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.
1. PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

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

II. To provide strong foundation in Insulation technology and in engineering necessary to formulate, solve and analyse electromagnetic field problems

III. To develop the ability to estimate and analyse overvoltages in power system

IV. To develop the ability to generate, measure the high voltages and to test High Voltage power apparatus

V. To provide strong foundation in the physics of insulating materials and develop the ability to design High Voltage power apparatus

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

2. PROGRAMME OUTCOMES (POs):

On successful completion of the programme, the graduate would have attained the

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<th>PO#</th>
<th>Graduate Attribute</th>
<th>Programme Outcome</th>
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<td>1</td>
<td>Engineering Knowledge</td>
<td>Apply knowledge of basic science and engineering science in the design and testing of high voltage system and equipment</td>
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<td>2</td>
<td>Problem Analysis</td>
<td>Formulate, simulate and design of power system and equipment under various types of overvoltages.</td>
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<td>3</td>
<td>Design / Development of Solutions</td>
<td>Optimal design of insulation scheme for power system and apparatus</td>
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<td>Conduct investigations of complex problems</td>
<td>Design and conduct experiments towards research in the areas of material characterization, insulation design, applications of high electric fields in interdisciplinary areas</td>
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<td>Model tool usage</td>
<td>Model and analyze power system for transient analysis and insulation design using computational softwares</td>
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<td>The Engineer and Society</td>
<td>To design power equipment and conduct Dielectric tests as per national and international test standards</td>
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<td>7</td>
<td>Environment and Sustainability</td>
<td>Design the system with environment consciousness and sustainable development based on electric and magnetic field distributions</td>
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<td>8</td>
<td>Ethics</td>
<td>To accept responsibilities in making engineering decisions consistent with the safety, health and welfare of public and to Interact with industry, business and society in a professional and ethical manner</td>
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<td>Individual and team work</td>
<td>Function in core and multi-disciplinary teams</td>
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<td>10</td>
<td>Communication</td>
<td>Proficiency in oral and written Communication to present technical subjects</td>
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11. Project Management and Finance
Implement cost effective and improved high voltage systems

12. Life-long learning
Continue professional development and learning as a life-long activity.

3. PROGRAMME SPECIFIC OUTCOMES (PSOs):
By the completion of High Voltage Engineering program the student will have the following specific outcomes

1. Foundation of High Voltage Engineering: Ability to understand the fundamental physics of insulating materials and to acquire and apply knowledge of mathematics and electromagnetic fields in High Voltage Engineering

2. Generation and measurement of High Voltage Engineering: Ability to design, analyse, simulate, generate, measure High voltages and currents and to conduct experiments towards research.

3. Insulation Design of High voltage apparatus: Ability to analyze power system for transient overvoltages and to optimally design insulation scheme for High Voltage power apparatus using computational softwares.

4. Testing of High voltage apparatus: Ability to conduct Destructive and Non-Destructive tests as per national and international test standards.

5. Design and conduct experiments towards research: Ability to use knowledge in development and characterisation of new dielectric materials, estimation and measurement of E & H fields to check design of power equipment and the exposure limits for environmental safety and application of high electric fields in interdisciplinary domains such as food preservation, cancer treatment and agriculture.

4. PEO / PO Mapping:

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ANNA UNIVERSITY, CHENNAI
UNIVERSITY DEPARTMENTS
REGULATIONS – 2019
CHOICE BASED CREDIT SYSTEM
M.E.HIGH VOLTAGE ENGINEERING
CURRICULA AND SYLLABI FOR I TO IV SEMESTERS

SEMESTER I

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### TOTAL CREDITS - 70

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### RESEARCH METHODOLOGY AND IPR COURSES (RMC)

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### AUDIT COURSES (AC)

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COURSE OBJECTIVES
- To provide strong knowledge on different types of electrical stresses on power system and equipment.
- To impart knowledge on generation of high AC and DC voltages
- To provide adequate knowledge to simulate and generate impulse voltages
- To expose the different techniques of measuring High voltages
- To provide adequate knowledge to generate impulse currents and its measurement techniques

UNIT I  GENERATION OF DIRECT VOLTAGES

UNIT II  GENERATION OF ALTERNATING VOLTAGES

UNIT III  GENERATION OF IMPULSE VOLTAGES
Impulse voltage, general shape and definition of lightning impulses, generator circuit – Marx generator – analysis of various impulse voltage generator circuits, controlled switching – multistage impulse generator circuits – Switching impulse generator circuits – generation of non-standard impulse voltages and very fast transient voltage (VFTO)- Relevant IS and IEC Standards

UNIT IV  MEASUREMENT OF HIGH VOLTAGES
Measurement of high AC, DC Impulse voltages - Peak voltage measurements by sphere gaps – Electrostatic voltmeter – generating voltmeters and field sensors – Chubb-Fortescue method – voltage dividers, types, dynamic response and impulse voltage measurements- Relevant IS and IEC Standards

UNIT V  GENERATION AND MEASUREMENT OF IMPULSE CURRENTS
Generation of impulse currents, measurement of high DC, AC and impulse currents – shunts, measurement using magnetic potentiometers and magnetic coupling - Fast digital transient recorders for impulse measurements

COURSE OUTCOMES:
CO1: Ability to design, simulate and generate HVDC
CO2: Ability to design, simulate and generate HVAC
CO3: Ability to design, simulate and generate impulse voltage
CO4: Ability to design and analyze the suitable measuring circuits for HV
CO5: Ability to design the suitable generating and measuring circuits of impulse current

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REFERENCES

HV5102 INSULATION TECHNOLOGY LT P C 4 0 0 4

COURSEOBJECTIVES:
• To gain in-depth knowledge on behavior of dielectrics under Static fields.
• To gain in-depth knowledge on behavior of dielectrics under alternating fields.
• To study the breakdown mechanism of Gaseous dielectrics.
• To study the breakdown mechanism of Liquid and Solid dielectrics.
• To enable the students to become familiar with application of dielectric materials for power equipment.

