ANNA UNIVERSITY, CHENNAI
NON-AUTONOMOUS COLLEGES AFFILIATED TO ANNA UNIVERSITY
M.E. ENERGY ENGINEERING
REGULATIONS 2021
CHOICE BASED CREDIT SYSTEM

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):
The Energy Engineering program seeks to prepare PG students for productive and rewarding careers in the energy arena. The PEOs are listed below

I. Acquire knowledge and accomplish a decent employment in energy sector and advance quickly to significant positions of leadership in their Profession.
II. Inclination towards advanced research for mitigating the short comings in energy systems.
III. Ascending as an energy consultant for providing solutions towards improving the efficacy of energy systems.
IV. Become a successful entrepreneur and be a part of a supply chain or manufacture or market energy products for sustainable development.
V. Lead an ethical life by engaging in life long learning experiences for developing environmentally benign and economically affordable energy products for societal upliftment.

PROGRAMME OUTCOMES (POs):
After studying Energy Engineering, our students will exhibit ability to:

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<td>1.</td>
<td>An ability to independently carry out research/investigation and development work to solve practical problems</td>
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<td>2.</td>
<td>An ability to write and present a substantial technical report/document</td>
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<td>3.</td>
<td>Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program</td>
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<td>4.</td>
<td>Versatile with modern tools, softwares and techniques for improving the efficiency of energy utilities/system/better management (technical and financial) of projects</td>
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<td>5.</td>
<td>Proficiency to work autonomously and amongst a team towards designing energy products and processes with environment consciousness for sustainable development</td>
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<td>6.</td>
<td>Development of competence and promoting lifelong learning for better interaction amongst industry peers, business conglomerates and society in a professional and ethical manner</td>
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PEO/PO Mapping:

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**TOTAL CREDITS TO BE EARNED FOR THE AWARD OF THE DEGREE = 75**
# PROGRAM CORE COURSES (PCC)

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**SEMESTER III, ELECTIVE IV**

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### RESEARCH METHODOLOGY AND IPR COURSES (RMC)

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### AUDIT COURSES (AC)

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### EMPLOYABILITY ENHANCEMENT COURSES (EEC)

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EY4101  ENERGY MANAGEMENT AND ENVIRONMENTAL BENEFITS

COURSE OBJECTIVES:
1. To create awareness on the energy scenario of India with respect to world
2. To learn the methodology adopted for an energy audit
3. To appreciate the concepts adopted in project management
4. To study the different techniques adopted for financial appraisal of a project
5. To Comprehend the impact of energy on environment

UNIT– I  ENERGY SCENARIO
9
Comparison of energy scenario – India and World (energy sources, generation mix, consumption pattern, T&D losses, energy demand, per capita energy consumption) – energy pricing – energy security-energy conservation and its importance -Energy Conservation Act 2001

UNIT– II  ENERGY MANAGEMENT
9

UNIT– III  PROJECT MANAGEMENT
9
Four Basic Elements of Project Management - Project Management Life Cycle - Steps in Project Management Project Definition and Scope, Technical Design, Financing, Contracting, Implementation Techniques (Gantt Chart, CPM and PERT) and Performance Monitoring - EnMS 5001

UNIT– IV  FINANCIAL MANAGEMENT
9

UNIT– V  ENERGY AND ENVIRONMENT
9
Greenhouse effect and the carbon cycle - current evidence and future effects of climate change - Global Environmental Concerns-United Nations Frame work Convention on Climate Change (UNFCC), Kyoto Protocol, Conference of Parties (COP), Emissions trading (ET), Joint implementation (JI), Clean Development Mechanism (CDM), Proto type Carbon Fund (PCF), Sustainable Development

TOTAL: 45 PERIODS

COURSE OUTCOMES:
Upon completion of this course, the students will be able to:
1. Recognize the importance of energy conservation and suggest measures for improving per capita energy consumption
2. Analyse the energy sharing and cost sharing pattern of fuels used in industries
3. Apply Gantt Chart, CPM and PERT in energy conservation projects
4. Evaluate the techno-economics of a project adopting discounting and non-discounting Cash flow techniques
5. Assess the sources of additional revenue generation for energy conservation projects
Adopting UNFCC

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EY4102 FLUID MECHANICS AND HEAT TRANSFER

COURSE OBJECTIVES:
1. To make students familiarize with the application of conservation equations
2. To explain the incompressible and compressible fluid flow concepts
3. To inculcate the analysis of conduction and gas radiation heat transfer
4. To provide the details of turbulent forced convective heat transfer
5. To impart the knowledge of design of single phase and multi-phase heat exchangers

UNIT– I BASIC EQUATION, POTENTIAL FLOW AND BOUNDARY LAYER THEORY

UNIT– II INCOMPRESSIBLE AND COMPRESSIBLE FLOWS
UNIT–III   CONDUCTION AND RADIATION HEAT TRANSFER  12
Governing Equation and Boundary conditions, Extended surface heat transfer, Transient
Conduction – Use of Heisler -Grober charts, Conduction with moving boundaries, Stefan and
Neumann problem –Gas Radiation.

UNIT– IV   TURBULENT FORCED CONVECTIVE HEAT TRANSFER  12
Turbulence theory–mixing length concept –turbulence model–k Є model–analogy between heat
and momentum transfer–Reynolds, Colburn, Prandtl turbulent flow in a tube–high speed flows.

UNIT– V   PHASE CHANGE HEAT TRANSFER AND HEAT EXCHANGER  12
Condensation on bank of tubes–boiling–pool and flow boiling, Heat exchanger–Є–NTU approach
and design procedure–compact heat exchanger.

TOTAL: 60 PERIODS

COURSE OUTCOMES:
Upon completion of this course, the students will be able to:
1. Identify, formulate and analyze the governing equations for various engineering
   Applications
2. Explain the flow concepts of incompressible and compressible flow.
3. Solve the conduction and radiation heat transfer problems.
4. Infer the turbulent forced convective heat transfer
5. Design a heat exchanger as per the industrial needs.

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COURSE OBJECTIVES:
1. To impart knowledge about characteristics of measurement system and statistical analysis of Measured data.
2. To make students conversant with the electrical measurements and signal conditioning circuits.
3. To provide insight into the digital measuring techniques of physical quantities and Solar instruments.
4. To make the students get acquainted with the measurement of thermo-physical properties and air pollutants.
5. To inculcate skills in the design and development of measurement and control systems.

UNIT– I  MEASUREMENT SYSTEM: CHARACTERISTICS AND STATISTICAL ANALYSIS 9
Introduction to measurement system, Errors in Measurement, Static and Dynamic characteristics of transducers, Statistical analysis of experimental data–Uncertainty analysis, Regression analysis, Design of experiments–Full and Half factorial design.

