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.
ANNA UNIVERSITY, CHENNAI
UNIVERSITY DEPARTMENTS
REGULATIONS - 2019
CHOICE BASED CREDIT SYSTEM
M.E. POWER ENGINEERING AND MANAGEMENT

1. PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

I. To prepare the students to have career in the electrical power industry/research organization/teaching.
II. To provide good foundation in mathematics, management and computational technology to analyze and solve problems encountered in electrical power industry.
III. Pursue lifelong learning and continuous improvement of their knowledge in the electrical power industry.
IV. To understand the national and global issues related to the electrical power industry and to be considerate of the impact of these issues on the environment and within different cultures.
V. To apply engineering and management principles to assess and evaluate renewable energy based power generation for maximum utilization and develop the skills of the students into power industry business.
VI. To provide the students with knowledge to be involved with the technology advancements and future developments in power generation, and management as well as with alternate and new energy resources.

2. PROGRAMME OUTCOMES (POs):

After going through the two years of study, our Power Engineering and Management graduates will exhibit ability to:

<table>
<thead>
<tr>
<th>PO#</th>
<th>Graduate Attribute</th>
<th>Programme Outcome</th>
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<tbody>
<tr>
<td>1</td>
<td>Engineering knowledge</td>
<td>impart the knowledge about the principles of energy conservation and management, power trading, power business and power management.</td>
</tr>
<tr>
<td>2</td>
<td>Problem analysis</td>
<td>Be able to apply the knowledge gained for the efficient power and energy management.</td>
</tr>
<tr>
<td>3</td>
<td>Design/development of solutions</td>
<td>Be able to provide all the possible solutions for the design and development of power management project.</td>
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<tr>
<td>4</td>
<td>Conduct investigations of complex problems</td>
<td>Be able to handle and analyse the problems of the power industry.</td>
</tr>
<tr>
<td>5</td>
<td>Modern tool usage</td>
<td>Hands on experience to work on real time software packages for the design and analysis of power engineering and management.</td>
</tr>
<tr>
<td>6</td>
<td>The Engineer and society</td>
<td>Conduct themselves to uphold the professional and social obligations.</td>
</tr>
<tr>
<td>7</td>
<td>Environment and sustainability</td>
<td>Design the system with environment consciousness, better reliability and sustainable development.</td>
</tr>
<tr>
<td>8</td>
<td>Ethics</td>
<td>Interaction among the industry and society in a professional and ethical manner.</td>
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<tr>
<td>9</td>
<td>Individual and team work</td>
<td>Functions as a multi-disciplinary team.</td>
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<tr>
<td>10</td>
<td>Communication</td>
<td>Proficiency in oral and written Communication.</td>
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<tr>
<td>11</td>
<td>Project management and finance</td>
<td>Implement cost effective and improved financial and business model meeting the requirement of power</td>
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3. PROGRAM SPECIFIC OUTCOMES (PSOs):

After the completion of Power Engineering and Management program the student will have the following Program specific outcomes.

1. Students will have strong core knowledge of energy conservation and management, power trading and power business.
2. Students will be able to derive mathematical models of the various electrical power apparatus to analyze their feasibility for the real time implementation.
3. Students will acquire ability to design and develop various indigenous high power controllers for the power management project.
4. By gaining in-depth knowledge of various electricity market models students will be able to participate as market players in pricing and emerge as entrepreneurs.
5. Students will be capable of integrating the green building concepts into the field of energy efficient buildings and energy recovery from the waste.
6. Students will be able to design solutions to mitigate the technical problems and challenges related to power industry.

4. PEO / PO Mapping:

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**YEAR 1**

**Semester 1**

**Semester 2**

**Semester 3**
| Semester 4 | Open Elective | | | | | | | | | | Project Phase I | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
|           |              | | | | | | | | | | Project Phase II | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
## ANNA UNIVERSITY, CHENNAI
### UNIVERSITY DEPARTMENTS
#### REGULATIONS - 2019
##### M.E. POWER ENGINEERING AND MANAGEMENT
### CURRICULUM AND SYLLABUS I TO IV SEMESTERS

#### SEMESTER I

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*Audit Course is optional

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| **PRACTICALS** |             |                                   |          |                  |                        |         |
| 4.   | PW5311      | Project Phase I                   | EEC      | 0 0 12           | 12                     | 6       |
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Total Credits 2

### OPEN ELECTIVE COURSES (OEC)

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

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### AUDIT COURSES (AC)

Registration for any of these courses is optional to students

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**Total Credits:** 21

### SUMMARY

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**Total Credit** 22 21 15 12 70
COURSE OBJECTIVES:

- To provide the electrical circuit concepts behind the different working modes of power converters so as to enable deep understanding of their operation.
- To equip with required skills to derive the criteria for the design of power converters for power engineering industry.
- To analyze the converter performance in wind energy systems.
- To understand the operation of UPS system.
- To know the working of converters with motor drive system.

UNIT I ADVANCED SOLID STATE DEVICES 9
MOSFETs, IGBT, GTO, IGCT etc., Power modules, intelligent power modules, gating circuits, Thermal design, protection, Digital signal processors used in their control.