UNIT I PROPERTIES OF DIELECTRICS IN STATIC FIELDS 12

UNIT II BEHAVIOR OF DIELECTRICS IN ALTERNATING FIELDS 12

UNIT III BREAKDOWN MECHANISMS IN GASEOUS DIELECTRICS 12

UNIT IV BREAKDOWN MECHANISMS IN SOLID AND LIQUID DIELECTRICS 12
UNIT V  LIFE ESTIMATION AND APPLICATION OF INSULATING MATERIALS

Life estimation- thermal modelling- DP/Furan/DGA Results and Application of insulating materials in power equipment and recent advancements-environment friendly and recyclable insulation

TOTAL : 60 PERIODS

COURSE OUTCOMES:

CO1  Ability to understand the fundamental behavior of dielectrics in static fields.
CO2  Ability to understand the fundamental behavior of dielectrics in alternating fields.
CO3  To understand the performance of gaseous dielectrics.
CO4  Ability to understand the behavior of liquid and solid dielectrics.
CO5  Ability to select the suitable insulation for an electrical power equipment.

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REFERENCES

HV5151 ELECTROMAGNETIC FIELD COMPUTATION AND MODELLING LT P C 3 0 0 3

COURSE OBJECTIVES:
- To refresh the fundamentals of Electromagnetic Field Theory
- To provide foundation in formulation and computation of Electromagnetic Fields using analytical and numerical methods.
- To impart knowledge in fundamentals of FEM
- To compute and analyze the field quantities using FEM
- To formulate, solve, analyze and optimize the design of electrical components
UNIT I  INTRODUCTION
Review of basic field theory – Maxwell’s equations – Constitutive relationships and Continuity equations – Laplace, Poisson and Helmholtz equation – principle of energy conversion – force/torque calculation

UNIT II  BASIC SOLUTION METHODS FOR FIELD EQUATIONS
Limitations of the conventional design procedure, need for the field analysis based design, problem definition, boundary conditions, solution by analytical methods-direct integration method – variable separable method – method of images, solution by numerical methods-Finite Difference Method

UNIT III  FORMULATION OF FINITE ELEMENT METHOD (FEM)
Variational Formulation – Energy minimization – Discretisation – Shape functions–Stiffness matrix –1D and 2D planar and axial symmetry problems

UNIT IV  COMPUTATION OF BASIC QUANTITIES USING FEM PACKAGES

UNIT V  DESIGN APPLICATIONS

COURSE OUTCOMES:
CO1 Ability to understand the field theory concepts
CO2 Ability to formulate and compute Electromagnetic Fields from Maxwell’s equations.
CO3 Ability to formulate FEM problems from the fundamental concepts
CO4 Ability to compute the respective field using FEM (post processing)
CO5 Ability to check and optimize the design of electrical power equipment

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COURSEOBJECTIVES:
- To gain knowledge in sources of transients like lightning, switching and temporary overvoltages.
- To model power system components and estimate the overvoltages in power system.
- To analyze travelling wave phenomena against different overvoltages.
- To compute transient overvoltages using Electromagnetic Transient Program (EMTP).
- To coordinate the insulation of power system and protective devices.

UNIT I LIGHTNING OVERVOLTAGES 12
Classification of over voltages- Mechanism and parameters of lightning flash, protective shadow, striking distance, electro geometric model for lightning strike, Grounding for protection against lightning – Steady state and dynamic tower-footing resistance, substation grounding Grid, Direct lightning strokes to overhead lines, without and with shield Wires

UNIT II SWITCHING AND TEMPORARY OVERVOLTAGES 12

UNIT III TRAVELLING WAVES ON TRANSMISSION LINE 12
Circuits and distributed constants, wave equation, reflection and refraction – behaviour of travelling waves at the line terminations – Lattice Diagrams – attenuation and distortion – multiconductor system and multivelocity waves

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
Computation of transients using electromagnetic transient program-Modelling of power system components- Simple case studies - Application of simplified method: single line station, two line station, gas insulated substations, comparison with IEEE and IEC guides

COURSEOUTCOMES:
CO1: Ability to understand various sources of transients
CO2: Ability to compute possible overvoltages in power systems
CO3: Ability to predict overvoltages in power system using travelling wave theory
CO4: Ability to compute overvoltages using EMTP with multiple sources
CO5: Ability to coordinate the insulation level of the power system

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L= 45; T=15, TOTAL : 60 PERIODS
REFERENCES

RM5151 RESEARCH METHODOLOGY AND IPR LT P C

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 TECHNICAL WRITING / PRESENTATION
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)
UNIT V INTELLECTUAL PROPERTY RIGHTS (IPR)


Traditional knowledge Case Studies, IPR and IITs.

TOTAL HOURS: 30

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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HV5111 HIGH VOLTAGE GENERATION AND MEASUREMENT LABORATORY

COURSE OBJECTIVES:
To acquire hands on experience

- to analyze and design HVAC and HVDC
- to analyze and design impulse voltage generators
- to generate and measure HVAC and HVDC
- to generate and measure standard and non-standard impulse voltages
- to generate and measure impulse current

LIST OF EXPERIMENTS
1. Analysis and Design of high voltage DC generators using circuit simulation package
2. Analysis and Design of high voltage AC generators using circuit simulation package
3. Analysis and Design of high Impulse voltage generators using circuit simulation package
4. Generation and measurement of HVDC
5. Generation and measurement of HVAC
6. Generation and measurement of standard impulse voltages
7. Generation and measurement of non-standard impulse voltages
8. Comparison of various high voltage measurement methods

P = 60 ,TOTAL = 60 PERIODS
COURSE OUTCOMES:
CO1: Ability to analyze and design HVAC and HVDC
CO2: Ability to analyze and design impulse voltage generators
CO3: Ability to generate and measure HVAC and HVDC
CO4: Ability to generate and measure standard and non-standard impulse voltages
CO5: Ability to generate and measure impulse current

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P = 60 , TOTAL = 60 PERIODS
## COURSE OBJECTIVES:
To acquire knowledge,
- on the different types of testing and measurement techniques
- on pre-testing procedures by statistical evaluation methods
- on required tests and the procedures for various high voltage power apparatus as per IS/IEC/IEEE standards.
- on Non-destructive test methods for assessing insulation characteristics
- on performing artificial pollution test and design of HV lab

