THE VISION OF THE DEPARTMENT OF MECHANICAL ENGINEERING

We, at the Department of Mechanical Engineering, Anna University shall strive hard to impart knowledge and state-of-the-art training to our students and expose them to broad areas of Mechanical Engineering, namely Design, Manufacturing, Energy, Thermal Sciences and currently related interdisciplinary areas, so that they can later practice their profession at home or abroad keeping in mind the needs and concern of the society they represent, safeguarding values, ethics and be instrumental in bringing about an overall technological development.

THE MISSION OF THE DEPARTMENT OF MECHANICAL ENGINEERING

1. To deliver knowledge in Mechanical Engineering and Materials Science and Engineering with high educational standards so that the outgoing students are employable and globally competitive.
2. To produce graduate and post graduate engineers with core competency as well as relevant software skills and social responsibility.
3. To be dynamic in imparting knowledge to students depending upon the changing national and International needs
PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):
The Solar Energy 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 solar energy sector and advance quickly to significant positions of leadership in their Profession.

II. Moving towards advanced research for mitigating the shortcomings in solar energy systems.

III. Ascending as a consultant for providing solutions towards increasing energy demand by moving towards decentralized solar energy systems.

IV. Become a successful entrepreneur and be a part of a supply chain or manufacture or market solar energy products for sustainable development.

V. Lead an ethical life by engaging in lifelong learning experiences for developing environmentally sustainable and economically affordable solar energy products for societal upliftment.

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

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<th>PO #</th>
<th>Graduate Attribute</th>
<th>Programme Outcome</th>
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<tr>
<td>1</td>
<td>Engineering knowledge</td>
<td>Apply knowledge of mathematics, basic science and engineering science.</td>
</tr>
<tr>
<td>2</td>
<td>Problem analysis</td>
<td>Identify, formulate and solve engineering problems.</td>
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<tr>
<td>3</td>
<td>Design/development of solutions</td>
<td>Design a system or process to improve its performance, satisfying its constraints.</td>
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<td>4</td>
<td>Conduct investigations of complex problems</td>
<td>Conduct experiments &amp; collect, analyze and interpret the data.</td>
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<td>5</td>
<td>Modern tool usage</td>
<td>Apply various tools and techniques to improve the efficiency of the system.</td>
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<td>6</td>
<td>The Engineer and society</td>
<td>Conduct themselves to uphold the professional and social obligations.</td>
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<tr>
<td>7</td>
<td>Environment and sustainability</td>
<td>Design the system with environment consciousness and sustainable development.</td>
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<td>8</td>
<td>Ethics</td>
<td>Interact in industry, business and society in a professional and ethical manner.</td>
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<td>Individual and team work</td>
<td>Function in a multidisciplinary team.</td>
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<td>Communication</td>
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<td>Project management and finance</td>
<td>Implement cost effective and improved system.</td>
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<td>Life-long learning</td>
<td>Continue professional development and learning as a life-long activity.</td>
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PROGRAM SPECIFIC OUTCOMES (PSOs):

1. To create awareness on the solar energy, generation from solar thermal and SPV systems, distribution, consumption and computation of plant efficiency.
2. To quantify the emission mitigation for sustainable development through solar energy system.
3. To impart knowledge in various domains to identify research gaps and ideate innovations by simulation of solar energy systems using softwares such as MATLAB, ANSYS- CFX, Fluent, TRNSYS, PV-SYST, PVF-Chart, F-Chart, COMSOL Multiphysics.

PEO / PO Mapping:

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I YEAR

II YEAR

Dissertation-II
## ANNA UNIVERSITY, CHENNAI

UNIVERSITY DEPARTMENTS

M.E. (SOLAR ENERGY) (FULL – TIME)

REGULATIONS - 2019

CHOICE BASED CREDIT SYSTEM

CURRICULA AND SYLLABI FOR I TO IV SEMESTERS

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* Audit Course is optional.

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* Audit Course is optional.
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### SEMESTER IV

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Total credits for the programme = 23 + 22 + 15 +12 = 72
## PROGRAM CORE COURSES (PCC)

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## PROGRAM ELECTIVE COURSES

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### RESEARCH METHODOLOGY AND IPR COURSES (RMC)

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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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EMPLOYABILITY ENHANCEMENT COURSES (EEC)

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EY5155  THERMODYNAMIC ANALYSIS OF ENERGY SYSTEMS  

OBJECTIVES:
1. To understand and apply the concept of availability and thermodynamic relations
2. To understand and calculate the behaviour of real gases and gas mixtures
3. To understand the applications of first and second law to chemically reacting systems
4. To learn various aspects of combustion chemistry
5. To use the concepts of advanced thermodynamics to combustion 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

OUTCOMES:
Upon completion of this course, the students will be able to:
1. Calculate the availability of the systems and cycles, and apply various thermodynamic relations
2. Predict the behavior of real gas and calculate the properties of gas mixtures
3. Apply first and second law to chemically reacting systems
4. Calculate the air fuel ratio, composition of combustion products and combustion limits
5. Apply the thermodynamic knowledge for analyzing the combustion process and combustion chamber design
REFERENCES:
4. Kuo, K.K., Principles of Combustion, John Wiley and Sons, 2005

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EY5152 FLUID MECHANICS AND HEAT TRANSFER L T P C

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
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
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. Learn the flow concepts of incompressible and compressible flow.
3. Solve the conduction and gas radiation heat transfer problems.
4. Understand the turbulent forced convective heat transfer
5. Design a heat exchanger as per the industrial needs.