UNIT– II  ELECTRICAL MEASUREMENTS AND SIGNAL CONDITIONING 9

UNIT– III  DIGITAL MEASUREMENT OF PHYSICAL QUANTITIES 9

UNIT– IV  MEASUREMENT OF THERMO-PHYSICAL PROPERTIES AND AIR POLLUTANTS 9

UNIT– V  CONTROL SYSTEMS 9

TOTAL: 45 PERIODS
COURSE OUTCOMES:
Upon completion of this course, the students will be able to:

1. Analyze and evaluate the uncertainties in measurement data.
2. Identify appropriate sensors for measuring electrical quantities and signal conditioning Circuits.
3. Explain the digital measurement techniques of physical quantities and solar instruments.
4. Compare the thermo-physical properties of air pollutants and identify air pollutant measurement techniques.
5. Design and develop the appropriate measurement and control system for an application.

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EY4104 RENEWABLE ENERGY SYSTEMS

COURSE OBJECTIVES:
1. To know the present status of Indian and global energy scenario.
2. To learn the various solar energy technologies and its applications.
3. To educate the various wind energy technologies.
4. To explore the various bio-energy technologies.
5. To study the ocean and geothermal technologies.

UNIT– I ENERGY SCENARIO
Indian energy scenario in various sectors–domestic, industrial, commercial, agriculture, transportation and others – Present conventional energy status – Present renewable energy status-Potential of various renewable energy sources-Global energy status-Per capita energy consumption –Future energy plans
UNIT– II SOLAR ENERGY

UNIT–III WIND ENERGY

UNIT– IV BIO-ENERGY

UNIT–V OCEAN AND GEOTHERMAL ENERGY

TOTAL: 45 PERIODS

COURSE OUTCOMES:
Upon completion of this course, the students will be able to:
1. Illustrate the Indian and global energy scenario
2. Compare various solar energy technologies and identify its applications
3. Infer wind data and compare various wind energy systems.
4. Examine various bio-energy technologies and identify their application.
5. Interpret ocean and geothermal energy conversion technologies.

REFERENCES:
COURSE OBJECTIVES:
1. To understand, apply and analyze the concept of availability to the thermodynamic systems
2. To understand, study and analyze the behavior of real gas and gas mixtures
3. To understand the applications of first and second law to chemically reacting systems
4. To study, balance and analyze the various combustion aspects of hydrocarbon fuels
5. To apply the concepts of thermodynamics to IC Engines and Gas turbines energy systems

UNIT - I
AVAILABILITY ANALYSIS AND THERMODYNAMIC PROPERTY RELATIONS

UNIT - II
PROPERTIES OF REAL GAS AND GAS MIXTURES

UNIT - III
CHEMICAL THERMODYNAMICS AND EQUILIBRIUM
First and second law analysis of reacting systems – Adiabatic flame temperature – entropy change of reacting systems. Criterion for reaction equilibrium. Equilibrium constant for gaseous mixtures and evaluation of equilibrium composition.

UNIT - IV
COMBUSTION CHEMISTRY

UNIT - V
COMBUSTION PROCESSES AND COMBUSTION CHAMBERS

TOTAL: 60 PERIODS

COURSE OUTCOMES:
Upon completion of this course, the students will be able to:
1. Explain the availability and entropy of the thermodynamic systems and simple cycles, and apply various thermodynamic relations to arrive at the T-dS relations
2. Examine the behavior of real gas through empirical equations and thermodynamic tables, and calculate the various properties of gas mixtures
3. Apply first and second law to chemically reacting closed and open systems and arrive at the various thermodynamic parameters
4. Calculate the air fuel ratio, chemical composition of combustion products, understand the various levels of air supply to the hydrocarbon fuels and combustion limits
5. Make use of the knowledge of thermodynamics for analyzing the process of combustion and its related parameters in an IC Engine and study the various arrangements of Gas Turbine systems

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UNIT I RESEARCH DESIGN
Overview of research process and design, Use of Secondary and exploratory data to answer the research question, Qualitative research, Observation studies, Experiments and Surveys.

UNIT II DATA COLLECTION AND SOURCES
Measurements, Measurement Scales, Questionnaires and Instruments, Sampling and methods. Data - Preparing, Exploring, examining and displaying.

UNIT III DATA ANALYSIS AND REPORTING
Overview of Multivariate analysis, Hypotheses testing and Measures of Association. Presenting Insights and findings using written reports and oral presentation.

UNIT IV INTELLECTUAL PROPERTY RIGHTS

UNIT V PATENTS

TOTAL : 30 PERIODS

REFERENCES
COURSE OBJECTIVES:
1. To learn the working of different renewable energy devices.
2. To understand the methodology adopted for performance evaluation of various renewable energy systems.
3. To understand the emission from biodiesel engines and biofuel analysis.

LIST OF EXPERIMENTS
1. Study on solar radiation measurement devices
2. Performance testing of solar water heater
3. Determining the characteristics of solar photovoltaic materials and estimation of MPP(I-V curve)
4. Performance evaluation of solar cookers (box type and concentrating type)
5. Evaluating and comparing the efficiency of conventional stove and improved (energy efficient) cook stoves.
6. Testing of biomass Gasifier in up draught / down draught mode. Study of biogas plant–fixed dome and floating drum model
7. Proximate analysis of a given biofuel
8. Estimation of calorific value of any solid fuels using bomb calorimeter
9. Computation of calorific value of liquid fuels using Junkers gas calorimeter
10. Synthesis of biodiesel – energy and mass balancing
11. Performance evaluation of engine on biodiesel
12. Comparison of combustion and emissions of B0 and B100

COURSE OUTCOMES:
Upon completion of this course, the students will be able to:
1. Evaluate the performance of renewable energy devices.
2. Analyze the factors influencing the efficiency and suggest methods for improving the
3. Adaptability and efficiency of renewable energy devices.
4. Appraise testing methods and evaluate emissions from renewable energy systems

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COURSE OBJECTIVES
1. To educate the students on the realities of thermal engineering.
2. To educate the students about calibration and its essentiality in thermal systems.
3. To Educate the students on thermal engineering concepts

LIST OF EXPERIMENTS
1. Experimental Studies on Thermal Boundary Layer for different geometries.
2. Calibration of Temperature Transducers (Thermocouple, RTD & Thermistors).
3. Calibration of Pressure Transducers.
5. Fluid and Thermal Transfer Properties of Liquid Fuels/Heat Transfer Fluids.
7. Flow Characteristic occurrence between Bodies in Wind Tunnel.
8. Experimental Studies on Fluidization of Solid Fuels.
10. Experimental Studies on Drying of Agro Products.
11. Determining the Actual p-v Diagram of an IC Engine.

