DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

ANNA UNIVERSITY, CHENNAI – 25

VISION OF THE DEPARTMENT

The vision of Anna University is to be a world class institution by producing professionals with high technical knowledge, professional skills and ethical values, and remain as a preferred partner to the industry and community for their economic and social development through excellence in teaching, research and consultancy. Anna University shall be recognized as a point of reference, a catalyst, a facilitator, a trend setter and a leader in technical education.

MISSION OF THE DEPARTMENT

To produce full fledged Electrical and Electronics Engineers to cater to the needs of the modern industries and be useful for building the nation.
PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

I. To prepare the students for successful career in electrical power industry, research and teaching institutions.

II. To provide strong foundation in Power Engineering, necessary for day-to-day operation and planning of Power System.

III. To develop the ability to assess the state of the system using Wide Area Measurements.

IV. To develop the ability to design damping controllers to enhance the stability margin and power transfer capability of the Power System.

V. To provide strong foundation in the power system protection and relaying.

VI. To promote student awareness for the lifelong learning and introduce them to the professional ethics

PROGRAMME OUTCOMES (POs):

2. PROGRAMME OUTCOMES (POs):

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<td>1.</td>
<td>Engineering Knowledge</td>
<td>Apply knowledge of basic science and engineering in analysis and modeling of the power system components</td>
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<td>2.</td>
<td>Problem Analysis</td>
<td>Formulate, simulate and analyze the Power system under steady state and dynamic conditions</td>
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<tr>
<td>3.</td>
<td>Design / Development of Solutions</td>
<td>Design of Power System protection schemes and damping Controllers to enhance the reliability and stability of the Power System</td>
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<td>4.</td>
<td>Conduct investigations of complex problems</td>
<td>Identification of problems such as power swing, sub synchronous resonance and controller interactions, reach of the protective relay, grid integration issues of renewable energy sources</td>
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<td>Model tool usage</td>
<td>Model and analyze the Power System under steady state and dynamic conditions using application software packages.</td>
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<td>6.</td>
<td>The Engineer and Society</td>
<td>To cater the need for restructuring the grid and incorporation of smartness in grid management</td>
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<td>7.</td>
<td>Environment and Sustainability</td>
<td>To address various renewable energy sources penetration issues</td>
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<td>Ethics</td>
<td>To impart Ethics in ensuring grid security in professional manner</td>
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<tr>
<td>9.</td>
<td>Individual and team work</td>
<td>Function in a multi-disciplinary team</td>
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<td>Communication</td>
<td>Proficiency in oral and written Communication to present technical subjects</td>
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<td>Project Management and Finance</td>
<td>Implement cost effective and cutting edge technologies in Power System</td>
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<td>12.</td>
<td>Life-long learning</td>
<td>Continue professional development and learning as a life-long activity.</td>
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PROGRAM SPECIFIC OUTCOMES (PSOs):

By the completion of M.E. Power System Engineering program the student will have following Program Specific Outcomes.

1. Ability to apply knowledge of electrical power system principles and techniques for power system applications.
2. Ability to develop steady-state and dynamic models of various power system components to perform system studies for generation and transmission system expansion planning.
3. Ability to design and develop various indigenous controllers for efficient and economic operation of power system.
4. Ability to design and develop principles, practices and state-of-art techniques to protect the power system.
5. Ability to analyze various electricity market models with distributed energy resources and demand response management.
6. Ability to incorporate interdisciplinary knowledge to address the recent problems in the electrical power industry.

PEO / PO Mapping:

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**YEAR 2**

Semester 4

Project Phase II
## ANNA UNIVERSITY, CHENNAI
### UNIVERSITY DEPARTMENTS
### REGULATIONS - 2019
### CHOICE BASED CREDIT SYSTEM
### M.E. POWER SYSTEMS ENGINEERING (FULL TIME)
### CURRICULUM AND SYLLABUS I TO IV SEMESTERS

### SEMESTER I

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**TOTAL NO OF CREDITS:** 70
# ANNA UNIVERSITY, CHENNAI
## UNIVERSITY DEPARTMENTS
### REGULATIONS - 2019
#### CHOICE BASED CREDIT SYSTEM
##### M.E. POWER SYSTEMS ENGINEERING (PART TIME)
###### CURRICULUM AND SYLLABUS I TO VI SEMESTERS

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Total Credits 2

**OPEN ELECTIVE COURSES [OEC]**

* (Out of 6 Courses one Course must be selected)

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**AUDIT COURSES (AC)**

Registration for any of these courses is optional to students

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### SUMMARY

#### POWER SYSTEMS ENGINEERING

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COURSE OBJECTIVES
Students will be able to:

- Study various methods of load flow and their advantages and disadvantages
- Study optimal power flow solutions in detail.
- Understand power system security concepts and study the methods to rank the contingencies
- Analyze the role of generation scheduling in day-to-day operation of power system.
- Understand need of state estimation and study simple algorithms for state estimation

UNIT I POWER FLOW ANALYSIS
Overview of Newton-Raphson, Gauss – Seidel, Fast Decoupled Power Flow method, convergence properties, handling Q-max violation in constant matrix, inclusion of frequency effects, AVR in load flow, handling of discrete variable in load flow-introduction to restructured power system

UNIT II OPTIMAL POWER FLOW
Problem statement; Solution of Optimal Power Flow (OPF) – The gradient method, Newton’s method, Linear Sensitivity Analysis; LP methods – With real power variables only – LP method with AC power flow variables and detailed cost functions; Security constrained Optimal Power Flow; Interior point algorithm; Bus Incremental costs.

UNIT III POWER SYSTEM SECURITY
Introduction to Power system security analysis and monitoring - DC Load flow - Factors affecting power system security - Contingency analysis for generator and line outages using linear sensitivity factors.

UNIT IV HYDROTHERMAL SCHEDULING PROBLEM

UNIT V STATE ESTIMATION

TOTAL: 60 PERIODS
COURSE OUTCOMES
Students will be able to:

CO1: calculate voltage phasors at all buses, given the data using various methods of load flow
CO2: calculate OPF solutions for economic operation of power system
CO3: Rank various contingencies according to their severity
CO4: Analyze the optimal scheduling of power system with various generation mix
CO5: Estimate the bus voltage phasors given various quantities viz. power flow, voltages, taps, CB status etc.

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REFERENCES

PS 5151
ANALYSIS AND COMPUTATION OF ELECTROMAGNETIC TRANSIENTS IN POWER SYSTEMS

COURSE OBJECTIVES
- To impart in depth knowledge about various power system transients and analyze the travelling wave phenomena.
- To impart knowledge on the EMTP Type modelling of overhead lines and underground cables.
- To impart knowledge on the EMTP Type modelling of transformers.
- To coordinate the insulation of power system and protective devices.
- To describe the methodology for computing the transients in power systems.
UNIT I  REVIEW OF TRAVELLING WAVE PHENOMENA  12
Lumped and Distributed Parameters – Wave Equation – Reflection, Refraction, Behavior of Travelling waves at the line terminations – Lattice Diagrams – Attenuation and Distortion-switching overvoltage: Short line or kilometric fault, energizing transients - closing and re-closing of lines, methods of control; temporary over voltages: line dropping, load rejection; voltage induced by fault; very fast transient overvoltage(VFTO).

UNIT II  PARAMETERS AND MODELLING OF OVER HEADLINES AND UNDER GROUND CABLES  12
Review of line parameters for simple configurations: series resistance, inductance and shunt capacitance; bundle conductors : equivalent GMR and equivalent radius; modal propagation in transmission lines: modes on multi-phase transposed transmission lines, α-β-0 transformation and symmetrical components transformation, modal impedances; analysis of modes on un-transposed lines; effect of ground return and skin effect; transposition schemes; introduction to frequency-dependent line modeling. Distinguishing features of underground cables: technical features, electrical parameters, overhead lines versus underground cables; cable types; series impedance and shunt admittance of single- core self-contained cables, impedance and admittance matrices for three phase system formed by three single-core self-contained cables; approximate formulas for cable parameters

UNIT III  PARAMETERS AND MODELLING OF TRANSFORMER  12

UNIT IV  INSULATION CO-ORDINATION  12
Insulation co-ordination –volt –time characteristics , Insulation strength and their selection-Evaluation of insulation strength standard BILs-Characteristics of protective devices, applications, location of arresters – insulation co-ordination in AIS and GIS

UNIT V  COMPUTATION OF POWER SYSTEM TRANSIENTS  12
Digital computation of line parameters: why line parameter evaluation programs? salient features of a typical line parameter evaluation program; constructional features of that affect transmission line parameters; line parameters for physical and equivalent phase conductors elimination of ground wires bundling of conductors; principle of digital computation of transients: features and capabilities of electromagnetic transients program; steady state and time step solution modules: basic solution methods; case studies on simulation of various types of transients and insulation co-ordination.

TOTAL: 60 PERIODS

COURSE OUTCOMES
Students will be able to:
  CO1: Understand and analyse the different types of transients.
  CO2: Model overhead lines and cables and for transient studies.
  CO3: Model transformers for transient studies.
  CO4: Design a reliable power system with appropriate insulation coordination.
CO5: Compute different types of transients in power systems.

MAPPING

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REFERENCES


PS5102 POWER SYSTEM DYNAMICS LT P C 3 1 0 4

COURSE OBJECTIVES

- To impart knowledge on dynamic modelling of a synchronous machine in detail
- To describe the modelling of excitation and speed governing system in detail.
- To understand the fundamental concepts of small disturbance stability of dynamic systems.
- Enable the students to evaluate rotor angle stability by explicit and implicit methods of integration.
- To expose the students to basic concepts of voltage stability.

UNIT I SYNCHRONOUS MACHINE MODELLING 12

Schematic Diagram, Physical Description: armature and field structure, machines with multiple pole pairs, mmf waveforms, direct and quadrature axes, Mathematical Description of a Synchronous Machine: Basic equations of a synchronous machine: stator circuit equations, stator self, stator mutual and stator to rotor mutual inductances, dq0 Transformation: flux linkage and voltage equations for stator and rotor in dq0 coordinates, electrical power and torque, physical interpretation of dq0 transformation, Equivalent Circuits for direct and quadrature axes, Steady-state Analysis: Voltage, current and flux-linkage relationships, Phasor representation, Rotor angle,
Steady-state equivalent circuit, Computation of steady-state values, Equations of Motion: Swing Equation, calculation of inertia constant, Representation in system studies, Synchronous Machine Representation in Stability Studies: Simplifications for large-scale studies

UNIT II MODELLING OF EXCITATION AND SPEED GOVERNING SYSTEMS  12

UNIT III SMALL-SIGNAL STABILITY ANALYSIS  12

UNIT IV TRANSIENT STABILITY ANALYSIS  12

UNIT V VOLTAGE STABILITY ANALYSIS  12

TOTAL: 60 PERIODS

COURSE OUTCOMES

Students will be able to:

CO1: Model the synchronous machine for stability analysis.
CO2: Model of excitation and speed governing system for stability analysis.
CO3: Analyze the small signal stability of power systems with controllers.
CO4: Analyze the rotor angle stability of the system stability by explicit and implicit methods of integration.
CO5: Investigate voltage stability of power system.

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REFERENCES


COURSE OBJECTIVES:
To impart knowledge and skills required for research and IPR:
• Problem formulation, analysis and solutions.
• Technical paper writing / presentation without violating professional ethics
• Patent drafting and filing patents.

UNIT I RESEARCH PROBLEM FORMULATION
Meaning of research problem- Sources of research problem, criteria characteristics of a good research problem, errors in selecting a research problem, scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, necessary instrumentations

UNIT II LITERATURE REVIEW
Effective literature studies approaches, analysis, plagiarism, and research ethics.
UNIT III  TECHNICALWRITING /PRESENTATION  6
Effective technical writing, how to write report, paper, developing a research proposal, format of
research proposal, a presentation and assessment by a review committee.

UNIT IV  INTRODUCTION TO INTELLECTUAL PROPERTY RIGHTS (IPR)  6
Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and
Development: technological research, innovation, patenting, development. International Scenario:
International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under
PCT.

UNIT V  INTELLECTUAL PROPERTY RIGHTS (IPR)  6
Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and
databases. Geographical Indications. New Developments in IPR: Administration of Patent System,
IPR of Biological Systems, Computer Software etc.
Traditional knowledge Case Studies, IPR and IITs.

TOTAL: 30 PERIODS

COURSE OUTCOMES:
1. Ability to formulate research problem
2. Ability to carry out research analysis
3. Ability to follow research ethics
4. Ability to understand that today's world is controlled by Computer, Information Technology,
   but tomorrow world will be ruled by ideas, concept, and creativity
5. Ability to understand about IPR and filing patents in R & D.