REFERENCES:

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
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  

UNIT – III  DIGITAL MEASUREMENT OF PHYSICAL QUANTITIES  

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

UNIT – V  CONTROL SYSTEMS  

TOTAL: 45 PERIODS

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.
4. Implement the measurement of thermo-physical properties and air pollutants.
5. Design and develop the appropriate measurement and control system for an application.

REFERENCES:
OBJECTIVES:
1. To impart the knowledge on the basics of solar energy and laws related to it.
2. To understand the physics of sun, angles and solar time.
3. To study the principle operations, types and applications of solar cells.
4. To provide insights of solar thermal collectors and basic solar cycles.
5. To understand the concepts of various energy storage technologies.

UNIT – I INTRODUCTION
Basics of solar energy - Brief History of solar energy utilization - Various approaches of utilizing solar energy - Blackbody radiation - Relation between radiation field energy density and radiation spectrum - Planck’s formula in energy unit - Maximum spectral density - Planck’s formula in wavelength unit - Wien displacement law - Stefan - Boltzmann law - Photoelectric effect - Einstein’s theory of photons - Einstein’s derivation of the black-body formula.

UNIT – II THE PHYSICS OF THE SUN & ATMOSPHERIC INTERACTION
The structure of the Sun - Basic parameters of the Sun - Measurement of the solar constant - Rotation and orbital motion of the Earth around the Sun - Solar time, sidereal time, universal standard time, local standard time - Equation of time - Intensity of sunlight on an arbitrary surface at any time - Interaction with the atmosphere - Air mass - Rayleigh and Mie scattering - Absorption.

UNIT – III SOLAR CELLS
Formation of a PN – junction - Space charge and internal field - Quasi - Fermi levels - The Shockley diode equation - Structure of a solar cell - The solar cell equation - Fill factor and maximum power - Various electron-hole pair recombination mechanisms - Crystalline silicon solar cells: Mono and Multi-crystalline, Thin film solar cells: CIGS, CdTe, a-Si and Tandem solar cells, Multi-junction cells, Emerging PV: DSSC - Organic solar cells – Perovskite – Quantum Dots.

UNIT – IV SOLAR THERMAL COLLECTORS
Solar flat plate collector – Concentrating collectors – Concentration ratio - Three types of imaging optics: trough or linear collectors, central receiver power tower with heliostats, and parabolic dish concentrator with duel axis tracking - Solar thermal electricity using Stirling engine or Ranking engine - Solar photovoltaics with concentration.

UNIT – V ENERGY STORAGE
Necessity of storage for solar energy - Chemical energy storage - Thermal energy storage - Thermal Flywheels - Compressed air energy storage- Rechargeable batteries.

TOTAL: 45 PERIODS

OUTCOMES:
Upon completion of this course, the students will be able to:
1. Enumerate the basic laws related to the solar radiation.
2. Predict the solar time due to the motion of the earth with respect to sun.
3. Provide accurate diagrams of solar cells and be able to classify solar cells.
4. Formulate scientific questions about the imaging type concentrating collectors.
5. Identify and classify the different energy storage techniques.
REFERENCES:

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RM5151 RESEARCH METHODOLOGY AND IPR L T P C
2 0 0 2

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)

15
UNIT V INTELLECTUAL PROPERTY RIGHTS (IPR)


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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SY5111 SOLAR THERMAL LABORATORY - I L T P C 0 0 4 2

OBJECTIVES:
1. To provide practical knowledge on various solar thermal systems
2. To evaluate the thermal performance of solar thermal systems

LIST OF EXPERIMENTS
1. Solar Radiation Measurements
2. Thermo-Syphon Solar Water Heater
3. Forced Convection Solar Water Heater
4. Wind load effect on Thermo-Syphon Solar Water Heater
5. Wind load effect on Forced Convection Solar Water Heater
6. Effect of inclination angle on the performance of solar water heater
7. Serpentine solar water heater
8. Forced convection Solar air collector
9. Natural convection solar air collector
10. Solar Box Cooker
11. Solar Box cooker with reflector
12. Thermal Energy Storage assisted Solar Box Cooker

TOTAL: 60 PERIODS
OUTCOMES:
Upon completion of this course, the students will be able to:
1. Measure the solar radiation using various measuring instruments
2. Assess the thermal behavior of solar systems.

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SY5112 ANALYSIS AND SIMULATION LABORATORY FOR SOLAR ENERGY

OBJECTIVES:
1. To provide a platform to learn and get familiar with transient system simulation tool
2. To learn the transient analysis simulation software for predicting the performance of solar system components

LIST OF EXPERIMENTS
1. Performance study on different types of solar flat plate collector
2. Performance study on stand-alone solar PV panel.
3. Detailed comparative study between horizontal and vertical sensible storage tank for uniform and non-uniform losses.
4. Performance study on thermo-syphon solar collector with internal storage.
5. Optimization of solar collector integrated with stratified thermal storage tank for hot water applications.
6. Performance study on linear parabolic concentrator using different heat transfer fluids.
7. Performance Study of solar flat plate collector including shading effects.
8. Performance study on one-ton solar refrigeration system.
9. Optimize the solar air heating system for drying application
10. Performance study on packed bed sensible thermal energy storage unit
11. Performance study on PVT solar collector using air and water as a heat transfer fluids
12. Performance Study of solar PV panel including shading effects.