TOTAL: 60 PERIODS

COURSE OUTCOMES:
Upon completion of this course, the students will be able to:
1. Construct the error curve and correction curve for different measuring instruments.
2. Analyze the critical/influential properties of thermal systems.
3. Interpret the heat transfer and mass transfer in thermal devices

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TOTAL: 60 PERIODS
COURSE OBJECTIVES:
1. To understand the types of fuels used in Industries and their characteristics
2. To Know the techniques adopted for performance evaluation of thermal utilities
3. To Learn and appreciate the working principle employed in VCRS and VAM systems
4. To list the parameters considered in electricity billing and the losses associated with a motor
5. To Comprehend the techniques available for energy conservation in electrical utilities

UNIT - I BOILERS
Types - Performances evaluation via direct and indirect method – energy conservation avenues.
Properties of steam – Assessment of steam distribution losses – Steam trapping – Condensate and flash steam recovery system – Opportunities for energy saving in steam consumption systems

UNIT - II FURNACES AND THERMIC FLUID HEATERS
Furnaces and Thermic Fluid Heaters: Types - Performances evaluation via direct and indirect method – energy conservation avenues. Insulation and Refractory: types and application

UNIT - III HVAC AND WASTE HEAT RECOVERY
VCRS – performance assessment – energy savings opportunities – VAM: working, types, benefits, comparison with vapor compression system. WHR systems: Classification – Benefits Commercial waste heat recovery devices: recuperator, regenerator, heat pipe, heat exchangers (Plate, Shell & Tube), heat pumps, thermo compressor. CHP – Poly generation

UNIT - IV ELECTRICAL SYSTEMS AND INDUCTION MOTORS

UNIT - V ENERGY CONSERVATION IN ELECTRICAL UTILITIES
Performance assessment and energy conservation avenues in: fans-blowers–pumps–air compressors–illumination systems – cooling towers

COURSE OUTCOMES:
Upon completion of this course, the students will be able to:
1. Estimate the stoichiometric air for fuel and suggest measures for efficient combustion
2. Discover the cause for underperformance of thermal utilities and suggest suitable remedial measures there of
3. Analyse the factors affecting the COP of a VCR and VAR system
4. Evaluate the performance of induction motors and transformers
5. Assess energy conservation avenues of thermal and electrical utilities

REFERENCES:
EY4202 Computational Fluid Dynamics for Energy Systems

COURSE OBJECTIVES:
1. To make students familiarize with the computational analysis.
2. To understand, apply and analyze to numerically solve the steady and unsteady diffusion problems by various schemes.
3. To understand, apply and analyze to numerically solve the convection-diffusion problems by various discretization techniques.
4. To study and understand the discretization of incompressible flow governing equations by various pressure velocity decoupling algorithms.
5. To impart and make students familiarize with the knowledge of various turbulence models

UNIT-I GOVERNING DIFFERENTIAL EQUATIONS AND DISCRETISATION TECHNIQUES
12

UNIT-II DIFFUSION PROCESSES: FINITE VOLUME METHOD
12

UNIT-III CONVECTION-DIFFUSION PROCESSES: FINITE VOLUME METHOD
12
One dimensional convection – diffusion problem, Central difference scheme, upwind scheme – Hybrid and power law discretization techniques – QUICK scheme. – Assessment of discretization scheme properties.

UNIT-IV INCOMPRESSIBLE FLOW PROCESSES: FINITE VOLUME METHOD
12

UNIT-V TURBULENCE MODELLING
12
Kolmogorov’s Theory – Turbulence – Algebraic Models, One equation model & $k-\omega$, $k-\varepsilon$ models – Standard and High and Low Reynolds number models.

TOTAL: 60 PERIODS
COURSE OUTCOMES:
Upon completion of this course, the students will be able to:
1. Infer the fundamental governing equations and apply the boundary conditions to arrive at the unknown variables.
2. Solve the diffusion heat transfer problems by finite volume method.
3. Formulate the convection-diffusion heat transfer problems by finite volume method.
4. Interpret the incompressible flow governing equations by applying various pressure velocity decoupling algorithms.
5. Construct various turbulence models available.

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EY4203 ENERGY EFFICIENT BUILDINGS DESIGN L T P C
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COURSE OBJECTIVES:
1. To learn the green buildings concepts applicable to alternate design
2. To be familiar with basic terminologies related to buildings
3. To learn the building(air)conditioning techniques
4. To know the methods to evaluate the performance of buildings
5. To incorporate Renewable energy systems in buildings

UNIT- I INTRODUCTION
Climate and Building, Historical perspective, Aspects of green building design – Sustainable Site, Water, Energy, Materials and IAQ, ECBC Standards
UNIT- II LANDSCAPE AND BUILDING ENVELOPES


UNIT- III PASSIVE HEATING AND COOLING


UNIT- V THERMAL PERFORMANCE OF BUILDINGS

Heat transfer due to fenestration / infiltration, Calculation of Overall Thermal Transmittance, Estimation of building loads: Steady state method, network method, numerical method, correlations, Thermal Storage integration in buildings

UNIT- V RENEWABLE ENERGY IN BUILDINGS


TOTAL: 45 PERIODS

COURSE OUTCOMES:
Upon completion of this course, the students will be able to:
1. Design climate responsive building
2. Discover various physical properties influencing passive building design
3. Apply the passive (air) conditioning techniques in energy efficient building
4. Interpret the energy performance of buildings
5. Appraise the adaptation of renewable energy systems in buildings

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**COURSE OBJECTIVES:**
1. To Understand the working and usage of instruments employed in energy audits
2. To Learn the methodology adopted for performance evaluation of industrial equipments
3. To compare the performance parameters of equipments with benchmark standards to explore the avenue for performance improvement.

**LISTOFEXPERIMENTS**
1. Study of energy audit instruments (flue gas analyser, calorimeter, pitottube, digital pressure indicator, differential manometer, anemometer – vane type and thermal type, digital tachometer – contact/non-contact, stroboscope, hygrometer, temperature indicator – contact type and non-contact type, ultrasonic leak detector, ultrasonic flow meter, lux meter, energy manager, harmonic analyzer, KVA demand analyser)
2. Performance evaluation of boiler adopting direct and indirect method
3. Determining the efficiency of a simple impulse steam turbine
4. Assessment of performance of steam condensers
5. Performance evaluation of air compressors and computing its specific energy consumption and cost of compressed air
6. Determining the characteristics of an induction motor and computing its efficiency adopting direct and indirect method
7. Determination of pump & pumping system characteristics (pump curve, system curve and BEP)
8. Comparison on the effect of different discharge control techniques in pumps (VFD, throttling and bypass mode) with respect to specific energy consumption
9. Analysis of various luminaries and evaluation of their efficacy
10. Determination of characteristic curves of blowers and comparison of its characteristic supon subjecting it to damper control at inlet and discharge.
11. Performance evaluation of cooling tower
12. Comparison on the performance of shell and tube, pipe-in-pipe and plate heat exchangers

**TOTAL: 60 PERIODS**

**COURSE OUTCOMES:**
Upon completion of this course, the students will be able to:
1. Evaluate the specific energy consumption of industrial utilities
2. Estimate the cost of energy for process essentials like steam, compressed air
3. Examine the performance parameters of various energy equipments
COURSE OBJECTIVES:
1. To provide a platform to learn and get familiar with computational analysis
2. To learn the simulation and analysis of software for solving of flow with heat transfer related problems
3. To predict the heat transfer equipment performance using models.