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REFERENCES:
COURSE OBJECTIVES

- To have hands on experience on various system studies and different techniques used for system operation and planning.
- To have Hands-on experience on various power system studies using user developed programs and validation of results using application software packages.
- To gain practical knowledge on load flow analysis solved by various methods.
- To do stability analysis on single machine and multi machine configuration.
- To calculate Available Transfer Capacity and Locational marginal pricing for Deregulated power system.

1. Power flow analysis by Newton-Raphson and Fast decoupled methods.
2. Contingency analysis: Generator shift factors and line outagedistribution factors.
6. Induction motor starting analysis.
7. Available Transfer Capability calculation using an existing load flow program.
8. Computation of harmonic indices generated by a rectifier feeding a R-L load.
10. Analysis of switching surge using EMTP: Energisation of a long distributed- parameter line.
12. Locational Marginal Pricing computation of Restructured power systems.

TOTAL: 60 PERIODS

COURSE OUTCOMES

CO1: Students will be able to gain Hands-on experience on various power system studies using user developed programs and validation of results using application software packages.

CO2: Students can gain practical knowledge on load flow analysis solved by various methods.

CO3: Students will be able to do stability analysis on single machine and multi machine configuration.

CO4: Students have learnt to calculate Available Transfer Capacity and Locational marginal pricing for Deregulated power system.

CO5: Experiments were conducted to mitigate and compute Harmonic indices.

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COURSE OBJECTIVES

Students will be able to:

- Study the performance of various renewable energy sources.
- Obtain hands-on experience on various wind turbine operation.
- Analyze the grid integration issues of renewable energy sources.
- To analyze the performance characteristics of DFIG and PMSG.
- To design and model PV system integration with grid.

1. Performance characteristics of solar PV panel.
2. Performance of PV panel in series and parallel combination.
3. VI characteristics of fuel cell.
5. Performance characteristics of DFIG.
6. Performance characteristics of PMSG.
7. MPPT tracking of DFIG based WT.
8. MPPT tracking of PMSG based WT.
9. Grid integration of RES.

TOTAL 60 PERIODS

COURSE OUTCOMES

CO1: Students will understand the characteristics of various renewable energy sources.
CO2: Students will be able to program different MPPT algorithm and understand their merits and demerits
CO3: Students will learn control of DFIG.
CO4: Students will learn control of PMSG.
CO5: Students will design and model PV system integration with grid.

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COURSE OBJECTIVES

Students will be able to:

- illustrate concepts of transformer protection
- describe about the various schemes of Over current protection
- analyze distance and carrier protection
- familiarize the concepts of Bus bar protection and Numerical protection
- to understand the concepts of substation automation

UNIT I  OVER CURRENT & EARTH FAULT PROTECTION  9
Zones of protection – Primary and Backup protection – operating principles and Relay Construction. Time – Current characteristics-Current setting – Time setting-Over current protective schemes – Concept of Coordination - Protection of parallel / ring feeders - Reverse power or directional relay – Polarisation Techniques – Cross Polarisation – Quadrature Connection -Earth fault and phase fault protection - Combined Earth fault and phase fault protection scheme - Phase fault protective - scheme directional earth fault relay - Static over current relays – Numerical over - current protection; numerical coordination example for a radialfeeder

UNIT II  TRANSFORMER & BUSBAR PROTECTION  13

UNIT III  DISTANCE AND CARRIER PROTECTION OF TRANSMISSION LINES  9
UNIT IV  GENERATOR PROTECTION  8
Electrical circuit of the generator – Various faults and abnormal operating conditions – Stator Winding Faults – Protection against Stator (earth) faults – third harmonic voltage protection - Rotor fault – Abnormal operating conditions - Protection against Rotor faults – Potentiometer Method – injection method – Pole slipping – Loss of excitation – Protection against Mechanical faults; Numerical examples for typical generator protection schemes

UNIT V  SUBSTATION AUTOMATION  6
Introduction to Substation Automation – Topology – Hardware Implementation – Introduction to Digital Substation – Importance of Communications in Digital world – OSI Layer – Ethernet Communication – Introduction to Analog to Digital Transformation – Merging Units (MU) - Introduction to IEC 61850 – Advantages of IEC 61850

TOTAL: 45 PERIODS

COURSE OUTCOMES

CO1: Understand the various schemes available in Transformer and Bus bar protection
CO2: Gain knowledge on over current protection.
CO3: Attain knowledge about Distance and Carrier protection for transmission lines.
CO4: Understand the concepts of generator protection.
CO5: Attain basic knowledge on substation automation.

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PS5251       HVDC AND FACTS

COURSE OBJECTIVES

- To impart knowledge on the need for HVDC and FACTS.
- To impart in depth knowledge the operation, modelling and control of thyristor based FACTS controllers.
- To have an in-depth knowledge on the operation, modelling and control of LCC based HVDC link.
- To have an in-depth knowledge on the operation, modelling and control of VSC based HVDC link and FACTS controllers.
- To analyze the interaction of AC-DC systems through Power flow analysis.

UNIT I    INTRODUCTION 12

Review of basics of power transmission networks-control of power flow in AC transmission line-
Analysis of uncompensated AC Transmission line- Passive reactive power compensation: Effect of
series and shunt compensation at the mid-point of the line on power transfer- Need for FACTS
controllers- types of FACTS controllers- Review of basics of LCC and VSC HVDC system.

UNIT II    THYRISTOR BASED FACTS 12

Configuration of SVC- voltage regulation by SVC- Modelling of SVC for power flow analysis-Stability
studies- Applications: transient stability enhancement and power oscillation damping of SMIB system
with SVC connected at the mid-point of the line-Concepts of Controlled Series Compensation –
Operation of TCSC- Analysis of TCSC – Modelling of TCSC for power flow and stability studies.

UNIT III   ANALYSIS OF LCC HVDC CONVERTERS AND HVDC SYSTEM CONTROL

Pulse number, choice of converter configuration – Simplified analysis of Graetz circuit Converter
bridge characteristics – characteristics of a twelve pulse converter- detailed analysis of converters.
General principles of DC link control – Converter control characteristics – System control hierarchy -
Firing angle control – Current and extinction angle control – Generation of harmonics and filtering -
power control – Higher level controllers.

UNIT IV    VOLTAGE SOURCE CONVERTER BASED FACTS AND HVDC CONTROLLERS 12

Static synchronous compensator (STATCOM) - Static synchronous series compensator (SSSC)
Operation of STATCOM and SSSC-Power flow control with STATCOM and SSSC- Modelling of
STATCOM and SSSC for power flow and transient stability studies –operation of Unified and Interline
power flow controllers (UPFC) - Modelling of UPFC and IPFC for power flow and transient stability
studies- Applications VSC based HVDC: Operation, Modelling for steady state and dynamic studies.

UNIT V     POWER FLOW ANALYSIS OF AC/DC SYSTEMS 12

Per unit system for DC Quantities - Modelling of DC links - Solution of DC load flow-Solution of AC-
DC power flow: Sequential and Simultaneous methods.

TOTAL: 60 PERIODS
COURSE OUTCOMES

Students will be able to:

CO1: Understand the basics of power transmission networks and need for HVDC and FACTS controllers.
CO2: Analyze the operation, control and application of thyristor based FACTS controllers.
CO3: Analyze the operation, control and application of LCC based HVDC link.
CO4: Analyze the operation, control and application of VSC based HVDC link.
CO5: Model HVDC and FACTS for Power Flow studies.

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COURSE OBJECTIVES

Students will be able to:

- describe various types of deregulated markets in power system.
- describe the technical and non-technical issues in deregulated power industry.
- classify different market mechanisms and summarize the role of various entities in the market.
- analyze the energy and ancillary services management in deregulated power industry.
- understand the restructuring framework US and Indian power sector

UNIT I INTRODUCTION

Reasons for restructuring - Understanding the restructuring process - objectives of deregulation of various power systems across the world - Consumer behavior - Supplier behavior - Market equilibrium - Short-run and Long-run costs - Various costs of production. The Philosophy of Market Models: Market models based on contractual arrangements - Market architecture -

UNIT II TRANSMISSION CONGESTION MANAGEMENT

Importance of congestion management in deregulated environment - Classification of congestion management methods - Calculation of ATC - Non-market methods - Market based methods - Nodal pricing - Inter-zonal Intra-zonal congestion management - Price area congestion management - Capacity alleviation method.

UNIT III LOCATIONAL MARGINAL PRICES (LMP) AND FINANCIAL TRANSMISSION RIGHTS


UNIT IV ANCILLARY SERVICE MANAGEMENT AND PRICING OF TRANSMISSION NETWORK

Types of ancillary services - Load-generation balancing related services - Voltage control and reactive power support services - Black start capability service - Mandatory provision of ancillary services - Markets for ancillary services - Co-optimization of energy and reserve services - International comparison. Pricing of transmission network: wheeling - principles of transmission pricing - transmission pricing methods - Marginal transmission pricing paradigm - Composite pricing paradigm - loss allocation methods.
UNIT V  MARKET EVOLUTION

US markets: PJM market - The Nordic power market - Reforms in Indian power sector: Framework of Indian power sector - Reform initiatives - availability based tariff (ABT) - The Electricity Act 2012 - Open Access issues - Power exchange

COURSE OUTCOMES

Students will be able to:
CO1: describe the requirement for deregulation of the electricity market and the philosophy of various market models
CO2: analyze the various methods of congestion management in deregulated power system
CO3: analyze the locational marginal pricing and financial transmission rights
CO4: analyze the ancillary service management
CO5: understand the framework of Indian power sector

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COURSE OBJECTIVES

Students will be able to

- To analyze feature of V&I and verify with DSO
- To analyze the different characteristics curves
- To analyze the relay with inrush phenomena
- To test the differential protection by PSCAD/EMTDC
- To study the Numerical Transformer / Distance Protection with Relay test kit.

1. Understanding feature of injection of V&I along with control parameters (Magnitude, Frequency, Phase angle) and verify with DSO
2. Ramping feature of V&I and verify with DSO.
3. Testing Different characteristics of curve (IEC – NI, VI, LTI, and EI).
4. Verification of Non-directional OC/EF along with different RCA/MTA with Inrush phenomena.
5. Analysis of High impedance and Low impedance biased current differential protection for transformers.
6. Testing of Low impedance biased Current Differential protection with Simulation of excitation failure of generator by PSCAD/EMTDC and implementation of protection settings and verifying relay characteristics.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

CO1: Ability to analyze feature of V&I and verify with DSO
CO2: Ability to analyze the different characteristics curves
CO3: Ability to analyze the relay with inrush phenomena
CO4: Ability to test the differential protection by PSCAD/EMTDC
CO5: Ability to test the Numerical Transformer / Distance Protection with Relay test kit.

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COURSE OBJECTIVES:
- To provide the requisite knowledge necessary to appreciate the dynamical equations involved in the analysis of different PED configurations.
- To understand the dynamics and different operating modes of power converters studied in the core courses on power converters.
- To analyze, design and simulate different rectifier circuits for generic load and for machine loads.
- To simulate different inverter topologies.
- To formulate, design, simulate power supplies for generic load and for machine loads.

LIST OF EXPERIMENTS:
1. Simulation of single phase half wave controlled converter fed RLE load.
2. Simulation of single phase fully controlled converter fed RLE load.
3. Simulation of three phase half controlled converter fed RL load.
5. Study of single phase Fully Controlled Rectifier, Half Controlled Rectifier with different Loads.
6. Study of Three phase Fully Controlled Rectifier, Half Controlled Rectifier with different Loads.
7. Simulation of single phase VSI fed RL/RC load.
8. Design of UPS.
9. Design of SMPS.
10. Simulation of multilevel inverter topologies.

TOTAL : 60 PERIODS

COURSE OUTCOMES:
CO1: Ability to solve dynamic equations involved in power electronics.
CO2: Ability to acquire and apply knowledge of mathematics and converter/machine dynamics in Electrical engineering.
CO3: Ability to model and analyze different rectifier circuits using computational software and to understand their various operating modes.
CO4: Ability to model and analyze different rectifier circuits using computational software and to understand their various operating modes.
CO5: Ability to formulate, design, simulate power supplies for generic load and for machine loads.

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REFERENCES:
COURSE OBJECTIVES

- To introduces the objectives of Load forecasting.
- To study the fundamentals of Generation system, transmission system and Distribution system reliability analysis
- To illustrate the basic concepts of Expansion planning
- To understand the overview of distribution system planning

UNIT I LOAD FORECASTING
Objectives of forecasting - Load growth patterns and their importance in planning - Load forecasting Based on discounted multiple regression technique-Weather sensitive load forecasting-Determination of annual forecasting-Use of AI in load forecasting.

UNIT II GENERATION SYSTEM RELIABILITY ANALYSIS
Probabilistic generation and load models- Determination of LOLP and expected value of demand not served –Determination of reliability of ISO and interconnected generation systems.