TOTAL: 60 PERIODS

OUTCOMES:
Upon completion of this course, the students will be able to:
1. Use modern engineering software tools to analyze the transient behavior of various solar systems.
2. Analyze the various parameters influencing the performance of solar systems.

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SY5201 SOLAR PHOTOVOLTAIC TECHNOLOGIES  L  T  P  C
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OBJECTIVES:
1. To explain basics of solar photovoltaic systems.
2. To know in depth of its types and design of various PV-interconnected systems.
3. To Learn about the grid connected PV systems.
4. To impart knowledge on need and type of Hybrid systems.
5. To design the System Components for different PV Applications.

UNIT – I INTRODUCTION TO SOLAR PHOTOVOLTAICS
Structure and working of Solar Cells - Types, Electrical properties and Behaviour of Solar Cells - Cell properties and design - PV Cell Interconnection and Module Fabrication - Electrical characteristics of the solar cell - equivalent circuit - Effects of temperature, irradiation and series/shunt resistances on the open-circuit voltage and short-circuit current - PV generators, shadow effects – Blocking and bypass diodes - hot spot problem in a PV module.

UNIT – II STAND ALONE PV SYSTEMS
Schematics and Components - Balance of system components for DC and/or AC Applications - Maximum power point tracking (MPPT) algorithms - Interfacing PV modules to loads - Direct connection of loads to PV modules - Connection of PV modules to a battery and load together - Typical applications for lighting, water pumping etc.

UNIT – III GRID CONNECTED PV SYSTEMS
Schematics and Components - Balance of system Components - Interface Components – Net metering - Feasible operating region of inverter at different power factor - Active power filtering with real power injection.

UNIT – IV HYBRID SYSTEMS
Need for Hybrid Systems - Range and type of Hybrid systems - Case studies of Diesel-PV, Wind-PV, Microhydel-PV, Biomass-Diesel systems, Electric and hybrid electric vehicles - Comparison and selection criteria for a given application.

UNIT – V DESIGN OF PV SYSTEMS
Design of System Components for different PV Applications - Sizing and Reliability - Modeling and simulation of stand-alone and grid-connected PV systems – Case Studies.

TOTAL: 45 PERIODS

OUTCOMES:
Upon completion of this course, the students will be able to:
1. Apply principle of evidence-based photovoltaic technology
2. Provide accurate schematic of stand-alone PV systems and BOS
3. Provide accurate schematic of grid-connected PV systems and BOS
4. Select appropriate hybrid system for different applications
5. Design and simulate the stand-alone and grid connected system.

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SY5202 SOLAR THERMAL TECHNOLOGIES

OBJECTIVES:
1. To clarify impression of various solar thermal energy collectors
2. To delineate the other applications and the devices used to collect solar energy
3. To study the various types and configurations of solar space conditioning system
4. To learn the various solar applications.
5. To summarize the basic economics of solar energy collection system.

UNIT – I SOLAR COLLECTORS

UNIT – II SOLAR WATER HEATING SYSTEMS

UNIT – III SOLAR SPACE CONDITIONING SYSTEMS

UNIT – IV OTHER SOLAR APPLICATIONS

UNIT – V SOLAR ECONOMICS
Application of economic methods to analyze the feasibility of solar systems to decide project / policy alternatives - Net energy analysis - and cost requirements for active and passive heating and cooling - for electric power generation - and for industrial process-heating.
Economics – Fixed and variable cost - Payback period - Net Present Value - Internal Rate of Return - Carbon credit – Embodied energy analysis.

OUTCOMES:
Upon completion of this course, the students will be able to:
1. Explain the technical and physical principles of different solar collectors
2. Measure and evaluate different solar energy technologies through knowledge of the physical function of the devices
3. Articulate the technical and economic fundamentals of solar thermal energy conversion useful to society and industry
4. Describe the spectrum of possible solar thermal technologies to assist industrial processing or power production
5. Communicate technological and socio-economic issues around solar energy in a concise and an accessible way to a target group with basic technical skills.

TOTAL: 45 PERIODS
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EY5251 COMPUTATIONAL FLUID DYNAMICS FOR ENERGY SYSTEMS L T P C 3 1 0 4

OBJECTIVES:
1. To make students familiarize with the computational analysis
2. To explain the numerical analysis of solving of steady and unsteady diffusion heat transfer
3. To explain the numerical analysis of solving of convection-diffusion heat transfer
4. To provide the details of discretization of incompressible flow governing equations
5. To impart the knowledge of turbulence modelling

UNIT – I GOVERNING DIFFERENTIAL EQUATIONS AND DISCRETISATION TECHNIQUES

UNIT – II DIFFUSION PROCESSES : FINITE VOLUME METHOD

UNIT – III CONVECTION - DIFFUSION PROCESSES : FINITE VOLUME METHOD
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
Discretization of incompressible flow equations – Stream Function – Vorticity methods - Pressure based algorithms, SIMPLE, SIMPLER, SIMPLEC & PISO algorithms.
UNIT – V  TURBULENCE MODELLING

Kolmogorov’s Theory - Turbulence - Algebraic Models, One equation model & \( k - \varepsilon \), \( k - \omega \) models - Standard and High and Low Reynolds number models.