UNIT II CONVERTERS IN POWER GRID 9

UNIT III CONVERTERS FOR WIND ENERGY SYSTEM 9

UNIT IV CONVERTERS FOR UPS SYSTEM 9

UNIT V CONVERTERS FOR MOTOR DRIVES 9
Vector control and direct torque control of induction, synchronous, permanent magnet sine fed, synchronous reluctance motors - Permanent magnet brushless dc (PMLDC) and switched reluctance motors - LCI (load commutated inverter) fed large rating synchronous motor drives. Energy conservation and power quality improvements in these drives – shipboard propulsion system.

COURSE OUTCOMES:
CO1: Able to understand the characteristics of solid state devices.
CO2: Learned the concept of converters in power grid.
CO3: Able to select the converters for various wind energy conversion systems.
CO4: Able to design the UPS system.
CO5: The students acquire the capability to analyze the performance of the converter with motor drive system.
REFERENCES:

PW5151 CLIMATE CHANGE AND ENERGY ENVIRONMENT L T 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 9
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 9
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 9
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 9
Energy use and its air pollution, acid rain, Technological and policy options for control of SO₂ and NOx emissions, the problem of Atmospheric Brown Cloud (ABC) and possible mitigation options.

UNIT V URBAN ENERGY USE AND THE ENVIRONMENT 9
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:

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

COURSE OBJECTIVES:
- 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

COURSE OUTCOMES:
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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REFERENCES
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.
REFERENCES:

RM5151 RESEARCH METHODOLOGY AND IPR LT P C 2002

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)

TOTAL: 30 PERIODS
COURSE OUTCOMES:
1. Ability to formulate research problem
2. Ability to carry out research analysis
3. Ability to follow research ethics
4. Ability to understand that today’s world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity
5. Ability to understand about IPR and filing patents in R & D.

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REFERENCES:

PW5111 POWER ENGINEERING LABORATORY LT P C 0 0 4 2

COURSE OBJECTIVES:
- To have hands on experience on various system studies and different techniques used for system planning, software packages.
- To apply iterative techniques for power flow analysis
- To analyse power system security using shift factors.
- To analyse the over current relay settings and their coordination
- To study the characteristics of PV cell, Wind Energy Conversion System and Fuel Cell.

LIST OF EXPERIMENTS:
1. Power flow analysis by Newton Raphson method
2. Power flow analysis by Fast decoupled method
3. Distribution Load Flow Analysis: Ladder Iterative Technique
4. Contingency analysis: Generator shift factors and line outage distribution factors
5. State Estimation by Weighted Least Square Method
6. Digital Over Current Relay Setting and Relay Coordination
7. Voltage stability: PV and VQ curves
8. Characteristics of Solar PV System
9. Characteristics of Wind Energy Conversion System
11. Power Management in hybrid power system
COURSE OUTCOMES:
CO1: Ability to analyze the power flow using Newton-Raphson method, Fast decoupled method and Ladder Iterative Technique.
CO2: Able to perform contingency analysis & state estimation
CO3: Ability to select and coordinate over current relay
CO4: Acquired knowledge in steady state voltage stability.
CO5: Able to analyze the characteristics of PV system, Wind Energy Conversion System & hybrid power system.

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TOTAL: 60 PERIODS

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

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

TOTAL: 60 PERIODS

COURSE OUTCOMES:
CO1: Ability to solve dynamic equations involved in power electronics.
CO2: Ability to acquire and apply knowledge of mathematics and converter/machine dynamics in Electrical engineering.
CO3: Ability to model and analyze different rectifier circuits using computational software and
to understand their various operating modes.

CO4: Ability to model and analyze different rectifier circuits using computational software and to understand their various operating modes.

CO5: Ability to formulate, design, simulate power supplies for generic load and for machine loads.

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PW5251       ENERGY MANAGEMENT AND AUDIT       LT P C

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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


UNIT V  ENERGY EFFICIENCY IN ELECTRICAL UTILITIES


TOTAL: 60 PERIODS

COURSE OUTCOMES:

CO1: Students able to acquire knowledge in the field of energy management and auditing process.
CO2: Learned 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.

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COURSE OBJECTIVES:

- To understand the probability concepts.
- To provide knowledge on the demand analysis and forecasting techniques.
- To emphasize 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  12
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  12
Drivers of energy demand, Sectoral energy demand: domestic, commercial, industrial, agricultural. Projections for future demands.

UNIT III  INTRODUCTION TO OPTIMIZATION  12

UNIT IV  LINEAR PROGRAMMING AND APPLICATION  12
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  12
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.

TOTAL: 60 PERIODS

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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PW5211 ENERGY AUDIT LABORATORY L T P C
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COURSE OBJECTIVES:

• To understand the energy audit procedures.
• To analyze the performance of electric motor systems.
• To know the cost benefit analysis in electrical systems.
• To understand the concept of waste minimization and resource conservation.
• To know the working of alternate energy sources.

List of Experiment:

1. Study of energy conservation and audit
2. Performance study of Electric Motors.
3. Analysis on fan characteristic curves at different operating points
4. Case study of illumination system
5. Power factor improvement and cost benefit analysis
6. Computation of pump & pumping system characteristics (pump curve, system curve)
7. Performance analysis of Compressors
8. Performance analysis of boiler
10. Performance study in a solar water heater.
11. Study of Cogeneration
12. Waste minimization and resource conservation

COURSE OUTCOMES:

CO1: Acquired knowledge in the field of the energy audit.
CO2: Able to analyze the performance of electric motor systems.
CO3: Ability to perform cost benefit analysis.
CO4: Learned various waste minimization and resource conservation techniques.
CO5: Ability to develop a system with alternate energy resources.

