M.Sc., ENERGY STUDIES (CBCS)

REGULATIONS, SCHEME & SYLLABUS

WITH EFFECTIVE FROM 2018-2019

DEPARTMENT OF ENERGY STUDIES

PERIYAR UNIVERSITY
PERIYAR PALKALAI NAGAR
SALEM – 636 011
TAMIL NADU

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Regulations & Scheme

Department of Energy Studies

PG Degree

Choice Based Credit System (CBCS) Regulation,
Scheme and Syllabus
(w.e.f. 2018-2019 onwards)

1. Eligibility for Admission

Candidate who has passed the B.Sc., degree in Physics/Chemistry /Geology/Electronics/Energy Studies or B.E/B.Tech degree in Mechanical/Mechatronics/Electrical & Electronics/Electronics & Communication/Automobile/Chemical Engineering of the University or an Examination of any other University accepted by the Syndicate as equivalent thereto shall be eligible for admission to M.Sc., Degree of this University or any other University recognized by the Syndicate as equivalent thereto shall be eligible to register for the Degree of Master in Energy Studies (M.Sc.,) and undergo the prescribed course of study in an approved department of this University.

2. Mode of Selection

The admission is subject to the prevailing rules and regulations for PG admission of this University and also as per the norms of Tamil Nadu Government.

3. Duration of the Course

The duration of the M.Sc., Degree shall be two years consist of four semesters under Choice Based Credit System.

4. Distribution of Credit Points

The minimum credit requirement for M.Sc., Degree shall be 90 Credits. The break-up of credits for the Programme is as follows;

- Core Courses : 68 credits
- Elective Courses : 16 credits
- Supportive Courses : 06 credits

5. Course of Study

The course of study for the M.Sc., Degree shall be in Energy Studies (CBCS) with internal assessment according to syllabi prescribed from time to time.

5.1 Component of Internal Examination

The allotment of marks and Scheme of examination as follows;

Internal Tests (Best of two out of 3)	10 Marks
Seminar	05 Marks
Assignment	05 Marks
Attendance	05 Marks
Total	25 Marks

5.2 Theory Core Paper

External	75 Marks
Internal	25 Marks
Total	100 Marks
Duration of examination	3 Hours

5.3 Practical Internal & External

Model Practical	30 Marks
Record	05 Marks
Viva Voce	05 Marks
Internal Total	40 Marks
External	60 Marks
Total	100 Marks

5.4 Marks allotment for attendance as follows

% of attendance	Marks
91% - 100%	5
85%- 90%	4
81% - 84%	3
75% - 80%	2
Below 75%	No marks

6. Details of Project Marks

Mini Project

Submission of Dissertation	50 Marks
Viva-Voce	25 Marks
Internal Marks ❖ The marks should be provided by Internal Examiner only (Supervisor of the student)	25 Marks
Total	100 Marks

Main Project

Submission of Dissertation	100 Marks
Viva-Voce	50 Marks
Internal marks ❖ The marks should be provided by Internal Examiner only (Supervisor of the student)	50 Marks
Total	200 Marks

7. Question Paper Pattern

Time: 3 Hrs **Maximum Marks: 75**

PART – A (20X1=20 Marks)

Objective Type Question filled in the OMR sheet (No choice)

PART – B (5X3=15 Marks)

Analytical Questions (One question from each UNIT)

PART – C (5X8=40 Marks)

Either or Type descriptive question (Two questions from each UNIT)

8. Passing Minimum

1. There shall be no Passing Minimum Marks for Internal.
2. For External Examination, Passing Minimum shall be of 50% (Fifty Percentage) of the maximum marks prescribed for the paper.
3. In the aggregate (External + Internal) the passing minimum shall be of 50% for each Paper/Practical/Project and Viva-voce.
4. Grading shall be based on overall marks obtained (internal + external).

9. Classification of Successful Candidates

9.0 and above	First Class with Exemplary
7.5 and above but below 9.0	First Class with Distinction
6.0 and above but below 7.5	First Class
5.0 and above but below 6.0	Second Class
0.0 and above but below 5.0	Re-appear

10. Marks and Grades

Letter Grade & Description	**Grade points**	**Range of Marks**
`O' = Outstanding	9.0 – 10.0	**90 – 100**
`D+' = Excellent	8.0 – 8.9	**80-89**
`D' = Distinction	7.5 – 7.9	**75-79**
`A+' = Very Good	7.0 – 7.4	**70-74**
`A' = Good	6.0 – 6.9	**60-69**
`B' = Average	5.0 – 5.9	**50-59**
`U' = Re-Appear	0.0	**00-49**
'AAA'= Absent	**0.0**	**Absent**

11. Industrial Visit

As a Part of M.Sc., Energy Studies Degree, students shall go for industrial visit at different types of Energy based companies and institutes etc., under the guidance of faculty members.

12. Elective courses

Department of Energy Studies offers following Elective courses.

- Basics of solar cells
- Basics of Fluid Mechanics
- Rural Electrification & its Management
- Bio –Energy Conversion
- Hydrogen and Fuel Cells
- Energy Conservation, Energy Storage, And Transportation
- Green Concepts in Buildings

13. Supportive Courses

Department of Energy Studies offers following Supportive courses to other Department students.

- Basic Concepts in Energy Sciences
- Energy and environmental impacts
- Climate Change and CO_2 Emission Assessment
- Erection and Maintenance of Refrigeration and Air-Conditioning

Course Structure

DEPARTMENT OF ENERGY STUDIES

PERIYAR UNIVERSITY, SALEM – 11

M.Sc., Energy Studies – Course Structure

(Applicable to the candidates admitted from the academic year 2018-2019 onwards)

SEM	Core Course	Paper Code	Subject	Credits	CIA	EA	Total
I	I	**18PGERSC01**	APPLIED MATHEMATICS FOR ENERGY	4	25	75	100
	II	**18PGERSC02**	BASICS OF ENERGY SCIENCE	4	25	75	100
	III	**18PGERSC03**	ENERGY AUDIT AND MANAGEMENT	4	25	75	100
	IV	**18PGERSP01**	ENERGY LABORATORY – I	4	40	60	100
	ELE-I	-	ELECTIVE – I	4	25	75	100
II	V	**18PGERSC04**	ENERGY ECONOMICS & POLICES	4	25	75	100
	VI	**18PGERSC05**	BASICS OF THERMODYNAMICS	4	25	75	100
	VII	**18PGERSC06**	FABRICATION OF SOLAR CELLS	4	25	75	100
	VIII	**18PGERSP02**	ENERGY LABORATORY –II	4	40	60	100
	ELE-II	-	ELECTIVE –II	4	25	75	100
	SUP-I	-	SUPPORTIVE-I	3	25	75	100
	COMM	**06PHR01**	HUMAN RIGHTS	0	25	75	100
III	IX	**18PGERSC07**	FUEL CELLS	4	25	75	100
	X	**18PGERSC08**	WIND ENERGY	4	25	75	100
	XI	**18PGERSC09**	INDUSTRIAL INSTRUMENTATION	4	25	75	100
	ELE-III	-	ELECTIVE –III	4	25	75	100
	SUP-II	-	SUPPORTIVE-II	3	25	75	100
	XII	**18PGERSPR01**	MINI PROJECT	8	25	75	100
IV	XIII	**18PGERSC10**	ENERGY STORAGE SYSTEMS	4	25	75	100
	ELE-IV	-	ELECTIVE –IV	4	25	75	100
	XIV	**18PGERSPR02**	PROJECT WORK	12	50	150	200
			TOTAL	90			2200
			SWAYAM Course – I (I Year)	04			
			SWAYAM Course –II (II Year)	04			