LIST OF EXPERIMENTS
1. Heat exchanger analysis—NTU method
2. Heat exchanger analysis—LMTD method
3. Convection heat transfer analysis—Velocity boundary layer
4. Convection heat transfer analysis—Internal flow
5. Radiation heat transfer analysis—Emissivity
6. Critical radius of insulation
7. Lumped heat transfer analysis
8. Conduction heat transfer analysis
9. Condensation heat transfer analysis
10. Analysis on flow through pipe
11. Nozzle/Diffuser Analysis
12. Boiling heat transfer analysis

TOTAL: 60 PERIODS

COURSE OUTCOMES:
Upon completion of this course, the students will be able to:
1. Use modern engineering software is to analyze the flow with heat transfer related problems
2. Analyse the various parameters influencing the performance of thermodynamic systems
3. Predict the thermal and flow performance of different models of various thermal and fluid systems.

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COURSE OBJECTIVES:
1. To understand the basics of isentropic flow and energy transfer process in turbo machines and to derive the governing equations.
2. To understand the functional aspects and performance of compressors.
3. To learn about the components of combustion chamber and their functions.
4. To understand the working and performance of axial & radial turbines.
5. To calculate the performance of gas turbines and jet engine cycles.

UNIT- I INTRODUCTION

UNIT- II CENTRIFUGAL AND AXIAL FLOW COMPRESSORS

UNIT- III COMBUSTIONCHAMBER

UNIT - IV AXIAL AND RADIAL FLOW TURBINES

UNIT- V GASTURBINEANDJETENGINECYCLES
Gas turbine cycle analysis – simple and actual. Reheated, Regenerative and Intercooled cycles for power plants. Working of Turbojet, Turboprop, Ramjet, Scramjet and Pulse jet Engines and cycle analysis – thrust, specific impulse, and specific fuel consumption, thermal and propulsive efficiencies.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
Upon completion of this course, the students will be able to:
1. Analyze the energy transfer process in thermodynamic systems
2. Appraise the performance of centrifugal flow and axial flow combustion systems
3. Design and develop the combustion chamber for turbo machines
4. Compare and analyze the performance of axial and radial flow turbines
5. Predict the performance of gas turbines and thermodynamic energy systems
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EY4093  FLUIDIZED BED SYSTEMS  L T P C
3 0 0 3

COURSE OBJECTIVES:
1. To understand the behavior of fluidized beds
2. To learn about the heat transfer process
3. To differentiate the combustion and gasification, and appreciate the relative merits
4. To design components of fluidized bed systems
5. To understand the industrial applications of fluidized bed systems

UNIT– I  FLUIDIZED BED BEHAVIOUR  9

UNIT– II  HEAT TRANSFER  9

UNIT–III  COMBUSTION AND GASIFICATION  9

UNIT– IV  DESIGN CONSIDERATIONS  9
UNIT– V  INDUSTRIAL APPLICATIONS

Physical operations like transportation, mixing of fine powders, heat exchange, coating, drying and sizing. Cracking and reforming of hydrocarbons, carbonization, combustion and gasification. Sulphur retention and oxides of nitrogen emission Control.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
Upon completion of this course, the students will be able to:
1. Illustrate the behavior of fluidized bed particles and explain the theory of fluidization.
2. Analyze the heat transfer process in fluidized beds.
3. Apply concepts of combustion and gasification in fluidized beds.
4. Interpret the design consideration for components of fluidized bed system.
5. Evaluate fluidized bed systems for various industrial applications.

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EY4071  BIO ENERGY TECHNOLOGIES  L T P C
3 0 0 3

COURSE OBJECTIVES:
1. To learn availability of biomass, methods of biomass analysis and study of characteristics.
2. To create awareness on the technologies available for conversion of biomass to energy in terms of its technical competence and economic implications.
3. To impart knowledge on stoichiometry and combustion of biofuels and costing of biomass technologies.
4. To elucidate the thermochemical conversion methods of biomass and its use in engines.
5. To provide insight to the possibilities of producing liquid fuels from biomass.

UNIT–I  INTRODUCTION
UNIT- II  BIOMETHANATION

UNIT- III COMBUSTION
Perfect, complete and incomplete combustion-stoichiometric air requirement for biofuels-equivalence ratio – fixed Bed and fluid Bed combustion – fuel and ash handling systems – steam cost comparison with conventional fuels.

UNIT- IV GASIFICATION, PYROLYSIS AND CARBONISATION

UNIT- V LIQUIFIED BIOFUELS
History of usage of Straight Vegetable Oil (SVO) as fuel – Biodiesel production from oil seeds, waste oils and algae – Process and chemistry – Biodiesel health effects / emissions / performance. Production of alcoholic fuels (methanol and ethanol) from biomass – engine modifications

TOTAL: 45 PERIODS

COURSE OUTCOMES:
Upon completion of this course, the students will be able to:
1. Estimate the availability of surplus biomass and study the characteristics
2. Design a biogas plant for different bioenergy sources
3. Determine and compare the cost of steam generation from biofuels with conventional fuels.
4. Analyze the influence of process governing parameters in thermo chemical conversion of biomass and in internal combustion engines
5. Evaluate the production of liquid biofuels for power generation from biomass

REFERENCES
1. David Boyles, Bio Energy Technology Thermodynamics and costs, Ellis Horwood Chichester, 1984.
2. Iyer PV Retal, Thermo chemical Characterization of Biomass, MNES

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COURSE OBJECTIVES:
1. To impart knowledge about the present status of energy scenario in India.
2. To predict the energy demand using various forecasting models.
3. To develop an optimization model for the effective utilization of energy sources.
4. To understand and learn the procedure to write the project proposal.
5. To learn the present status of energy policies in the country.

UNIT- I ENERGY SCENARIO

UNIT- II FORECASTING MODEL

UNIT- III OPTIMIZATION MODEL

UNIT- IV PROJECT MANAGEMENT

UNIT- V ENERGY POLICY

COURSE OUTCOMES:
Upon completion of this course, the students will be able to:
1. Illustrate the energy scenario and appraise energy availability
2. Predict energy demand using various forecasting models.
3. Develop different optimization model for energy planning.
4. Formulate project proposal and financial evaluation.
5. Interpret the national and state energy policies.

REFERENCES:
3. Fred Luthans, Brett C. Luthan, Kyle W. Luthans, Organisational Behaviour: An Evidence-Based
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EY4001 MODELING AND ANALYSIS OF ENERGY SYSTEMS

COURSE OBJECTIVES:
1. To learn to apply mass and energy balances for the energy systems
2. To impart knowledge about the modeling and simulation techniques for energy systems.
3. To provide insight into optimization techniques to optimize the energy system.
4. To learn to use the energy-economy models.
5. To explore the various application and case studies.