### UNIT I  INTRODUCTION
Objectives of high voltage testing, classification of testing methods- self restoration and non-self-restoration systems- IS/IEC/IEEE standards and specifications, measurement techniques
,Diagnostic testing – online measurement, standard test cells

### UNIT II  STATISTICAL EVALUATION OF MEASURED RESULTS
Determination of probability values, Distribution function of a measured quantity, confidence limits of the mean values of disruptive discharges - ‘Up and Down’ method for determining the 50% disruptive discharge voltage, multi stress ageing, life data analysis

### UNIT III  TESTING TECHNIQUES FOR ELECTRICAL EQUIPMENT
Testing of insulators, bushings, air break switches, isolators, circuit breakers, power transformers, voltage transformers, current transformers, surge arresters ,cable -testing methodology-recording of oscillograms - interpretation of test results

### UNIT IV  NON-DESTRUCTIVE INSULATION TEST TECHNIQUES
Dynamic properties of dielectrics-dielectric loss and capacitance measurement-partial discharge measurements-basic partial discharge (PD) circuit – PD currents- PD quantities -Digital PD instruments and measurements, acoustic, emission technique and UHF Techniques for PD identification, Corona and RIV measurements on line hardware

### UNIT V  POLLUTION TESTS AND DESIGN OF HIGH VOLTAGE LAB
Artificial Pollution tests- salt-fog method, solid layer method, Design of High voltage laboratory, equipment- fencing, earthing and shielding.

### COURSE OUTCOMES:
CO1: Ability to select appropriate type of test for each high voltage power apparatus
CO2: Ability to do life data analysis and statistical evaluation of measured results
CO3: Ability to conduct Dielectric tests as per standards on various HV power apparatus
CO4: Ability to carry out Non-destructive tests on evaluation of insulation characteristics
CO5: Ability to execute artificial pollution test and design different types of HV lab

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HV5201  HIGH VOLTAGE TESTING TECHNIQUES

COURSE OBJECTIVES:
To acquire knowledge,
- on the different types of testing and measurement techniques
- on pre-testing procedures by statistical evaluation methods
- on required tests and the procedures for various high voltage power apparatus as per IS/IEC/IEEE standards.
- on Non-destructive test methods for assessing insulation characteristics
- on performing artificial pollution test and design of HV lab

UNIT I  INTRODUCTION
Objectives of high voltage testing, classification of testing methods- self restoration and non-self-restoration systems- IS/IEC/IEEE standards and specifications, measurement techniques
,Diagnostic testing – online measurement, standard test cells

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UNIT V  POLLUTION TESTS AND DESIGN OF HIGH VOLTAGE LAB
Artificial Pollution tests- salt-fog method, solid layer method, Design of High voltage laboratory, equipment- fencing, earthing and shielding.

L=60: Total = 60 PERIODS

19
REFERENCES
3. Relevant test standards.

COURSEOBJECTIVES:

• To provide fundamental knowledge about the role and schemes of insulation and stress control techniques in high voltage equipment.
• To acquire knowledge on design principles of Insulators, bushings and capacitors
• To design the different insulation schemes, stress control methods and to study the transient behavior of the windings.
• To design the high voltage instrument transformers and cable joints
• To design and model the surge arrester under different operating conditions.
UNIT I INTRODUCTION
Electrical field distribution and breakdown strength of insulating materials - factors affecting the breakdown strength - electric field distribution in homogenous and multi-dielectric isotropic materials- electrical field control techniques

UNIT II HV INSULATORS, BUSHINGS AND CAPACITORS
Basic configurations, Classification based on insulating materials and application, design principles

UNIT III POWER TRANSFORMERS
Insulation schemes in transformer, types of transformer winding, design of internal, main and end insulation, surge phenomena in transformer windings- stress control techniques

UNIT IV INSTRUMENT TRANSFORMERS AND CABLE JOINTS
Classification based on insulating materials and design of potential and current transformers, Types of cable joints and terminations-capacitive grading- non-linear resistive grading

UNIT V SURGE ARRESTER
Types of surge arresters - gapped and gapless - electrical characteristics – housing materials – design - pollution performance - modeling of arrester

L = 45: T = 0, Total = 45 PERIODS

COURSE OUTCOMES:
CO1 Ability to analyze the factors influencing the performance of insulation of power equipment.
CO2 Ability to design high voltage Insulators, bushing and capacitors
CO3 Ability to design and optimize the insulation design of the power transformer
CO4 Ability to understand the concept of insulation design of Instrument transformers and cable joints
CO5 Ability to understand the design concepts based on construction and arrester non-linear characteristics

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COURSEOBJECTIVES:
To compute and analyse
- the electrical field distribution in homogeneous and non-homogeneous materials
- the various electric stress control methods
- the insulation design and appropriate stress control methods in Insulator, Bushing and cable joints.
- electric field distribution and transient response of transformer windings
- the insulation design and the transient response of Surge arrester

LIST OF EXPERIMENTS
The electric field analysis and the transient response of the equipment are to be carried out using Field computational software (FEM based) and Circuit simulation package respectively.

1. Electric field in homogeneous and non-homogeneous materials
   i. Symmetrical and asymmetrical electrode configurations
   ii. Parallel plate, coaxial cable and concentric spheres
2. Dielectric refraction of electric in practical insulation systems – Transverse, longitudinal and inclined boundary condition: electric field behavior for a finite contact angle.
3. Design of insulator with grading and corona rings
4. Design of condenser and non-condenser bushing
5. Design of cable joints
6. Transformer design
   i. Stress control techniques for different types of winding in transformer (layer, disc)
   ii. High frequency equivalent circuit model
   iii. Transient analysis
7. Insulation design of Surge Arrester

P= 60, TOTAL : 60 PERIODS

COURSEOUTCOMES:
CO1 Ability to understand the field distribution and utilization for basic configurations
CO2 Gain knowledge in various stress control techniques for HV equipment
CO3 Ability to design high voltage insulators, bushing and cable joints
CO4 Ability to check the design of transformer insulation and apply suitable techniques to improve the design if necessary
CO5 Ability to improve the design of the surge arrester