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TOTAL: 60 PERIODS

PW5261 RENEWABLE ENERGY LABORATORY

COURSE OBJECTIVES

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

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

TOTAL 60 PERIODS

COURSE OUTCOMES

CO1: Students will understand the characteristics of various renewable energy sources.
CO2: Students will be able to program different MPPT algorithm and understand their merits and demerits.
CO3: Students will learn control of DFIG.
CO4: Students will learn control of PMSG.
CO5: Students will design and model PV system integration with grid.
COURSE OBJECTIVES:
- To provide knowledge about management of distribution system and distribution automation
- To gain knowledge about planning of distribution system
- To gain knowledge about design of distribution system
- To analyse power quality issues in distribution system
- To provide knowledge about distribution system automation

UNIT I INTRODUCTION
Overview of distribution system, Importance of Distribution Systems, the Differences of Power Supply between Urban and Rural Areas, Distribution system Consumer Classification.

UNIT II OVERVIEW OF DISTRIBUTION SYSTEM
Factors affecting planning, techniques, planning models (Short term planning, long term planning and dynamic planning), planning for the future, Load forecast, Load characteristics and Load models.

UNIT III DISTRIBUTION SYSTEM DESIGN
Types of sub-transmission, Distribution substation, bus schemes, substation location, rating of substation, calculation of voltage drops with primary feeders and secondary feeders, uniformly distributed load and Non uniformly distributed load.

UNIT IV POWER QUALITY AND DISTRIBUTION SYSTEM PERFORMANCE ANALYSIS
Power quality problems in distribution systems, Power quality study as per IEEE and IEC Standards, Distribution Feeder Analysis – the ladder Iterative technique, Power loss calculations and control measures. Distribution system voltage regulation: voltage control, Application of capacitors in Distribution system. Case study on TNEB distribution system.

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

TOTAL: 45 PERIODS
COURSE OUTCOMES:

CO1: Students gained knowledge about distribution system management
CO2: Students gained knowledge about distribution system operation and planning
CO3: Understand the design concept of a distribution system
CO4: Acquired knowledge about Power quality issues in distribution system
CO5: Gained ability to understand the distribution system automation

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PW5002 POWER BUSINESS MANGEMENT LT P C 3 0 0 3

COURSE OBJECTIVES:

• To understand the power scenario in India.
• To understand the electricity acts and regulatory commission policies
• To provide knowledge about distribution utility, metering and billing.
• To give exposure about tariff policy and tariff regulations.
• To introduce the procedure for power purchase and its management.

UNIT I POWER MANAGEMENT IN INDIA

Growth of Power Industry in India, Organizational Structure of central and state companies and its major roles and regulations, Power scenario in India, Load management in power sector, Grid Management, Development of power projects in India vs. demand study, Management of Electricity Demand Scenario in state and overall India, Energy Management System, Energy conservation & Efficiency measures. Case Study: Power demand study in state, Load management study in state.

UNIT II ACT AND REGULATORY COMMISSIONS

UNIT III  STATE UTILITY SERVICES

UNIT IV  TARIFF POLICY AND DETERMINATION OF TARIFF
Tariff policy, Tariff regulations, Tariff structure, fixed tariff, availability based tariff, time of the day tariff, Multi Year Tariff, Assessment of tariff levels, Determination of tariff for Generation, transmission and distribution levels, Comparison of year wise tariff/ state wise. Case Study: Present tariff Scenario in Tamilnadu and compare with other states.

UNIT V  POWER PURCHASE MANAGEMENT
Scope of the power purchase management, Definition and interpretation of terms of a model power purchase agreement (PPA), Desirable Principles of power purchase agreements, Requirements of PPA, Risks and responsibilities in a power purchase agreement, Negotiating Power purchase agreements, PPA - Financial and legal issues, Drafting of a model PPA.

Case Study: Study and Analysis of a sample PPA between a Generation and Distribution Utility, Financial Statement Analysis of a State Power Sector Organization, Power Project Appraisal, Returns of a large Power Project etc.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
CO1: Acquired knowledge about power scenario in India.
CO2: Understand the electricity acts and regulatory commission policies.
CO3: Able to identify elements in distribution utility and the concept of billing.
CO4: Able to evaluate the tariff policy and its regulations.
CO5: Able to understand and create awareness about power purchase and its management.

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2. Leon K. Kirchmayer, ‘Economic Operation of Power Systems’ Publisher by Wiley Eastern Ltd.
3. ‘Terms and Conditions of Tariff’ –CERC Regulations.
COURSE OBJECTIVES:

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

UNIT I  HYBRID ELECTRIC VEHICLE ARCHITECTURE AND POWER TRAIN COMPONENTS

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

UNIT II  MECHANICS OF HYBRID ELECTRIC VEHICLES

Fundamentals of vehicle mechanics - Tractive force, power and energy requirements for standard drive cycles of HEV's - Motor torque and power rating and battery capacity.