UNIT- I INTRODUCTION
Primary energy analysis- energy balance for closed and control volume systems – applications of energy analysis for selected energy system design – modeling overview – levels and steps in model development –Examples of models–curve fitting and regression analysis

UNIT- II MODELLING AND SYSTEMS SIMULATION

UNIT- III OPTIMISATION TECHNIQUES

UNIT- IV ENERGY-ECONOMY MODELS
UNIT- V APPLICATIONS AND CASE STUDIES

Case studies of optimization in Energy systems problems- Dealing with uncertainty- probabilistic techniques – Trade-offs between capital and energy using Pinch analysis

COURSE OUTCOMES:
Upon completion of this course, the students will be able to:
1. Apply mass and energy balances for the energy systems
2. Propose simulation and modeling of typical energy system
3. Identify optimization techniques for energy systems.
4. Appraise Energy-Economic Analysis for the typical applications
5. Examine the application of optimization for energy systems and its economics

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EY4002 POWER GENERATION, TRANSMISSION AND DISTRIBUTION

COURSE OBJECTIVES:
1. To learn knowledge on Conventional Power Plants (Steam, Hydro, Nuclear and Gas Turbine plants)
2. To impart knowledge on Non-Conventional Power Plants(Renewable Energy)
3. To understand various components and factors affecting power transmission
4. To learn & understand the major electrical energy components and its Utilization of Electrical energy for various applications.
5. To understand the Economics of Power generation and transmissions.

UNIT- I CONVENTIONAL POWER GENERATION

UNIT- II NON CONVENTIONAL POWER GENERATION
Wind power generation-characteristics of wind power-design of wind mills-Tidal power generation – Single and two-basin systems –Turbines for tidal power – Solar power generation –Energy from biomass, biogas and waste

UNIT- III ELECTRICAL POWER TRANSMISSION

UNIT- IV UTILISATION OF ELECTRICAL ENERGY
Selection of Electrical Drives-Electrical characteristics and mechanical considerations-size, rating and cost, Transformer characteristics – illumination – laws of illumination-polar curve –incandescent – fluorescent and vapour lamps – Design of OLTC lighting Scheme of industry-electrical welding-energy efficient aspects of devices

UNIT- V ECONOMIC OF POWER GENERATION & TRANSMISSION
Daily load curves – load factor – diversity factor – load deviation curve – load management – number and size of generating unit, distribution losses, cost of electrical energy – tariff – power factor improvement

TOTAL: 45 PERIODS

COURSE OUTCOMES
Upon completion of this course the student will be able to
1. Explain the selection and operation of conventional power plants.
2. Appraise the operation of renewable energy power generation
3. Explain about the functioning of major electrical energy component
4. Elucidate about power transmission and various factors involved affecting it
5. Assess the economics of power generation and utilization of electrical energy

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COURSE OBJECTIVES:
1. To elucidate on the physics involved in nuclear reaction and radiation detection
2. To understand the reactor theory and classification of nuclear fuels
3. To comprehend the working of nuclear power plants and economic analysis
4. To understand the application of radioactivity
5. To acquire knowledge on nuclear waste management, storage and regulatory issues.

UNIT- I  NUCLEAR PHYSICS, RADIATION SOURCES AND DETECTION  9
Basic properties of nucleus and nuclear radiations, Nuclear Stability, Binding energy and nuclear stability, Radioactive Decay, Determination of mass of neutrino, Sources of Alpha, beta, gamma radiations, neutron sources, spontaneous fission source Detection techniques – Gas filled ionization detectors – Ionization chambers, proportional counters and GM counters. Pulse height spectra and energy resolution.

UNIT- II  NUCLEAR REACTOR THEORY, NUCLEAR REACTOR MATERIALS AND FUELS  9

UNIT- III  NUCLEAR POWER ENGINEERING AND ECONOMICS  9
Principles of conversion – Types of nuclear power plants – Fast breeder reactors- Breeding requirements and fast reactors, Fast reactor system features Economics of nuclear power plants- capital costs, fuel costs and O&M (operations and maintenance) costs, Economics of nuclear vs. other types of power plants.

UNIT- IV  APPLICATION OF RADIATION TECHNOLOGY  9
Material analysis – Basic principles, nuclear techniques for elemental analysis, Rutherford back scattering (RBS) and elastic recoil detection analysis (ERDA). Medical applications – Projection imaging, positron emission tomography, magnetic resonance imaging, radiation therapy. Sterilization plants

UNIT- V  NUCLEAR WASTE STORAGE AND MANAGEMENT  9
Classification of nuclear waste, environmental impacts of nuclear waste, nuclear decay law, nuclear fuel cycle. Treatment of liquid and solid radioactive wastes, hydraulic cements in waste immobilization and cementation technology.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
Upon completion of the course the student will able to
1. Detail the principle of nuclear physics and various radiation detection methods
2. Recognize the significance on proper selection of nuclear reactor materials / fuels
3. Describe the working of various nuclear power plants and evaluate the economics of nuclear power plant
4. Interpret the application of nuclear radiation in diverse fields and devise strategies for application in other diverse fields
5. Explain the challenges involved in treatment and disposal of nuclear waste.
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EY4008 SOLAR ENERGY TECHNOLOGIES

OBJECTIVES:
1. To learn and study the solar radiation and various solar collectors
2. To study the various solar thermal energy technologies and their applications
3. To learn about various solar PV cell materials and conversion techniques
4. To learn various Solar SPV systems designs and their applications
5. To know about various solar passive building techniques for cooling and heating applications

UNIT – I SOLAR RADIATION AND MEASUREMENT

UNIT – II SOLAR COLLECTORS

UNIT – III SOLAR PV FUNDAMENTALS
UNIT– IV SPV SYSTEM DESIGN AND APPLICATIONS
Solar cell array system analysis and performance prediction- Shadow analysis: reliability – solar cell array design concepts – PV system design – design process and optimization – detailed array design-storage autonomy-voltage regulation-maximum tracking-centralized and decentralized SPV systems-standalone-hybrid and grid connected system-System installation - Operation and maintenances – field experience – PV market analysis and economics of SPV systems.

UNIT– V SOLAR PASSIVE ARCHITECTURE

COURSE OUTCOMES:
Upon completion of this course, the students will be able to:
1. Illustrate solar radiation and its measurement
2. Identify various solar thermal energy technologies and their applications
3. Compare various solar PV cell materials and interpret factors influencing of conversion efficiency
4. Infer various SPV systems designs and their applications
5. Evaluate various solar passive building techniques for cooling and heating applications

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COURSE OBJECTIVES:
1. To understand the various types of energy storage technologies and its applications.
2. To study the various modeling techniques of energy storage systems using TRNSYS.
3. To learn working concepts and types of batteries.
4. To make the students to get understand the concepts of Hydrogen and Biogas storage.
5. To provide the insights on super capacitor, Fly wheel and compressed energy storage system.

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

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

UNIT–III ELECTRICAL ENERGY STORAGE
Fundamental concept of batteries–measuring of battery performance, charging and discharging of a battery, storage density, energy density, and safety issues. Types of batteries – Lead Acid, Nickel–Cadmium, Zinc Manganese di oxide and modern batteries for example(i)zinc-Air(ii)Nickel Hydride,(iii)Lithium Battery.