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COURSE OBJECTIVES:
To acquire hands on experience
• on breakdown study of air, liquid and solid dielectrics under different electrode configurations and voltages
• to measure harmonics and E/H fields using meters
• to measure transient voltage distribution in transformer windings
• to measure and analyse the different types of Partial discharges
• on dielectric testing of high voltage equipment as per Standards

LIST OF EXPERIMENTS
1. Study on the AC and DC breakdown characteristics of air at different pressures
2. Study on the AC and Impulse voltage breakdown characteristics of Liquid Dielectrics
3. Study on the AC breakdown characteristics of Solid Dielectrics under Uniform and Non-Uniform fields
4. Measurement of Electric and Magnetic fields using field meters
5. Measurement of resonant frequencies and internal voltage distribution in transformer windings
6. Measurement of Partial Discharges
7. Measurement of Harmonics using energy analyzer
8. Dielectric withstand tests on Insulator / Bushing
9. Dielectric withstand tests on Air Break Switch / Circuit Breaker
10. Dielectric withstand tests on Transformer

COURSE OUTCOMES:
CO1 knowledge in breakdown characteristics of different types of dielectric media under different voltages and electrode configurations
CO2 Ability to check the E/H field exposure levels
CO3 Ability to analyze the transient behavior of transformer windings under various types of overvoltages
CO4 Ability to check the quality of the power and the equipment
CO5 Ability to test the power equipment asper standards for Certification purpose

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P = 60 , TOTAL = 60 PERIODS
PROFESSIONAL ELECTIVE COURSES (PEC)

HV5001 DESIGN OF HIGH VOLTAGE SWITCHGEAR LT P C
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COURSE OBJECTIVES:
To impart knowledge on,
- the clearances between contacts in different insulating media
- the arcing phenomenon in circuit breaker and model of arc.
- the design techniques and governing factors of air circuit breaker
- the design techniques and governing factors of oil circuit breakers
- the design techniques and governing factors of vacuum and SF6 circuit breakers

UNIT I INTRODUCTION
Insulation of switchgear - coordination between inner and external insulation, Insulation clearances in air, oil, SF6 and vacuum, bushing insulation, solid insulating materials – dielectric and mechanical strength consideration – Isolating, earthing and load switches.

UNIT II CIRCUIT INTERRUPTION

UNIT III DESIGN OF AIR CIRCUIT BREAKERS

UNIT IV DESIGN OF OIL CIRCUIT BREAKERS

UNIT V DESIGN OF SF6 AND VACUUM CIRCUIT BREAKERS
Insulating and Interrupting Properties of SF6 –Analysis and Construction of SF6 Circuit Breakers – Vacuum circuit breakers: Status and trends in continuous current and interrupting ratings – Mechanical and thermal withstand capabilities – Construction and layout – Breaker design – Case studies

P=45: TOTAL = 45 PERIODS

COURSE OUTCOMES:
CO1: Ability to analyze insulation clearances in external and internal installations
CO2: Ability to analyze and model arc interruption in circuit breakers
CO3: Ability to design different air circuit breakers effectively
CO4: Ability to meet design trends in oil-less circuit breakers
CO5: Ability to design and analyze SF6 and VCB circuit breakers
REFERENCES

HV5002 CONDITION MONITORING OF HIGH VOLTAGE POWER EQUIPMENT

COURSE OBJECTIVES:
- To provide strong knowledge on different types condition monitoring methods
- To impart knowledge in condition monitoring of
  - Transformers
  - Switchgear components
  - Rotating equipment
- To be aware of the latest and future trends in condition monitoring

UNIT I BASICS OF CONDITION MONITORING
Need for Condition monitoring, Diagnostic methods- Requirements of diagnosis methods, design acceptance test, age related failure, insulation assessment methodologies, Destructive and non-destructive techniques, Offline and online condition monitoring, sensors.

UNIT II CONDITION MONITORING OF TRANSFORMERS
Diagnostic test chart, Impulse fault analysis, Partial discharge measurements and analysis Conventions diagnostic techniques - Chemical and electrical techniques, Dielectric response measurements in time domain and frequency domain – FRA

UNIT III CONDITION MONITORING OF SWITCHGEARS
Need for monitoring, objectives for switching equipment monitoring, Diagnostic techniques for switching equipment - insulation, current carrying, switching, mechanical operation, control of auxiliary functions
UNIT IV  CONDITION MONITORING OF ROTATING EQUIPMENT
Failure modes - Stator and rotor failure mechanisms, Monitoring methods - temperature, chemical, vibration, current, flux, power and discharges

UNIT V  FUTURE TRENDS
Reaming life analysis, Condition based maintenance and asset management, Introduction to Artificial Intelligence techniques, latest methodologies and Future trends.

TOTAL : 45 PERIODS

COURSE OUTCOMES:
CO1 Knowledge in the different types and methodologies of Condition monitoring practices
   Ability to monitor the condition of
CO2 Transformers
CO3 Switchgear components
CO4 Rotating equipment
CO5 Knowledge in in future trends and tools for condition monitoring

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6. IEC 60599 Interpretation of the analysis of gases in transformers and oil filled equipment in service
7. CIGRE TB No 462, Obtaining Value from On Line Substation Condition Monitoring
8. CIGRE TB No 558., Guide for the Monitoring, Diagnosis and Prognosis of Large Motors.
9. CIGRE TB No 167, USER GUIDE FOR THE APPLICATION OF MONITORING AND DIAGNOSTIC TECHNIQUES FOR SWITCHING EQUIPMENT FOR RATED VOLTAGES OF 72.5 kV AND ABOVE.
COURSE OBJECTIVES:
- To enable the students to become familiar with different types of nano materials.
- To understand the various properties of nano materials.
- To expose the knowledge on synthesization of nano materials.
- To impart knowledge on characterization methods of nano composites.
- To obtain the idea about the application of nano polymers.

UNIT I  INTRODUCTION TO NANO MATERIALS
Introduction to nanomaterials- Definition of nanocomposite, nanofillers, classification of nanofillers, carbon and non-carbon based nanofillers - Properties of nanomaterials- role of size in nanomaterials, nanoparticles, semiconducting nanoparticles, nanowires, nanoclusters, quantum wells, conductivity and enhanced catalytic activity in the macroscopic state.