UNIT III  CONTROL OF DC AND AC MOTOR DRIVES

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

UNIT IV  ENERGY STORAGE SYSTEMS


UNIT V  HYBRID VEHICLE CONTROL STRATEGY AND ENERGY MANAGEMENT

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

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PW5072 ENERGY EFFICIENT BUILDINGS LT P C
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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

UNIT II PRINCIPLES OF ENERGY CONSCIOUS BUILDING DESIGN

UNIT III PASSIVE SOLAR HEATING

UNIT IV ENERGY CONSERVATION IN BUILDING

UNIT V EFFICIENT TECHNOLOGIES IN ELECTRICAL SYSTEMS
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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PW5073  ENERGY FORECASTING, MODELLING AND PROJECT MANAGEMENT  LT P C 3 0 0 3

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  

UNIT V       ENERGY POLICY  

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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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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PW5075 GRID INTEGRATION OF RENEWABLE ENERGY SOURCES LT P C
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COURSE OBJECTIVES:
• To study about the integration of various renewable energy sources into the grid.
• To analyse various grid issues due to renewable energy sources.
• To analyse the dynamics of network due to wind farm
• To provide knowledge about power system stabilizers.
• To provide knowledge about grid connected and standalone PV system

UNIT I INTRODUCTION 9
Introduction to renewable energy grid integration - Concept of mini/micro grids and Smart grids - Different types of grid interfaces - Issues related to grid integration of small and large scale of synchronous generator based - induction generator based and converter based sources together - Network voltage management - Power quality management (voltage dips, harmonics, flickers, and reactive power control) - Frequency management - Influence of WECS on system transient response - Interconnection standards and grid code requirements for integration.

UNIT II NETWORK INFLUENCE OF GENERATION TYPE 9

UNIT III INFLUENCE OF WIND FARMS ON NETWORK DYNAMIC PERFORMANCE 9

UNIT IV POWER SYSTEM STABILIZERS AND NETWORK DAMPING CAPABILITY OF WIND 9
A Power System Stabilizer for a Synchronous Generator - A Power System Stabilizer for a DFIG - A Power System Stabilizer for a FRC Wind Farm.

UNIT V STAND ALONE AND GRID CONNECTED PV SYSTEM 9

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

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COURSE OBJECTIVES:

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

UNIT I MICRO SOURCES AND STORAGE

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

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

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

UNIT V MICROGRID PROTECTION

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

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COURSE OBJECTIVES

- To provide knowledge about various renewable energy technologies
- To enable students to understand and design a PV system.
- To provide knowledge about wind energy systems.
- 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.

UNIT II 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’.

PW5078 SCADA SYSTEM AND APPLICATIONS MANAGEMENT L T P C

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

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

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

UNIT III SCADA IN POWER SYSTEM AUTOMATION 9
Applications in Generation, Transmission and Distribution sector, Substation SCADA system Functional description, System specification, System selection such as Substation configuration, IEC61850 ring configuration, SAS cubicle concepts, gateway interoperability list, signal naming concept. System Installation, Testing and Commissioning,

CASE STUDIES: SCADA Design for 66/11KV and 132/66/11KV or 132/66 KV any utility Substation and IEC 61850 based SCADA Implementation issues in utility Substations
UNIT IV ENERGY MANAGEMENT CENTRE
Functions, production control and load management, economic despatch, distributed centres and power pool management, energy management system and its role.

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

TOTAL: 45 PERIODS

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

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PW5079 WASTE MANAGEMENT AND ENERGY RECOVERY TECHNIQUES

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 student 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  9

UNIT V  HAZARDOUS WASTE MANAGEMENT & WASTE RECYCLING  9

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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PS5252 RESTRICTED 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.

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

UNIT IV ANCILLARY SERVICE MANAGEMENT AND PRICING OF TRANSMISSION NETWORK

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

UNIT V MARKET EVOLUTION

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

COURSE OUTCOMES

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

TOTAL: 45 PERIODS

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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 OVERHEAD LINES 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, $\alpha-\beta-0$ 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  3 1 0 4

COURSE OBJECTIVES

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

UNIT I  INTRODUCTION  12

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

UNIT II  THYRISTOR BASED FACTS  12


UNIT III  ANALYSIS OF LCC HVDC CONVERTERS AND HVDC SYSTEM CONTROL  12


UNIT IV  VOLTAGE SOURCE CONVERTER BASED FACTS AND HVDC CONTROLLERS  12

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

UNIT V  POWER FLOW ANALYSIS OF AC/DC SYSTEMS  12

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

TOTAL: 60 PERIODS
COURSE OUTCOMES

Students will be able to:

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

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SMART GRID

COURSE OBJECTIVES

Students will be able to:

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

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

UNIT II  SMART GRID TECHNOLOGIES (Transmission)
Technology Drivers, Smart energy resources, Smart substations, Substation Automation, Feeder Automation, Transmission systems: EMS, FACTS and HVDC, Wide area monitoring, Protection and control

UNIT III  SMART GRID TECHNOLOGIES (Distribution)
DMS, Volt/VAr control, Fault Detection, Isolation and service restoration, Outage management, High-Efficiency Distribution Transformers, Phase Shifting Transformers, and Plug in Hybrid Electric Vehicles (PHEV).

UNIT IV  SMART METERS AND ADVANCED METERING INFRASTRUCTURE
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
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.
### 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 Wind Turbines

### Unit III Fixed Speed Systems
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 Variable Speed 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.

