RULES FOR DEGREE OF THE MASTER OF SCIENCE (M.Sc.) IN RENEWABLE ENERGY (RE)

**RPG.RE.1:** A candidate who has obtained the degree of Bachelor of Science (Any Sciences Graduation) and Engineering (Any B.E/ B. Tech Graduation) from any recognized University, after successful completion of the course work prescribed for the M. Sc. degree examination, for a period of two years subsequent to his passing the B. Sc. Degree/ B.E/B. Tech. Degree examination will be admitted to the examination for the degree of M. Sc. The degree of the Master of Science will be taken by papers, practical and project work only.

**RPG.RE.2:** The examination for the various theory courses and laboratory work will be conducted under semester system. For this purpose each academic year will be divided into two semesters.

**RPG.RE.3:** The ratio between the External and Internal assessment will be 70:30

**RPG.RE.4:** Candidate will be required to attend at least 80 % of the total theory, lectures, practical and project work organized under each of the course by them during the semester.

**RPG.RE.5:** Candidate will be offered specialization in three different disciplines in second year (from III semester) on the basis of merit list

**RPG.RE.6:** (i) The head of the department in consultation with other teachers of the department will prepare in the beginning of the semester a detailed scheme of the periodic test(s), seminars, quizzes etc., and the program for the test examinations and the same will be announced to the candidates. (ii) The record of the test examinations as well as seminars and quizzes will be maintained by the department. (iii) Every candidate shall maintain a regular record of this practical and project work which shall be duly certified by his teacher(s) from time to time.

**RPG.RE.7:** The weightage of the semester evaluation (internal evaluation) shall be 40 % (30%) and weightage of the semester evaluation (external evaluation) shall be 60% (70%)

In internal assessment, the student will have to score 25 % marks in each of the Course and in aggregate have to score 35 %. In external assessment, the student will have to score 40 % marks in each of the course. In overall, aggregate of internal and external for particular course student will also have to score 40% marks in each of the course. The candidate will NEVER be said to have failed in a course if he/she is unsuccessful in completing the course by the end of the semester. On the contrary he/she is said to have DROPPED the paper.

**RPG.RE.8:** A teacher offering a particular course will be one of the examiners at the university examination and the examiner may be either a teacher from within the university or from outside the university.

**RPG.RE.9:** The final results for the awards of the degree will be declared on the basis of the grand total of all the semesters examinations prescribed for the degree examination.

**RPG.RE.10:** No candidate will be allowed to reappear in course in which he / she has already passed.
RPG.RE.11: Standard of passing: The standard of passing of M. Sc. (Renewable Energy) degree examination will be as under:

i. To pass any semester examination for the M. Sc. degree a candidate must obtain at least 40% marks in the university examination and 40% marks in the aggregate of university and internal examination in each course of Theory, Practical and project work.

ii. Those of the successful candidates who obtain 50% or more marks in the aggregate of all the semesters taken together will be placed in the Second class and those who obtain 60% or more marks in the aggregate will be placed in the first class.

The successful candidates who obtain 70% or more marks in the aggregate of all the semesters taken together will be declared to have passed the examination in the first class with distinction.

RPG.RE.12:
A candidate who has undergone a regular course of study in a particular Semester, fulfill the required criteria of attendance and has secured marks equal to passing standard both in internal and External Examination shall be eligible for continuing study in next semester, provided that-

“A candidate will be allowed to go to IV semester only if he/she has passed all the courses of I semester.”
Syllabus (Effective from the academic year June, 2013)
Institute of Studies and Research in Renewable Energy
Sardar Patel University, Vallabh Vidyanagar – 388 120, Gujarat

M. Sc. (Renewable Energy)
Structure for Semester System & Choice Based Credit System (CBCS)

INSTITUTE OF STUDIES AND RESEARCH IN RENEWABLE ENERGY (ISRRE) NEW VALLABH
VIDYANAGAR

M. Sc. in Renewable Energy (UNDER CBCS)

**SEMMESTER-I: RENEWABLE ENERGY**

<table>
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<td>2</td>
<td>PS01CREN02 Solar Energy</td>
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<td>3</td>
<td>PS01CREN03 Geothermal Energy and Biomass Energy</td>
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**ELECTIVE COURSE**