TOTAL: 60 PERIODS

OUTCOMES:
Upon completion of this course, the students will be able to:
1. Know the differences between various discretization techniques.
2. Learn the finite volume based numerical method for solving diffusion heat transfer problems.
3. Learn the finite volume based numerical method for solving convection-diffusion heat transfer problems.
4. Understand the discretization of incompressible flow governing equations
5. Recognize the impact of various turbulence modelling

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SY5211  SOLAR THERMAL LABORATORY - II  L  T  P  C
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OBJECTIVES:
1. To provide practical knowledge on various solar thermal concentrating collectors
2. To evaluate the thermal performance of various solar thermal systems

LIST OF EXPERIMENTS
1. Evacuated tube solar collector
2. Solar dish collector
3. Compound parabolic collector connected in series
4. Compound parabolic collector connected in parallel
5. Parabolic trough collector
6. Scheffler Dish solar concentrator
7. Heat pipe solar collector
8. PVT air collector
9. PVT air collector integrated greenhouse dryer
10. Solar still
11. Integrated PVT Solar still
12. Thermal Energy Storage assisted Solar still

TOTAL: 60 PERIODS
OUTCOMES:
Upon completion of this course, the students will be able to:
1. Assess the thermal performance of solar concentrating collectors
2. Demonstrate the experiment of various integrated solar systems

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SY5212 SOLAR PHOTOVOLTAIC LABORATORY

OBJECTIVES:
1. To construct a practical knowledge on stand-alone solar PV systems.
2. To construct a practical knowledge on grid tide solar PV systems.

LIST OF EXPERIMENTS
1. Study on Solar Cell Characteristics
2. Testing of SPV Stand-alone Systems
3. Testing on Solar Home Systems
4. Optimization of SPV Systems with Load Resizing
5. Testing of Simple Hybrid Systems
6. Testing of Solar PV Water Pumps
7. Studies on Charging and Discharging Cycles of the batteries.

TOTAL: 60 PERIODS

OUTCOMES:
Upon completion of this course, the students will be able to:
1. The performance of the Solar PV cell under various specified operating temperature ranges and will be able to relate it with nominal values.
2. The various radiation measuring instruments related to solar photovoltaics.

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SY5001 MATERIALS FOR SOLAR DEVICES

OBJECTIVES:
1. To comprehend the materials that has been implicated in various forms of solar energy sources and its storages.
2. To educate the structure-property relationship and appreciate novel developments in the materials.
3. To explain the concept and the diverse materials used for solar devices.
4. To explicate in depth knowledge of about solar cells, thermal energy storage and electrical energy storages
5. To gather some idea of system balance and analysis with reference to its cost.
UNIT – I MATERIALS FOR SOLAR COLLECTORS

UNIT – II MATERIALS FOR SOLAR CELLS

UNIT – III THIN FILM AND NOVEL SOLAR CELL MATERIALS

UNIT – IV ENERGY STORAGE MATERIALS

UNIT – V BALANCE OF SYSTEM MATERIALS & COST ANALYSIS
Functional requirements of other materials for components like Invertors, Charge Controllers, Wires, Pipes, Valves, etc. and identification of suitable materials - Simple Cost Analysis for alternative selection of materials - Case studies.

TOTAL: 45 PERIODS

OUTCOMES:
Upon completion of this course, the students will be able to:
1. The students will get fundamental understanding on principles of materials used in solar cells.
2. The students will be able to understand the structure-property relationship and appreciate novel developments in the materials.
3. To explain the concept and the diverse materials used for solar devices.
4. To explicate in depth knowledge of about solar cells, thermal energy storage and electrical energy storages.
5. To gather some idea of system balance and analysis with reference to its cost.

REFERENCES:
5. Thomas Markvart, Solar Electricity, John Wiley and Sons, 2007
OBJECTIVES:
1. To know the 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 9
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 9

UNIT – III WIND ENERGY 9

UNIT – IV BIO-ENERGY 9

UNIT – V OCEAN AND GEOTHERMAL ENERGY 9

TOTAL: 45 PERIODS

OUTCOMES:
Upon completion of this course, the students will be able to:
1. Know the Indian and global energy scenario
2. Learn the various solar energy technologies and its applications.
3. Have knowledge in the various wind energy technologies.
4. Explore the various bio-energy technologies.
5. Learn the ocean and geothermal technologies.

REFERENCES:
EY5151

ENERGY MANAGEMENT AND ENVIRONMENTAL BENEFITS

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
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

UNIT – III PROJECT MANAGEMENT
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

UNIT – IV FINANCIAL MANAGEMENT
Investment appraisal for energy conservation projects - Financial analysis techniques -Simple pay back period, Return on investment, Net present value, Internal rate of return - Cash flows - Risk and sensitivity analysis: micro and macro factors - Financing options - energy performance contracts - ESCOs.