### References
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 modelling issue.

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

PE5074 POWER QUALITY

COURSE OBJECTIVES:

- To provide knowledge about various power quality issues.
- To understand the concept of power and power factor in single phase and three phase systems supplying nonlinear loads.
- To equip with required skills to design conventional compensation techniques for power factor correction and load voltage regulation.
- To introduce the control techniques for the active compensation.
- To understand mitigation techniques using custom power devices such as DVR & UPQC
UNIT I INTRODUCTION
Introduction – Characterisation of Electric Power Quality: Transients, short duration and long duration voltage variations, Voltage imbalance, waveform distortion, Voltage fluctuations, Power frequency variation, Power acceptability curves – power quality problems: poor load power factor, Non linear and unbalanced loads, DC offset in loads, Notching in load voltage, Disturbance in supply voltage – Power quality standards.

UNIT II ANALYSIS OF SINGLE PHASE AND THREE PHASE SYSTEM

UNIT III CONVENTIONAL LOAD COMPENSATION METHODS

UNIT IV LOAD COMPENSATION USING DSTATCOM

UNIT V SERIES COMPENSATION OF POWER DISTRIBUTION SYSTEM

TOTAL : 45 PERIODS

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

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

PE5073 POWER ELECTRONICS FOR RENEWABLE ENERGY L T P C
SYSTEMS 3 0 0 3

COURSE OBJECTIVES:
• To provide knowledge about the stand alone and grid connected renewable energy systems.
• To equip with required skills to derive the criteria for the design of power converters for renewable energy applications.
• To analyse and comprehend the various operating modes of wind electrical generators and solar energy systems.
• To design different power converters namely AC to DC, DC to DC and AC to AC converters for renewable energy systems.
• To develop maximum power point tracking algorithms.

UNIT I INTRODUCTION 9
Introduction to renewable energy systems, environmental aspects of electric energy conversion, impacts of renewable energy generation on environment, GHG Effect, Qualitative study of different renewable energy resources Ocean, Biomass, Hydrogen energy systems and Fuel cells.

UNIT II POWER ELECTRONIC CONVERTERS FOR RENEWABLE ENERGY 9
Solar: Block diagram of solar photo voltaic system: line commutated converters (inversion mode) - Boost and buck-boost converters.
Wind: three phase AC voltage controllers- AC-DC-AC converters: uncontrolled rectifiers, PWM Inverters, Grid Interactive Inverters-matrix converters.

UNIT III PHOTO VOLTAIC ENERGY CONVERSION SYSTEMS 9
Introduction, Photo Voltaic (PV) effect, Solar Cell, Types, Equivalent circuit of PV cell, PV cell characteristics (I/V and P/V) for variation of insolation, temperature and shading effect, Stand-alone PV system, Grid connected PV system, Design of PV system-load calculation, array sizing, selection of converter/inverter, battery sizing.

UNIT IV WIND ENERGY CONVERSION SYSTEMS 9
Introduction, Power contained in wind, Efficiency limit in wind, types of wind turbines, Wind control strategies, Power curve and Operating area, Types of wind generators system based on Electrical machines-Induction Generator and Permanent Magnet Synchronous Generator(PMSG), Grid Connected-Single and Double output system, Self-excited operation of Induction Generator and Variable Speed PMSG.

UNIT V HYBRID RENEWABLE ENERGY SYSTEMS AND MPPT 9
Energy Storage systems, Need for Hybrid Systems, Features of Hybrid Systems, Range and types of Hybrid systems (Wind-Diesel, PV-Diesel and Wind-PV), Case studies of PV-
Maximum Power Point Tracking (MPPT) and Wind Energy system

TOTAL: 45 PERIODS

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

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

REFERENCES:

COURSE OBJECTIVES:
1. To review the fundamental concepts of permanent magnets and the operation of permanent magnet brushless DC motors.
2. To introduce the concepts of permanent magnet brushless synchronous motors and synchronous reluctance motors.
3. To develop the control methods and operating principles of switched reluctance motors.
4. To introduce the concepts of stepper motors and its applications.
5. 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.

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 analyse 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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CO5152 INTELLIGENT CONTROLLERS

COURSE OBJECTIVES
To educate the students on
- Design of ANN and fuzzy set theory.
- Analysis and implementation of ANN and Fuzzy logic for modeling and control of Non-linear system and to get familiarized with the Matlab toolbox.
- Impart the knowledge of various optimization techniques and hybrid schemes with the ANFIS tool box.

UNIT I OVERVIEW OF ARTIFICIAL NEURAL NETWORK (ANN) & FUZZY LOGIC
Review of fundamentals - Biological neuron, Artificial neuron, Activation function, Single Layer Perceptron – Limitations – Multi Layer Perceptron – Back propagation algorithm (BPA); Fuzzy set theory – Fuzzy sets – Operation on Fuzzy sets - Scalar cardinality, fuzzy cardinality, union
and intersection, complement (yager and sugeno), equilibrium points, aggregation, projection, composition, fuzzy relation – Fuzzy membership functions.

UNIT II NEURAL NETWORKS FOR MODELLING AND CONTROL
Generation of training data - optimal architecture – Model validation- Control of non linear system using ANN- Direct and Indirect neuro control schemes- Adaptive neuro controller –Case study - Familiarization of Neural Network Control Tool Box.