Elective courses

18PGERSE01 - Basics of solar cell
18PGERSE02 - Basics of fluid Mechanics
18PGERSE03 - Rural Electrification Technologies and Economics
18PGERSE04 - Bio –Energy Conversion
18PGERSE05 - Hydrogen and Fuel Cells
18PGERSE06 - Energy Conservation, Energy Storage and Transportation
18PGERSE07 - Green Concepts in Buildings

Supportive Courses

18PGERSS01 - Basic Concepts in Energy Sciences
18PGERSS02 - Energy and environmental impacts
18PGERSS03 - Climate Change and CO_2 Emission Assessment
18PGERSS04 - Erection and Maintenance of Refrigeration and Air-Conditioning

Detailed Syllabus

18PGERSC01- APPLIED MATHEMATICS FOR ENERGY

OBJECTIVE

- ✓ To expose the student to various numerical problems that are frequently used in Energy Application
- ✓ To make the student proficient in solving problems in heat transfer and fluid that require numerical analysis

OUTCOMES

Students will have

- ✓ Identify the specific numerical technique required to solve a problem
- ✓ Numerically solve problems related to heat transfer and fluid flow.

UNIT-I EMPIRICAL LAWS AND CURVE FITTING

Introduction - Linear law –Method of group averages – Law containing three constants –Principle of Least Squares – Fitting a Straight line – Fitting a parabola – Fitting an exponential curve – Methods of moments

UNIT-II FINITE DIFFERENCES

Finite Differences – Interpolation – Newton forward Interpolation formula – Methods: Forward difference, backward difference, central difference-Gaussian forward and backward formula –Operators – Forward (Δ) , backward (∇)and central (δ) , shifting (E) Average (μ) and their interrelations

UNIT-III FOURIER TRANSFORM

Applications of Fourier Transform Fourier Transform methods – One-dimensional heat conduction problems in infinite and semi -Infinite rod – Laplace Equation – Poisson Equation.

UNIT-IV CALCULUS OF VARIATIONS

Calculus of Variations Concept of variation and its properties – Euler's equation – Functional dependent on first and higher order derivatives – Functional dependent on functions of several independent variables – Variation problems with moving boundaries – Direct methods – Ritz and Kantorovich methods.

UNIT- V CONFORMAL MAPPING

Conformal mapping and applications -The Schwarz-Christoffel transformation – Transformation of boundaries in parametric form – Physical applications: Fluid flow and heat flow problems

TEXT BOOK

1. Singaravelan, E (1999) NumericalMethods, Tata Mc Graw Hill , New Delhi

REFERENCE BOOKS

1. Spiegel, M.R., Theory and Problems of Complex Variables and its Application (Schaum's Outline Series), McGraw Hill Book Co., Singapore (1981).

18PGERSC02- BASICS OF ENERGY SCIENCE

OBJECTIVES

- ✓ To exposure the different types of energy
- ✓ To exposure other various types of Non- renewable energy

OUTCOME

Students will have

- ✓ Awareness on the existence of various mechanisms for basics energy, their merits, constraints and drawbacks

UNIT-I THERMAL AND HYDRO ENERGY

Vapor power cycles - Boiler systems - Types of boilers; Fuel handling systems - Degasifies and Deaerators -Importance and potential of hydro-electric power - Hydropower - Merits and demerits - Types of hydroelectric power plants - Run-of-the-river power plants - Components of a hydroelectric power plant

UNIT-II NUCLEAR ENERGY

Nuclear energy – Potential, challenges and opportunities - Nuclear fuels - Nuclear fusion and fission technologies - Breeder technology - Nuclear fuel enrichment - Nuclear reaction control - Types of Nuclear Reactor - Recent developments in nuclear reactors - Reactor safety and safety measures.

UNIT-III SOLAR ENERGY AND WIND ENERGY

India's solar energy potential and challenges - Solar thermal energy conversions systems - Flat plate collectors - Solar concentrators and applications - Technology of wind energy conversion - Storage of wind energy - Developments of wind farms - Advantages and disadvantages of wind energy.

UNIT-IV BIOENERGY

Biomass as energy resources - Origins and use of biomass -India's bio-energy potential and challenges - Classification and estimation of biomass - Source and characteristics of biofuels – Biodiesel – Bioethanol – Biogas.

UNIT- V GEOTHERMAL AND TIDAL ENERGY

Introduction - Classifications and energy extractions - Advantages and disadvantages of geothermal energy over other energy forms - Geothermal energy in India - Prospects- Applications of Geothermal energy - Tidal energy -Introduction - Main types - Tidal power plant - Advantages and limitations of tidal power generation.

TEXT BOOKS

1. Non-conventional energy sources, GD Rai, Khanna Publishers, Delhi, 1998.
2. Wakil M, Power Plant Engineering, McGraw Hill, 2004.

REFERENCES BOOK

1. D. A. Spera, Wind Turbine Technology: Fundamental concepts of Wind Turbine Engineering, ASME Press.

18PGERSC03- ENERGY AUDIT AND MANAGEMENT

OBJECTIVES

- ✓ To understand the energy utilization pattern including wastage and its management.

OUTCOME

Students will have

- ✓ Student will be able to Carry out the energy audit in any type of building and suggest the relevant and appropriate conservation measures.

UNIT-I INTRODUCTION TO ROLE OF ENERGY AUDITING IN IDUSTRY

Basic elements and measurements - Mass and energy balances - Scope of energy auditing industries - Evaluation of energy conserving opportunities.

UNIT-II ENERGY AUDIT

Need of Energy audit - Types of energy audit - Energy management (audit) approach - Understanding energy costs - Bench marking - Energy performance - Matching energy use to requirements - Maximizing system efficiencies - Optimizing the input energy requirements.

UNIT-III ENERGY MANAGEMENT

Design of Energy Management Programmes - Development of energy management systems – Importance -Indian need of Energy Management - Duties of Energy Manager - Preparation and presentation of energy audit reports - Some case study and potential energy savings.

UNIT-IV THERMAL ENERGY MANAGEMENT

Energy conservation in boilers - steam turbines and industrial heating systems - Application of FBC - Cogeneration and waste heat recovery - Thermal insulation - Heat exchangers and heat pumps - Building Energy Management.

UNIT- V ELECTRICAL ENERGY MANAGEMENT

Supply side Methods to minimize supply - Demand gap - Renovation and modernization of power plants - Reactive power management - HVDC - FACTS - Demand side - Conservation in motors - Pumps and fan systems - Energy efficient motors.