UNIT– IV HYDROGEN AND BIOGAS STORAGE

UNIT– V ALTERNATE ENERGY STORAGE TECHNOLOGIES
Flywheel, Super capacitors, Principles & Methods–Applications, Compressed air Energy storage, Concept of Hybrid Storage – Applications.

COURSE OUTCOMES:
Upon completion of this course, the students will be able to:
1. Identify the energy storage technologies for suitable applications.
2. Analyze the energy storage systems using TRNSYS.
3. Summarise the concepts and types of batteries.
4. Examine the principle of operation of Hydrogen and Biogas storage systems.
5. Explain the working of super capacitor, Flywheel and compressed energy storage systems

REFERENCES:
COURSE OBJECTIVES:
1. To make students familiarize with the various types of heat exchangers
2. To explain the importance of thermal and stress analysis of heat exchangers
3. To inculcate the thermal design aspects of tubular heat exchangers
4. To provide the details of design aspects of compact heat exchangers
5. To explain the function and design aspects of condensers and cooling towers

UNIT- I  FUNDAMENTALS OF HEAT EXCHANGER  9
Temperature distribution and its implications types—shell and tube heat exchangers—regenerators and recuperators – analysis of heat exchangers—LMTD and effectiveness method

UNIT- II  STRESS ANALYSIS  9

UNIT- III  DESIGN ASPECTS  10

UNIT- IV  COMPACT AND PLATE HEAT EXCHANGERS  8

UNIT- V  CONDENSERS AND COOLING TOWERS  9
Design of surface and evaporative condensers–cooling tower –performance characteristics

COURSE OUTCOMES:
Upon completion of this course, the students will be able to
1. Classify heat exchangers and illustrate the applications of various types of heat exchangers
2. Interpret the significance of stress analysis of heat exchangers
3. Analyse the design of tubular heat exchangers for various applications
4. Appraise the design of compact heat exchangers for industrial requirements
5. Evaluate the performance calculation of condensers and cooling towers

TOTAL: 45 PERIODS
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IC4092 HYBRID AND ELECTRIC VEHICLES 3 0 0 3

COURSE OBJECTIVES:
- To introduce the concept of hybrid and electric drive trains.
- To elaborate on the types and utilisation of hybrid and electric drive trains.
- To expose on different types of AC and DC drives for electric vehicles.
- To understand and utilise different types of energy storage systems.
- To introduce concept of energy management strategies and drive sizing.

UNIT I INTRODUCTION 9
Basics of vehicle performance, vehicle power source characterization, transmission characteristics, History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies.

UNIT II HYBRID ELECTRIC DRIVE TRAINS 9
Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis.
Electric Drive-trains: Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis.

UNIT III CONTROL OF AC & DC DRIVES 9
Introduction to electric components used in hybrid and electric vehicles, Configuration and control - DC Motor drives, Induction Motor drives, Permanent Magnet Motor drive, and Switch Reluctance Motor drives, drive system efficiency.

UNIT IV ENERGY STORAGE 9
UNIT V  DRIVE SIZING AND ENERGY MANAGEMENT STRATEGIES

Sizing the drive system: Matching the electric machine and the internal combustion engine (ICE), sizing the propulsion motor, sizing the power electronics, selection of appropriate energy storage technology, Energy Management Strategies: Introduction to energy management strategies used in hybrid and electric vehicles, classification and comparison of energy management strategies, implementation issues.

TOTAL : 45 PERIODS

COURSE OUTCOMES:
On successful completion of this course, the students will be able to:

1. Characterise and configure hybrid drivetrains requirement for a vehicle
2. Design and apply appropriate hybrid and electric drive trains in a vehicle
3. Design and install suitable AC and DC drives for electric vehicles.
4. Arrive at a suitable energy storage system for a hybrid / electric vehicle
5. Apply energy management strategies to ensure better economy and efficiency

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EY4004  POWER ELECTRONICS FOR RENEWABLE ENERGY SYSTEMS  L T P C

3 0 0 3

COURSE OBJECTIVES
1. To impart knowledge on conversion techniques and renewable energy technologies.
2. To study the mechanisms of machines for the conversion of renewable energy sources.
3. To learn the power converters and its applications in renewable energy systems.
4. To understand the different conversion mechanisms of wind and solar systems.
5. To understand the various hybrid systems of renewable energy conversion techniques.

UNIT- I  INTRODUCTION
Environmental aspects of electric energy conversion: impacts of renewable energy generation on environment (cost-GHG Emission) – Qualitative study of different renewable energy resources: Solar, wind, ocean, Biomass, Fuel cell, Hydrogen energy systems and hybrid renewable energy systems
UNIT- II  ELECTRICAL MACHINES FOR RENEWABLE ENERGY 9
CONVERSION
Review of reference theory fundamentals-principle of operation and analysis: IG, PMSG, SCIG and DFIG

UNIT- III  POWER CONVERTERS 9
Solar: Block diagram of solar photovoltaic system-Principle of operation: line commutated converters (inversion-mode) – Boost and buck-boost converters- selection Of inverter, battery sizing, array sizing
Wind: three phase AC voltage controllers- AC-DC-AC converters: uncontrolled rectifiers, PWM Inverters, Grid Interactive Inverters-matrix converters. Power Quality Measurements – Maximum power point tracking (MPPT)

UNIT- IV  ANALYSIS OF WIND AND PV SYSTEMS 9
Stand-alone operation of fixed and variable speed wind energy conversion systems and solar system-
Grid connection Issues –Grid integrated PMSG and SCIG Based WECS Grid Integrated solar system

UNIT- V  HYBRID RENEWABLE ENERGY SYSTEMS 9
Need for Hybrid Systems- Range and type of Hybrid systems- Case studies of Wind and PV in micro-
grid

TOTAL: 45 PERIODS

COURSE OUTCOMES:
1. Analyze the various conversion techniques in renewable energy technologies.
2. Apply the various mechanisms for the conversion of renewable energy sources.
3. Evaluate the appropriate power converters for renewable energy systems.
4. Examine the different conversion mechanisms for wind and solar systems.
5. Interpret the importance of various hybrid renewable energy systems.