UNIT III FUZZY LOGIC FOR MODELLING AND CONTROL

UNIT IV GENETIC ALGORITHM
Basic concept of Genetic algorithm and detail algorithmic steps, adjustment of free parameters. Solution of typical control problems using genetic algorithm. Concept on some other search techniques like Tabu search, Ant-colony search and Particle Swarm Optimization.

UNIT V HYBRID CONTROL SCHEMES
Fuzzification and rule base using ANN–Neuro fuzzy systems-ANFIS –Optimization of membership function and rule base using Genetic Algorithm and Particle Swarm Optimization - Case study– Familiarization of ANFIS Tool Box.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
Ability to
CO1: Understand the basic architectures of NN and Fuzzy sets
CO2: Design and implement ANN architectures, algorithms and know their limitations.
CO3: Identify and work with different operations on the fuzzy sets.
CO4: Develop ANN and fuzzy logic based models and control schemes for non-linear systems.
CO5: Understand and explore hybrid control schemes and PSO

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CO5072 CONTROL OF ELECTRICAL DRIVES

COURSE OBJECTIVES

- To introduce the PWM converters and their analysis.
- To educate on modeling of dc motor, drives and control techniques.
- To educate on dynamic modeling of Induction motor drive.
- To educate on the V/f and vector control of Induction motor.
- To educate on generation of firing pulses and control algorithms in embedded platforms.

UNIT I POWER ELECTRONIC CONVERTERS FOR DRIVES


UNIT II CONTROL OF DC DRIVES

Modelling of DC machines-block diagram/transfer function-phase control-1phase/3phase converter fed DC drives- Chopper fed DC drives-four quadrant chopper circuit-closed loop control-speed control-current control-cascade control -constant torque/power operation-comparison of chopper/converter fed drives- techniques-merits/demits.

UNIT III ANALYSIS AND MODELLING OF INDUCTION MOTOR DRIVE


UNIT IV CONTROL OF INDUCTION MOTOR DRIVE

VSI fed induction motor drives- waveforms for 1-phase, 3-phase Non-PWM and PWM VSI fed induction motor drives -principles of V/F control- principle of vector control-direct vector control-space vector modulation- indirect vector control.

UNIT V EMBEDDED CONTROL OF DRIVES

Generation of firing pulses- generation of PWM pulses using embedded processors-IC control of DC drives- fixed frequency/variable frequency/current control- V/F control using PIC microcontroller- vector control using embedded processors.

TOTAL : 45 PERIODS

COURSE OUTCOMES

CO1: understand Power Electronic Converter Switches and different PWM approach.
CO2: design and analyze converter and chopper driven dc drives.
CO3: analyze converter and chopper driven dc drives.
CO4: understand conventional control techniques of Induction motor drive.
CO5: understand V/f Control using PIC Micro Controller and Vector control using Embedded processor.
REFERENCES

CO5153 MEMS DESIGN: SENSORS AND ACTUATORS

COURSE OBJECTIVES
- To analyse the properties of materials, microstructure and fabrication methods.
- To design and modeling of Electrostatic sensors and actuators.
- To teach the characterizing thermal sensors and actuators through design and modeling.
- To understand the fundamentals of piezoelectric sensors and actuators through exposure to different MEMS and NEMS devices.

UNIT I MICRO-FABRICATION, MATERIALS AND ELECTRO-MECHANICAL CONCEPTS
Overview of micro fabrication – Silicon and other material based fabrication processes – Concepts: Conductivity of semiconductors-Crystal planes and orientation-stress and strain-flexural beam bending analysis- torsional deflections-Intrinsic stress- resonant frequency and quality factor.

UNIT II ELECTROSTATIC SENSORS AND ACTUATION
Principle, material, design and fabrication of parallel plate capacitors as electrostatic sensors and actuators-Applications.

UNIT III THERMAL SENSING AND ACTUATION
Principle, material, design and fabrication of thermal couples, thermal bimorph sensors, thermal resistor sensors-Applications.

UNIT IV PIEZOELECTRIC SENSING AND ACTUATION
Piezoelectric effect-cantilever piezo electric actuator model-properties of piezoelectric materials Applications.
UNIT V  CASE STUDIES
Piezoresistive sensors, Magnetic actuation, Micro fluidics applications, Medical applications, Optical MEMS.-NEMS Devices

TOTAL : 45 PERIODS

COURSE OUTCOMES:
At the end of this course, the students will demonstrate the ability

CO1: To analyse the learning process to design of micro sensors, embedded sensors & actuators
CO2: To analyse the electrostatic sensors and actuators through MEMS and NEMS devices
CO3: To analyse the thermal sensors and actuators through MEMS and NEMS devices
CO4: To analyse the piezoelectric sensors and actuators through MEMS and NEMS
CO5: Design of piezoresistive sensors for biomedical and micro fluidic applications

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CO5151  CONTROL SYSTEM DESIGN

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

UNIT I  ANALYSIS OF LINEAR SYSTEMS

UNIT II  DESIGN OF SISO SYSTEM
Design Specifications – In continuous domain – Limitations – Controller Structure – Multiple degrees of freedom – PID controllers and Lag-lead compensators- Design – Discretization and direct discrete design - Design in continuous and discrete domain
UNIT III  STATE SPACE DESIGN  12

UNIT IV  OPTIMAL CONTROL  12

UNIT V  OPTIMAL FILTERING  12
Filtering – Linear system and estimation – System noise smoothing and prediction – Kalman Filter – Recursive estimation.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

Ability to

CO1: Analyse controllers for linear systems defined in transfer function and state space forms.