UNIT II  PROPERTIES OF NANOMATERIALS
Nanocomposites and Properties- Metal-Metal nanocomposites, Polymer-Metal nanocomposites, Ceramic nanocomposites: Dielectric and CMR based nanocomposites. Mechanical Properties, Modulus and the Load-Carrying Capability of Nanofillers, Failure Stress and Strain Toughness, Glass Transition and Relaxation Behavior, Abrasion and Wear Resistance, Permeability, Dimensional Stability Contents, Thermal Stability and Flammability, Electrical and Optical Properties, Resistivity, Permittivity and Breakdown Strength, Refractive Index.

UNIT III  SYNTHESIZATION AND CHARACTERIZATION METHODS
Synthesis of Nanomaterials by Physical Methods - Inert gas condensation, Arc discharge, Ball Milling, Molecular beam epitaxy-Chemical vapour deposition method and Electro deposition.

Chemical methods for Synthesis of Nanomaterials: Chemical precipitation and co-precipitation, Sol-gel synthesis, Microwave heating synthesis, Sonochemical synthesis; Electrochemical synthesis; Photochemical synthesis.


UNIT IV  NANOCOMPOSITE
Direct Mixing, Solution Mixing ,Preparation and characterization of inorganic nanofillers properties, synthesis, characterization and applications of SiO2, TiO2, ZrO2, Al2O3 and CNT composite. Applications of nano filled materials for outdoor and indoor equipments.

UNIT V  NANOPOLYMERS
Polymerization, Particle Processing Ceramic/Polymer Composites, Preparation and characterization of Copolymer based nano composites- Barrier properties of polymer nanocomposites- Permeation and diffusion models - Thermo Electric Materials – Applications.

TOTAL : 45 PERIODS

COURSE OUTCOMES:
CO1 Ability to understand the nano material structure
CO2 Ability to understand the characteristics of nano materials.
CO3 Ability to understand the methods of synthesization and characterization.
CO4 Ability to understand the processing methods of nanocomposite and applications.
CO5 Ability to design and fabricate the electrical insulations with nano dielectric materials.
HV5071  APPLICATIONS OF HIGH ELECTRIC FIELDS  LT P C
3 0 0 3

COURSEOBJECTIVES:
To impart knowledge on,

- industrial applications of High electric fields
- in-activation of microbes by High electric fields
- food preservation by High electric fields
- High electric fields applications in cancer treatment
- the awareness on electro-static hazards and safety measures

UNIT I  APPLICATION IN INDUSTRY
9

UNIT II  APPLICATION IN MICROBIAL INACTIVATION
9
Introduction-definitions, descriptions and applications-mechanisms of microbial in-activation,electrical breakdown-electroporation-inactivation models-Critical factors-analysis of process, product and microbial factors-pulse generators and treatment chamber design-Research needs

UNIT III  APPLICATION IN FOOD PRESERVATION
9
Processing of juices, milk, egg, meat and fish products- Processing of water and waste – Industrial feasibility, cost and efficiency analysis

UNIT IV  APPLICATION IN CANCER TREATMENT
9
Different types of cancer – Different types of treatments, anti-cancer drugs – Electrochemotherapy – Electric fields in cancer tissues – Modeling, analysis of cancer tissues
UNIT V SAFETY AND ELECTROSTATIC HAZARDS


TOTAL : 45 PERIODS

COURSE OUTCOMES:
CO1: Ability to apply high electric fields in day-to-day life problems
CO2: Ability to apply high electric fields in microbial inactivation
CO3: Ability to preserve food by high electric fields
CO4: Ability to work in multidisciplinary projects like cancer treatment with high electric fields
CO5: Ability to provide safety measures against electrostatic hazards

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7. Indian Electricity Rules; IS-5216; Electrical Safety Handbook by John Cadick

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


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.

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HV5073 ELECTROMAGNETIC INTERFERENCE AND COMPATIBILITY

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 CABLING
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

TOTAL : 45 PERIODS

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.
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COURSE OBJECTIVES:
To provide in-depth knowledge on
- the mechanism and effect of pollution
- Artificial and field pollution test methods
To the pollution performance of
- High voltage insulators
- surge diverters
- indoor equipment.

UNIT I INTRODUCTION

UNIT II POLLUTION TESTING

UNIT III POLLUTION PERFORMANCE OF INSULATORS
Ceramic and non-ceramic insulators – design of shed profiles – rib factor effect in AC and DC insulators – modelling

UNIT IV POLLUTION PERFORMANCE OF SURGE ARRESTERS
External insulation – effect of pollution on the protective characteristics of gap and gapless arresters – modeling of surge diverters under polluted conditions.

UNIT V POLLUTION PERFORMANCE OF INDOOR EQUIPMENT
Condensation and contamination of indoor switch gear – performance of organic insulator under polluted conditions – accelerated testing techniques.

TOTAL : 45 PERIODS

COURSE OUTCOMES:
CO1 Ability to understand the mechanism and factors affecting the pollution performance
CO2 Ability to design and conduct pollution tests
CO3 Ability to design insulator profile based on pollution
CO4 Ability to understand the external insulation based on pollution
CO5 Ability to design indoor equipment

REFERENCES
COURSEOBJECTIVES:
• 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

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

COURSEOUTCOMES:
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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CO5251 MACHINE LEARNING LT P C

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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

UNIT II DATA PREPROCESSING
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:60PERIODS

COURSE OUTCOMES:
At the end of this course, the students will demonstrate the ability
• To understand the basic theory underlying machine learning.
• A range of machine learning algorithms along with their strengths and weaknesses.
• To formulate machine learning problems corresponding to different applications.
• To apply machine learning algorithms to solve problems of moderate complexity.
• To read current research papers and understand the issues raised by current research.

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3. Jiawei Han, Micheline Kamber, Jian Pei, Data Mining: Concepts and Techniques: Concepts and Techniques, Elsevier, 2011.
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

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 OVERHEADLINES AND UNDERGROUND CABLES

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 modelling. 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


UNIT IV  INSULATION CO-ORDINATION

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

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.