UNIT III TRANSMISSION SYSTEM RELIABILITY ANALYSIS
Deterministic contingency analysis-probabilistic load flow-Fuzzy load flow probabilistic transmission system reliability analysis-Determination of reliability indices like LOLP and expected value of demand not served.

UNIT IV EXPANSION PLANNING
Basic concepts on expansion planning-procedure followed for integrate transmission system planning, current practice in India-Capacitor placer problem in transmission system and radial distributions system.

UNIT V DISTRIBUTION SYSTEM PLANNING OVERVIEW
Introduction, sub transmission lines and distribution substations-Design primary and secondary systems-distribution system protection and coordination of protective devices.

COURSE OUTCOMES
Students will be able to:

CO1: Develop the ability to learn about load forecasting.
CO2: learn about reliability analysis of ISO and interconnected systems.
CO3: Understand the concepts of Contingency analysis and Probabilistic Load flow analysis
CO4: Understand the concepts of Expansion planning
CO5: Understand the fundamental concepts of the Distribution system planning

TOTAL: 45 PERIODS
COURSE OBJECTIVES

Students will be able to:

- To impart knowledge on Motor Starting Studies.
- To understand the need for power factor correction and analyse the various methods that are used in the Power Factor Correction studies.
- To learn about the sources of harmonics, evaluate the harmonics present in the power system and mitigate them by filters.
- To analyse the sources that can cause the voltage flicker and find solutions to minimize the flicker.
- To impart knowledge on the ground grid analysis.

UNIT I      MOTOR STARTING STUDIES

UNIT II POWER FACTOR CORRECTION STUDIES

UNIT III HARMONIC ANALYSIS

UNIT IV FLICKER ANALYSIS
Sources of Flicker-Flicker Analysis-Flicker Criteria-Data for Flicker analysis- Case Study-Arc Furnace Load-Minimizing the Flicker Effects-Summary.

UNIT V GROUND GRID ANALYSIS

TOTAL: 45 PERIODS

COURSE OUTCOMES:
Students will be able to:
CO1: perform motor starting studies.
CO2: To model and carry out power factor correction studies.
CO3: Perform harmonic analysis and reduce the harmonics by using filters.
CO4: Carry out the flicker analysis by proper modeling of the load and its minimization.
CO5: Design the appropriate ground grid for electrical safety.

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COURSE OBJECTIVES
- To impart knowledge on sub-synchronous resonance and oscillations.
- To analyze impact of generation and transmission aspects on voltage stability
- To analyze impact of load aspects on voltage stability
- To familiarize the methods that mitigates voltage instability.
- To familiarize the methods that enhances the small signal stability of power system.

UNIT I
SUBSYNCHRONOUS RESONANCE (SSR ) AND OSCILLATIONS

UNIT II
TRANSMISSION AND GENERATION ASPECTS OF VOLTAGE STABILITY ANALYSIS

UNIT III
LOAD ASPECTS OF VOLTAGE STABILITY ANALYSIS
- Load Aspects - Voltage dependence of loads - Load restoration dynamics - Induction motors - Load tap changers - Thermostatic load recovery - General aggregate load models.

UNIT IV
INSTABILITY MECHANISM AND COUNTER MEASURES TO VOLTAGE STABILITY
- Types of Counter measures - Classification of Instability Mechanisms - Examples of Short term Voltage Instability- Counter measures to Short – term Instability – Case studies of Long Term voltage Instability – Corrective Actions against Long-term Instability – Problems.

UNIT V
SMALL SIGNAL STABILITY ANALYSIS AND ENHANCEMENT
- Multi machine small signal stability analysis - Effects Of Excitation System - Power System Stabilizer: Block diagram with AVR and PSS, Illustration of principle of PSS application with numerical example, Block diagram of PSS with description, system state matrix including PSS, analysis of stability with numerical example. Multi-Machine Configuration: Equations in a common reference frame, equations in individual machine rotor coordinates, illustration of formation of system state matrix with classical model and variable voltage behind transient reactant model of synchronous machines, illustration of stability analysis using a numerical example. Principle behind small-signal stability improvement methods: delta-omega and delta P-omega stabilizers

TOTAL : 45 PERIODS
COURSE OUTCOMES

Students will be able to:

CO1: Understand the concepts behind sub-synchronous resonance and detect the SSR by suitable modeling
CO2: Analyze the effect of generation and transmission system on voltage stability.
CO3: Analyze the effect of load dynamics on power system voltage stability.
CO4: Analyze and enhance the voltage stability of the sample power system.
CO5: Design a damping controller to enhance small signal stability of the power system.

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PS5004 POWER SYSTEM STATE ESTIMATION

COURSE OBJECTIVES

- To introduce the state estimation on DC network.
- To impart in-depth knowledge on power system state estimation.
- To study alternative formulations of WLS state estimation.
- To get insight of network observability.
- To gain knowledge on bad data deduction and identification.

UNIT I INTRODUCTION TO STATE ESTIMATION

Need for state estimation – Measurements – Noise - Measurement functions - Measurement

UNIT II WEIGHTED LEAST SQUARE ESTIMATION


UNIT III ALTERNATIVE FORMULATION OF WLS STATE ESTIMATION

Weakness of normal equation formulation, Orthogonal factorization, Hybrid method, Method of Peters and Wilkinsons, Equality constraints WLS State estimation, Augmented matrix approach, Blocked formulation and comparison of techniques.

UNIT IV NETWORK OBSERVABILITY ANALYSIS


UNIT V BAD DATA DETECTION AND IDENTIFICATION

Properties of measurement residuals - Classification of measurements - Bad data detection and identification using Chi-squares distribution and normalized residuals - Bad data identification - Largest normalized residual test and Hypothesis testing identification. bad data detection using PMU.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Students will be able to:

CO1: Gain knowledge about state estimation
CO2: Gain knowledge on weighted least square estimation.
CO3: Learn alternative formulation of WLS state estimation.
CO4: Get insight of network observability.
CO5: Gain knowledge on bad date detection and identification.

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PS5071 APPLICATION OF AI TECHNIQUES TO POWER SYSTEMS

COURSE OBJECTIVES
- Formulating the optimization problems using ANN.
- Using appropriate ANN framework for solving power system problems.
- Using Fuzzy Logic for optimization problems.
- Formulating the optimization problems using GA.
- Applying different Artificial Intelligence techniques for optimizing power system problems.

UNIT I ARTIFICIAL NEURAL NETWORKS

UNIT II ANN PARADIGMS

UNIT III FUZZY LOGIC

UNIT IV GENETIC ALGORITHMS

UNIT V APPLICATIONS OF AI TECHNIQUES

TOTAL: 45 PERIODS
COURSE OUTCOMES:

Students will be able to:

CO1: Learn problem formulation using Artificial Neural Network.
CO2: Choose methodology suiting the problem statement.
CO3: Learn Fuzzy Logic based implementation of optimization problem
CO4: Learn problem formulation using Genetic Algorithm
CO5: Apply ANN, Fuzzy Logic and Genetic Algorithm for Power System Optimization Problem

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PS5072  APPLICATION OF DSP TO POWER SYSTEM PROTECTION  L T P C

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COURSE OBJECTIVES:

- To expose the students to learn about DFT and Wavelet transforms.
- To provide an in-depth knowledge on the components used for the implementation of digital protection.
- To impart knowledge on different algorithms for digital protection of power system components.
- To implement digital protection for transformer.
- To understand different decision making methodologies in protective relays.

UNIT I  DIGITAL SIGNAL PROCESSING TECHNIQUES  9
UNIT II  DIGITAL PROTECTION  9

UNIT III  ALGORITHMIC TECHNIQUES  9
Finite difference techniques- Interpolation-Numerical differentiation-curve fitting and smoothing. Sinusoidal wave based algorithms -First and second derivative method -two and three sample technique .Walsh function analysis- least squares based methods-differential equation based techniques -Travelling wave protective schemes.FIR based algorithms-Least square curve fitting algorithm.

UNIT IV  DIGITAL PROTECTION TECHNIQUES  9

UNIT V  DIGITAL PROTECTIVE RELAYS  9

TOTAL: 45 PERIODS

COURSE OUTCOMES

CO1: The students will be able to apply DSP techniques for digital protection.
CO2: The students will be capable of decision making algorithm suitable for digital relaying applications.
CO3: The students will be able to employ FIR based algorithms for digital relaying.
CO4: The students will be able to do transformer protection using digital techniques.
CO5: The students will be able to perform coordinated operation of relays for specific purposes.

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PS5073 DISTRIBUTED GENERATION CONTROL AND AUTOMATION

COURSE OBJECTIVES
Students will be able to:
- learn about distributed generation (DG) and distribution automation
- gain knowledge about planning and designing of distribution system
- understand the concepts of grid integration and control of DG
- familiarize the concepts of economic aspects of DG
- analyze the application of SCADA in automation

UNIT I DISTRIBUTED GENERATION

UNIT II GRID INTEGRATION AND CONTROL OF DG
Recent trends in power electronic DG interconnection. General power electronic DG interconnection topologies for various sources and control. Control of DG inverters, current control and DC voltage control for stand-alone and grid parallel operations. Protection of the converter, Control of grid interactive power converters, phase locked loops, synchronization and phase locking techniques, current control, DC bus control during grid faults, converter faults during grid parallel and stand-alone operation.

UNIT III ISSUES AND ECONOMIC ASPECTS OF DG

UNIT IV IMPLEMENTATION OF SCADA IN AUTOMATION
Introduction to SCADA, Monitoring and supervisory functions, SCADA applications in Utility Automation, SCADA System Components, RTU, IED, PLC, Communication Network, SCADA Server, SCADA/HMI Systems, Various SCADA architectures, single unified standard architecture-IEC 61850, SCADA Communication, open standard communication protocols.

UNIT V DISTRIBUTION AUTOMATION AND COMPONENTS
Distribution automation planning, communication, Wireless and wired Communications-DA Communication Protocols, Architectures and user interface, sensors, Supervisory Control and Data Acquisition Systems (SCADA), Case Studies.
COURSE OUTCOMES:

Students will be able to:
CO1: describe the principle and operation of different distributed generation
CO2: Attain knowledge in grid integration of distributed generation and control and will enhance their capability of planning and designing of distribution system.
CO3: analyze the impact of distributed generators on the performance of distribution system
CO4: gain knowledge about SCADA in automation
CO5: familiarize with the components of distribution automation

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COURSE OBJECTIVES

Students will be able to:

- understand the classification of optimization
- study the linear programming models and solution techniques
- study the different non-linear programming problem solution techniques
- understand the concept of dynamic programming
- study the fundamentals genetic algorithm and its applications.

UNIT I INTRODUCTION

Definition, Classification of optimization problems, Classical Optimization Techniques, Single and Multiple Optimization with and without inequality constraints.

UNIT II LINEAR PROGRAMMING (LP)

Simplex method of solving LPP, revised simplex method, duality, Constrained optimization, Theorems and procedure, Linear programming, mathematical model, solution technique, duality.

UNIT III NONLINEAR PROGRAMMING


UNIT IV DYNAMIC PROGRAMMING (DP)

Multistage decision processes, concept of sub-optimization and principle of optimality, Recursive relations, Integer Linear programming, Branch and bound algorithm

UNIT V GENETIC ALGORITHM

Introduction to genetic Algorithm, working principle, coding of variables, fitness function, GA operators; Similarities and differences between Gas and traditional methods; Unconstrained and constrained optimization using genetic Algorithm, real coded gas, Advanced Gas, global optimization using GA, Applications to power system.

COURSE OUTCOMES

Students will be able to:

CO1: learn about different classifications of optimization problems and techniques.
CO2: attain knowledge on linear programming concepts
CO3: understand the application of non-linear programming in optimization techniques
CO4: understand the fundamental concepts of dynamic programming
CO5: gain knowledge about Genetic algorithm and its application to power system optimization.

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REFERENCE BOOKS


PS5075 SMART GRID

COURSE OBJECTIVES

Students will be able to:

- Understand concept of smart grid and its advantages over conventional grid
- Know smart metering techniques
- Learn wide area measurement techniques
- Understanding the problems associated with integration of distributed generation & its solution through smart grid.
- To familiarize the high performance computing for Smart Grid applications

UNIT I INTRODUCTION TO SMART GRID

Evolution of Electric Grid, Concept, Definitions and Need for Smart Grid, Smart grid drivers, Functions, opportunities, challenges and benefits, Difference between conventional & Smart Grid, National and International Initiatives in Smart Grid.