CO2: Design controllers for linear systems defined in transfer function and state space forms.

CO3: Apply state space forms to continuous and discrete systems.

CO4: Apply optimal control to linear systems in continuous and discrete systems

CO5: Apply filtering concepts to linear systems in continuous and discrete systems.

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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

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COURSE OBJECTIVES:

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

UNIT I INTRODUCTION

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

UNIT II CALCULATION OF LINE PARAMETERS

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

UNIT III VOLTAGE GRADIENTS OF CONDUCTORS

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

UNIT IV ELECTROSTATIC FIELD AND DESIGN OF EHV LINES

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

UNIT V HVDC LINES

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

TOTAL : 45 PERIODS

COURSE OUTCOMES:

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


HV5071 APPLICATIONS OF HIGH ELECTRIC FIELDS LT P C 3 0 0 3

COURSE OBJECTIVES:
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-activationselectrical 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  
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  
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
ET5072  AUTOMOTIVE EMBEDDED SYSTEM  LT P C

3003

COURSE OBJECTIVES:

- To expose the students to the fundamentals and building of Electronic Engine Control systems.
- To teach on functional components and circuits for vehicles
- To discuss on programmable controllers for vehicles management systems
- To teach logics of automation & commercial techniques for vehicle communication
- To introduce the embedded systems concepts for E-vehicle system development.

UNIT I  BASIC OF ELECTRONIC ENGINE CONTROL SYSTEMS  9
Overview of Automotive systems, fuel economy, air-fuel ratio, emission limits and vehicle performance; Automotive microcontrollers- Electronic control Unit- Hardware & software selection and requirements for Automotive applications – open source ECU- RTOS - Concept for Engine management-Standards; Introduction to AUTOSAR and Introduction to Society SAE- Functional safety ISO 26262- Simulation and modeling of automotive system components.

UNIT II  SENSORS AND ACTUATORS FOR AUTOMOTIVES  9
Review of sensors- sensors interface to the ECU, conventional sensors and actuators, Modern sensor and actuators - LIDAR sensor- smart sensors- MEMS/NEMS sensors and actuators for automotive applications.

UNIT III  VEHICLE MANAGEMENT SYSTEMS  9

UNIT IV  ONBOARD DIAGNOSTICS AND TELEMATICS  9

UNIT V  ELECTRIC VEHICLES  9

NOTE: Miniproject/Discussions/Practice on Workbench/AUTOSAR/ Vehicle simulators / modeling packages on the basics of interfacing sensors, actuators specific to automobile-microcontrollers/ special automobile-microcontrollers for i/o port communication applicable to vehicles

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: The learning process delivers insight into the significance of the role of embedded system for automotive applications.

CO2: Understanding the need, selection of sensors and actuators and interfacing with ECU

CO3: Applying the Embedded concepts for vehicle management and control systems.
CO4: Understanding the need of Electrical vehicle and able to apply the embedded system technology for various aspects of EVs
CO5: Improved Employability and entrepreneurship capacity due to knowledge upgradation on recent trends in embedded systems design and its application in automotive systems.

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5. Electronic Engine Control technology – Ronald K Jurgen Chilton’s guide to Fuel Injection – Ford

ET5076 MEMS TECHNOLOGY

COURSE OBJECTIVES:
- To introduce the diverse technological and functional approaches of MEMS and applications.
- To understand the microstructures and fabrication methods.
- To provide an insight of micro sensors, actuators.
- To emphasis the need and role of MEMS process techniques.
- To update the ongoing trends and real time applications of MEMS technology.

UNIT I INTRODUCTION TO
Overview of Micro electro mechanical systems (MEMS), devices and technologies, Laws of scaling- multi disciplinary nature of MEMS- Survey of materials- Smart Sensors-Applications of MEMS.
UNIT II MICRO-MACHINING AND MICROFABRICATION TECHNIQUES
Photolithography- Film deposition, Etching Processes- wafer bonding- Bulk micro machining, silicon surface micro machining- LIGA process.

UNIT III MICRO SENSORS AND MICRO ACTUATORS
Transduction mechanisms in different energy domain- Micromachined capacitive, Piezoelectric , piezoresistive and Electromechanical and thermal sensors/actuators and applications

UNIT IV MEMS PROCESS TECHNIQUES
Simulation and modeling of MEMS components - Computer- aided design for MEMS layout, SOI, Metal and Poly MUMPs- Microsystem Design and Packaging -Rapid product development.

UNIT V MEMS APPLICATION AND RECENT TRENDS

TOTAL: 45 PERIODS

COURSE OUTCOMES:
CO1: Understanding the material properties and the significance of MEMS for industrial automation.
CO2: Knowledge delivery on micromachining and micro fabrication.
CO3: Applying the fabrication mechanism for MEMS sensor and actuators.
CO4: Applying the concepts of MEMS to models, simulate and process the sensors and actuators.
CO5: Improved Employability and entrepreneurship capacity due to knowledge up gradation on MEMS technology.