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

TOTAL: 45 PERIODS
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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RA5071 SOLAR REFRIGERATION AND AIR-CONDITIONING L T P C
COURSE OBJECTIVES:
1. To impart the knowledge on thermodynamic cycles.
2. To provide thermal aspects on solar cooling.
3. To teach the students to have a broad understanding on absorption chillers.
4. To teach the students on modeling of solar refrigeration system.
5. To learn about economics in solar cooling systems.

UNIT – I INTRODUCTION 9

UNIT – II SOLAR COOLING 9
UNIT – III  ABSORPTION COOLING

UNIT – IV  COMPONENT DESIGN VAPOUR COMPRESSION REFRIGERATION
Vapour compression refrigeration cycles - Rankine cycle - Sterling cycle based solar cooling systems - Thermal modelling for continuous and intermittent solar refrigeration and air-conditioning systems.

UNIT – V  IMPLEMENTATION TECHNIQUES
PV powered refrigerator – Free cooling - Solar thermoelectric refrigeration and air-conditioning – Solar economics of cooling systems - Case studies.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
Upon completion of this course, the students will be able to:
1. Analyze the performance of different refrigeration cycles.
2. Design the different types of solar collectors for a given cooling load.
3. Analyze the performance of absorption chillers.
4. Design the solar powered vapor compression refrigeration system.
5. To analyze the economics of solar based cooling system.

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SY5002  SOLAR SYSTEMS FOR BUILDING TECHNIQUES

OBJECTIVES:
1. To explain the concept of solar thermal and electrical applications of building
2. To study the green buildings concepts applicable to modern and alternative building design
3. To be familiar with simple terminologies associated to building techniques
4. To know the methods to evaluate the performance of buildings
5. To summarize life cycle analysis for thermal and electrical solar systems

27
UNIT – I  INTRODUCTION

UNIT – II  SOLAR HEAT GAIN IN BUILDINGS

UNIT – III  SOLAR THERMAL SYSTEMS FOR BUILDINGS

UNIT – IV  SOLAR PV SYSTEMS FOR BUILDINGS

UNIT – V  ECONOMIC ANALYSIS

TOTAL: 45 PERIODS

OUTCOMES:
Upon completion of this course, the students will be able to:
1. Will be aware with climate responsive building design and simple concepts
2. Will Know the basic terminologies associated with buildings
3. Will be able to estimate the performance of buildings
4. Gets familiar with Renewable energy systems in buildings
5. Will understand the solar PV systems for buildings

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OBJECTIVES:
1. To understand about National energy scenario.
2. To predict the energy demand using various forecasting models.
3. To develop an optimization model for the effective utilisation of energy sources.
4. To know the procedure to write the project proposal.
5. To know the energy policies in the country.

UNIT – I  ENERGY SCENARIO  9
Role of energy in economic development and social transformation: Energy & GDP, GNP and its
dynamics - Energy Sources and Overall Energy demand and Availability - Energy Consumption
in various sectors and its changing pattern - Status of Nuclear and Renewable Energy: Present
Status and future promise.

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
Principles of Optimization - Formulation of Objective Function - Constraints - Multi Objective
Optimization - Mathematical Optimization Software – Development of Energy Optimization
Model - Development of Scenarios – Sensitivity Analysis - Concept of Fuzzy Logic.

UNIT – IV  PROJECT MANAGEMENT  9
Project Preparation – Feasibility Study – Detailed Project Report - Project Appraisal – Social-cost
benefit Analysis - Project Cost Estimation – Project Risk Analysis - Project Financing – Financial
Evaluation.

UNIT – V  ENERGY POLICY  9
National solar mission - state solar energy policy - Framework of Central Electricity Authority
(CEA), Central & States Electricity Regulatory Commissions (CERC & ERCs)-Costing.

OUTCOMES:
Upon completion of this course, the students will be able to:
1. Have knowledge in the National energy scenario.
2. Do Energy prediction using various forecasting techniques.
3. Develop optimization model for energy planning.
4. Capable of writing project proposals.
5. Understand the National and state energy policies.

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2. DhandapaniAlagiri, Energy Security in India Current Scenario, The ICFAI University Press,
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Based Approach, Information Age Publishing; 13 edition, 2015
4. Spyros G. Makridakis, Steven C. Wheelwright, Rob J. Hyndman, Forecasting: Methods and
5. Yang X.S., Introduction to mathematical optimization: From linear programming to
EY5081                   SOLAR ENERGY TECHNOLOGIES  L  T  P  C
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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 COLLECTORS
Solar angles – Sun path diagrams – Radiation - extraterrestrial characteristics - measurement and estimation on horizontal and tilted surfaces - flat plate collector thermal analysis - testing methods- evacuated tubular collectors - concentrator collectors – classification - design and performance parameters - tracking systems - compound parabolic concentrators - parabolic trough concentrators - concentrators with point focus - Heliostats – performance of the collectors