UNIT II SMART GRID TECHNOLOGIES (Transmission)

Technology Drivers, Smart energy resources, Smart substations, Substation Automation, Feeder Automation, Transmission systems: EMS, FACTS and HVDC, Wide area monitoring, Protection and control

UNIT III SMART GRID TECHNOLOGIES (Distribution)

DMS, Volt/VAr control, Fault Detection, Isolation and service restoration, Outage management, High-Efficiency Distribution Transformers, Phase Shifting Transformers, and Plug in Hybrid Electric Vehicles (PHEV).
UNIT IV SMART METERS AND ADVANCED METERING INFRASTRUCTURE 9
Introduction to Smart Meters, Advanced Metering infrastructure (AMI) drivers and benefits, AMI protocols, standards and initiatives, AMI needs in the smart grid, Phasor Measurement Unit (PMU), Intelligent Electronic Devices (IED) & their application for monitoring & protection.

UNIT V HIGH PERFORMANCE COMPUTING FOR SMART GRID APPLICATIONS 9
Local Area Network (LAN), House Area Network (HAN), Wide Area Network (WAN), Broadband over Power line (BPL), IP based Protocols, Computing algorithms for Smart grid, IOT, Cyber Security for Smart Grid.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Students will be able to:
CO1:Understand on the concepts of Smart Grid and its present developments.
CO2:Analyze about different Smart Grid transmission technologies.
CO3:Analyze about different Smart Grid distribution technologies.
CO4:Acquire knowledge about different smart meters and advanced metering infrastructure.
CO5:Develop more understanding on LAN, WAN and Cloud Computing for Smart Grid applications.

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REFERENCES

4. Xi Fang, Satyajayant Misra, Guoliang Xue, and Dejun Yang “Smart Grid – The New and Improved Power Grid: A Survey”, IEEE Transaction on Smart Grid
COURSE OBJECTIVES

- To learn about the basic concepts of wind energy conversion system
- To learn the design and control principles of Wind turbine.
- To understand the concepts of fixed speed wind energy conversion systems.
- To understand the concepts of Variable speed wind energy conversion systems.
- To analyze the grid integration issues.

UNIT I  INTRODUCTION  9
Components of WECS-WECS schemes-Power obtained from wind-simple momentum theory-Power coefficient-Sabinin’s theory-Aerodynamics of Wind turbine

UNIT II  WINDTURBINES  9
HAWT-VAWT-Power developed-Thrust-Efficiency-Rotor selection-Rotor design considerations- Tip speed ratio-No. Of Blades-Blade profile-Power Regulation-yaw control-Pitch angle control-stall control-Schemes for maximum power extraction.

UNIT III  FIXEDSPEEDSYSTEMS  9
Generating Systems- Constant speed constant frequency systems -Choice of Generators-Deciding factors-Synchronous Generator-Squirrel Cage Induction Generator- Model of Wind Speed- Model wind turbine rotor - Drive Train model- Generator model for Steady state and Transient stability analysis.

UNIT IV  VARIABLESPEED SYSTEMS  9
Need of variable speed systems-Power-wind speed characteristics-Variable speed constant frequency systems synchronous generator- DFIG- PMSG -Variable speed generators modelling - Variable speed variable frequency schemes.

UNIT V  GRIDCONNECTED SYSTEMS  9
Wind interconnection requirements, low-voltage ride through (LVRT), ramp rate limitations, and supply of ancillary services for frequency and voltage control, current practices and industry trends wind interconnection impact on steady-state and dynamic performance of the power system including modeling issue.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Students will be able to:

CO1: Attain knowledge on the basic concepts of Wind energy conversion system.
CO2: Attain the knowledge of the mathematical modelling and control of the Wind turbine
CO3: Develop more understanding on the design of Fixed speed system
CO4: Study about the need of Variable speed system and its modelling.
CO5: Learn about Grid integration issues and current practices of wind interconnections with power system.
REFERENCES

5. N. Jenkins, "Wind Energy Technology" John Wiley & Sons, 1997

PRINCIPLES OF ELECTRIC POWER TRANSMISSION

COURSE OBJECTIVES:

- To understand power system structure and line configurations
- To compute line parameters and understand effect of ground return
- To understand voltage gradients of transmission line conductors.
- To compute electrostatic field and design of EHV AC
- To design and know basic concepts of HVDC lines.

UNIT I INTRODUCTION
Standard transmission voltages-AC and DC – different line configurations– average values of line parameters – power handling capacity and line loss – costs of transmission lines and equipment – mechanical considerations in line performance

UNIT II CALCULATION OF LINE PARAMETERS
Calculation of resistance, inductance and capacitance for multi-conductor lines – calculation of sequence inductances and capacitances – line parameters for different modes of propagation – effect of ground return

UNIT III VOLTAGE GRADIENTS OF CONDUCTORS
Charge-potential relations for multi-conductor lines – surface voltage gradient on conductors – gradient factors and their use – distribution of voltage gradient on sub conductors of bundle - voltage gradients on conductors in the presence of ground wires on towers-I^2R loss and corona loss-RIV

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UNIT IV  ELECTROSTATIC FIELD AND DESIGN OF EHV LINES

Effect of EHV line on heavy vehicles - calculation of electrostatic field of AC lines- effect of high field on humans, animals, and plants - measurement of electrostatic fields - electrostatic Induction in unenergised circuit of a D/C line - induced voltages in insulated ground wires - electromagnetic interference, Design of EHV lines

UNIT V  HVDC LINES

Introduction- Reliability and failure issues-Design-tower, ROW, clearances, insulators, electrical and mechanical protection-Maintenance-Control and protection-D.C Electric field and Magnetic field -Regulations and guide lines-under ground line design.

TOTAL : 45 PERIODS

COURSE OUTCOMES:
CO1: Ability to identify voltage level and line configurations
CO2: Ability to model EHV AC and HVDC lines
CO3: Ability to compute voltage gradients of transmission line conductors
CO4: Ability to understand effects of electrostatic field on living and nonliving organisms
CO5: Ability to coordinate the insulation level of the power system

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REFERENCES
COURSE OBJECTIVES:

- To provide fundamental knowledge on electromagnetic interference and electromagnetic compatibility.
- To know about the importance of Grounding and shielding.
- To study the important techniques to control EMI and EMC.
- To expose the knowledge on testing techniques as per Indian and international standards in EMI measurement.

UNIT I  INTRODUCTION
Definitions of EMI/EMC - Sources of EMI - Inter systems and Intra system - Conducted and radiated interference - Characteristics - Designing for electromagnetic compatibility (EMC) - EMC regulation - typical noise path - EMI predictions and modelling, Methods of eliminating interferences and noise mitigation

UNIT II  GROUNDING AND CABLELING
Cabling - types of cables, mechanism of EMI emission / coupling in cables - capacitive coupling, inductive coupling - shielding to prevent magnetic radiation - shield transfer impedance, Grounding - safety grounds - signal grounds - single point and multipoint ground systems - hybrid grounds - functional ground layout - grounding of cable shields - guard shields - isolation, neutralizing transformers, shield grounding at high frequencies, digital grounding - Earth measurement Methods

UNIT III  BALANCING, FILTERING AND SHIELDING
Power supply decoupling - decoupling filters - amplifier filtering - high frequency filtering - EMI filters characteristics of LPF, HPF, BPF, BEF and power line filter design - Choice of capacitors, inductors, transformers and resistors, EMC design components - shielding - near and far fields shielding effectiveness - absorption and reflection loss - magnetic materials as a shield, shield discontinuities, slots and holes, seams and joints, conductive gaskets - windows and coatings - grounding of shields

UNIT IV  EMI IN ELEMENTS AND CIRCUITS
Electromagnetic emissions, noise from relays and switches, non-linearities in circuits, passive inter modulation, transients in power supply lines, EMI from power electronic equipment, EMI as combination of radiation and conduction

UNIT V  ELECTROSTATIC DISCHARGE, STANDARDS AND TESTING TECHNIQUES
Static Generation - human body model - static discharges - ESD versus EMC, ESD protection in equipment - standards - FCC requirements - EMI measurements - Open area test site measurements and precautions - Radiated and conducted interference measurements, Control requirements and testing methods

COURSE OUTCOMES:
CO1 Ability to understand the types and sources of EMI.
CO2 Ability to understand the needs of rounding and cabling.
CO3 Ability to understand the design concept of filtering and shielding.
CO4 Ability to study the effect of EMI in elements and circuits.
CO5 Ability to know about the effects of electrostatic discharge and testing techniques.
REFERENCES
canton street, Norwood, MA 02062 USA) 1987.
Wiley and sons, USA 1976.
5. William Duff G., & Donald White R. J, “Series on Electromagnetic Interference and
Compatibility”, Vol.

HV5072 DESIGN OF SUBSTATIONS

COURSE OBJECTIVES:
• To provide in-depth knowledge on design criteria of Air Insulated Substation (AIS) and Gas
Insulated Substation (GIS).
• To obtain the knowledge about layout of AIS and GIS with proper Right of Way.
• To study the substation insulation co-ordination and protection scheme.
• To study the source and effect of fast transients in AIS and GIS.

UNIT I INTRODUCTION TO AIS AND GIS
Introduction – characteristics – comparison of Air Insulated Substation (AIS) and Gas Insulated
Substation (GIS) – main features of substations, Environmental considerations, Planning and
installation- GIB / GIL

UNIT II MAJOR EQUIPMENT AND LAYOUT OF AIS AND GIS
Major equipment – design features – equipment specification, types of electrical stresses,
mechanical aspects of substation design- substation switching schemes- single feeder circuits;
single or main bus and sectionalized single bus- double main bus-main and transfer bus- main,
reserve and transfer bus- breaker-and-a- half scheme-ring bus

UNIT III INSULATION COORDINATION OF AIS AND GIS
Introduction – stress at the equipment – insulation strength and its selection – standard BILs –
Application of simplified method – Comparison with IEEE and IEC standards.

UNIT IV GROUNDING AND SHIELDING
Definitions – soil resistivity measurement – ground fault currents – ground conductor – design of
substation grounding system – shielding of substations – Shielding by wires and masts.
UNIT V    FAST TRANSIENTS PHENOMENON IN AIS AND GIS


TOTAL : 45 PERIODS

COURSE OUTCOMES:

CO1 Ability to understand the fundamental components of AIS AND GIS.
CO2 Ability to understand the role of major equipment and layout of AIS AND GIS.
CO3 Ability to understand the insulation coordination of AIS and GIS.
CO4 Ability to understand the significance of grounding and shielding.
CO5 Ability to know about the effects of fast transients in Substation equipment.

REFERENCES

UNIT I    PERTURBATION THEORY
Vanishing and Non vanishing Perturbations – Continuity of solutions on the infinite interval – Interconnected systems – Slowly varying systems – Perturbation method – Averaging - Weakly

CO5071    ADVANCED NON-LINEAR CONTROL

COURSE OBJECTIVES
To educate the students on
- Theory of perturbation
- Gain scheduling and feedback linearization
- input-output stability and passivity
- theory and design of back stepping controllers.
nonlinear second-order oscillators – Exercises

UNIT II  SINGULAR PERTURBATIONS  \[9\]
Standard singular perturbation model – Time scale properties – Singular perturbation on the infinite interval – Slow and fast manifolds – stability analysis – exercises

UNIT III  GAIN SCHEDULING AND FEEDBACK LINEARIZATION  \[9\]

UNIT IV  INPUT-OUTPUT STABILITY  \[9\]

UNIT V  BAKSTEPPING CONTROL ALGORITHMS  \[9\]
Passivity based control – High gain observers – stabilization – Regulation via integral control - exercises

TOTAL : 45 PERIODS

COURSE OUTCOMES
CO1: Understanding different types of perturbation models.
CO2: Analysis of Stability of various perturbation models.
CO3: Apply gain schedule all kind of perturbation systems.
CO4: Apply L stability and lyapunov stability conditions for systems
CO5: Apply Bakstepping control algorithms.

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1. Hasan Khalil," Nonlinear systems and control", 3rd ed, PHI,
CO5251  MACHINE LEARNING  LT P C  3 1 0 4

COURSE OBJECTIVES
To educate the students
• On several fundamental concepts and methods for machine learning.
• And get acquaint with basic learning algorithms and techniques and their applications.
• Acquire knowledge in processing, analyzing and handling data sets.
• Demonstrate typical applications of various clustering based learning algorithms

UNIT I  INTRODUCTION TO MACHINE LEARNING
12

UNIT II  DATA PREPROCESSING
12
Data quality – Data preprocessing: - Data Cleaning:– Handling missing data and noisy data – Data integration:– Redundancy and correlation analysis – Data Reduction:– Dimensionality reduction (Linear Discriminant Analysis – Principal Components Analysis – Factor Analysis – Independent Components Analysis) – Numerosity Reduction - Data Compression - Data Normalization and Data Discretization.