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REFERENCES:
COURSE OBJECTIVES:
- To teach the need of embedded system technology for robot building
- To Study The Various Parts Of Robots And Fields Of Robotics.
- To Study The Various Kinematics And Inverse Kinematics Of Robots.
- To Study The Trajectory Planning For Robot.
- To Study The Control Of Robots For Some Specific Applications.

UNIT I INTRODUCTION TO ROBOTICS

UNIT II POWER SOURCES AND SENSORS

UNIT III MANIPULATORS, ACTUATORS AND GRIPPERS

UNIT IV KINEMATICS AND PATH PLANNING
Solution Of Inverse Kinematics Problem – Multiple Solution Jacobian Work Envelop – Hill Climbing Techniques –path planning algorithms- Robot Programming Languages- Simulation and modeling of simple

UNIT V CASE STUDIES

TOTAL: 45 PERIODS

COURSE OUTCOMES:
- CO1: Selection of suitable embedded boards for robots
- CO2: Understanding the concepts of robotics & automation and Working Of Robot
- CO3: Analyze the Function of Sensors and actuators In the Robot
- CO4: Write Program to Use a Robot For a Typical Application
- CO5: Apply and improve Employability and entrepreneurship capacity due to knowledge up gradation on Embedded system based robot development
REFERENCES:

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.

REFERENCES:
OE5092 INDUSTRIAL SAFETY

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

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

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

UNIT III WEAR AND CORROSION AND THEIR PREVENTION

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

UNIT V PERIODIC AND PREVENTIVE MAINTENANCE

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

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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REFERENCES:

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

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

UNIT II ADVANCES IN LINEAR PROGRAMMING 9
Solutions to LPP using simplex algorithm- Revised simplex method - primal dual relationships – Dual simplex algorithm - Sensitivity analysis

UNIT III NETWORK ANALYSIS – I 9
Transportation problems -Northwest corner rule, least cost method,Voges’s approximation method - Assignment problem -Hungarian algorithm

UNIT IV NETWORK ANALYSIS – II 9
Shortest path problem: Dijkstra’s algorithms, Floyds algorithm, systematic method -CPM/PERT

UNIT V NETWORK ANALYSIS – III 9
Scheduling and sequencing - single server and multiple server models - deterministic inventory models - Probabilistic inventory control models

TOTAL: 45 PERIODS

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

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OE5094 COST MANAGEMENT OF ENGINEERING PROJECTS 30 0 3

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

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

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

UNIT III PROJECT EXECUTION AND COSTING CONCEPTS 9

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

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

TOTAL: 45 PERIODS

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

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2. Charles T. Horngren and George Foster, Advanced Management Accounting, 1988
OBJECTIVES:

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

UNIT I  INTRODUCTION

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

UNIT II  REINFORCEMENTS

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

UNIT III  MANUFACTURING OF METAL MATRIX COMPOSITES


UNIT IV  MANUFACTURING OF POLYMER MATRIX COMPOSITES


UNIT V  STRENGTH

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

TOTAL: 45 PERIODS
OUTCOMES:
- CO1 - Know the characteristics of composite materials and effect of reinforcement in composite materials.
- CO2 – Know the various reinforcements used in composite materials.
- CO3 – Understand the manufacturing processes of metal matrix composites.
- CO4 – Understand the manufacturing processes of polymer matrix composites.
- CO5 – Analyze the strength of composite materials.

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OE5096 WASTE TO ENERGY L T P C 3 0 0 3

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
Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors

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

UNITIII BIOMASS GASIFICATION

UNITIV BIOMASS COMBUSTION
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

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

TOTAL : 30 PERIODS

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

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REFERENCES
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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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
1. Chakraborty, S.K."Values and Ethics for organizations Theory and practice", Oxford University, Press, New Delhi
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

L T P C

2 0 0 0

OBJECTIVES

Students will be able to:

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

UNIT I

INTRODUCTION AND METHODOLOGY:

Aims and rationale, Policy background, Conceptual framework and terminology - Theories of learning, Curriculum, Teacher education - Conceptual framework, Research questions - Overview of methodology and Searching.

UNIT II

THEMATIC OVERVIEW

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

UNIT III

EVIDENCE ON THE EFFECTIVENESS OF PEDAGOGICAL PRACTICES

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

UNIT IV

PROFESSIONAL DEVELOPMENT

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

UNIT V

RESEARCH GAPS AND FUTURE DIRECTIONS

Research design – Contexts – Pedagogy - Teacher education - Curriculum and assessment - Dissemination and research impact.

TOTAL: 30 PERIODS

OUTCOMES

Students will be able to understand:

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

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

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

UNIT I
Definitions of Eight parts of yoga (Ashtanga)

UNIT II
Yam and Niyam - Do’s and Don’ts 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 a stable mind, pleasing personality and determination
- To awaken wisdom in students

UNIT I
Neetisatakam-holistic development of personality - Verses- 19,20,21,22 (wisdom) - Verses- 29,31,32 (pride & heroism) – Verses- 26,28,63,65 (virtue) - Verses- 52,53,59 (don'ts) - 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

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 mankind 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-tringar-vairagya, New Delhi,2010