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PS5251           HVDC AND FACTS           L T P C
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
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

UNIT III  ANALYSIS OF LCC HVDC CONVERTERS AND HVDC SYSTEM CONTROL

UNIT IV  VOLTAGE SOURCE CONVERTER BASED FACTS AND HVDC CONTROLLERS
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- ApplicationsVSC based HVDC: Operation, Modelling for steady state and dynamic studies.

UNIT V  POWER FLOW ANALYSIS OF AC/DC SYSTEMS
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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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 9
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) 9
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) 9
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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PS5071            APPLICATION OF AI TECHNIQUES TO POWER SYSTEMS                L T P C
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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               9
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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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
Components of WECS-WECS schemes-Power obtained from wind-simple momentum theory-
Power coefficient-Sabinin’s theory-Aerodynamics of Wind turbine

UNIT II WINDTURBINES
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
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
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
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.

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

PS5252 RESTRUCTURED POWER SYSTEM

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.

UNITIII LOCATIONAL MARGINAL PRICES(LMP) AND FINANCIAL TRANSMISSION RIGHTS


UNITIV 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

TOTAL: 45 PERIODS

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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PS5074 OPTIMISATIONTECHNIQUES

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 of genetic algorithm and its applications.

UNITI INTRODUCTION

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

UNITII LINEAR PROGRAMMING (LP)

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

UNITIV DYNAMIC PROGRAMMING (DP)
Multistage decision processes, concept of sub-optimization and principle of optimality, Recursive relations, Integer Linear programming, Branch and bound algorithm

UNITV 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.

TOTAL: 45 PERIODS

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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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


UNIT II DIGITAL PROTECTION


UNIT III ALGORITHMIC TECHNIQUES

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


UNIT V DIGITAL PROTECTIVE RELAYS


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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COURSE OBJECTIVES:

- To apply iterative techniques for power flow analysis
- To provide knowledge about state estimation
- To analyse the power system security under different contingency events
- To gain knowledge about power system protection.
- To provide basic knowledge on voltage stability

UNIT I  POWER FLOW ANALYSIS  12

UNIT II  STATE ESTIMATION  12

UNIT III  POWER SYSTEM SECURITY  12

UNIT IV  POWER SYSTEM PROTECTION  12
Introduction to Power System Protection– Operating principles and Relay Construction – Overcurrent Protection– Microprocessor based Overcurrent Relays

UNIT V  VOLTAGE STABILITY  12

TOTAL: 60 PERIODS

COURSE OUTCOMES:
CO1: Ability to carry out power flow analysis for transmission and distribution network.
CO2: Able to Compute the state of the power system.
CO3: Ability to carry out contingency analysis to analyse power system security.
CO4: Able to understand over current protection for system security.
CO5: Analyse the concept of voltage stability.

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PW5151 CLIMATE CHANGE AND ENERGY ENVIRONMENT LT P C
3 0 0 3

COURSE OBJECTIVES:

- To provide knowledge about climate change and its environmental impact
- To give exposure about technology and policy options for GHG emission
- To provide knowledge about international climate change conventions, protocols and perspectives.
- To know the environmental problems related to energy use.
- To know the various options to improve the energy use.

UNIT I CLIMATE CHANGE
Energy use and Global Warming, Climate Change Concerns, Climate Change in India, the Greenhouse Effect, Earth’s Radiation balance, Greenhouse Gases (GHG) types and Sources, Climate Change Impacts.

UNIT II TECHNOLOGY AND POLICY OPTIONS FOR GHG EMISSION MITIGATION
Renewable Energy, Energy Efficient Technologies by Sector and End-Use, Cleaner Production, Barriers to GHG Mitigation Technologies, Carbon tax and Tradable Emission Permits, Other Policy Options.

UNIT III INTERNATIONAL CLIMATE CHANGE CONVENTIONS, PROTOCOLS AND PERSPECTIVES
Climate Change in India and mitigation measures on Indian perspectives, United Nations Framework Convention on Climate Change (UNFCCC), Clean Development Mechanism (CDM) as per the Kyoto Protocol and Flexible Mechanisms, comparison on India vs developed countries perspectives on GHG mitigations.
UNIT IV  ENVIRONMENTAL PROBLEMS RELATED TO ENERGY USE
Energy use and its air pollution, acid rain, Technological and policy options for control of SO$_2$ and NOx emissions, the problem of Atmospheric Brown Cloud (ABC) and possible mitigation options.

UNIT V  URBAN ENERGY USE AND THE ENVIRONMENT
Efficient/cleaner transport options of electric vehicles and their effects on energy use, environment and GHG emissions, other options to improve energy use and environment in urban areas.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
CO1: Able to understand the climate change and its environmental impact.
CO2: Acquired knowledge about technology and policy options for GHG emission.
CO3: Ability to understand the international climate change conventions, protocols and perspectives.
CO4: Learned the environmental problems related to energy use.
CO5: Ability to identify the various options to improve the energy use.

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REFERENCES:
6. UNEP and C4, The Asian Brown Cloud,'Climate and Other Environmental Impacts’, UNEP, Nairobi, 2002

PW5251  ENERGY MANAGEMENT AND AUDIT  LT P C  3 1 0 4

COURSE OBJECTIVES:
- To study the concepts behind economic analysis and Load management.
- To understand the basics of materials and energy balance.
- To analyze the energy efficiency in thermal utilities.
- To know the concept of compressed air system.
- To illustrate the concept of lighting systems and cogeneration.
UNIT I        GENERAL ASPECTS OF ENERGY MANAGEMENT AND ENERGY AUDIT  12

UNIT II      MATERIAL AND ENERGY BALANCE  12
Methods for preparing process flow - material and energy balance diagrams - Energy policy purpose - location of energy management - roles and responsibilities of energy manager – employees training and planning - Financial Management: financial analysis techniques, simple payback period, return on investment, net present value, internal rate of return – Case Study.