UNIT III  SUPERVISED LEARNING
12

UNIT IV  CLUSTERING AND UNSUPERVISED LEARNING
12

UNIT V  BAYESIAN LEARNING
12

TOTAL:60 PERIODS

COURSE OUTCOMES:
At the end of this course, the students will demonstrate the ability
CO1:To understand the basic theory underlying machine learning.
CO2:A range of machine learning algorithms along with their strengths and weaknesses.
CO3:To formulate machine learning problems corresponding to different applications.
CO4:To apply machine learning algorithms to solve problems of moderate complexity.
CO5:To read current research papers and understand the issues raised by current research.
REFERENCES:
3. Jiawei Han, Micheline Kamber, Jian Pei, Data Mining: Concepts and Techniques.

CO5075 SYSTEM THEORY

COURSE OBJECTIVES

- To educate on modeling and representing systems in state variable form.
- To educate on solving linear and non-linear state equations.
- To illustrate the role of controllability and observability.
- To educate on stability analysis of systems using Lyapunov’s theory.
- To educate on modal concepts and design of state and output feedback controllers and estimators.

UNIT I STATE VARIABLE REPRESENTATION

Introduction-Concept of State-State equation for Dynamic Systems-Time invariance and linearity-Non uniqueness of state model-State Diagrams - Physical System and State Assignment.

UNIT II SOLUTION OF STATE EQUATIONS


UNIT III CONTROLLABILITY AND OBSERVABILITY

Controllability and Observability-Stabilizability and Detectability-Test for Continuous time Systems-Time varying and Time invariant case-Output Controllability-Reducibility-System Realizations.
UNIT IV STABILITY

UNIT V MODAL CONTROL
Introduction-Controllable and Observable Companion Forms-SISO and MIMO Systems – The Effect of State Feedback on Controllability and Observability-Pole Placement by State Feedback for both SISO and MIMO Systems-Full Order and Reduced Order Observers.

TOTAL : 45 PERIODS

COURSE OUTCOMES
CO1: To understand the concept of State-State equation for Dynamic Systems and the uniqueness of state model.
CO2: To understand the concept of the uniqueness of state model.
CO3: Analyse Controllability and Observability for Time varying and Time invariant case
CO4: Analyse the linear systems in state space
CO5: Design controllers in state space

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COURSE OBJECTIVES
To educate the students on
- Analysis and design of controllers for linear systems defined in transfer function and state space forms.
- Application of optimal control and filtering concepts for linear systems continuous and discrete domain.

UNIT I    ANALYSIS OF LINEAR SYSTEMS

UNIT II   DESIGN OF SISO SYSTEM

UNIT III  STATE SPACE DESIGN

UNIT IV   OPTIMAL CONTROL

UNIT V    OPTIMAL FILTERING
Filtering – Linear system and estimation – System noise smoothing and prediction – Kalman Filter – Recursive estimation.

TOTAL: 60 PERIODS

COURSE OUTCOMES:
Ability to
- CO1: Analyse controllers for linear systems defined in transfer function and state space forms.
- CO2: Design controllers for linear systems defined in transfer function and state space forms.
- CO3: Apply state space forms to continuous and discrete systems.
- CO4: Apply optimal control to linear systems in continuous and discrete systems.
- CO5: Apply filtering concepts to linear systems in continuous and discrete systems.
TEXT BOOKS:

REFERENCES:

UNIT I  INTRODUCTION
Statement of optimal control problem – Problem formulation and forms of optimal Control– Selection of performance measures. Necessary conditions for optimal control – Pontryagin’s minimum principle
– State inequality constraints – Minimum time problem.

UNIT II  LINEAR QUADRATIC TRACKING PROBLEMS 9

UNIT III  NUMERICAL TECHNIQUES FOR OPTIMAL CONTROL 9
Numerical solution of 2-point boundary value problem by steepest descent and Fletcher Powell method - solution of Ricatti equation by negative exponential and interactive Methods

UNIT IV  FILTERING AND ESTIMATION 9

UNIT V  KALMAN FILTER AND PROPERTIES 9

TOTAL : 45 PERIODS

COURSE OUTCOMES

Ability to
CO1: Understand the concept of Optimal Control problem.
CO2: Identify, Formulate and measure the performance of Optimal Control.
CO3: understand the Linear Quadratic Tracking Problems and implement dynamic programming application for discrete and continuous systems.
CO4: Solve Numerical solution of 2-point boundary value problem by steepest descent and Fletcher Powell method.
CO5: Understand Filtering problem their properties, linear estimator property of Kalman Filter and Time invariance and asymptotic stability of filters.

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REFERENCES:
COURSE OBJECTIVES

- To introduce various model structures for system identification.
- To impart knowledge on parametric and non-parametric identification
- To introduce non-linear identification techniques.
- To introduce the concept of adaptation techniques and control.
- To illustrate the identification and adaptive control techniques through case studies.

UNIT I MODELS FOR IDENTIFICATION


UNIT II NON-PARAMETRIC AND PARAMETRIC IDENTIFICATION


UNIT III NON-LINEAR IDENTIFICATION


UNIT IV ADAPTIVE CONTROL AND ADAPTATION TECHNIQUES


UNIT V CASE STUDIES

Inverted Pendulum, Robot arm, process control application: heat exchanger, Distillation column, application to power system, Ship steering control.

TOTAL : 45 PERIODS

COURSE OUTCOMES

Ability to
CO1: model LTI system and to analyse the Non-linear state-space model of a black box.
CO2: analyse frequency, spectral, correlation and transient response of a system.
CO3: Identify the Open & closed Loop of a Non-linear system by Neural network and Fuzzy Logic controller.
CO4: Realize different tuning parameters for adaptive control and adaptive technique.
CO5: Apply different control techniques to various applications

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REFERENCES
3. Astrom and Wittenmark, "Adaptive Control ", PHI
4. William S. Levine, "Control Hand Book".
COURSE OBJECTIVES:

- To perform steady state analysis of Non-Isolated DC-DC DC-DC converter.
- To perform steady state analysis of Isolated DC-DC converter.
- To understand different converter dynamics.
- To design controllers for DC DC converters.
- To design magnetics for SMPS applications.

UNIT I ANALYSIS OF NON-ISOLATED DC-DC CONVERTERS

Buck, Boost, Buck- Boost and Cuk converters: Principles of operation – Continuous conduction mode– Concepts of volt-sec balance and charge balance – Analysis and design based on steady-state relationships – Introduction to discontinuous conduction mode other topologies, SEPIC topologies - design examples.

UNIT II ANALYSIS OF ISOLATED DC-DC CONVERTERS


UNIT III CONVERTER DYNAMICS


UNIT IV CONTROLLER DESIGN


UNIT V DESIGN OF MAGNETICS


TOTAL : 45 PERIODS

COURSE OUTCOMES:

CO1 Ability to design Non-Isolated DC-DC.
CO2 Ability to design Isolated DC-DC converter.
CO3 Ability to derive transfer function of different converters.
CO4 Ability to design controllers for DC DC converters.
CO5 Ability to design magnetics for SMPS applications

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REFERENCES:

PE5252 VECTOR CONTROL OF AC MACHINES LT P C 3 1 0 4

COURSE OBJECTIVES:
• To study the space phasor model of alternating current machines.
• To understand the field oriented control for permanent magnet synchronous machines.
• To analyse the concept of vector control based salient pole machines.
• To provide the knowledge about concept and control techniques of induction motor.
• To develop the flux oriented control circuit for induction motor.

UNIT I SPACE PHASOR MODEL OF AC MACHINES 12
Introduction-Smooth Air gap machine and salient pole machines- flux linkage space phasors- voltage equation- expression for electromagnetic torque.

UNIT II VECTOR CONTROL OF PM SYNCHRONOUS MACHINE 12
PMSM with surface mounted magnets- control scheme for of rotor oriented controlled PMSM with interior magnets-stator flux oriented control- rotor oriented control

UNIT III VECTOR CONTROL OF SALIENT POLE MACHINE WITH ELECTRICALLY EXCITED ROTOR 12
Magnetizing flux oriented control –variable frequency operation of salient pole synchronous machine-rotor oriented control of reluctance machines-considerations of the effects of main flux saturation

UNIT IV STATOR FLUX ORIENTED CONTROL OF INDUCTION MACHINE 12
Squirrel cage machine -Electromagnetic torque-voltage equations, doubly fed induction machines-control-static converter cascade, magnetizing flux oriented control of induction machine.

UNIT V ROTOR FLUX ORIENTED CONTROL OF INDUCTION MACHINE 12
Control by a VSI – voltage equation-decoupling circuits- electromagnetic torque-voltage equations- current controlled PWM inverter- control by CSI – current controlled operation - control of slip ring induction machines
COURSE OUTCOMES:

CO1: Ability to carry out space phasor model for electrical machines.
CO2: Able to synthesis the vector controller for permanent magnet synchronous machines.
CO3: Able to compute and analyse the controllers of salient pole machines.
CO4: Able to understand and select the various control schemes suitable for induction motor.
CO5: The students acquire the flux oriented control concept of induction motor.

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COURSE OBJECTIVES:

- To provide knowledge about various power quality issues.
- To understand the concept of power and power factor in single phase and three phase systems supplying nonlinear loads.
- To equip with required skills to design conventional compensation techniques for power factor correction and load voltage regulation.
- To introduce the control techniques for the active compensation.
- To understand mitigation techniques using custom power devices such as DVR & UPQC

UNIT I

INTRODUCTION

Introduction – Characterisation of Electric Power Quality: Transients, short duration and long duration voltage variations, Voltage imbalance, waveform distortion, Voltage fluctuations, Power frequency variation, Power acceptability curves – power quality problems: poor load power factor, Non linear and unbalanced loads, DC offset in loads, Notching in load voltage, Disturbance in supply voltage – Power quality standards.
UNIT II ANALYSIS OF SINGLE PHASE AND THREE PHASE SYSTEM


UNIT III CONVENTIONAL LOAD COMPENSATION METHODS


UNIT IV LOAD COMPENSATION USING DSTATCOM

Compensating single – phase loads – Ideal three phase shunt compensator structure – generating reference currents using instantaneous PQ theory – Instantaneous symmetrical components theory – Generating reference currents when the source is unbalanced – Realization and control of DSTATCOM – DSTATCOM in Voltage control mode

UNIT V SERIES COMPENSATION OF POWER DISTRIBUTION SYSTEM


TOTAL : 45 PERIODS

COURSE OUTCOMES:

CO1 Ability to understand consequences of Power quality issues.
CO2 Ability to conduct harmonic analysis of single phase and three phase systems supplying nonlinear loads.
CO3 Ability to design passive filter for load compensation.
CO4 Ability to design active filters for load compensation.
CO5 Ability to understand the mitigation techniques using custom power devices such as distribution static compensator (DSTATCOM), dynamic voltage restorer (DVR) & UPQC.

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1. Power Quality - R.C. Duggan
2. Power system harmonics – A.J. Arrillaga
3. Power Electronic Converter Harmonics – Derek A. Paice
PE5072 ADVANCED POWER CONVERTERS LT P C 3 0 0 3

COURSE OBJECTIVES:
- To study the operation of voltage lift circuits
- To study the operation of super lift circuits.
- To study the operation of ultra lift converters and multiple quadrant converters
- To study the principle of bidirectional dual active bridge converters
- To study the working principle of Impedance source converter.

UNIT I VOLTAGE-LIFT CONVERTERS 9
Introduction- Self-lift and reverse self-lift circuits- Cuk converter, Luo converter and SEPIC converters- continuous and discontinuous conduction mode.

UNIT II POSITIVE OUTPUT &NEGATIVE OUTPUT SUPER-LIFT LUO- CONVERTERS 9
Main series, -Elementary Circuit, Re-Lift Circuit, Triple-Lift Circuit, Higher-Order Lift Circuit-. Continuous conduction and discontinuous conduction mode.

UNIT III ULTRA LIFT CONVERTERS AND MULTIPLE-QUADRANT OPERATING LUO- CONVERTERS 9
Ultra-Lift Luo- Converter- Operation - Continuous conduction and discontinuous conduction Mode and of Ultra-Lift Luo-Converter-Instantaneous Values- Multiple quadrant operating Luo Converters- Circuit explanations-modes of operation

UNIT IV BIDIRECTIONAL DUAL ACTIVE BRIDGE DC–DC CONVERTERS 9
Application of Bidirectional DC–DC Converter-Classification of Bidirectional DC–DC Converter - Working Principle of Hybrid-Bridge-Based Dual active bridge (DAB) converter-Performance-Voltage match control- Principle of Dual-Transformer based DAB converter-Three-Level bidirectional DC–DC converter

UNIT V IMPEDANCE SOURCE CONVERTER 9

TOTAL : 45 PERIODS

COURSE OUTCOMES:
- CO1Ability to understand the working of voltage lift circuits.
- CO2 Ability to design super lift converters
- CO3 Ability to design ultra-lift converters
- CO4 Ability to understand the working and design of bi-directional DC-DC converters
- CO5 Ability to understand the concepts related with impedance source converter

TEXT BOOKS:
1. Advanced DC/DC Converters,2nd Edition, Fang Lin Luo, Hong Ye, CRC press,2018
3. High-Frequency Isolated Bidirectional Dual Active Bridge DC–DC Converters with Wide Voltage Gain, Deshang Sha,GuoXu, Springer 2019.