UNIT – II   SOLAR THERMAL TECHNOLOGIES

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
Thermal comfort - bioclimatic classification – passive heating concepts: direct heat gain - indirect heat gain - isolated gain and sunspaces - passive cooling concepts: evaporative cooling - Radiative cooling- application of wind, water and earth for cooling; shading - paints and cavity walls for cooling – roof radiation traps - earth air-tunnel – energy efficient landscape design - thermal comfort

TOTAL: 45 PERIODS
OUTCOMES:
Upon completion of this course, the students will be able to:
1. Learn and study the solar radiation and various solar collectors
2. Know the various solar thermal energy technologies and their applications
3. Aware about various solar PV cell materials and conversion techniques
4. Learn various Solar SPV systems designs and their applications
5. Know about various solar passive building techniques for cooling and heating applications

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SY5003 SOLAR ENERGY APPLIANCES L T P C
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OBJECTIVES:
1. To learn the principle behind operation of solar PV cell and its application in lighting system.
2. To understand the principle of working of solar cooker with types and its solar applications.
3. To learn the need for solar drying and operation of different dryer types.
4. To learn about various desalination techniques and factors influencing productivity of solar still with its types.
5. To know about solar furnaces and its components.

UNIT – I SOLAR LIGHTING 9

UNIT – II SOLAR COOKING 9

UNIT – III SOLAR DRYING 9
UNIT – IV  SOLAR DESALINATION 9

UNIT – V  SOLAR FURNACES 9

TOTAL: 45 PERIODS

OUTCOMES:
Upon completion of this course, the students will be able to:
1. Diagnose the fundamental concepts about solar energy systems and devices.
2. Will be familiar with concepts of solar home lighting and solar street lighting systems.
3. Identify the solar cooker technologies for suitable applications.
4. Recognize the applications and types of solar dryers.
5. Aware about various desalination techniques and material problems in solar still.

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EY5071  ADVANCED ENERGY STORAGE TECHNOLOGIES  

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COURSE OBJECTIVES:
1. To understand the various types of energy storage technologies and its applications.
2. To study the various modelling techniques of energy storage systems using TRNSYS.
3. To learn the 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 Flywheel and compressed 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 – 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  9
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 dioxide and modern batteries for example (i) zinc-Air (ii) Nickel Hydride, (iii) Lithium Battery.

UNIT – IV  HYDROGEN AND BIOGAS STORAGE  9

UNIT – V  ALTERNATE ENERGY STORAGE TECHNOLOGIES  9
Flywheel, Super capacitors, Principles & Methods – Applications, Compressed air Energy storage, Concept of Hybrid Storage – Applications.

TOTAL: 45 PERIODS

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. Recognize the concepts and types of batteries.
4. Diagnose the principle operations of Hydrogen and Biogas storage.
5. Analyze the concepts of Flywheel and compressed energy storage systems.

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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 IV   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

OUTCOMES:
Upon completion of this course, the students:
1. Will be familiar with climate responsive building design and basic concepts
2. Will Know the basic terminologies related to buildings
3. Will Know the passive (air) conditioning techniques
4. Will be able to evaluate the performance of buildings
5. Gets acquainted with Renewable energy systems in buildings

REFERENCES:
OBJECTIVES:
1. To learn the fundamental concepts of solar energy power generating systems and devices.
2. To comprehend Indian governmental regulatory policy on renewable energy technology particularly on solar energy.
3. To appreciate the concepts adopted in techno-economic analysis of solar thermal power plants.
4. To know the energy policies in the country.
5. To forecast the energy demand using different forecasting models.

UNIT – I SOLAR THERMAL POWER GENERATION
Solar Parabolic trough - Design considerations, tracking and control systems - Thermal design of receivers - Solar parabolic dish - Design considerations, Sterling engine, Brayton cycle, tracking and control systems - Solar tower concepts - Tower design - Heliostat design - Receiver types, tracking and control systems - Performance study, site selection and land requirement for the above technologies - Techno-economic analysis of solar thermal power plants.

UNIT – II SOLAR PHOTOVOLTAIC POWER GENERATION
Solar PV technologies overview - Stationary and concentrated PV - Inverter and control technologies - Master slave inverter system design - Standalone systems - Grid connected systems - Hybridization, synchronization and power evacuation - Site selection and land requirements - Techno-economic analysis of solar PV power plants - Environmental considerations.

UNIT – III SOLAR ENERGY POLICY PLANNING
Elements in policy making in solar energy - Components of policy making - Essentials and other requirements - Pre-requirements of policy planning - Models for planning for effective policy making - Data requirements for policy plans - Monitoring and assessments of policies - Global policy pronouncement.