TEXT BOOKS

1. Energy Management: W.R.Murphy, G.Mckay 109
2. Energy Economics A.V.Desai

REFERENCE BOOK

1. Hamies, Energy Auditing and Conservation; Methods Measurements, Management and Case study, Hemisphere, Washington, 1980.

18PGERSP01 - Energy Laboratory–I

S. No.	List of Experiments
1	I-V and P-V characteristics of PV module with various radiation and temperature
2	I-V and P-V characteristics of series and parallel combination of PV module
3	Effect of variation in tilt angle on PV module power
4	Effect of shading on solar module
5	Demonstration the working of diode as bypass and blocking diode
6	Charging period analysis of system containing PCM-1 (Organic Fatty Acid)
7	Discharging period analysis of system containing PCM-1 (Organic Fatty Acid)
8	Charging period analysis of system containing PCM-2 (Paraffin Wax)
9	Discharging period analysis of system containing PCM-2 (Paraffin Wax)
10	Charging period analysis of the system containing PCM-1 and PCM-2 in cascading

18PGERSC04- ENERGY ECONOMICS & POLICES

OBJECTIVE

- ✓ To get an awareness of present energy pattern and to understand the energy policy

OUTCOMES

Students will have

- ✓ An exposure to Evaluation / utilization of energy usage and finding alternate energy resources and policy implications.

UNIT-I ENERGY CONSERVATION

Energy Conservation Act-2001 and its features - Electricity Act – 2003 and its features - Framework of Central Electricity Authority (CEA) - Central & States Electricity Regulatory Commissions (CERC & ERCs) - Role of MOP (Ministry of Power) - BEE (Bureau of Energy Efficiency).

UNIT-II INDIAN ENERGY SCENARIO

Energy resources & Consumption-Commercial and noncommercial forms of energy - Fossil fuels - Renewable sources in India - Sector wise energy Consumption -Impact of energy on economy – Need for use of new and renewable energy sources - Present status and future of nuclear and renewable energy - Energy Policy Issues related fossil fuels - Renewable energy - Power sector reforms - Restructuring of energy supply sector - Energy strategy for future.

UNIT-III GLOBAL ENERGY SCENARIO

Role of energy in economic development and social transformation - Energy and GDP - GNP and its dynamics - Energy sources – Overall energy demand and availability - Energy consumption in various sectors and its changing pattern - Depletion of energy sources and impact economics on international relations.

UNIT-IV INDIAN ENERGY POLICY

Global energy issues - National & State level energy issues - National & State energy policy -Industrial energy policy - Energy security - Energy vision - Energy pricing and impact of global variations - Energy productivity (National & Sector wise productivity).

UNIT- V GLOBAL ENERGY POLICY

International Energy Polices of G-8 Countries - G-20 Countries - OPEC Countries - EU Countries -International energy treaties (Rio, Montreal and Kyoto) -INDO-US Nuclear deal - Future energy options - Sustainable development - Energy crisis - Role of international energy agency.

TEXT BOOKS

1. P. Meier and M. Munasinghe: Energy Policy Analysis & Modeling, Cambridge University Press, (1993).
2. Charles E. Brown, World Energy Resources, Springer 2002.
3. Resources, Charles E. Brown, 'International Energy Outlook' - EIA annual Publication.

REFRENCE BOOKS

1. Principles of Energy Conversion: A.W. Culp (McGraw Hill International edition) BEE Reference book: no. 1/2/3/4
2. S Rao, Energy Technology, Khanna Publishers

18PGERSC05 – BASICS OF THERMODYNAMICS

OBJECTIVES

- ✓ To understand and apply the concept of availability and to calculate the behavior of real gases
- ✓ To predict the condition of systems and analyze them by the criteria of equilibrium

OUTCOMES

Students will have

- ✓ To calculate the availability of the systems and cycles
- ✓ Analyze the engineering systems to improve and optimize its performance
- ✓ Understand the working and the design principles of combustion systems and refrigeration systems

UNIT-I BASIC CONCEPTS AND FIRST LAWS THERMODYNAMICS

Basic concepts of Thermodynamics - Thermodynamics and Energy - Closed and open systems - Properties of a system - State and equilibrium - Processes and cycles - Forms of energy - Work and heat transfer - Temperature and Zeroth law of thermodynamics - First law of thermodynamics - Energy balance for closed systems

UNIT-II SECOND LAW OF THERMODYNAMICS

Limitations of the first law of Thermodynamics - Thermal energy reservoirs - Kelvin-Planck statement of the second law of thermodynamics - Clausius statement - Equivalence of Kelvin-Planck and Clausius statements – Refrigerators - Heat Pump and Air-Conditioners –COP - Perpetual Motion Machines - Reversible and Irreversible process - Carnot cycle.

UNIT-III VAPOUR AND GAS POWER CYCLES

Properties of pure substance - Property diagram for phase - change processes - Carnot vapor cycle - Rankine cycle - Methods for improving the efficiency of Rankine cycle -Ideal Reheat and Regenerative cycles - Binary vapor cycles - Combined gas - Vapor power cycles - Analysis of power cycles - Carnot cycle.

UNIT-IV IDEAL GAS MIXTURES IDEAL

Vander Waals equation - Principle of corresponding states -Ideal gas equation of state - Other equations of state - Compressibility factor - Compressibility charts - Composition of gas mixtures - Mass and mole fractions - Dalton's law of additive pressures - Amagat's law of additive volumes.

UNIT- V THERMODYNAMIC PROPERTIES OF FLUIDS

Properties of pure substances - Concept of phase change - Graphical representation of Pressure - Volume and Temperature - (PVT)– T and H diagrams - Properties of steam - Use of steam Tables and Moller diagram -

Thermodynamic relations involving entropy – Enthalpy -Internal energy - Maxwell relations and Clapeyron equation.

TEXT BOOKS

1. Nag PK, Engineering Thermodynamics, Tata McGraw Hill (2008).
2. Sonntag RE, Borgnakke C and Van Wylen GJ, Fundamentals of Thermodynamics, John Wiley (2007).

REFRENCE BOOKS

1. Smith JM, van Ness H and Abbott M, Introduction to Chemical Engineering Thermodynamics, McGraw-Hill (2001)
2. Holman JP, Heat Transfer, McGraw-Hill (2004).

18PGERSC06 – FABRICATION OF SOLAR CELL

OBJECTIVE

- ✓ To understand Basics of Solar radiation
- ✓ To understand detailed understanding of PV systems

OUTCOMES

Students will have

- ✓ Understanding the solar cell theory to improve and optimize its performance of Solar cell device

UNIT-I INTRODUTION OF SILICON

Solar PV industry and Silicon requirement-steps in producing Silicon wafers-production of metallurgical grade Silicon (MGS)-production of electronics grade silicon (EGS)-production of silicon wafers-Mono crystalline silicon ingots-multi crystalline silicon ingots-wafer dicing-silicon feedstock for solar industry.

