learning Applications, Learning Types **Supervised Learning** -Learning a Class from Examples, Vapnik-Chervonenkis (VC) Dimension, Probably Approximately Correct (PAC) Learning,Noise, Learning Multiple Classes, Regression, Model Selection and Generalization, **Dimensions of a Supervised Machine Learning** Algorithm Dimensionality Reduction-Introduction,Subset Selection, Principal Components Analysis, Factor Analysis, Multidimensional Scaling, Linear Discriminant Analysis,Isomap, Locally Linear Embedding | | |
| Unit 05 | Linear Regression | 08 hrs |
| Introduction, Linear Regression Models and Least Squares, Subset Selection, Shrinkage Methods-Ridge Regression, Lasso Regression, Least Angle Regression, Methods Using Derived Input Directions-Principal Components Regression, Partial Least Squares, A Comparison of the Selection and Shrinkage Methods , Multiple Outcome Shrinkage and Selection, More on the Lasso and Related Path Algorithms, Logistic Regression-Fitting Logistic Regression Models, Quadratic Approximations and Inference, L1 Regularized Logistic Regression | | |
| Unit 06 | Unsupervised and reinforcement learning | 08 hrs |
| Introduction, Association Rules-Market Basket Analysis, The Apriori Algorithm, Unsupervised as Supervised Learning,Generalized Association Rules, Cluster Analysis. Proximity Matrices, Clustering Algorithms-K-mean, Gaussian Mixtures as Soft K-means Clustering. **Reinforcement Learning:** Introduction, Single state case, elements of reinforcement learning, model based learning, Temporal difference learning | | |
| Text Books: | | |
| [T1] | Russell, S. and Norvig, P. 2015. Artificial Intelligence - A Modern Approach, 3rd edition, Prentice Hall | |
| [T2] | J. Gabriel, Artificial Intelligence: Artificial Intelligence for Humans (Artificial Intelligence, Machine Learning), Create Space Independent Publishing Platform, First edition , 2016 | |
| [T3] | Introduction to Machine Learning Edition 2, by Ethem Alpaydin | |
| [T4] | The Elements of Statistical Learning. Trevor Hastie, Robert Tibshirani and Jerome Friedman. Second Edition. 2009. | |
| [T5] | Machine Learning. Tom Mitchell. First Edition, McGraw- Hill, 1997 | |
| Reference Books: | | |
| [R1] | Introduction to Artificial Intelligence & Expert Systems, Dan W Patterson, PHI.,2010 2. S Kaushik, Artificial Intelligence, Cengage Learning, 1st ed.2011 | |
| [R2] | Ric, E., Knight, K and Shankar, B. 2009. Artificial Intelligence, 3rd edition, Tata McGraw Hill | |
| [R3] | Luger, G.F. 2008. Artificial Intelligence -Structures and Strategies for Complex Problem Solving, 6th edition, Pearson | |
| [R4] | Alpaydin, E. 2010. Introduction to Machine Learning. 2nd edition, MIT | |

| | |
|---|---|
| [R5] | Pattern Recognition and Machine Learning. Christopher Bishop. Springer. 2006. |
| [R6] | Understanding Machine Learning. Shai Shalev-Shwartz and Shai Ben-David. Cambridge University Press. 2017. |
| [R7] | Understanding Machine Learning. Shai Shalev-Shwartz and Shai Ben-David. Cambridge University Press. 2017. |

Online Resources:

| | |
|---|---|
| [O1] | https://nptel.ac.in/courses/106/106/106106139/ |
| [O2] | https://nptel.ac.in/courses/106/106/106106202/ |
| [O3] | https://nptel.ac.in/courses/106/106/106106198/ |
| [O4] | https://nptel.ac.in/courses/106/105/106105152/ |
| [O5] | https://nptel.ac.in/courses/106/106/106106213/ |
| [O6] | https://www.coursera.org/learn/machine-learning |

Mapping:

| Unit | Text Books | Reference Books |
|---|---|---|
| 01 | T1, T2 | R1, R2, R3 |
| 02 | T1, T2 | R1, R2, R3 |
| 03 | T1, T2 | R1, R2, R3 |
| 04 | T3, T4, T5 | R4, R5, R6, R7 |
| 05 | T3, T4, T5 | R4, R5, R6, R7 |
| 06 | T3, T4, T5 | R4, R5, R6, R7 |

# 403152: Project Stage II

| Teaching Scheme | | | Credits | | Examination Scheme | |
|---|---|---|---|---|---|---|
| SEM/PW/IN | 12 | Hrs./Week | SEM/PW/IN | 6 | ORAL | 50 |
| | | | | | Termwork | 100 |

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## Preamble:

Project is an important part of the engineering curriculum covered in the final year. It is divided into Project Stage I and Project Stage II in Semesters I and II of the Final Year. This project is a substantial piece of work that will require creative activity and original thinking. The project aims to provide students with a transitional experience from the academic world to the professional world. The objectives, outcomes, and guidelines for Project Stage II are given below.