UNIT – IV SOLAR ENERGY REGULATIONS AND POLICY PROGRAMMES

UNIT – V POLICY MANAGEMENT CHALLENGES
Challenges for planning and policies - Issues of subsidization - Entrepreneurship development and management challenges - Issues in entrepreneurship development and management challenges in renewable energy sector in India – Production – Storage - Transmission and distribution - End-use - Pricing, etc

TOTAL: 45 PERIODS
OUTCOMES:
Upon completion of this course, the students will be able to:
1. The fundamentals of solar energy power generating systems and devices were learnt.
2. The Indian governmental policies on renewable energy and the policy management challenges particularly on solar energy technology were studied in detail.
3. Know the Indian and global energy scenario.
4. Learn the various solar power generation and environmental considerations.
5. Do Energy prediction using various forecasting techniques

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EY5073 ELECTRICAL DRIVES AND CONTROLS

OBJECTIVES
1. To impart the knowledge on the principle of conventional motor drives, various starting and speed control methods of motors.
2. To understand the concepts of various losses and harmonics effects in motors.
3. To study the Power Electronics components and controllers.
4. To provide insights of Superconductivity theory and super conducting magnetic energy storage.
5. To understand the concept of Solid State motor controllers and their applications

UNIT I CONVENTIONAL MOTOR DRIVES
Characteristics of DC and AC motor for various applications - starting and speed control - methods of breaking

UNIT II PHYSICAL PHENOMENA IN ELECTRICAL MACHINES
Various losses in motors-Saturation and Eddy current effects - MMF harmonics and their influence of leakage-stray losses - vibration and noise.
UNIT III SOLID STATE POWER CONTROLLERS

Power devices: Triggering Circuits, Rectifiers – Single Phase and Three Phase with R, RL and Freewheeling Diode, Choppers - Type-A, Type-B, Type C and Type D, Inverters - Single Phase and Three Phase with R, RL and Freewheeling Diode, AC Voltage Controllers

UNIT IV SUPERCONDUCTIVITY

Principle of Super conductivity, Super conducting generators-motors and magnets - Super conducting magnetic energy storage (SMES).

UNIT V SOLID STATE MOTOR CONTROLLERS

Single and Three Phase fed DC motor drives - AC motor drives - Voltage Control - Rotor resistance control - Frequency control - Slip Power Recovery scheme

OUTCOMES
1. Diagnose the operations of conventional motor drives, various starting and speed control methods of motors.
2. Analyze the different losses and harmonic effects in motors.
3. Recognize the Power electronics components and design the controllers.
4. Apply the Superconductivity theory and analyze the super conducting magnetic energy storage.
5. Analyse the concept of Solid State motor controllers and their applications

REFERENCES
3. Rene Husson, Modelling and Control of Electrical machines, Elsevier Science Ltd, 2009

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EY5079 POWER ELECTRONICS FOR RENEWABLE ENERGY SYSTEMS

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  9
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 CONVERSION  9
Review of reference theory fundamentals-principle of operation and analysis: IG, PMSG, SCIG and DFIG

UNIT III  POWER CONVERTERS  9

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-PV Maximum Power Point Tracking (MPPT).

TOTAL: 45 PERIODS

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

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OBJECTIVES:
1. To explain concept of various power cycles involved in the solar power plants
2. To learn and study the solar radiation and various solar power plants
3. To outline the variety of solar systems used to collect solar energy
4. To learn electrical performance of PV power plants.
5. To summarize basic economics of solar power plants.

UNIT – I  INTRODUCTION
Power Plant Scenario - Classification, Basic Principles and Features - Comparison and selection Criteria.

UNIT – II  SOLAR POWER CYCLES

UNIT – III  SOLAR THERMAL POWER PLANTS

UNIT – IV  SOLAR PV POWER PLANTS

UNIT – V  ECONOMICS OF POWER PLANTS

OUTCOMES:
Upon completion of this course, the students will be able to:
1. The concept of various power cycles involved in the solar power plants were learnt.
2. Learn and study the solar radiation and various solar collectors
3. Know the various solar thermal energy technologies and their applications
4. The variety of solar systems used to collect solar energy were studied in detail.
5. The basic economics of solar power plants were understood

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TOTAL: 45 PERIODS
OBJECTIVES:
1. To learn the fundamental concepts of solar passive building architecture
2. To know the concepts of passive solar heating and cooling of buildings.
3. To learn about various building materials.
4. To know the zero energy building concept and rating systems
5. To study the energy management of buildings and green globe assessment standards.

UNIT – I INTRODUCTION

UNIT – II PASSIVE SOLAR HEATING OF BUILDINGS

UNIT – III PASSIVE COOLING OF BUILDINGS
Passive cooling concept - Solarium Passive cooling - Ventilation cooling - Nocturnal radiation cooling - Evaporative cooling - Roof surface evaporative cooling (RSEC) - Direct evaporative cooling using drip-type (desert) coolers – Radiation cooling - Earth coupling - Basic principles and systems.

UNIT – IV CLIMATE AND HUMAN THERMAL COMFORT

UNIT – V BUILDING RATING SYSTEMS

OUTCOMES:
Upon completion of this course, the students will be able to:
1. The fundamental concepts of solar passive architecture were understood along with examples and case studies.
2. The concepts of passive solar heating and cooling of buildings, human comfort conditions.
3. Aware about various building materials.
4. Know the zero energy building concept and rating systems.
5. Learn the energy management of buildings and green globe assessment standards.