UNIT-II SILICON WAFER BASED SOLAR CELL TECHNOLOGY

Commercial silicon solar cells-Process Flow of Commercial Silicon Cell Technology-Processes Used In Solar Cell Technologies-High Efficiency Silicon Solar Cells-Passivated Emitter Solar Cells (PESC)-buried contact solar cells-rear point contact solar cells-passivated emitter and rear contact.

UNIT-III THIN FILM SOLAR CELL TECHNOLOGIES

Thin film deposition techniques-common features of thin film technologies-amorphous silicon solar cell technologies-cadmium telluride solar cell technology-chalcopyrite (CIGS) solar cell technology-thin film crystalline silicon solar cell technologies.

UNIT-IV EMERGING SOLAR CELL TECHNOLOGIES

Need of emerging cell technologies-organic solar cells-dye sensitized solar cell (DSC) –GaAs solar cells- Thermo photovoltaic (TPV)- Crystalline Silicon Multifunction Solar Cells-Quantum Well Solar Cells-Hot Carrier Solar Cells

UNIT-V BATTERIES AND CONVERTERS

Definition-types of batteries-parameters of batteries-batteries for photovoltaic systems-liquid vented and sealed-AC to DC converters-DC to AC converters (inverters)-DC to DC power converters-charge controllers-PWM charge controller-maximum power point tracking (MPPT)

TEXT BOOKS

1. Chetan Singh Solanki , Solar Photovoltaic Technology And Systems PHI Learning Private limited
2. Richard A.Dunlap, Sustainable energy, Cengage (2018)

REFERENCE BOOK

1. Boxwell Michael, Solar Electricity Handbook, Green stream publishing LTD

18PGERSP02 - Energy Laboratory–II

S.No.	List of Experiments
1	Power flow calculation of PV system of DC load with battery
2	Power flow calculation of PV system of AC load with battery
3	Power flow calculations of PV system of AC&DC load with battery
4	Power flow calculations of PV system of DC load in series connection
5	Power flow calculations of PV system with AC load in series connection
6	Charging analysis of fatty acid as PCM by varying mass flow rate
7	Discharging analysis of fatty acid as PCM by varying mass flow rate
8	Charging analysis of paraffin wax as PCM by different mass flow rate
9	Discharging analysis of paraffin wax as PCM for different mass flow rate
10	Charging analysis of both fatty acid and paraffin wax cascading method by varying mass flow rate

18PGERSC07 – FUEL CELLS

OBJECTIVE

- ✓ To understand about fuel cells, their working principle, Types, Design and performance analysis.

OUTCOME

After completing the course, student should have learnt

- ✓ Basics and working principles of the Fuel cell technology.
- ✓ Selection the suitable materials for electrode, catalyst, membrane for the fuel cells

UNIT-I OVERVIEW OF FUEL CELLS

Low and high temperature fuel cells - Fuel cell thermodynamics – Heat - Work potentials - Prediction of reversible voltage - Fuel cell efficiency.

UNIT-II FUEL CELL REACTION KINETICS

Electrode kinetics – Overvoltage - Tafel equation - Charge transfer reaction - Exchange currents - Electro catalysis – Design - Activation kinetics - Fuel cell charge and mass transport - Flow field - Transport in electrode and electrolyte.

UNIT-III FUEL CELL CHARACTERIZATION

In-situ and ex-situ characterization techniques -I-V curve - Frequency response analysis - Fuel cell modelling and system integration - 1D model – Analytical solution and CFD models.

UNIT-IV BALANCE OF PLANT

Hydrogen production from renewable sources and storage - Safety issues - Cost expectation and life cycle analysis of fuel cells.

UNIT-V FUEL CELL POWER PLANTS

Fuel processor - Fuel cell power section (fuel cell stack) - Power conditioner - Automotive applications - Portable applications.

TEXT BOOKS:

1. Liu, H.,Principles of fuel cells, Taylor & Francis, N.Y., (2006)

REFERENCE BOOK

1. Fuel cell technology handbook, edited by GregorHoogers, CRC Press (2003).

18PGERSC08 – WIND ENERGY

OBJECTIVES

- ✓ Understand the processes of generation of wind, its potential and energy extraction
- ✓ Understand the aerodynamic principles of turbine blade design

OUTCOMES

Students will have

- ✓ Prepare and evaluate detailed project reports for establishing a wind farm
- ✓ Understand the operation of a wind farm and economics of power generation

UNIT-I INTRODUCTION OF WIND ENERGY

Historical and recent development of Wind Energy - Wind Turbine Technology – Onshore and Offshore - Components of wind turbines - Design aspects of wind turbines - Electrical and mechanical aspects of wind turbines - Aerodynamic aspects of wind turbine - Characteristics of wind - Wind resource Assessment and techniques.

UNIT-II WIND ENERGY INSTRUMENTS & MEASUREMENTS

The Nature of the Wind - Site Selection, Wind measurements - Monitoring Stations - Wind Resource Mapping, Installation -Instrumentation and Commissioning of WMS - Met Mast and Modern Measurement Techniques - Measurement using remote sensing instruments (SODAR & LiDAR).

UNIT-III WIND RESOURCE ASSESSMENT

Latest trends in Wind Resource Assessment - Data collection - Data processing, Data Analysis Processing - Software tools for Wind data Analysis - Design and Layout - Micro siting - Wind Atlas: A Case Study - Forecasting and Wind Energy Production.

UNIT-IV WIND TURBINE TECHNOLOGY

Latest wind turbine technology - Constant / Variable Speed wind turbines – Transformers - Power electronics - Power converters – Blades - Drive train – Nacelle - Rotor hub - Control strategies (Pitch and Stall Regulation) – Gearbox – Generator – Brake - Yaw drive - Tower and foundation.

UNIT- V WIND FARMS

Wind Farm development - Pre-feasibility studies -Installation & Commissioning of wind farms - Grid Integration of wind turbines - Wind Power Evacuation - Operation and Maintenance - SCADA & Condition monitoring - Power quality characteristic - Energy Storage - Testing and Certification of wind turbines - Small wind turbines and Hybrid systems.

TEXT BOOKS

1. Thomas Ackermann, (2005), Wind Power in Power System, John Wiles & Son Ltd.
2. Ray Hunter, (19970, Wind Energy Conversion: From Theory to Practice, John Wiley and Son Ltd.

REFERENCE BOOKS

1. Gary L.Johnson, (1985), Wind Energy Systems, Prentice-Hall Inc., New Jersey.
2. Desire Le Gouriers, (1982), Wind Power Plants: Theory and Design, Pergamon Press.

18PGERSC09–INDUSTRIAL INSTRUMENTATION

OBJECTIVES

- ✓ To understand the principles and use of transducers for measurement of different pressure, thermal and electrical parameters.
- ✓ To understand the concepts of control systems, modes and design.

OUTCOME

Students will have

- ✓ To obtain knowledge on measurement and control techniques applicable to energy systems

UNIT-I GENERALIZED INSTRUMENTATION SYSTEM

Error theory – Calibration of instruments – Range – Resolution – Span – Linearity – Sensitivity - Signal conditioning systems

UNIT-II PRESSURE AND TEMPERATURE MEASUREMENT

Biomaterials - Pressure thermometers – Thermocouples – RTD , Thermistor and Pyrometer - Pyrometers - Calibration of pressure measuring equipment - Principles and operation of various vacuum pumps and gauges.