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<tr>
<td>4</td>
<td>PS01EREN01 Wind Energy</td>
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**SEMMESTER-II: RENEWABLE ENERGY**

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<td>PS02CREN01 Renewable Energy: Conversion, Storage and Environmental</td>
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<td>PS02CREN02 Ocean Energy and Tidal Energy</td>
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<td>PS02CREN03 Hydro Energy and Chemical Energy Sources</td>
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<td>PS02EREN01 Alternate Energy Sources</td>
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**SEMESTER-III: RENEWABLE ENERGY-SYSTEM TECHNOLOGY**

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**SEMESTER-III: RENEWABLE ENERGY-ENVIRONMENTAL MODELING**

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**ELECTIVE COURSE**

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<td>4</td>
<td>PS3EREEMO1 Environmental Control</td>
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**SEMESTER-III: RENEWABLE ENERGY-ENERGY MANAGEMENT**

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**SEMESTER-IV: RENEWABLE ENERGY-SYSTEM TECHNOLOGY**

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<td>PS4CRESYT2 Modelling of Solar Thermal system</td>
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<tr>
<td>3</td>
<td>PS4ERESYT1 Solar Heating and Cooling of Building</td>
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<td>PS4ERESYT2 Energy Storage and Distribution</td>
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Note: Project will be offered in forth semester to student who will have to complete PS4CRESYT1, PS4CRESYT2, PS4CRESYT3 and PS4CRESYT6 courses only

**SEMMESTER-IV: RENEWABLE ENERGY-ENVIRONMENTAL MODELING**

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<td>PS4 CREEMO1 Statistical and Research Methods: Theory and Practical</td>
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**TOTAL**

Note: Project will be offered in forth semester to student who will have to complete PS4CREEMO1, PS4CREEMO2, PS4CREEMO3, and PS4CREEMO6 courses only

**SEMMESTER-IV: RENEWABLE ENERGY-ENERGY MANAGEMENT**

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**TOTAL**

Note: Project will be offered in forth semester to student who will have to complete PS4CREEMO1, PS4CREEMO2, PS4CREEMO3, and PS4CREEMO6 courses only
Note: Project will be offered in forth semester to student who will have to complete PS4CREEMA1, PS4CREEMA2, PS4CREEMA3, and PS4CREEMA6 courses only

ALL THE COURSES ARE COMPULSORY

Scope: The scope of the course is very wide. The students passing with the M. Sc. degree in Renewable Energy are expected to have opportunity at:

a. Renewable energy industries like solar, wind, biofuels.
b. Colleges and Universities in academics
c. Nonprofit organizations working in Renewable Energy Field
d. As research scientists, associate or fellow at various research organizations, college universities
e. The students may start their own entrepreneurship as research administrator, programmer, and data analyst, product manufacture

Duration: Two years Master Degree Course in Science with Four Semesters.

Eligibility: Bachelor of Science (Any Sciences Graduation) and Engineering (Any B.E or B. Tech Graduation)

Number of Seats: 75 (Seventy Five)
COURSE STRUCTURE, M. Sc. in Renewable Energy (UNDER CBCS)

SEMESTER-I
CORE COURSES
PS01CREN01: Fundamental of Renewable Energy Technology
PS01CREN02: Solar Energy
PS01CREN03: Geothermal Energy and Biomass Energy

ELECTIVE COURSES
PS01EREN01: Wind Energy
PS01CREN04: Practical
PS01CREN05: Practical
PS01CREN06: Viva Voce

SEMESTER-II
CORE COURSES
PS02CREN01: Renewable Energy: Conversion, Storage and Environmental aspects
PS02CREN02: Ocean Energy and Tidal Energy
PS02CREN03: Hydro Energy and Chemical Energy Sources

ELECTIVE COURSES
PS02EREN01: Alternate Energy Sources
PS02CREN04: Practical
PS02CREN05: Practical
PS02CREN06: Viva Voce

SEMESTER-III-RENEWABLE ENERGY-SYSTEM TECHNOLOGY
CORE COURSES
PS3CRESYT1: Energy Audit and Energy Conservation
PS3CRESYT2: Energy Policy & Regulation Act- India
PS3CRESYT3: Solar Thermal Technology