REFERENCES:
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
Man & Environment – Types of Pollution – Global Environmental issues – Environmental Impact Assessment – Global Warming Issues – CO₂ Mitigation – Basic definition of Pollution Indicators – Noise Pollution

UNIT – II WATER POLLUTION
Pollutants in Water & Wastewater – 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 WASTE MANAGEMENT

TOTAL: 45 PERIODS

OUTCOMES:
Upon completion of this course, the students will be able to:
1. Types and effects of each type of pollution on man – earth will be made known.
2. Technical aspects of Global Warming will make them understand the impact they have on climate
3. Technologies that are available for reduction of pollutants dumped into the atmosphere.
4. Cursory / superficial formation - the students – had in Hazardous waste, waste disposal hitherto will be deep & sensible enough after studying this subject
5. Comprehend the different techniques available for safe disposal of hazardous waste

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EY5080 SMART GRIDS L T P C 3 0 0 3

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 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/VArcontrol, 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 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, Basics of Web Service and CLOUD Computing to make Smart Grids smarter, Cyber Security for Smart Grid.

TOTAL: 45 PERIODS

OUTCOMES
1. Students will develop more understanding on the concepts of Smart Grid and its present developments.
2. Students will study about different Smart Grid technologies.
3. Students will acquire knowledge about different smart meters and advanced metering infrastructure.
4. Students will have knowledge on power quality management in Smart Grids.
5. Students will develop more understanding on LAN, WAN and Cloud Computing for Smart Grid applications.

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SY5007 SOLAR ENERGY FOR INDUSTRIAL PROCESS HEATING  L  T  P  C
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OBJECTIVES:
1. To learn the basic concepts of solar energy related industrial process heat.
2. To familiarize about materials for flat plate collector and their properties.
3. To study about industrial hot water, hot sir and steam process heat system.
4. To understand the applications of solar industrial process heat.
5. To study the techno-economic details for the related process heat industries.

UNIT – I INTRODUCTION
Solar energy – Availability and utilization - Historical background of solar industrial process heat (IPH) - Need of the day – Opportunities and challenges of industrial process heat - Characteristics of industrial process heat.

UNIT – II SOLAR ENERGY COLLECTORS FOR INDUSTRIAL PROCESS HEATING
UNIT – III  INDUSTRIAL PROCESS HEATING SYSTEM

Introduction – Hot water industrial process heat system – Hot air industrial process heat system – Steam industrial process heat system – Problems involved with industrial process heat system – Case studies on industrial process heat.

UNIT – IV  APPLICATIONS OF SOLAR INDUSTRIAL PROCESS HEAT

Industrial sectors and processes with the potential for solar thermal uses - Food and beverage industries - The textile and chemical industries - Power generation applications – Washing process – Drying process – Distillation and chemical process.

UNIT – V  TECHNO-ECONOMIC ANALYSIS


TOTAL: 45 PERIODS

COURSE OUTCOMES:
Upon completion of this course, the students will be able to:
1. The basic concepts of solar energy-related industrial process heat systems were understood.
2. Students will have knowledge on materials for flat plate collector and their properties.
3. Students will acquire knowledge about industrial hot water, hot air and steam process heat system.
4. Learn the various applications of solar industrial process heat.
5. The techno-economic details for the related process heat industries were incorporated.

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OPEN ELECTIVE COURSES (OEC)

OE5091  BUSINESS DATA ANALYTICS

COURSE 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

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  


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  


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

COURSE 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 L T P C
3 0 0 3

COURSE 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  9
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  9

UNIT IV  FAULT TRACING  9
Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, i. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.

UNIT V  PERIODIC AND PREVENTIVE MAINTENANCE  9
Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: i. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance

TOTAL: 45 PERIODS

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

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

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

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

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

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

TOTAL: 45 PERIODS

COURSE 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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REFERENCES:
OE5094  COST MANAGEMENT OF ENGINEERING PROJECTS  L T P C  3 0 0 3

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

UNIT IV  COSTING OF SERVICE SECTOR AND BUDGETERY CONTROL  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
OE5095 COMPOSITE MATERIALS

COURSE 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

COURSE 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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COURSE 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

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

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

UNIT III BIOMASS GASIFICATION

UNIT IV 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.

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

TOTAL: 45 PERIODS

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

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AUDIT COURSES (AC)

AX5091 ENGLISH FOR RESEARCH PAPER WRITING

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

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AX5092 DISASTER MANAGEMENT L T P C
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COURSE 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

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

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AX5093 SANSKRIT FOR TECHNICAL KNOWLEDGE L T P C
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COURSE 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

COURSE 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” Pratham Deeksha-Vempati Kutumbshastri, Rashtriya Sanskrit Sansthanam, New Delhi Publication

AX5094 VALUE EDUCATION

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

SUGGESTED READING

AX5095 CONSTITUTION OF INDIA

COURSE 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 Revolution1917 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

COURSE 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

COURSE OBJECTIVES
Students will be able to:
- Review existing evidence on the 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 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 III THEMATIC OVERVIEW
Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries - Curriculum, Teacher education.

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

COURSE 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

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

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

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

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

TOTAL: 30 PERIODS

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

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

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

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

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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 (dont’s) - Verses-71,73,75,78 (do’s)

UNIT II
Approach to day to day work and duties - Shrimad Bhagwad Geeta: Chapter 2-Verses 41, 47,48 - Chapter 3-Verses 13, 21, 27, 35 Chapter 6-Verses 5,13,17,23, 35 - Chapter 18-Verses 45, 46, 48.

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

TOTAL: 30 PERIODS

COURSE 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-sringar-vairagya, New Delhi,2010