UNIT-III FLOW MEASUREMENT

Variable head flow meters - Rota meters - Electromagnetic flow meters - Hot wire anemometers - Hot film transducers - Ultrasonic flow meters -Impellers turbine system - Corollas meters - Vortex-shed meters.

UNIT-IV AIR POLLUTION AND ENERGY MEASUREMENTS

Particulate sampling techniques - SO_2 - Combustion Products – Opacity - Odour measurements - Measurement of liquid level – Humidity - O_2, CO_2 in flue gases - pH measurement - Moisture analyzer.

UNIT-V ELECTRICAL ENERGY MEASUREMENT AND ADVANCE MEASURMENT TECHNIQUES

Power factor - load factor - Harmonic analyzer – Lighting – Shadowgraph – Schlieren – Interferometer - Laser Doppler Anemometer - Hot wire – Anemometer - Heat flux sensors - Telemetry in measurement.

TEXT BOOKS

1. Sawhney A K and PuneetSawney, A course in Mechanical Measurements and instrumentation, DhanpatRai & Co (2002).
2. Doebelin E O, Measurement Systems - Application and Design, McGraw-Hill, (2004).

REFERENCE BOOKS

1. Bechwith, Marangoni and Lienhard, “Mechanical Measurements” Addison-Wesley, (2000).
2. Holman J P, “Experimental methods for engineer’s”, McGraw-Hill, (1994).
3. Rangan C S, Sharma G R and Mani V S V, “Instrumentation Devices and Systems”, Tata McGraw-Hill, (1983).

18PGERSC10- ENERGY STORAGE SYSTEMS

OBJECTIVES

- ✓ To understand the concept of understand / analyses the various types of energy storage.
- ✓ To study the various applications of energy storage systems

OUTCOME

- ✓ Students will be Able to analyses various types of energy storage devices and perform the selection based on techno economic view point

UNIT-I LEAD ACID BATTERY

Advantages and disadvantages of lead acid batteries - Electrochemical reactions - Physical and chemical properties of active materials - Characteristics and properties of sulphuric acid - Constructional features - Materials and manufacturing methods - SLI (Automotive) batteries - Charge and discharge properties ties of lead acid batteries - Sealed lead acid or maintenance free batteries fabrication technology and testing - Lead acid battery for PV and automotive applications.

UNIT-II LITHIUM-ION BATTERY

Advanced anodes and cathodes – Theoretical capacity – Merits and demerits - Nanomaterials for anodes - Carbon nanotubes - SnO_2 – NiO - TiO_2 & $LiTiO_4$ - Battery fabrication technology and testing - Batteries for electric vehicles - Hybrid vehicles and solar photovoltaic applications.

UNIT-III METAL-AIR BATTERIES

Lithium-Air - Sodium-Air – Zinc - Air batteries - Principle – Components – anodes – Cathodes - Fabrication – Evaluation – Merits - Demerits and Applications.

UNIT-IV FUEL CELLS

Membrane electrode assemblies – Fabrication - Catalyst layer - Fuel cell supports – GDL - Bipolar plates - Fuel cell catalysts – Precious and non-precious metal catalysts - Bi-functional catalysts – Nanomaterials for low temperature fuel cells – Reversible fuel cells - Fuel cell stacks and systems - Fuel cells for vehicles and grid connected applications.

UNIT-V HYBRID ENERGY SYSTEMS

Concept of hybrid energy systems - Supercapacitors – Fundamentals and types - Battery/supercapacitors hybrid systems – Example – Applications - Hybrid fuel cell/battery systems – Example – Applications.

TEXT BOOKS

1. Subramanian Srinivasan, Fuel Cells from fundamentals to applications, Springer, (2006).
2. Modern Batteries, Colin A Vincent and Bruno Scrosati, (1997) Pub Arnold ISBN 0-340-66278-6.

3. Electric Vehicle Battery Systems Sandeep Dhameja, October (2001), Pub Newnes, ISBN 0750699167.

REFERENCE BOOKS

1. T. R. Crompton, Battery Reference Book, SAE International, (1996). Edition: 2EV/Hybrid Batteries & Battery Material Suppliers: An Automotive Market Review.
2. David Linden, Hand Book of Batteries, McGraw-Hill, Inc), 4th edition, (2010) New York.

ELECTIVE COURSES

18PGERSE01- BASICS OF SOLAR CELL

OBJECTIVE

- ✓ To understand Basics of Solar radiation
- ✓ To understand detailed understanding of PV systems

OUTCOMES

Students will have

- ✓ Understanding the solar cell theory to improve and optimize its performance of Solar cell device

UNIT-I BASICS OF ELECTRICITY

Introduction to Electricity-Voltage-Current-Resistance-Electric Power-Electrical Energy-Types of Power-Measurement of Electrical Quantities-Millimeter-Measurement of DC Voltage-AC Voltage-DC Current-AC Current-Resistance- Electrical Power and Energy

UNIT-II INTRODUCTION TO SOLAR PHOTOVOLTAIC ENERGY

Photovoltaic effect- Solar Cell-Parameters of Solar Cells -Solar Cell Technology -Effect of Conversion Efficiency-Input Light- Solar Cell Area-Angle of Light Falling on Solar Cell-Solar Cell Operating Temperature.

UNIT-III SOLAR CELL MATERIALS

Semiconductors-Intrinsic Semiconductor-Extrinsic Semiconductor-P Type and N Type Semiconductors-Generation of Carriers-Recombination of Carriers- P-N Junction-Energy Band Diagram of P-N Junction-Carrier Movements and Current Densities.

UNIT-IV CONCENTRATED PV CELLS

Light concentration-Concentration Ratio Optics for Concentrator PV- 'V' Trough Concentrator –Compound Parabolic Concentrator-Parabolic Trough Concentrator-Parabolic Reflector-Fresnel's Lenses Concentrator-Tracking Requirement of CPV-Cooling Requirements.

UNIT-V PV MODULES AND ARRAYS

Definition of PV module-Module Ratings-PV Module Parameters -IV and PV characteristics of PV module- Number of cells in a module-designing wattage of PV module-Definition of array-connection of modules in series-parallel and mixed combination-mismatch effect

TEXT BOOKS

1. Chetan singh Solanki, solar photovoltaic technology and systems PHI learning private limited
2. H.P.Garg Solar Energy: Fundamentals And Applications , McGraw Higher Ed Publication

REFERENCE BOOK

1. Suneel Deambi, From Sunlight to Electricity: A practical handbook on solar photovoltaic applications, The Energy And Resources Institute.

18PGERSE02- BASICS OF FLUID MECHANICS

OBJECTIVES

- ✓ To familiarize with the properties of fluids and the applications of fluid mechanics.
- ✓ To understand the concept of fluid measurement, types of flows and dimensional analysis.

OUTCOME

Students will have

- ✓ Identify and obtain the values of fluid properties and relationship between them and understand the principles of continuity, momentum, and energy as applied to fluid motions.