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COURSE OBJECTIVES:

1. To understand the fundamentals of wind energy and its conversion system
2. To impart knowledge on airfoil design and braking system
3. To learn gear coupled generator wind turbine components
4. To brief on the working of different generators and power conditioning system used in grid tied wind systems
5. To impart knowledge on modern wind turbine control & monitoring

UNIT- I  WIND ENERGY FUNDAMENTALS & WIND MEASUREMENTS  

UNIT- II  AERODYNAMICS THEORY & WIND TURBINE TYPES  
Airfoil terminology, Blade design, Rotor performance and dynamics, Balancing technique (Rotor & Blade), Types of loads; Sources of loads Vertical Axis Type, Horizontal Axis, Constant Speed Constant Frequency, Variable speed Variable Frequency, Up Wind, Down Wind, Stall Control, Pitch Control, Gear Coupled Generator type, Direct Generator Drive /PMG/Rotor Excited Sync Generator

UNIT- III  GEAR COUPLED GENERATOR WIND TURBINE COMPONENTS AND THEIR CONSTRUCTION  

UNIT- IV  DIRECT ROTOR COUPLED GENERATOR (MULTI POLE) [VARIABLE SPEED VARIABLE FREQ.]  
Excited Rotor Synch. Generator/PMG Generator, Control Rectifier, Capacitor Banks, Step Up/Boost Converter (DC-DC Step Up), Grid Tied Inverter, Power Management, Grid Monitoring Unit(Voltage and Current), Transformer, Safety Chain Circuits

UNIT- V  MODERN WIND TURBINE CONTROL & MONITORING SYSTEM  

TOTAL: 45 PERIODS

COURSE OUTCOMES:

1. Determine energy available in wind and limitations in wind turbine design
2. Analyze the wind turbine aerodynamics and breaking system
3. Explain about various components of wind turbine and its working
4. Explain about different types of generators and power condition used in wind systems
5. Assess modern wind turbine control, monitoring and maintenance and report generation.
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TE4091 ADVANCED POWER PLANT ENGINEERING L T P C
3 0 0 3

COURSE OBJECTIVES:
1. Understand the thermodynamics associated with power plants
2. Detail on the role of various utilities in coal based thermal power plants
3. Acquire know-how on the working of gas turbine and diesel power plants
4. Appreciate the concept of Poly generation for total energy recovery from a system
5. Brief on the working of hydro electric and nuclear power plants

UNIT–I INTRODUCTION

UNIT–II COAL BASED THERMAL POWER PLANTS
Basics of typical power plant utilities – Boilers, Nozzles, Turbines, Condensers, Cooling Towers, Water Treatment and Piping system – steam rate and heat rate – mean temperature of heat addition-Rankine cycle improvements–Superheat, Reheat, Regeneration, Supercritical, AFBC/PFBC – computation of per unit cost of power generation from coal/biomass

UNIT–III GAS TURBINE AND DIESEL POWER PLANTS
Brayton cycle – Open and Closed – Improvements – Intercooler, Reheating and Regeneration. Diesel power plant – Layout – Performance analysis and improvement – Techniques for starting, cooling and lubrication of diesel engines-computation of per unit cost of power generation

UNIT–IV CHP AND MHD POWER PLANTS
UNIT – V  HYDRO ELECTRIC & NUCLEAR POWER PLANTS  9

TOTAL: 45 PERIODS

COURSE OUTCOMES:
Upon completion of this course, the students will be able to:
1. Evaluate appropriate power generation technologies for mitigating the energy gap
2. Appraise the steam rate, heat rate and cost for generating electricity from coal based thermal power plants
3. Analyse and suggest measures for improving the performance of gas turbine and diesel power plants
4. Assess the applicability and performance of a cogeneration system
5. Decide a suitable type of hydroelectric/nuclear power plant commensurate with the prevailing conditions

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TE4073  HYDROGEN AND FUEL CELL TECHNOLOGIES  L T P C  3 0 0 3

COURSE OBJECTIVES
- To study in detail on the hydrogen production methodologies, possible applications and various storage options.
- To understand the working principle of a typical fuel cell, its types and to elaborate on its thermodynamics and kinetics.
- To study the cost effectiveness and eco-friendliness of Fuel Cells.

UNIT I  HYDROGEN – BASICS AND PRODUCTION TECHNIQUES  9

UNIT II  HYDROGEN STORAGE AND APPLICATIONS  9
UNIT III  FUEL CELLS

UNIT IV  FUEL CELL – TYPES
Types of fuel cells – AFC, PAFC, SOFC, MCFC, DMFC, PEMFC – relative merits and demerits.

UNIT V  APPLICATION OF FUEL CELL AND ECONOMICS
Fuel cell usage for domestic power systems, large scale power generation, Automobile, Space. Economic and environmental analysis on usage of Hydrogen and Fuel cell. Future trends in fuel cells.

TOTAL: 45 PERIODS

COURSE OUTCOME
After completion of the syllabus student able to:
Know the working of various fuel cells, their relative advantages / disadvantages and hydrogen generation/storage technologies.

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EY4006  SMART GRID
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COURSE OBJECTIVES:
1. To Study about Smart Grid technologies with its benefits and challenges
2. To study about smart grid transmission technologies
3. To study about smart grid distribution technologies
4. To familiarize about smart metering and need for Advanced metering infrastructure
5. To familiarize the high performance computing for Smart Grid applications
UNIT- I  INTRODUCTION TO SMART GRID  9
Evolution of Electric Grid, Concept, Definitions and Need for Smart Grid, Smart grid drivers, functions, opportunities, challenges and benefits, Difference between conventional & Smart Grid, National and International Initiatives in Smart Grid.

UNIT- II  SMARTGRID TECHNOLOGIES (Transmission)  9
Technology Drivers, Smart energy resources, Smart substations, Substation Automation, Feeder Automation, Transmission systems: EMS, FACTS and HVDC, Wide area monitoring, Protection and control

UNIT- III  SMARTGRID TECHNOLOGIES (Distribution)  9
DMS, Volt/VAr control, Fault Detection, Isolation and service restoration, Outage management, High-Efficiency Distribution Transformers, Phase Shifting Transformers, Plug in Hybrid Electric Vehicles(PHEV).

UNIT- IV  SMART METERS AND ADVANCED METERING INFRASTRUCTURE  9
Introduction to Smart Meters, Advanced Metering infrastructure (AMI) drivers and benefits, AMI protocols, standards and initiatives, AMI needs in the smart grid, Phasor Measurement Unit(PMU), Intelligent Electronic Devices(IED) & their application for monitoring & protection.

UNIT- V  HIGH PERFORMANCE COMPUTING FOR SMART GRID APPLICATIONS  9
Local Area Network (LAN), House Area Network (HAN), Wide Area Network (WAN), Broad band over Power line (BPL), IP based Protocols, Basics of Web Service and CLOUD Computing to make Smart Grids smarter, Cyber Security for Smart Grid.

TOTAL:  45 PERIODS

COURSE OUTCOMES:
Upon completion of this course, the students will be able to:
   1. Demonstrate concepts of smart grid and its present developments.
   2. Interpret different smart grid technologies.
   3. Infer different smart meters and advanced metering infrastructure.
   4. Appraise power quality management in smart grids.
   5. Recommend LAN, WAN and cloud computing for smart grid applications.

REFERENCES:
COURSE OBJECTIVES

1. To impart knowledge on the atmosphere and its present condition and, global warming.
2. To detail on the sources of water pollution and possible solutions for mitigating their degradation.
3. To detail on the sources of air pollution and possible solutions for mitigating their degradation.
4. To detail on the sources of solid waste and possible ways to dispose them safely.
5. To impart knowledge on hazardous waste management.