REFERENCES:
1. Essential DC/DC Converters, 1st Edition, Fang Lin Luo, Hong Ye, CRC,2005

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PE5152 ANALYSIS OF POWER CONVERTERS LT P C 3 1 0 4

COURSE OBJECTIVES:
- To provide the mathematical fundamentals necessary for deep understanding of power converter operating modes.
- To provide the electrical circuit concepts behind the different working modes of power converters so as to enable deep understanding of their operation.
- To provide required skills to formulate and design inverters for generic load and for machine loads.
- To equip with required skills to derive the criteria for the design of power converters starting from basic fundamentals.
- To analyze and comprehend the various operating modes of different configurations of power converters

UNIT I SINGLE PHASE AC-DC CONVERTER
Static Characteristics of power diode, SCR and GTO, half controlled and fully controlled converters with R-L, R-L-E loads and freewheeling diodes – continuous and discontinuous modes of operation - inverter operation –Sequence control of converters – performance parameters: harmonics, ripple, distortion, power factor – effect of source impedance and overlap-reactive power and power balance in converter circuits

UNIT II THREE PHASE AC-DC CONVERTER

UNIT III SINGLE PHASE INVERTERS
Introduction to self-commutated switches: MOSFET and IGBT - Principle of operation of half and full bridge inverters – Performance parameters – Voltage control of single phase inverters using various PWM techniques – various harmonic elimination techniques – Design of UPS-VSR operation

UNIT IV THREE PHASE INVERTERS
180 degree and 120 degree conduction mode inverters with star and delta connected loads – voltage control of three phase inverters: single, multi pulse, sinusoidal, space vector modulation
techniques – VSR operation-Application to drive system – Current source inverters.

UNIT V MODERN INVERTERS

Multilevel concept – diode clamped – flying capacitor – cascaded type multilevel inverters -
Comparison of multilevel inverters - application of multilevel inverters – PWM techniques for MLI –
Single phase & Three phase Impedance source inverters - Filters.

TOTAL : 60 PERIODS

COURSE OUTCOMES:

CO1 Ability to acquire and apply knowledge of mathematics in power converter analysis
CO2 Ability to model, analyze and understand power electronic systems and equipment
CO3 Ability to formulate, design and simulate phase controlled rectifiers for generic load and for
machine loads
CO4 Ability to formulate, design, simulate switched mode inverters for generic load and for
machine loads
CO5 Ability for device selection and calculation of performance parameters of power converters
under various operating modes

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COURSE OBJECTIVES:

- To provide knowledge about the fundamentals of magnetic circuits, energy, force and torque of multi-excited systems.
- To analyze the steady state and dynamic state operation of DC machine through mathematical modeling and simulation in digital computer.
- To provide the knowledge of theory of transformation of three phase variables to two phase variables.
- To analyze the steady state and dynamic state operation of three-phase induction machines using transformation theory based mathematical modeling and digital computer simulation.
- To analyze the steady state and dynamic state operation of three-phase synchronous machines using transformation theory based mathematical modeling and digital computer simulation.

UNIT I  PRINCIPLES OF ELECTRO MAGNETIC ENERGY CONVERSION  12
Magnetic circuits, permanent magnet, stored magnetic energy, co-energy - force and torque in singly and doubly excited systems – machine windings and air gap mmf– determination of winding resistances and inductances of machine windings – determination of friction coefficient and moment of inertia of electrical machines.

UNIT II  DC MACHINES  12

UNIT III  REFERENCE FRAME THEORY  12
Historical background of Clarke and Park transformations – power invariance and phase transformation and commutator transformation – transformation of variables from stationary to arbitrary reference frame - variables observed from several frames of reference.

UNIT IV  INDUCTION MACHINES  12

UNIT V  SYNCHRONOUS MACHINES  12

TOTAL :  60  PERIODS
COURSE OUTCOMES:

CO1 Ability to optimally design magnetics required in power supplies and drive systems.

CO2 Ability to acquire and apply knowledge of mathematics of machine dynamics in Electrical engineering.

CO3 Ability to model, simulate and analyze the dynamic performance of electrical machines using computational software.

CO4 Ability to formulate, design, simulate power supplies and loads for complete electrical machine performance.

CO5 Ability to verify the results of the dynamic operation of electrical machine systems.

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2. R Ramanujam, “Modelling and Analysis of Electrical Machines”, I.K International Publishing Pvt. Ltd., New Delhi, 2018

REFERENCES:


PE5073 POWER ELECTRONICS FOR RENEWABLE ENERGY SYSTEMS

COURSE OBJECTIVES:

• To provide knowledge about the stand alone and grid connected renewable energy systems.

• To equip with required skills to derive the criteria for the design of power converters for renewable energy applications.

• To analyse and comprehend the various operating modes of wind electrical generators and solar energy systems.

• To design different power converters namely AC to DC, DC to DC and AC to AC converters for renewable energy systems.

• To develop maximum power point tracking algorithms.

UNIT I INTRODUCTION

Introduction to renewable energy systems, environmental aspects of electric energy conversion, impacts of renewable energy generation on environment, GHG Effect, Qualitative study of different renewable energy resources Ocean, Biomass, Hydrogen energy systems and Fuel cells.
UNIT II  POWER ELECTRONIC CONVERTERS FOR RENEWABLE ENERGY

Solar: Block diagram of solar photo voltaic system: line commutated converters (inversion mode) - Boost and buck-boost converters.
Wind: three phase AC voltage controllers- AC-DC-AC converters: uncontrolled rectifiers, PWM Inverters, Grid Interactive Inverters-matrix converters.

UNIT III  PHOTO VOLTAIC ENERGY CONVERSION SYSTEMS

Introduction, Photo Voltaic (PV) effect, Solar Cell, Types, Equivalent circuit of PV cell, PV cell characteristics (I/V and P/V) for variation of insolation, temperature and shading effect, Stand-alone PV system, Grid connected PV system, Design of PV system-load calculation, array sizing, selection of converter/inverter, battery sizing.

UNIT IV  WIND ENERGY CONVERSION SYSTEMS

Introduction, Power contained in wind, Efficiency limit in wind, types of wind turbines, Wind control strategies, Power curve and Operating area, Types of wind generators system based on Electrical machines-Induction Generator and Permanent Magnet Synchronous Generator(PMSG), Grid Connected-Single and Double output system, Self-excited operation of Induction Generator and Variable Speed PMSG.

UNIT V  HYBRID RENEWABLE ENERGY SYSTEMS AND MPPT

Energy Storage systems, Need for Hybrid Systems, Features of Hybrid Systems, Range and types of Hybrid systems (Wind-Diesel, PV-Diesel and Wind-PV), Case studies of PV-Maximum Power Point Tracking (MPPT) and Wind Energy system

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1 Ability to understand different renewable energy systems
CO2 Ability to design and simulate power electronics converters used for interfacing Renewable energy systems
CO3 Ability to design standalone renewable energy system employing embedded energy storage and MPPT strategy.
CO4 Ability to design grid connected renewable energy system.
CO5 Ability to extract maximum power using different MPPT algorithms

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REFERENCES:

PW5071 ELECTRIC VEHICLES AND POWER MANAGEMENT LT P C 3003

COURSE OBJECTIVES:

- To provide knowledge about electric vehicle architecture and power train components.
- To know the concepts of dynamics of electrical vehicles
- To impart knowledge on vehicle control for standard drive cycles of hybrid electrical vehicles (HEVs)
- To understand the concept of energy storage systems.
- To provide knowledge about different energy sources and energy management in HEVs.

UNIT I HYBRID ELECTRIC VEHICLE ARCHITECTURE AND POWER TRAIN COMPONENTS

History of evolution of Electric Vehicles - Comparison of Electric Vehicles with Internal Combustion Engines - Architecture of Electric Vehicles (EV) and Hybrid Electric Vehicles (HEV) – Plug-in Hybrid Electric Vehicles (PHEV) - Power train components and sizing, Gears, Clutches, Transmission and Brakes.

UNIT II MECHANICS OF HYBRID ELECTRIC VEHICLES

Fundamentals of vehicle mechanics - tractive force, power and energy requirements for standard drive cycles of HEV’s - motor torque and power rating and battery capacity.

UNIT III CONTROL OF DC AND AC MOTOR DRIVES

Speed control for constant torque, constant HP operation of all electric motors - DC/DC chopper based four quadrant operation of DC motor drives, inverter based V/f Operation (motoring and braking) of induction motor drives, vector control operation of Induction motor and PMSM, Brushless DC motor drives, Switched reluctance motor (SRM) drives

UNIT IV ENERGY STORAGE SYSTEMS


UNIT V HYBRID VEHICLE CONTROL STRATEGY AND ENERGY MANAGEMENT

HEV supervisory control - Selection of modes - power split mode - parallel mode - engine brake mode - regeneration mode - series parallel mode - energy management of HEV's.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: Learned the electric vehicle architecture and power train components.
CO2: Acquired the concepts of dynamics of electrical vehicles
CO3: Able to understand the vehicle control for standard drive cycles of hybrid electrical vehicles (HEVs).
CO4: Ability to design and select energy storage systems.
CO5: Acquired the knowledge of different energy sources and energy management in HEVs.
REFERENCES:

PW5074 ENERGY STORAGE TECHNOLOGIES

COURSE OBJECTIVES:
- To understand the various types of energy storage Technologies.
- To analyze thermal storage system.
- To analyze different battery storage technologies.
- To analyze the thermodynamics of Fuel Cell.
- To study the various applications of energy storage systems.

UNIT I INTRODUCTION
Necessity of energy storage – types of energy storage – comparison of energy storage technologies – Applications.

UNIT II THERMAL STORAGE SYSTEM
Thermal storage – Types – Modeling of thermal storage units – Simple water and rock bed storage system – pressurized water storage system – Modelling of phase change storage system – Simple units, packed bed storage units - Modelling using porous medium approach, Use of TRNSYS.

UNIT III ELECTRICAL ENERGY STORAGE
Fundamental concept of batteries – measuring of battery performance, charging and is charging of a battery, storage density, energy density, and safety issues. Types of batteries – Lead Acid, Nickel – Cadmium, Zinc Manganese dioxide - Mathematical Modelling for Lead Acid Batteries – Flow Batteries.

UNIT IV FUEL CELL

UNIT V ALTERNATE ENERGY STORAGE TECHNOLOGIES

TOTAL: 45 PERIODS
**COURSE OUTCOMES:**
CO1: Gained knowledge of various storage technologies.
CO2: Able to design a thermal storage system.
CO3: Ability to model battery storage system.
CO4: Learned to analyze the thermodynamics of fuel cell.
CO5: Gained Knowledge of various applications of storage technologies and perform the selection based on techno-economic view point.

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**PW5075 GRID INTEGRATION OF RENEWABLE ENERGY SOURCES**

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**COURSE OBJECTIVES:**
- To study about the integration of various renewable energy sources into the grid.
- To analyse various grid issues due to renewable energy sources.
- To analyse the dynamics of network due to wind farm
- To provide knowledge about power system stabilizers.
- To provide knowledge about grid connected and standalone PV system

**UNIT I INTRODUCTION**
Introduction to renewable energy grid integration - Concept of mini/micro grids and Smart grids - Different types of grid interfaces - Issues related to grid integration of small and large scale of synchronous generator based - induction generator based and converter based sources together - Network voltage management - Power quality management (voltage dips, harmonics, flickers, and reactive power control) - Frequency management - Influence of WECS on system transient response - Interconnection standards and grid code requirements for integration.

**UNIT II NETWORK INFLUENCE OF GENERATION TYPE**
UNIT III  INFLUENCE OF WIND FARMS ON NETWORK DYNAMIC PERFORMANCE

UNIT IV  POWER SYSTEM STABILIZERS AND NETWORK DAMPING CAPABILITY OF WIND
A Power System Stabilizer for a Synchronous Generator - A Power System Stabilizer for a DFIG - A Power System Stabilizer for a FRC Wind Farm.

UNIT V  STAND ALONE AND GRID CONNECTED PV SYSTEM

TOTAL: 45 PERIODS

COURSE OUTCOMES:
CO1: Know about the integration of various renewable energy sources into the grid.
CO2: Able to analyze various grid issues due to renewable energy sources.
CO3: Able to analyze the dynamics of network due to windfarm
CO4: Know about power system stabilizers.
CO5: Able to design the grid connected and standalone PV system.

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COURSE OBJECTIVES:

- To illustrate the concept of micro sources and storage.
- To study concept of AC microgrid and its controllers.
- To study concept of DC microgrid and its controllers.
- To study concept of hybrid microgrid and its controllers.
- To study concept of islanding and impact on protection.