UNIT-I PROPERTIES OF FLUIDS

Introduction –Density-Specific Weight-Specific Volume-Specific Gravity-Viscosity-Kinematic Viscosity-Dynamic Viscosity-Compressibility and Bulk Modulus-Surface Tension and Capillarity

UNIT-II PRESSURE MEASURING DEVICES

Pascal's law – Absolute gauge – Atmospheric and vacuum pressures – manometers – simple manometer – piezometer –U tube manometer- single column manometer-differential manometer- U tube differential manometer – inverted U tube differential manometer.

UNIT – III FLUID FLOW AND LOSSES

Types of flows- Rate of Flow (Or) Discharge- Continuity Equation- Euler's Equation of Motion-Bernoulli's Equation from Euler's Equation -Application Of Bernoulli's Equation- Venture- Orifice Meter-Pitot-Tube.

UNIT-IV DIMENSIONAL AND MODEL ANALYSIS

Introduction-Derived Quantities- Buckinghams Π Theorem Method of Selecting Repeating Variables-Procedure for Solving Buckinghams Π Theorem- Dimensionless Number

UNIT-V HYDRAULIC MACHINES & APPLICATION

Centrifugal pump- Construction-Working-Reciprocating Pump-Construction- Working –Hydraulic Press –Hydraulic Accumulator-Hydraulic Intensifier – Hydraulic Ram-Hydraulic-Lift-Hydraulic Crane.

TEXT BOOK

1. Fang, Chung, An Introduction to Fluid Mechanics, Springer Publications

REFERENCE BOOKS

1. Fluid Mechanics, Spurk, Joseph, Aksel, Nuri, Springer Publications.
2. Fluid Mechanics And Hydraulic Machines – Dr. R.K.Bansal, Laxmi Publications

18PGERSE03- RURAL ELECTRIFICATION TECHNOLOGIES AND ECONOMICS

OBJECTIVES

- ✓ To give introduction about Indian energy scenario
- ✓ To provide knowledge about urban and rural environment and its energy demand

OUTCOMES

Students will have

- ✓ To knowledge the concept of green building and electric vehicle charging station

UNIT-I GENERATION TECHNOLOGIES

Decentralized generation technologies - Costs and choice of technology - Demand and benefits forecasting and program development - Principles of cost - Benefit calculations.

UNIT-II FINANCIAL ANALYSIS

Economic and financial analysis of stand-alone electrification projects - Decentralized versus central station generation - Traditional power systems - Load curves and load curve analysis.

UNIT-III GAS TURBINE GENERATOR

Basic gas turbine generator concepts - Utility system turbine generators - Mini and micro gas turbine generators - Solar thermal power generation - Utility Scale Photovoltaic (USPV) generation - Wind powered generation.

UNIT-IV BIOMASS BASED GENERATION

Biomass based generation - DG Evaluation - Cost from past, present and future - Basic DG cost analysis - Cost evaluation and schedule of demand.

UNIT-V POWER GRID

The power grid - DG-Grid interconnection issues - Mini and Micro Grids – Economics – Environmental Factors – Transmission and Regulations.

TEXT BOOKS

1. H. Lee Willis and W.G. Scott: Distributed Power Generation: Planning and Evaluation, Marcel Dekker, (2000).
2. J. J. Burke: Power Distribution Engineering, Fundamentals and Applications, Marcel Dekker, (1994).

REFERENCE BOOKS

1. T. Gonen: Electric Power Distribution System Engineering, McGraw Hill (1986).
2. M Mohan: Rural electrification for development: policy analysis and applications. Boulder: Westview Press, (1987).

18PGERSE04- BIO ENERGY CONVERSION

OBJECTIVES

- ✓ To have an exposure on the types of Bio and Geothermal energy, its surplus availability and characteristics.
- ✓ Analyze the technologies available for conversion of biomass to energy in terms of its technical competence and economic implications.

OUTCOME

Students will have

- ✓ A practical understanding on the various Bio and Geo thermal energy conversion technologies and its relevance towards solving the present energy crisis.

UNIT-I BIOMETHANATION

Microbial Systems – Phases in Biogas production – Parameters affecting gas production – Effect of additives on Biogas yield – Possible feed stocks - Biogas plants – Types – Design – Constructional details & comparison – Biogas appliances – Burner -Illumination & Power Generation – Effect on Engine Performance.

UNIT-II COMBUSTION

Perfect, Complete & Incomplete – Equivalence ratio – Fixed Bed, Fluid Bed – Fuel & Ash handling – Steam Cost comparison with conventional fuels – Briquetting - Types of Briquetting – Merits & Demerits – Feed requirements & Preprocessing – Advantages – Drawbacks.

UNIT-III GASIFICATION

Types – Comparison – Application – Performance Evaluation – Economics – Dual fuel engines –100 % Gas Engines – Engine characteristics on gas mode – Gas Cooling & cleaning train.

UNIT-IV IMPORTANT ASPECTS OF GEOTHERMAL ENERGY

Important aspects of Geothermal Energy (GTE) – Applications - Geothermal Energy Resources - Origin of Geothermal Thermal Resources - Geothermal Thermal Gradients - Non-uniform Geothermal Thermal Gradients - Hydro-Geothermal Resources.

UNIT- V GEOTHERMAL ELECTRIC POWER (GTEP) PLANTS

Introduction - Classification and Types - Historical Background - Vapor dominated GTEP Plant (Steam) - Liquid dominated GTEP Plant (Hot Water) - Liquid dominated Flashed Steam GTEP Plant - Scope for Geothermal Energy systems in India.

TEXT BOOKS

1. G D Rai, Non-Conventional Energy Sources, Khanna Publishers, New Delhi.
2. David Boyles, Bio Energy Technology Thermodynamics and costs, Ellis Hoknood, Chichester, (1984).

REFERENCE BOOKS

1. Khandelwal KC, Mahdi SS, Biogas Technology – A Practical Handbook, Tata McGraw Hill, (1986)
2. R.C. Mahaeswari, Bio Energy for Rural Energisation, Concepts Publication, (1997).

18PGERSE05- HYDROGEN AND FUEL CELLS

OBJECTIVE

- ✓ To introduce to emerging technologies like production and storage of Hydrogen

OUTCOME

- ✓ Exposure to different fuel cells in particularly Hydrogen fuel cells

UNIT-I HYDROGEN ENERGY ECONOMY

Hydrogen Energy Economy – Conception - Present status and a vision – Applications of Hydrogen - Transport application - cars, light trucks, buses - Stationary and Portable - Electronic gadgets.

UNIT-II HYDROGEN AND PRODUCTION TECHNIQUES

Hydrogen – Physical and chemical properties - Salient characteristics - Production of hydrogen – Steam reforming – Water electrolysis – Gasification and woody biomass conversion – Biological hydrogen production – Photo dissociation – Direct thermal or catalytic splitting of water.

UNIT-III HYDROGEN STORAGE & TRANSPORT

Hydrogen storage options – Compressed gas – Liquid hydrogen – Hydride – Chemical Storage – Comparisons - Transport of Hydrogen -
Pipelines, Gaseous, Liquid and Compound materials.