UNIT– I  INTRODUCTION

UNIT– II  WATER POLLUTION
Pollutants in Water & Waste water – Physical and Chemical Treatment Methods–(An Overview) Neutralization – Aeration –Colour / Odour Removal - Sludge dewatering – Biological Treatment including Aerobic & Anaerobic Treatment

UNIT–III  AIR POLLUTION
Sources – Ambient Air Quality Standards – Emission Limits – Equipment for Ambient Air & Stack Monitoring – Principles of operation of Particulate Control Equipments-ESPs, Bag Filters, Cyclone Separators–Vehicular Pollution and its Control–BS standards

UNIT– IV  SOLID WASTE MANAGEMENT

UNIT– V  HAZARDOUS WASTEMANAGEMENT
Sources – Classification – Characterization of waste - health effects - Incineration– Radio active Waste from nuclear power plants and disposal options -RDF- Mass Firing–Material Recycling

TOTAL: 45 PERIODS
COURSE OUTCOMES:
Upon completion of this course, the students will be able to:
1. Classify types and effects of each type of pollution.
2. Assess technical aspects of global warming and their impact on climate change
3. Choose technologies that are available for reduction of pollutants dumped into the atmosphere
4. Appraise waste management and hazardous waste disposal.
5. Comprehend the different techniques available for safe disposal of hazardous waste

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</table>
OBJECTIVES:
- Identify and prevent operational hazard
- Categorize, analyze and interpret the accidents data based on various safety techniques.
- Use proper safety techniques on safety engineering and management.
- Design the system with environmental consciousness by implementing safety regulation
- Use safety management practices in Industries.

UNIT I OPERATIONAL SAFETY

UNIT II SAFETY APPRAISAL AND ANALYSIS

UNIT III OCCUPATIONAL HEALTH
Concept and spectrum of health functional units and activities of operational health service – occupational and related disease – levels of prevention of diseases – notifiable occupational diseases Toxicology Lead – Nickel, chromium and manganese toxicity – gas poisoning (such as CO, Ammonia Chlorise, So2, H2s.) their effects and prevention – effects of ultra violet radiation and infrared radiation on human system.

UNIT IV SAFETY AND HEALTH REGULATIONS

UNIT V SAFETY MANAGEMENT

TOTAL: 45 PERIODS

OUTCOMES:
CO1: Ability to Identify and prevent operational hazard
CO2: Ability to collect, analyze and interpret the accidents data based on various safety techniques.
CO3: Ability to apply proper safety techniques on safety engineering and management.
CO4: Ability to design the system with environmental consciousness by implementing safety regulation
CO5: Ability to apply safety management practices in Industries.

REFERENCES:

**CO-PO MAPPING**

<table>
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<tr>
<th></th>
<th>PO1</th>
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<td>CO5</td>
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<td>Avg.</td>
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1-low, 2-medium, 3-high, ‘-’- no correlation

**AUDIT COURSES**

**AX4091 ENGLISH FOR RESEARCH PAPER WRITING**

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**COURSE OBJECTIVES**

- Teach how to improve writing skills and level of readability
- Tell about what to write in each section
- Summarize the skills needed when writing a Title
- Infer the skills needed when writing the Conclusion
- Ensure the quality of paper at very first-time submission

**UNIT-I INTRODUCTION TO RESEARCH PAPER WRITING**

Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

**UNIT-II PRESENTATION SKILLS**


**UNIT-III TITLE WRITING SKILLS**

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**

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

TOTAL: 30 PERIODS

COURSE OUTCOMES
CO 1 – Understand that how to improve your writing skills and level of readability
CO 2 – Learn about what to write in each section
CO 3 – Understand the skills needed when writing a Title
CO 4 – Understand the skills needed when writing the Conclusion
CO 5 – Ensure the good quality of paper at very first-time submission

REFERENCES

AX4092 DISASTER MANAGEMENT

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
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
UNIT-III DISASTER PRONE AREAS IN INDIA  
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  
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  
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
CO 1: Ability to summarize basics of disaster
CO 2: Ability to explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
CO 3: Ability to illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
CO 4: Ability to describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
CO 5: Ability to develop the strengths and weaknesses of disaster management approaches

REFERENCES

AX4093 CONSTITUTION OF INDIA

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
- The Constitution of India, 1950(Bare Act), Government Publication.
<table>
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<tr>
<th>UNIT I</th>
<th>சங்க இலக்கியம்</th>
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<td>1.</td>
<td>தமிழின் துவக்க நூல் ததொல்கொப்பியம் – எழுத்து, ததொல், தம்பொருள்</td>
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<td>4.</td>
<td>புராணநூறு (95,195) - பாப்புள் நிறுத் சாருவப்பாரு</td>
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<td>1.</td>
<td>அறநநறித் வகுத்த திருவள்ளுவர் - அறம் வலியுறுத்தல், அன்புகடகம், ஒப்புரவ்</td>
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<td>பிற அறநூல்கள் - இலக்கியம் மருந்து – ஏலொதி, சிறுபஞ்</td>
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<td>மூலம் – திரிகடுகம், ஆரக்கபொகவுடன் (வெளிப்பகுதியிய நூல்)</td>
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<td>கண்காணகியின் புரட்சி – சிலப்பதிகொரவழக்குகரகொரமூகப்பகவிலக்கியம்</td>
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<td>பாப்பு தற்கொடுத்தது, அதியமொன் ஒளகவக்குத்தன்</td>
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<td>2.</td>
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<th>UNIT V</th>
<th>நவீன தமிழ் இலக்கியம்</th>
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</table>
1. உகரநகடத் தமிழ்,
   - தமிழின் புதிய புத்தகங்கள்,
   - தமிழின் முதல் சிறுககதங்கள்,
   - கட்டுகர இலக்கியம்,
   - பயண இலக்கியம்,
   - நொடகம்,
2. நொட்டுவிடுதகல் பபொரொட்டமும் தமிழ் இலக்கியமும்,
3. முதொய விடுதகலயும் தமிழ் இலக்கியமும்,
4. தபண விடுதகலயும் விளிம்பு நிகலயினரின் பம்பொட்டில் தமிழ் இலக்கியமும்,
5. அறிவியல் தமிழ்,
6. இகணயத்தில் தமிழ்,
7. சுற்றுசூழல் பம்பொட்டில் தமிழ் இலக்கியம்.

TOTAL: 30 PERIODS

தமிழ் இலக்கிய தொடர்பியல் / படத்தியல்
1. தமிழ் விலையாம கல்விகுழுக்கள் (Tamil Virtual University) - www.tamilvu.org
2. தமிழ் விளையாட்டுப் பம்பொட்டி (Tamil Wikipedia) -https://ta.wikipedia.org
3. கொம்பு தொழில் பார்வை
4. வொழியல் கல்விகுழு - தமிழ் பல்கலைக்கழகம், தஞ்சாвар்
5. தமிழ்கல்விக் கல்விகுழு - தமிழ் பல்கலைக்கழகத்தின் தொலை (thamilvalarchithurai.com)
6. அறிவியல் கல்விகுழு - தமிழ் பல்கலைக்கழகம், தஞ்சாவுர்