UNIT I       MICRO SOURCES AND STORAGE  9

UNIT II      AC MICROGRID  9
Hierarchical Control: Primary, Secondary and Tertiary Control– Primary Control: Droop Control, Virtual Synchronous Generator Control for VSC – Secondary Control – Simulation Studies

UNIT III     DC MICROGRID  9
Hierarchical Control: Primary, Secondary and Tertiary Control – Primary Control: Droop Control, Virtual Inertia Control – Secondary Control: Centralized and Decentralized Control – Simulation Studies

UNIT IV      HYBRID MICROGRID  9
Hybrid AC/DC Microgrid Structure: AC Coupled, DC Coupled, AC-DC Coupled – Control Strategies: different modes of operation, during transition – Simulation Studies

UNIT V       MICROGRID PROTECTION  9

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: Ability to analyze micro-sources and storage systems.
CO2: Able to analyse the configurations and control aspects of AC microgrid.
CO3: Understand and analyse the configurations and control aspects of DC microgrid.
CO4: Acquired knowledge about configurations and control aspects of Hybrid microgrid.
CO5: Learned the protection aspects of microgrid.

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methods of harnessing the energy, potential in India. OTEC, Principles utilization, setting of OTEC plants, thermodynamic cycles. Tidal and wave energy: Potential and conversion techniques, mini-hydel power plants and their economics.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: Attained knowledge about various renewable energy technologies  
CO2: Ability to understand and design a PV system.  
CO3: Understand the concept of various wind energy system.  
CO4: Gained knowledge about various possible hybrid energy systems  
CO5: Attained knowledge about various application of renewable energy technologies

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2. Tiwari and Ghosal/ Narosa, ‘Renewable energy resources’.

PW5078 SCADA SYSTEM AND APPLICATIONS MANAGEMENT L T P C

COURSE OBJECTIVES:
- To understand the basic concepts and components of SCADA
- To introduce the SCADA communication protocols
- To apply the SCADA technology to power systems for automation
- To provide knowledge about SCADA based energy management centre.
- To emphasize the role of SCADA monitoring and control concepts.

UNIT I INTRODUCTION TO SCADA 9
SCADA overview, general features, SCADA architecture, SCADA Applications, Benefits, Remote Terminal Unit (RTU), Human- Machine Interface Units (HMI), Display Monitors/Data Logger Systems, Intelligent Electronic Devices (IED), Communication Network, SCADA Server, SCADA Control systems and Control panels

UNIT II SCADA COMMUNICATION 9
SCADA Communication requirements, Communication protocols: Past, Present and Future, Structure of a SCADA Communications Protocol, Comparison of various communication protocols, IEC61850 based communication architecture, Communication media like Fiber optic, PLC etc. Interface provisions and communication extensions, synchronization with NCC, DCC, IOT, Cyber cell, Redundancy of Network.
UNIT III  SCADA IN POWER SYSTEM AUTOMATION

Applications in Generation, Transmission and Distribution sector, Substation SCADA system Functional description, System specification, System selection such as Substation configuration, IEC61850 ring configuration, SAS cubicle concepts, gateway interoperability list, signal naming concept. System Installation, Testing and Commissioning,

CASE STUDIES: SCADA Design for 66/11KV and 132/66/11KV or 132/66 KV any utility Substation and IEC 61850 based SCADA Implementation issues in utility Substations

UNIT IV  ENERGY MANAGEMENT CENTRE

Functions, production control and load management, economic despatch, distributed centres and power pool management, energy management system and its role.

UNIT V  SCADA MONITORING AND CONTROL

Online monitoring the event and alarm system, trends and reports, Blocking list, Event disturbance recording. Control function: Station control, bay control, breaker control and disconnector control.

COURSE OUTCOMES:

CO1: Students will learn the SCADA system components and its significance.
CO2: Students will understand the need and advantages of communication protocols for SCADA
CO3: Students will get implementation knowledge about the application of SCADA to Power System.
CO4: Students will get exposure to the best operating mechanism for Energy centre based on SCADA concepts
CO5: Students will understand the need and importance of monitoring and control logic for SCADA based power systems.

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COURSE OBJECTIVES:

- To expose the fundamentals of digital signal processing in frequency domain & its application
- To teach the fundamentals of digital signal processing in time-frequency domain & its application
- To teach the fundamentals of audio signal processing & its application
- To discuss on Application development with commercial family of DS Processors
- To involve Discussions/Practice/Exercise onto revising & familiarizing the concepts acquired over the 5 Units of the subject for improved employability skills

UNIT I INTRODUCTION TO DIGITAL SIGNAL PROCESSING 6

UNIT II WAVELET TRANSFORM 9
Introduction to continuous wavelet transform - discrete wavelet transform - orthogonal wavelet decomposition- Multiresolution Analysis-Wavelet function-DWT, bases, orthogonal Basis-Scaling function, Wavelet coefficients- Multirate signal processing and their relationship to filter banks-Digital filtering interpolation (i) Decomposition filters, (ii) reconstruction, the signal- Example MRA-Haar & Daubechies wavelet.

UNIT III AUDIO SIGNAL PROCESSING 12
Introduction to Speech and Audio Processing - Speech Signal Processing- Pitch-period estimation, all-pole and all-zero filters- convolution - autoregressive model, autocorrelation estimation, General structure of speech coders; Requirements of speech codecs - quality, LPC model of speech production- LPC encoders and decoders-Power spectral density, periodogram, Spectral measures of audio signal.

UNIT IV ARCHITECTURES OF COMMERCIAL DIGITAL SIGNAL PROCESSORS 12
Introduction, categorisation of DSP Processors-one case example Architecture Processor for Fixed Point (Blackfin), Floating Point & Speech Processor- Basics of Architecture – study of functional variations of Computational building blocks(with comparison onto their MAC, Bus Architecture, I/O interface, application).

UNIT V IMPLEMENTATION OF DSP BASED SYSTEMS 6
Introduction- Interfacing processor- Memory Interface-I/O Interface-Mapping of DSP algorithm onto hardware -Design of Filter-FFT Algorithm- Application with DSP based Interfacing- Power Meter; DSP as motor control

NOTE: Discussions/Miniproject/Practice on Workbench : Signal analysis transforms, Filter design concepts with simulation tools as Matlab /Labview/ VLSI/CCS/other suites to understand the commercial DSP processor technology and practice in programming.

TOTAL: 45 PERIODS
COURSE OUTCOMES:

CO1: The concepts of Time and frequency analysis of Signal Transforms based on signal types.
CO2: The fundamentals of Time-Frequency Transforms are introduced
CO3: Analyze the quality and properties of speech based on DSP
CO4: Study features through comparison on commercial available DSPProcessors
CO5: Improved Employability and entrepreneurship capacity due to knowledge upgradation on recent trends in signal processing for embedded systems design.

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OBJECTIVES:
- To understand the basics of business analytics and its life cycle.
- To gain knowledge about fundamental business analytics.
- To learn modeling for uncertainty and statistical inference.
- To understand analytics using Hadoop and Map Reduce frameworks.
- To acquire insight on other analytical frameworks.

UNIT I  OVERVIEW OF BUSINESS ANALYTICS  9

Suggested Activities:
- Case studies on applications involving business analytics.
- Converting real time decision making problems into hypothesis.
- Group discussion on entrepreneurial opportunities in Business Analytics.

Suggested Evaluation Methods:
- Assignment on business scenario and business analytical life cycle process.
- Group presentation on big data applications with societal need.
- Quiz on case studies.

UNIT II  ESSENTIALS OF BUSINESS ANALYTICS  9

Suggested Activities:
- Solve numerical problems on basic statistics.
- Explore chart wizard in MS Excel Case using sample real time data for data visualization.
- Use R tool for data visualization.

Suggested Evaluation Methods:
- Assignment on descriptive analytics using benchmark data.
- Quiz on data visualization for univariate, bivariate data.

UNIT III  MODELING UNCERTAINTY AND STATISTICAL INference  9
Suggested Activities:
- Solving numerical problems in sampling, probability, probability distributions and hypothesis testing.
- Converting real time decision making problems into hypothesis.

Suggested Evaluation Methods:
- Assignments on hypothesis testing.
- Group presentation on real time applications involving data sampling and hypothesis testing.
- Quizzes on topics like sampling and probability.

UNIT IV ANALYTICS USING HADOOP AND MAPREDUCE FRAMEWORK

Suggested Activities:
- Practical – Install and configure Hadoop.
- Practical – Use web based tools to monitor Hadoop setup.
- Practical – Design and develop MapReduce tasks for word count, searching involving text corpus etc.

Suggested Evaluation Methods:
- Evaluation of the practical implementations.
- Quizzes on topics like HDFS and extensions to MapReduce.

UNIT V OTHER DATA ANALYTICAL FRAMEWORKS
Overview of Application development Languages for Hadoop – PigLatin – Hive – Hive Query Language (HQL) – Introduction to Pentaho, JAQL – Introduction to Apache: Sqoop, Drill and Spark, Cloudera Impala – Introduction to NoSQL Databases – Hbase and MongoDB.

Suggested Activities:
- Practical – Installation of NoSQL database like MongoDB.
- Practical – Demonstration on Sharding in MongoDB.
- Practical – Install and run Pig
- Practical – Write PigLatin scripts to sort, group, join, project, and filter data.
- Design and develop algorithms to be executed in MapReduce involving numerical methods for analytics.

Suggested Evaluation Methods:
- Mini Project (Group) – Real time data collection, saving in NoSQL, implement analytical techniques using Map-Reduce Tasks and Result Projection.

OUTCOMES:
On completion of the course, the student will be able to:
- Identify the real world business problems and model with analytical solutions.
- Solve analytical problem with relevant mathematics background knowledge.
- Convert any real world decision making problem to hypothesis and apply suitable statistical testing.
- Write and Demonstrate simple applications involving analytics using Hadoop and MapReduce

TOTAL: 45 PERIODS
• Use open source frameworks for modeling and storing data.
• Apply suitable visualization technique using R for visualizing voluminous data.

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OE5092 INDUSTRIAL SAFETY

OBJECTIVES:
• Summarize basics of industrial safety
• Describe fundamentals of maintenance engineering
• Explain wear and corrosion
• Illustrate fault tracing
• Identify preventive and periodic maintenance

UNIT I INTRODUCTION
Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and firefighting, equipment and methods.

UNIT II FUNDAMENTALS OF MAINTENANCE ENGINEERING
Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.
UNIT III WEAR AND CORROSION AND THEIR PREVENTION


UNIT IV FAULT TRACING

Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, i. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.

UNIT V PERIODIC AND PREVENTIVE MAINTENANCE

Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: i. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance

OUTCOMES:
CO1: Ability to summarize basics of industrial safety
CO2: Ability to describe fundamentals of maintenance engineering
CO3: Ability to explain wear and corrosion
CO4: Ability to illustrate fault tracing
CO5: Ability to identify preventive and periodic maintenance

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OE5093 OPERATIONS RESEARCH LT P C 3 0 0 3

OBJECTIVES:
- Solve linear programming problem and solve using graphical method.
- Solve LPP using simplex method
- Solve transportation, assignment problems
- Solve project management problems
- Solve scheduling problems

UNIT I  LINEAR PROGRAMMING
Introduction to Operations Research – assumptions of linear programming problems
Formulations of linear programming problem – Graphical method

UNIT II  ADVANCES IN LINEAR PROGRAMMING
Solutions to LPP using simplex algorithm - Revised simplex method - primal dual relationships
Dual simplex algorithm - Sensitivity analysis

UNIT III  NETWORK ANALYSIS – I
Transportation problems -Northwest corner rule, least cost method, Voges’s approximation method
- Assignment problem - Hungarian algorithm

UNIT IV  NETWORK ANALYSIS – II
Shortest path problem: Dijkstra’s algorithms, Floyd’s algorithm, systematic method - CPM/PERT

UNIT V  NETWORK ANALYSIS – III
Scheduling and sequencing - single server and multiple server models - deterministic inventory
models - Probabilistic inventory control models

TOTAL: 45 PERIODS

OUTCOMES:
CO1: To formulate linear programming problem and solve using graphical method.
CO2: To solve LPP using simplex method
CO3: To formulate and solve transportation, assignment problems
CO4: To solve project management problems
CO5: To solve scheduling problems

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OE5094  COST MANAGEMENT OF ENGINEERING PROJECTS

OBJECTIVES:
- Summarize the costing concepts and their role in decision making
- Infer the project management concepts and their various aspects in selection
- Interpret costing concepts with project execution
Develop knowledge of costing techniques in service sector and various budgetary control techniques
Illustrate with quantitative techniques in cost management

UNIT I             INTRODUCTION TO COSTING CONCEPTS 9
Objectives of a Costing System; Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost; Creation of a Database for operational control.