UNIT-IV FUEL CELLS

History – Principle - Working - Thermodynamics and kinetics of fuel cell process – Performance evaluation of fuel cell – Comparison on battery Vs fuel cell - Types of fuel cells – AFC, PAFC, SOFC, MCFC, DMFC, PEMFC – Relative merits and demerits.

UNIT- V APPLICATION OF FUEL CELL

Fuel cell usage for domestic power systems - Large scale power generation – Automobile - Space - Environmental analysis of usage of Hydrogen in Fuel cell - Future trends in fuel cells.

TEXT BOOKS

1. Hydrogen and Fuel Cells: A Comprehensive Guide, Rebecca L. and Busby, Penn Well Corporation, Oklahoma , (2005).
2. Hydrogen and Fuel Cells: Emerging Technologies and Applications, Bent Sorensen (Sorensen), Elsevier, UK ,(2005).

REFERENCE BOOKS

1. Fuel Cell and Their Applications, Kordesch, K and G.Simader, Wiley-Vch, Germany ,(1996).
2. Fuel Cells: Theory and Application, Hart, A.B and G.J.Womack, Prentice Hall, NewYork Ltd., London, (1989).

18PGERSE06- ENERGY CONSERVATION, ENERGY STORAGE AND TRANSPORTATION

OBJECTIVE

- ✓ To Introduce to emerging technologies like production and storage of Energy

OUTCOME

- ✓ Exposure Students will be Able to analyses various types of energy storage devices and perform the selection based on techno economic view point

UNIT –I ENERGY CONSERVATION

Introduction- approaches to energy conservation-energy conservation in the united states- energy conservation in India- cogeneration- smart grid-energy conservation in the community-LED street lights.

UNIT-II HOME HEATING COOLING AND TRANSPORTATION

Furnace efficiency-heat pumps- air conditioning-integrated HVAC systems-minimizing heat loss-insulation, windows, and air leaks-residential lighting-transportation-FUEL Economy-hybrid vehicles.

UNIT-III ENERGY STORAGE

Introduction-pumped hydroelectric power-bath country pumped hydroelectric facility-compressed air energy storage-implementation of compressed air energy storage-fly wheels-superconducting magnetic energy storage (SMES).

UNIT-IV BATTERY ELECTRIC VEHICLES (BEVs)

Introduction-battery types-the cost of electricity-BEV requirements and design-flow batteries-history of BEVs-rechargeable sodium batteries-super capacitors.

UNIT-V HYDROGEN FUELS

Introduction-properties of hydrogen-hydrogen production methods – electrolysis-Thermal Decomposition of Water-Chemical Reactions-Storage And Transportation of Hydrogen-Hydrogen Internal Combustion Vehicles-Fuel Cells-Fuel Vehicles-Hydrogen Present And Future-Efficiency of Different Transportation Technologies.

TEXT BOOK

1. Richard a. Dunlap sustainable energy Cenguage

REFERENCE BOOK

1. Jochen Fricke, Walter L. Borst , Essentials of Energy Technology: Sources, Transport, Storage, Conservation 1st Edition

18PGERSE07 - GREEN CONCEPTS IN BUILDINGS

OBJECTIVES

- ✓ To understand and apply the concept of availability and to calculate the behavior of real gases
- ✓ To predict the condition of systems and analyze them by the criteria of equilibrium

OUTCOMES

Students will have

- ✓ To calculate the availability of the systems and cycles
- ✓ Analyze the engineering systems to improve and optimize its performance

UNIT-I ENVIRONMENTAL IMPLICATIONS OF BUILDINGS

Environmental implications of buildings energy - Carbon emissions - Water use - Waste disposal - Building materials – Sources - Methods of production and environmental Implications - Embodied Energy in Building Materials - Transportation Energy for Building Materials - Maintenance Energy for Buildings.

UNIT-II IMPLICATIONS OF BUILDING TECHNOLOGIES

Implications of Building Technologies Embodied Energy of Buildings - Framed Construction - Masonry Construction - Resources for Building Materials - Alternative concepts - Recycling of Industrial and Buildings Wastes - Biomass Resources for buildings.

UNIT-III COMFORTS IN BUILDING

Comforts in Building - Thermal comfort in buildings – Issues - Heat transfer characteristic of building materials and building techniques -Incidence of solar heat on buildings -Implications of geographical locations.

UNIT-IV UTILITY OF SOLAR ENERGY IN BUILDINGS

Utility of Solar energy in buildings concepts of solar passive cooling and heating of buildings - Low energy cooling - Case studies of solar passive cooled and heated buildings.

UNIT- V GREEN COMPOSITES FOR BUILDINGS

Green Composites for buildings - Concepts of green composites - Water utilization in buildings - Low energy approaches to water management - Management of Solid Wastes - Management of silage water and sewage - Urban environment and green buildings - Green cover and built environment.

TEXT BOOKS

1. K. S. Jagadish, B. U. Venkataramareddy and K. S. Nanjundarao. Alternative Building Materials and Technologies. New Age International, (2007).

2. Low Energy Cooling For Sustainable Buildings. John Wiley and Sons Ltd, (2009).

REFRENCE BOOKS

1. Green My Home: 10 Steps to Lowering Energy Costs and Reducing Your Carbon Footprint, by Dennis C.
2. Brewer, ISBN: 9781427798411, Publisher: Kaplan Publishing, Publication (2008).
3. B. Givoni, Man, Climate and Architecture Elsevier, (1969).
4. T. A. Markus and E. N. Morris Buildings Climate and Energy. Pitman, London, (1980).

SUPPORTIVE COURSES (For other Departments)

18PGERSS01- BASIC CONCEPTS IN ENERGY SCIENCES

OBJECTIVES

- ✓ To analyze the working principle, pros and cons of Conventional energy conversion techniques

OUTCOME

Students will have

- ✓ Awareness on the existence of various mechanisms for conversion and storage of energy, their merits, constraints and drawbacks

UNIT–I ENERGY SOURCES

Environment and sustainable development - Energy sources - Sun as the source of energy – Photosynthesis - Classification of energy sources - Fossil fuel reserves and resources - Overview of global/ India's energy scenario.

UNIT-II SOLAR ENERGY

Solar radiation - Measurements and prediction - Solar thermal energy conversions systems - Flat plate collectors - Solar concentrators and other applications - Solar Photovoltaic - Principle of photovoltaic conversion of solar energy.

UNIT – III WIND ENERGY

Wind Resource: Meteorology of wind, India's wind energy potential and challenges -distribution across the world - Elian features - Biological indicators - Wind measurement systems - Wind Energy Conversion Systems.

UNIT-IV BIOENERGY

Biomass as energy resources - Classification and estimation of biomass - Source and characteristics of biofuels – Biodiesel – Bioethanol – Biogas - Waste to energy conversions.

UNIT- V GEOTHERMAL ENERGY

Introduction - Geothermal sources - Advantages and disadvantages of geothermal energy over other energy forms - Geothermal energy in India - Prospects - Applications of Geothermal energy - Material selection for geothermal power plants.