## Course Objectives:

The objectives of this course are to:
1. Provide an opportunity to learn new software, interdisciplinary theory, concept, technology, etc. not covered in earlier subjects
2. Empower students to use engineering knowledge and skills learned in previous courses to deliver a product that has passed through the design, analysis, testing, and evaluation
3. Encourage multidisciplinary project work through the integration of knowledge
4. Allow students to develop problem-solving, analysis, synthesis, and evaluation skills.
5. Encourage teamwork.
6. Improve students' communication skills by asking them to produce both a professional report and to give an oral presentation
7. Exposed to the project management skills and ethical practices in project

## Course Outcomes:

Course outcomes can be different for the different projects undertaken by the student groups. However, in general, the course outcomes for Project Stage-II can be stated as follows.
At the end of this course, students should be able to:
CO1: Identify tools, techniques, methods, concepts, measuring devices, and instruments required for the project to define the methodology of the project
CO2: Justify the selection of electrical, electronic and mechanical components for the project prototyping
CO3: Select the appropriate testing method for system performance evaluation
CO4: Interpret results obtained by simulation, and hardware implementation and decide on further action or write a conclusion
CO5: Write a project report and research paper on the project work

## Guidelines:

Termwork evaluation guidelines are given below.

| Sr. No. | Activity | Deadline (Semester II) | Parameters for Evaluation |
|---|---|---|---|
| 1 | Progress Review-3 Presentation | Up to 6th Week | Revised Final Design (10)<br>Tools and Techniques Used with justification (10)<br>Partial Implementation/ development (15)<br>Partial Results (15) |

| | | | |
|---|---|---|---|
| | | | **Total Marks (50)** |
| 2 | Progress Review-4 Presentation | Up to 12th Week | Implementation Status of project (10)<br>Testing and Evaluation (10)<br>Intermediate Results (15)<br>Conclusion (10)<br>Future Scope (5)<br>**Total Marks (50)** |
| 3 | Submission of Project Stage –II Report | Up to 14th Week | Timely submission (5)<br>Formatting and Report Writing Style (5)<br>Abstract, Literature Survey, Conclusion (10)<br>Grammatical correctness in the report (5)<br>Publication/participation in project exhibition (20)<br>**Total Marks (50)**<br><br>**Review 3+ Review 4+ Final Project Report = 150**<br>**Rounded to 100 Marks** |

**Guidelines to students:**

1. Continue with the same group and identify opportunities for self-learning and upgrading skills.
2. Actively participate in all the activities related to the project.
3. Document the project in the form of a hard-bound report at the end and submit it to the department.
4. Attempt to make a prototype, working model, and demonstration of the project to display during the final presentation.
5. Participate in project competitions, paper presentations, etc.
6. Maintain an institutional culture of authentic collaboration, self-motivation, peer learning, and personal responsibility.
7. Maintain a notebook to keep records of all the meetings, discussions, notes, etc. This is to be done by the individual student and submitted at the end to the supervisor or guide.
8. Some parameters, mentioned in the above table, will be evaluated and assessed at a group level and some at an individual level.

# 403153A: German Language-II

| Teaching Scheme | | | Credits | | Examination Scheme | | |
|---|---|---|---|---|---|---|---|
| Theory | 02 | Hrs/Week | Theory | – | ISE | | – |

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## Course Objectives:

This course aims to:

- Get introduced to the Culture, Routine of the German Society through language.
- Meet the needs of ever growing German industry with respect to language support.

## Course Outcomes:

At the end of this course, students:
CO1: Will have the ability of advanced communication.
CO2: Will develop reading, writing and listening skills.
CO3: Will understand tenses in German Language.
CO4: Will develop interest to pursue a German language course.

| | | |
|---|---|---|
| Unit 01 | Introduction of Cases: | 06 hrs |

Introduction of Cases: Nominative, Akkusative, Dative.
Personal & Possessive Pronouns in Nominative, Akkusative, Dative.

| | | |
|---|---|---|
| Unit 02 | Prepositions:- | 06 hrs |

Prepositions:- Akkusative & Dative.

| | | |
|---|---|---|
| Unit 03 | Tenses:- | 06 hrs |

Tenses:-
Past tense of sein & haben Verbs, Perfect tense

## Text Books:

| | |
|---|---|
| [T1] | Netzwerk A-1 (Deutsch als Fremdsprache), Goyal Publishers & Distributors Pvt. Ltd. |

## Reference Books:

| | |
|---|---|
| [R1] | Tipps und Uebungen A1 |

## Online Resources:

| | |
|---|---|
| [O1] | Practice Material like online Worksheets regarding the Grammar, listening Module, reading Texts. |

# 403153B: Engineering Economics-II

| Teaching Scheme | | | Credits | | Examination Scheme | | |
|---|---|---|---|---|---|---|---|
| Theory | 02 | Hrs/Week | Theory | – | ISE | | – |

==========

## Course Objectives:

This course aims to:

1. Describe basics methods of Engineering Economic Analysis
2. Explain inflation and its impact on business decisions.

## Course Outcomes:

At the end of this course, students will be able to:
CO1:Apply various techniques for evaluation of engineering projects.
CO2:Assess cash flow under risk with varying parameters.

| | | |
|---|---|---|
| Unit 01 | Engineering Economic Analysis | 10 hrs |

Internal Rate Of Return, Calculating Rate of Return, Incremental Analysis; Best Alternative Choosing An Analysis Method, Future Worth Analysis, Benefit-Cost Ratio Analysis, Sensitivity And Breakeven Analysis. Public Sector Economic Analysis (Benefit Cost Ratio Method).Introduction to Lifecycle Costing, Introduction to Financial and Economic Analysis.Case Study – Tata Motors

| | | |
|---|---|---|
| Unit 02 | Inflation and Risk Analysis | 10 hrs |

Concept of Inflation., Measuring Inflation, Equivalence Calculation Under Inflation, Impact of Inflation on Economic Evaluation.
Sources of Project Risks, Methods of Describing Project Risks, Sensitivity Analysis, Break Even Analysis, Scenario Analysis, Probability Concept of Economic Analysis, Decision Tree and Sequential Investment Decisions

## Text Books:

| | |
|---|---|
| [T1] | Riggs, Bedworth and Randhwa, “Engineering Economics”, McGraw Hill Education India. |
| [T2] | D.M. Mithani, Principles of Economics. Himalaya Publishing House |

## Reference Books:

| | |
|---|---|
| [R1] | Sasmita Mishra, “Engineering Economics & Costing “, PHI |
| [R2] | Sullivan and Wicks, “ Engineering Economy”, Pearson |
| [R3] | R. Paneer Seelvan, “ Engineering Economics”, PHI |
| [R4] | Chan S. Park, Contemporary Engineering Economics, Prentice Hall, Inc. |

# 403153C: GREEN BUILDING

| Teaching Scheme | | | Credits | | Examination Scheme | | |
|---|---|---|---|---|---|---|---|
| Theory | 02 | Hrs/Week | Theory | -- | ISE | | -- |

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## Course Objectives:

This course aims to:

- To learn the principles of planning and orientation of buildings.
- To acquire knowledge on various aspects of green buildings.

## Course Outcomes:

At the end of this course, students will be able to:
CO1:Design green and sustainable techniques for both commercial and residential buildings.
CO2:Design water, lighting, energy efficiency plan using renewable energy sources.
CO3:Explain the principles of building planning, its bylaws and provide facilities for rainwater harvesting
CO4:Understand the concepts of green buildings

| Unit 01 | Sustainability and Building design | 06 hrs |
|---|---|---|

Sustainability, objectives of sustainable development, Sustainable aspects of habitat design, sustainable buildings, principles, approaches and characteristics, climate data, climate parameters and zones, comparative analysis of various climatic zones, site planning recommended checklist for identifying site characteristics, site development and layout. Efficient water management and waste water treatment, solid waste management.

| Unit 02 | Energy efficiency | 06 hrs |
|---|---|---|

Solar passive techniques in building design to minimize load on conventional systems i.e. heating, cooling, ventilation and lighting. Designing Energy efficient lighting and HVAC systems. Use of renewable energy systems to meet part of building load. Green building certification. Overview of various green buildings in India. Policy and regulatory mechanisms.

## Text Books:


| | |
|---|---|
| [T1] | Seven Wonders of Green Building Technology: Karen Sirvaitis, Twenty-First Century Books. |
| [T2] | Jerry Yudelson Green building Through Integrated Design. McGraw Hill, 2009. |
| [T3] | Osman Attmann Green Architecture Advanced Technologies and Materials. McGraw Hill, 2010. |
| [T4] | Fundamentals of Integrated Design for Sustainable Building By Marian Keeler, Bill Burke |


## Reference Books:

| | |
|---|---|
| [R1] | Sustainable Building Design Manual, Volume 2, TERI, New Delhi |
| [R2] | Energy Efficient Buildings in India, TERI, New Delhi |
| [R3] | Sustainable Building Design Manual, Volume 1 TERI, New Delhi |
| [R4] | Mili Majumdar, “Energy-efficient buildings in India” Tata Energy Research Institute, 2002. |
| [R5] | TERI “Sustainable Building Design Manual- Volume I & II” Tata Energy Research Institute, 2009. |
| Online Resources: | |
| [O1] | https://nptel.ac.in/courses/105102175 |
| [O2] | https://theect.org/energy-efficiency-buildings-distance-learning/ |
| [O3] | https://www.udemy.com/topic/energy-management/ |
| [O4] | https://archive.nptel.ac.in/noc/courses/noc19/SEM1/noc19-ce13/ |
| [O5] | https://beeindia.gov.in/content/certification |
| [O6] | https://elearning.iea.org/ |
| [O7] | https://onlinecourses.nptel.ac.in/noc20_ce08/preview |