UNIT II            INTRODUCTION TO PROJECT MANAGEMENT 9
Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and nontechnical activities, Detailed Engineering activities, Pre project execution main clearances and documents, Project team: Role of each member, Importance Project site: Data required with significance, Project contracts.

UNIT III           PROJECT EXECUTION AND COSTING CONCEPTS 9

UNIT IV            COSTING OF SERVICE SECTOR AND BUDGETERY CONTROL 9
Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis, Budgetary Control: Flexible Budgets; Performance budgets; Zero-based budgets.

UNIT V            QUANTITATIVE TECHNIQUES FOR COST MANAGEMENT 9
Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Learning Curve Theory.

TOTAL: 45 PERIODS

OUTCOMES
 CO1 – Understand the costing concepts and their role in decision making
 CO2–Understand the project management concepts and their various aspects in selection
 CO3–Interpret costing concepts with project execution
 CO4–Gain knowledge of costing techniques in service sector and various budgetary control techniques
 CO5 - Become familiar with quantitative techniques in cost management

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2. Charles T. Horngren and George Foster, Advanced Management Accounting, 1988
COMPOSITE MATERIALS

OBJECTIVES:
- Summarize the characteristics of composite materials and effect of reinforcement in composite materials.
- Identify the various reinforcements used in composite materials.
- Compare the manufacturing process of metal matrix composites.
- Understand the manufacturing processes of polymer matrix composites.
- Analyze the strength of composite materials.

UNIT I INTRODUCTION
Definition – Classification and characteristics of Composite materials - Advantages and application of composites - Functional requirements of reinforcement and matrix - Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance.

UNIT II REINFORCEMENTS
Preparation-layup, curing, properties and applications of glass fibers, carbon fibers, Kevlar fibers and Boron fibers - Properties and applications of whiskers, particle reinforcements - Mechanical Behavior of composites: Rule of mixtures, Inverse rule of mixtures - Isostrain and Isostress conditions.

UNIT III MANUFACTURING OF METAL MATRIX COMPOSITES

UNIT IV MANUFACTURING OF POLYMER MATRIX COMPOSITES

UNIT V STRENGTH
Laminar Failure Criteria-strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hygrothermal failure. Laminate first play failure-insight strength; Laminate strength-ply discount truncated maximum strain criterion; strength design using caplet plots; stress concentrations.

TOTAL: 45 PERIODS

OUTCOMES:
- CO1 - Know the characteristics of composite materials and effect of reinforcement in composite materials.
- CO2 – Know the various reinforcements used in composite materials.
- CO3 – Understand the manufacturing processes of metal matrix composites.
- CO4 – Understand the manufacturing processes of polymer matrix composites.
• CO5 – Analyze the strength of composite materials.

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UNIT V BIO ENERGY
Properties of biogas (Calorific value and composition), Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion - Types of biogas Plants – Applications - Alcohol production from biomass - Bio diesel production - Urban waste to energy conversion - Biomass energy programme in India.

TOTAL: 45 PERIODS

OUTCOMES:
CO1 – Understand the various types of wastes from which energy can be generated
CO2 – Gain knowledge on biomass pyrolysis process and its applications
CO3 – Develop knowledge on various types of biomass gasifiers and their operations
CO4 – Gain knowledge on biomass combustors and its applications on generating energy
CO5 – Understand the principles of bio-energy systems and their features

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AUDIT COURSES (AC)

AX5091 ENGLISH FOR RESEARCH PAPER WRITING L T P C

OBJECTIVES
• Teach how to improve writing skills and level of readability
• Tell about what to write in each section
• Summarize the skills needed when writing a Title
• Infer the skills needed when writing the Conclusion
• Ensure the quality of paper at very first-time submission
UNIT I  INTRODUCTION TO RESEARCH PAPER WRITING  6
Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

UNIT II  PRESENTATION SKILLS  6

UNIT III  TITLE WRITING SKILLS  6
Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check

UNIT IV  RESULT WRITING SKILLS  6
Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions

UNIT V  VERIFICATION SKILLS  6
Useful phrases, checking Plagiarism, how to ensure paper is as good as it could possibly be the first-time submission

TOTAL: 30 PERIODS

OUTCOMES
CO1 – Understand that how to improve your writing skills and level of readability
CO2 – Learn about what to write in each section
CO3 – Understand the skills needed when writing a Title
CO4 – Understand the skills needed when writing the Conclusion
CO5 – Ensure the good quality of paper at very first-time submission

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AX5092 DISASTER MANAGEMENT L T P C
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OBJECTIVES
• Summarize basics of disaster
• Explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
• Illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
• Describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
• Develop the strengths and weaknesses of disaster management approaches

UNIT I INTRODUCTION
6
Disaster: Definition, Factors and Significance; Difference between Hazard And Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

UNIT II REPERCUSSIONS OF DISASTERS AND HAZARDS
6

UNIT III DISASTER PRONE AREAS IN INDIA
6
Study of Seismic Zones; Areas Prone To Floods and Droughts, Landslides And Avalanches; Areas Prone To Cyclonic and Coastal Hazards with Special Reference To Tsunami; Post-Disaster Diseases and Epidemics

UNIT IV DISASTER PREPAREDNESS AND MANAGEMENT
6
Preparedness: Monitoring Of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological And Other Agencies, Media Reports: Governmental and Community Preparedness.

UNIT V RISK ASSESSMENT
6
Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People’s Participation in Risk Assessment. Strategies for Survival

TOTAL : 30 PERIODS

OUTCOMES
CO1: Ability to summarize basics of disaster
CO2: Ability to explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
CO3: Ability to illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
CO4: Ability to describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
CO5: Ability to develop the strengths and weaknesses of disaster management approaches

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AX5093 SANSKRIT FOR TECHNICAL KNOWLEDGE L T P C
2 0 0 0

OBJECTIVES
- Illustrate the basic sanskrit language.
- Recognize sanskrit, the scientific language in the world.
- Appraise learning of sanskrit to improve brain functioning.
- Relate sanskrit to develop the logic in mathematics, science & other subjects enhancing the memory power.
- Extract huge knowledge from ancient literature.

UNIT I ALPHABETS 6
Alphabets in Sanskrit

UNIT II TENSES AND SENTENCES 6
Past/Present/Future Tense - Simple Sentences

UNIT III ORDER AND ROOTS 6
Order - Introduction of roots

UNIT IV SANSKRIT LITERATURE 6
Technical information about Sanskrit Literature

UNIT V TECHNICAL CONCEPTS OF ENGINEERING 6
Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics

TOTAL: 30 PERIODS

OUTCOMES
- CO1 - Understanding basic Sanskrit language.
- CO2 - Write sentences.
- CO3 - Know the order and roots of Sanskrit.
- CO4 - Know about technical information about Sanskrit literature.
- CO5 - Understand the technical concepts of Engineering.

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REFERENCES
1. “Abhyaspustakam” – Dr. Vishwas, Samskrita-Bharti Publication, New Delhi
2. “Teach Yourself Sanskrit” Prathama Deeksha-Vempati Kutumbshastri, Rashtriya Sanskrit Sansthanam, New Delhi Publication
AX5094 VALUE EDUCATION

OBJECTIVES
Students will be able to
- Understand value of education and self-development
- Imbibe good values in students
- Let the should know about the importance of character

UNIT I

UNIT II

UNIT III

UNIT IV

TOTAL: 30 PERIODS

OUTCOMES
Students will be able to
- Knowledge of self-development.
- Learn the importance of Human values.
- Developing the overall personality.

Suggested reading
OBJECTIVES
Students will be able to:

- Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
- To address the growth of Indian opinion regarding modern Indian intellectuals’ constitutional role and entitlement to civil and economic rights as well as the emergence nation hood in the early years of Indian nationalism.
- To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.

UNIT I  HISTORY OF MAKING OF THE INDIAN CONSTITUTION:
History, Drafting Committee, (Composition & Working)

UNIT II  PHILOSOPHY OF THE INDIAN CONSTITUTION:
Preamble, Salient Features

UNIT III  CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES:

UNIT IV  ORGANS OF GOVERNANCE:
Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions.

UNIT V  LOCAL ADMINISTRATION:

UNIT VI  ELECTION COMMISSION:
Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners - Institute and Bodies for the welfare of SC/ST/OBC and women.

OUTCOMES
Students will be able to:

- Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
- Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.
- Discuss the circumstances surrounding the foundation of the Congress Socialist Party (CSP) under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
- Discuss the passage of the Hindu Code Bill of 1956.

Suggested reading
1. The Constitution of India, 1950 (Bare Act), Government Publication.

AX5096 PEDAGOGY STUDIES

OBJECTIVES
Students will be able to:
- Review existing evidence on there view topic to inform programme design and policy
- Making under taken by the DfID, other agencies and researchers.
- Identify critical evidence gaps to guide the development.

UNIT I INTRODUCTION AND METHODOLOGY:
Aims and rationale, Policy background, Conceptual framework and terminology - Theories of learning, Curriculum, Teacher education - Conceptual framework, Research questions - Overview of methodology and Searching.

UNIT II THEMATIC OVERVIEW
Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries - Curriculum, Teacher education.

UNIT III EVIDENCE ON THE EFFECTIVENESS OF PEDAGOGICAL PRACTICES
Methodology for the in depth stage: quality assessment of included studies - How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy? - Theory of change - Strength and nature of the body of evidence for effective pedagogical practices - Pedagogic theory and pedagogical approaches - Teachers' attitudes and beliefs and Pedagogic strategies.

UNIT IV PROFESSIONAL DEVELOPMENT
Professional development: alignment with classroom practices and follow up support - Peer support - Support from the head teacher and the community - Curriculum and assessment - Barriers to learning: limited resources and large class sizes

UNIT V RESEARCH GAPS AND FUTURE DIRECTIONS
Research design – Contexts – Pedagogy - Teacher education - Curriculum and assessment - Dissemination and research impact.

TOTAL: 30 PERIODS

OUTCOMES
Students will be able to understand:
- What pedagogical practices are being used by teachers informal and informal classrooms in developing countries?
- What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?
- How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?

Suggested reading

AX5097                        STRESS MANAGEMENT BY YOGA                        L   T   P   C
                                    2   0   0   0

OBJECTIVES
• To achieve overall health of body and mind
• To overcome stress

UNIT I
Definitions of Eight parts of yoga.(Ashtanga)

UNIT II
Yam and Niyam - Do’s and Don’t’s in life - i) Ahinsa, satya, astheya, bramhacharya and aparigraha, ii) Ahinsa, satya, astheya, bramhacharya and aparigraha.

UNIT III
Asan and Pranayam - Various yog poses and their benefits for mind & body - Regularization of breathing techniques and its effects-Types of pranayam

TOTAL: 30 PERIODS

OUTCOMES
Students will be able to:
• Develop healthy mind in a healthy body thus improving social health also
• Improve efficiency

SUGGESTED READING
1. ‘Yogic Asanas for Group Tarining-Part-I”-Janardan Swami Yoga bhyasi Mandal, Nagpur
2. “Rajayoga or conquering the Internal Nature” by Swami Vivekananda, Advaita Ashrama (Publication Department), Kolkata

AX5098               PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS               L   T   P   C
                                2   0   0   0

OBJECTIVES
• To learn to achieve the highest goal happily
• To become a person with stable mind, pleasing personality and determination
• To awaken wisdom in students

UNIT I
Neetisatakam-holistic development of personality - Verses- 19,20,21,22 (wisdom) - Verses- 29,31,32 (pride & heroism) – Verses- 26,28,63,65 (virtue) - Verses- 52,53,59 (don’t's) - Verses- 71,73,75,78 (do's)
UNIT II
Approach to day to day work and duties - Shrimad Bhagwad Geeta: Chapter 2-Verses 41, 47,48 - Chapter 3-Verses 13, 21, 27, 35 Chapter 6-Verses 5,13,17,23, 35 - Chapter 18-Verses 45, 46, 48.

UNIT III
Statements of basic knowledge - Shrimad Bhagwad Geeta: Chapter2-Verses 56, 62, 68 Chapter 12 -Verses 13, 14, 15, 16,17, 18 - Personality of role model - shrimad bhagwad geeta - Chapter2- Verses 17, Chapter 3-Verses 36,37,42 - Chapter 4-Verses 18, 38,39 Chapter18 – Verses 37,38,63

TOTAL: 30 PERIODS

OUTCOMES
Students will be able to
• Study of Shrimad-Bhagwad-Geeta will help the student in developing his personality and achieve the highest goal in life
• The person who has studied Geeta will lead the nation and man kind to peace and prosperity
• Study of Neet is hatakam will help in developing versatile personality of students.

Suggested reading
1. Gopinath, Rashtriya Sanskrit Sansthanam P, Bhartrihari’s Three Satakam, Niti-sringar-vairagya, New Delhi,2010