TEXT BOOKS

1. D. A. Spera, Wind Turbine Technology: Fundamental concepts of Wind Turbine Engineering, ASME Press.
2. S.P. Sukhatme, Solar Energy: principles of Thermal Collection and Storage, Tata McGraw-Hill (1984).

REFERENCE BOOKS

1. Loulou, Richard, Waaub, Jean-Philippe; Zaccour, Georges, Energy and Environment Set: Mathematics of Decision Making, (Eds.), (2005), XVIII, 282 p. ISBN: 978-0-387-25351-0.
2. Ristinen, Robert A. Kraushaar, Jack J. AKraushaar, Jack P. Ristinen, Robert A, Energy and the Environment, 2nd Edition, John Wiley, 2006, ISBN:9780471172482, Pub Wiley, New York, (2006).

18PGERSS02- ENERGY AND ENVIRONMENTAL IMPACTS

OBJECTIVES

- ✓ To teach the principal of energy and environmental issues
- ✓ To explore the environmental impact of various energy sources and also the effects of different types of pollutants.

OUTCOME

Students will have

- ✓ Learn about challenges and opportunities related to energy use and conversion. Learn how to evaluate the sustainability of energy systems.

UNIT-I ENERGY SOURCES

Present Energy resources in India and its sustainability - Different type of conventional Power Plant - Energy Demand Scenario in India - Advantage and Disadvantage of conventional Power Plants – Conventional vs Non-conventional power generation

UNIT-II SOLAR ENERGY

Basics of Solar Energy - Solar Thermal Energy - Solar Photovoltaic - Advantages and disadvantages - Environmental impacts and safety.

UNIT-III BIOMASS AND GEO THERMAL ENERGY

Biomass resources - Biomass conversion Technologies - Feedstock preprocessing and treatment methods - Bioenergy program in India-Environmental benefits and impacts - Geothermal Energy resources – Ocean Thermal Energy Conversion – Tidal.

UNIT-IV POLLUTION CONTROL

Air pollution - Sources – Effects – control - Air quality standards - Air pollution act - Air pollution measurement - Water pollution - Sources and impacts - Soil pollution - Sources and impacts - Disposal of solid waste.

UNIT- V ENVIRONMENTAL AFFECT FACTORS

Greenhouse gases – Effect - Acid rain - Noise pollution - Pollution aspects of various power plants - Fossil fuels and impacts -Industrial and transport emissions -Impacts.

TEXT BOOKS

1. Boyle, G..' Renewable energy: Power for a sustainable future'. Oxford University press, (2004).
2. B H Khan, 'Non Conventional Energy Resources'-The McGraw –Hill Second edition.

REFERENCE BOOKS

1. G. D. Rai, 'Non conventional energy sources', Khanna Publishers, New Delhi, (2006).

2. Gilbert M. Masters, 'Introduction to Environmental Engineering and Science', 2nd Edition, Prentice Hall, (2003).

18PGERSS03- CLIMATE CHANGE AND CO_2 EMISSION ASSESSMENT

OBJECTIVES

- ✓ To study the global climate change
- ✓ To analysis emission assessment

OUTCOME

Students will have

- ✓ Awareness on the existence of various mechanisms for conversion and storage of energy, their merits, constraints and drawbacks

UNIT-I INTRODUCTION TO ENERGY

Introduction to Energy - Overview of energy sources and technologies - Energy consumption Pattern - Social and economic implications of energy Uses - Equity and disparity.

UNIT-II INTRODUCTION TO GLOBAL CLIMATE CHANGE

Introduction to global climate change - Theory of global climate change - Mechanism of Greenhouse Gases Emission - Theory and proof of climate Change impacts - Global overview -International concern on Climate change and mitigation efforts.

UNIT-III CARBON DIOXIDE (CO_2) EMISSIONS AND CONVERSION/CONSUMPTION

Carbon dioxide (CO_2) emissions in relation to energy conversion/consumption - Theory of CO_2 emission in relation to energy conversion processes.

UNIT-IV METHODOLOGY FOR CO_2 ASSESSMENT

Methodology for CO_2 assessment/carbon foot print - Estimation of emission from fossil fuel combustion (Fuels and their composition - Fuel to energy conversion - Concept of emission factor) - Emission from major sectors (industry – transport – agriculture – domestic - service).

UNIT-V CARBON CREDIT

Carbon credit - Definition - concept and examples - Carbon credit - National policies *vs* international market scenario - Current efforts and future prospect/limitation of carbon trading mechanism.

TEXT BOOKS

1. Mathez E. A. Climate Change: The Science of Global Warming and Our Energy Future, First edition, Columbia University Press (2009).
2. Dessler A. Introduction to Modern Climate Change, Cambridge University Press, (2011).
3. Yamin F. (ed.) Climate Change and Carbon Markets: A Handbook of Emissions Reduction Mechanisms, Earthscan, (2005)

REFERENCE BOOKS

1. Franchetti M. J. and Apul D. S., Carbon Footprint Analysis: concepts, methods, implementation and case studies, CRC Press, (2013).
2. Clean Development Mechanism, UNFCC Website; http://cdm.unfccc.int/
3. Stern N.,The Economics of Climate Change. The Stern Review. Cambridge University Press, (2007).
4. Barrett S. Why Cooperate? The Incentive to Supply Global Public Goods. Oxford University Press, (2007).

18PGERSS04- ERECTION AND MAINTENANCE OF REFRIGERATION AND AIR-CONDITIONING EQUIPMENTS

OBJECTIVES

- ✓ To analyze the working principle, pros and cons of Conventional energy conversion techniques
- ✓ To know about energy based testing measurement
- ✓ To know about energy based measurement & maintenance system

OUTCOME

Students will have

- ✓ Awareness on the existence of various instrument objective and their merits, constraints and drawbacks

UNIT-I INTRODUCTION

Refrigeration and air-conditioning plant layout - Parameters affecting the location.

UNIT-II ERECTION OF R&AC SYSTEMS

Erection methodology – Foundation – Padding - Network analysis - Critical path – Interconnections - Safety precautions - Air handling equipment's - Maintenance procedures.

UNIT-III TESTING OF EQUIPMENTS

Testing of compressors – Condensers – Evaporators - Cooling towers – Motors – Controls - Test rings -ISI standards - Testing of control systems - Circuitry and troubleshooting - Condition monitoring.

UNIT-IV TOTAL PREVENTIVE MAINTENANCE

TPM Principles - Corrective and preventive measures and Reliability analysis.

UNIT-V MAINTENANCE SCHEDULES

Studies on different maintenance schedules followed by various industries

TEXT BOOKS

1. Arora C.P., Refrigeration and Air conditioning II Ed. McGraw-Hill, Pub., (2000).
2. ASHRAE Hand book on Refrigeration & Air conditioning, Published by ISHRAE, Bangalore, (1998).

REFERENCE BOOKS

1. Althouse A.D. and Turnquist C.H., Modern refrigeration and air-conditioning, Good HeartWilcoz Co Inc., (1980).
2. Nelson C.W., Commercial and Industrial refrigeration, McGraw-Hill, (1982).