UNIT III     ENERGY EFFICIENCY IN THERMAL UTILITIES  12

UNIT IV  ENERGY EFFICIENCY IN COMPRESSED AIR SYSTEM  12

UNIT V    ENERGY EFFICIENCY IN ELECTRICAL UTILITIES  12

TOTAL: 60 PERIODS

COURSEOUTCOMES:
CO1: Students able to acquire knowledge in the field of energy management and auditing process.
CO2: Learned the about basic concepts of economic analysis and load management.
CO3: Able to design the effective thermal utility system.
CO4: Able to improve the efficiency in compressed air system.
CO5: Acquired the design concepts in the field of lighting systems, light sources and various forms of cogeneration.
REFERENCES:

PW5077 RENEWABLE ENERGY TECHNOLOGY LT P C
3 0 0 3

COURSEOBJECTIVES
- To Provide knowledge about various renewable energy technologies
- To enable students to understand and design a PV system.
- To provide knowledge about wind energy system.
- To Provide knowledge about various possible hybrid energy systems
- To gain knowledge about application of various renewable energy technologies

UNIT I INTRODUCTION
Primary energy sources, renewable vs. non-renewable primary energy sources, renewable energy resources in India, Current usage of renewable energy sources in India, future potential of renewable energy in power production and development of renewable energy technologies.

UNITII SOLAR ENERGY

UNIT III WIND ENERGY
Wind energy principles, wind site and its resource assessment, wind assessment, Factors influencing wind, wind turbine components, wind energy conversion systems (WECS), Classification of WECS devices, wind electric generating and control systems, characteristics and applications. Hybrid systems - safety and environmental aspects, economic aspects.
UNIT IV BIO-ENERGY

UNIT V OTHER TYPES OF ENERGY
Energy conversion from Hydrogen and Fuel cells, Geo thermal energy Resources, types of wells, 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

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

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PW5071 ELECTRIC VEHICLES AND POWER MANAGEMENT

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
UNIT II MECHANICS OF HYBRID ELECTRIC VEHICLES 9
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 9
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 9

UNIT V HYBRID VEHICLE CONTROL STRATEGY AND ENERGY MANAGEMENT 9
HEV supervisory control - Selection of modes - power spilt 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.

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REFERENCES:

PW5072 ENERGY EFFICIENT BUILDINGS LT P C 3 0 0 3

COURSE OBJECTIVES:

- To understand the different climate zones and modelling methods
- To understand about the principle of energy conscious building design.
- To understand about the concept of passive solar heating and efficient technologies in electrical system.
- To provide knowledge about the energy conservation techniques in buildings.
• To provide knowledge about energy efficient technologies.

UNIT I  CLIMATE AND SHELTER  9

UNIT II  PRINCIPLES OF ENERGY CONSCIOUS BUILDING DESIGN  9

UNIT III  PASSIVE SOLAR HEATING  9

UNIT IV  ENERGY CONSERVATION IN BUILDING  9

UNIT V  EFFICIENT TECHNOLOGIES IN ELECTRICAL SYSTEMS  9
Maximum demand controllers, automatic power factor controllers, energy efficient motors, and soft starters – Energy efficient Lighting and Transformers.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
CO1: Able to understand the different climate zones and modelling methods
CO2: Able to design energy conscious building design.
CO3: Able to understand about the concept of passive solar heating and efficient technologies in electrical system.
CO4: Able to gain knowledge about the energy conservation techniques in buildings.
CO5: Know about different energy efficient technologies.

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COURSE OBJECTIVES:
- To analyze the energy availability & changing pattern
- To analyze different forecasting models.
- To learn different optimization techniques for energy planning.
- To equip the students in writing project proposals and making project cost estimation.
- To learn about the different energy policy.

UNIT I  ENERGY SCENARIO
9

UNIT II  FORECASTING MODEL
9
Forecasting Techniques - Regression Analysis - Double Moving Average - Double Experimental Smoothing - Triple Exponential Smoothing – ARIMA model - Validation techniques – Qualitative forecasting – Delphi technique - Concept of Neural Net Works.

UNIT III  OPTIMIZATION MODEL
9

UNIT IV  PROJECT MANAGEMENT
9

UNIT V  ENERGY POLICY
9

TOTAL : 45 PERIODS

COURSE OUTCOMES:
CO1: Knowledge in Energy pattern and availability.
CO2: Ability to apply forecasting techniques.
CO3: Able to develop optimization model for energy planning
CO4: Equipped to write project proposal and cost estimation.
CO5: Acquired knowledge of national and state energy policies

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PW5152 ENERGY CONSERVATION IN ELECTRICAL SYSTEMS LT P C 3 0 0 3

COURSEOBJECTIVES:

- To study the concepts of power factor, load management.
- To study the various measures for energy conservation in electrical devices both static & rotating machineries.
- To understand the energy conservation in pump and compressor systems.
- To study the performance of lighting systems.
- To understand the concept of PAT systems and cost factor.

UNIT I ELECTRICAL ENERGY USAGE : BASICS

UNIT II TRANSFORMERS AND MOTORS

UNIT III FANS, PUMPS AND COMPRESSORS

UNIT IV ILLUMINATION AND ENERGY EFFICIENCY DEVICES

UNIT V CASE STUDIES & CO2 MITIGATION

TOTAL: 45 PERIODS

COURSEOUTCOMES:
CO1: Able to know the importance of power factor improvement.
CO2: Learned the various measures for energy conservation in electrical devices.
CO3: Able to improve the energy efficiency in pump and compressor systems.
CO4: Able to design effective lighting systems.
CO5: The students acquire the concept of PAT systems and cost factor.

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PW5252 OPTIMIZATION TECHNIQUES FOR ENERGY MANAGEMENT L T P C
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COURSEOBJECTIVES:
- To understand the probability concepts.
- To provide knowledge on the demand analysis and forecasting techniques
- To emphasis the optimization for energy management.
- To provide knowledge about the selection of optimization techniques for real time problems and to analyze the solutions.
- To analyze and comprehend the various operating modes of different configurations at different applications.

UNIT I PROBABILITY THEORY
The nature of random variables: populations and samples, parameters and statistics. Probability concepts; properties of random variables, probability distribution functions.

UNIT II DEMAND ANALYSIS AND FORECASTING
Drivers of energy demand, Sectoral energy demand: domestic, commercial, industrial, agricultural. Projections for future demands.

UNIT III INTRODUCTION TO OPTIMIZATION

UNIT IV LINEAR PROGRAMMING AND APPLICATION
Assumptions, problems formulation and solutions, graphical methods, simplex algorithm, duality concept, sensitivity analysis. Power system planning using optimization techniques, case study.

UNIT V DYNAMIC PROGRAMMING AND APPLICATION
Introduction, multi stage decision problems, recursive equations, principle of optimality, discrete dynamic programming. Optimal energy resource, technology mix in micro and macro level energy planning exercises. Power generation expansion planning, case study.
COURSE OUTCOMES:
CO1: Ability to define and use optimization techniques and concepts.
CO2: Understand the concept of optimization methods for energy system planning
CO3: Able to define an optimization problem and exploring the solution by applying optimization methods and interpreting results.
CO4: Excel the selection of optimization techniques for real time problems and to analyze the solutions.
CO5: Analyze the various operating modes of different configurations in different applications.

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REFERENCES

PW5079 WASTE MANAGEMENT AND ENERGY RECOVERY TECHNIQUES LT P C
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COURSE OBJECTIVES:
- To provide information on various methods of waste management.
- To impart knowledge about separation techniques & transformation technologies.
- To detail on the recent technologies of waste disposal.
- To familiarize students with recent energy generation techniques.
- To make students realize on the importance of healthy environment.

UNIT I CHARACTERISTICS AND PERSPECTIVES 9

UNIT II UNIT OPERATIONS & TRANSFORMATION TECHNOLOGIES 9

UNIT III WASTE DISPOSAL 9
UNIT IV TRANSFORMATION TECHNOLOGIES AND VALUE ADDITION


UNIT V HAZARDOUS WASTE MANAGEMENT & WASTE RECYCLING


TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: Acquired basic knowledge about the Methods of Waste Management.
CO2: Understand the concept of Segregation & Transformation Techniques.
CO3: Learned the technologies that are available for effective waste disposal along with pros / cons.
CO4: Ability to develop various Energy generation Techniques.
CO5: Able to predict the waste related problems (Hazardous Waste, Pharma Waste, Biomedical Waste etc).

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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 9
Necessity of energy storage – types of energy storage – comparison of energy storage technologies – Applications.

UNIT II  THERMAL STORAGE SYSTEM 9
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 9
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 9

UNIT V  ALTERNATE ENERGY STORAGE TECHNOLOGIES 9

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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COURSEOBJECTIVES:
- 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

COURSEOUTCOMES:
- 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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**TEXTBOOKS:**

**REFERENCES:**
1. Power Quality - R.C. Duggan
2. Power system harmonics – A.J. Arrilga
3. Power Electronic Converter Harmonics – Derek A. Paice

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**PE5251 SPECIAL ELECTRICAL MACHINES**

**COURSEOBJECTIVES:**
- To review the fundamental concepts of permanent magnets and the operation of permanent magnet brushless DC motors.
- To introduce the concepts of permanent magnet brushless synchronous motors and synchronous reluctance motors.
- To develop the control methods and operating principles of switched reluctance motors.
- To introduce the concepts of stepper motors and its applications.
- To understand the basic concepts of other special machines.

**UNIT I PERMANENT MAGNET BRUSHLESS DC MOTORS**

**UNIT II PERMANENT MAGNET SYNCHRONOUS MOTORS**

**UNIT III SWITCHED RELUCTANCE MOTORS**
Constructional features – Principle of operation- Torque prediction– Characteristics Power controllers – Control of SRM drive- Sensorless operation of SRM – Applications.

**UNIT IV STEPPER MOTORS**

**UNIT V OTHER SPECIAL MACHINES**
Principle of operation and characteristics of Hysteresis motor – AC series motors – Linear motor – Applications.
**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

CO1 Ability to model and analyze power electronic systems and equipment using computational software.

CO2 Ability to optimally design magnetics required in special machines based drive systems using FEM based software tools.

CO3 Ability to analyze the dynamic performance of special electrical machines.

CO4 Ability to understand the operation and characteristics of other special electrical machines.

CO5 Ability to design and conduct experiments towards research.

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**PE5151 ANALYSIS OF ELECTRICAL MACHINES**

**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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TEXT BOOKS:
2. R Ramanujam,”Modelling and Analysis of Electrical Machines”, I.K International Publishing Pvt. Ltd., New Delhi, 2018
REFERENCES:

OPEN ELECTIVE COURSES (OEC)

OE5091 BUSINESS DATA ANALYTICS LT P C
3 0 0 3

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.

TOTAL: 45 PERIODS

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
- 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 LT P C 3 0 0 3

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  
9
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  
9
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

TOTAL: 45 PERIODS

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  
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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  
9
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, Floyds 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 MANAGEMENTOF ENGINEERING PROJECTS LT P C
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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
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
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
Project execution Project cost control, Bar charts and Network diagram, Project commissioning: mechanical and process, Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis, Various decision-making problems, Pricing strategies: Pareto Analysis, Target costing, Life Cycle Costing.

UNIT IV COSTING OF SERVICE SECTOR AND BUDGETERY CONTROL
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
Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Learning Curve Theory.

TOTAL: 45 PERIODS

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
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 9
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 REINFORCMENTS 9
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 9

UNIT IV MANUFACTURING OF POLYMER MATRIX COMPOSITES 9

UNIT V STRENGTH 9
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.
OBJECTIVES:
- Interpret the various types of wastes from which energy can be generated
- Develop knowledge on biomass pyrolysis process and its applications
- Develop knowledge on various types of biomass gasifiers and their operations
- Invent knowledge on biomass combustors and its applications on generating energy
- Summarize the principles of bio-energy systems and their features

UNITI  INTRODUCTION TO EXTRACTION OF ENERGY FROM WASTE 9
Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors

UNITII  BIOMASS PYROLYSIS 9
Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods - Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.

UNITIII  BIOMASS GASIFICATION 9

UNITIV  BIOMASS COMBUSTION 9
Biomass stoves – Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.

UNITV  BIO ENERGY 9
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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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 2 0 0 0

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 ASSESSMENT6
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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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
Alphabets in Sanskrit

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

UNIT III ORDER AND ROOTS
Order - Introduction of roots

UNIT IV SANSKRIT LITERATURE
Technical information about Sanskrit Literature

UNIT V TECHNICAL CONCEPTS OF ENGINEERING
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
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.

TOTAL: 30 PERIODS

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

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
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 (dons) - 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