ELECTIVE COURSES
PS3ERESYT1: Solar Photovoltaic Technology
PS3CRESYT4: Practical
PS3CRESYT5: Practical
PS3CRESYT6: Viva Voce

SEMESTER-III-RENEWABLE ENERGY-ENVIRONMENTAL MODELING
CORE COURSES
PS3CREEMO1: Energy Audit and Energy Conservation
PS3CREEMO2: Energy Policy & Regulation Act- India
PS3CREEMO3: Environmental Modeling

ELECTIVE COURSES
PS3EREEMO1: Environmental Control
PS3CREEMO4: Practical
PS3CREEMO5: Practical
PS3CREEMO6: Viva Voce
SEMESTER-III-RENEWABLE ENERGY-ENERGY MANAGEMENT

CORE COURSES
PS3CREEMA1: Energy Audit and Energy Conservation
PS3CREEMA2: Energy Policy & Regulation Act- India
PS3CREEMA3: Energy Management and Energy Planning

ELECTIVE COURSES
PS3EREEMA1: Solar Thermal Technology
PS3CREEMA4: Practical
PS3CREEMA5: Practical
PS3CREEMA5: Viva Voce

SEMESTER-IV-RENEWABLE ENERGY-SYSTEM TECHNOLOGY

CORE COURSES
PS4CRESYT1: Research Methodology
PS4CRESYT2: Modeling of Solar Thermal system

ELECTIVE COURSES
PS4ERESYT1: Solar Heating and Cooling of Building
PS4ERESYT2: Energy Storage and Distribution
PS4CRESYT3: Practical
PS4ERESYT4: Practical
PS4CRESYT5: Project/ Dissertation
PS4CRESYT6: Viva Voce

SEMESTER-IV-RENEWABLE ENERGY-ENVIRONMENTAL MODELING

CORE COURSES
PS4CREEMO1: Research Methodology
PS4CREEMO2: Environmental Planning and Management

ELECTIVE COURSES
PS4EREEMO2: Statistical and Research Methods: Theory and Practical
PS4EREEMO3: Modeling of Solar Thermal system
PS4CREEMO3: Practical
PS4EREEMO4: Practical
PS4CREEMO5: Project/ Dissertation
PS4CREEMO6: Viva Voce

SEMESTER-IV-RENEWABLE ENERGY-ENERGY MANAGEMENT

CORE COURSES
PS4CREEMA1: Research Methodology
PS4CREEMA2: Energy Efficiency and Analysis in Electrical Systems I

ELECTIVE COURSES
PS4EREEMA2: Energy Efficiency and Analysis in Electrical Systems II
PS4EREEMA3: Energy Efficiency and Analysis in Thermal Utilities
PS4CREEMA3: Practical
PS4EREEMA4: Practical
PS4CREEMA5: Project/ Dissertation
PS4CREEMA6: Viva Voce
SEMESTER-I

PS01CREN01: Fundamental of Renewable Energy Technology

Unit 1: Fundamentals of Energy Science & Energy Technology


Unit 2: Energy Measurements, Conversion & Calculations


Unit 3: Fundamental of Heat, Heat and Mass Transfer


Unit 4: Fundamentals of Thermodynamic cycles


Reference Book:
   G.N.Tiwari. (2013)

Text Book:
   G.D.Rai. (2011)
   G.D.Rai. (2011)

SEMESTER-I

PS01CREN02: Solar Energy

Unit 1: Solar Radiation Analysis

**Unit 2: Solar Radiation Measurement and Data Estimation**
Solar energy measuring equipments-classification, Pyrheliometers, Pyranometers, Sun-shine recorder, Solar radiation data, Estimation of average solar radiation, Estimation of Direct and Diffused radiation-during no cloudy days-during cloudy days, Ratio of Beam radiation on tilted surface to horizontal surface, Ratio of total radiation on tilted surface to a horizontal surface.

**Unit 3: Radiation Characteristics of Opaque Materials**

**Unit 4: Principle of Solar Energy Collecting Devices**

**Text Book:**
   Duffie and Beckman. (2013)
   G.N.Tiwari. (2013)

**Reference Book:**

**PS01CREN03: Geothermal Energy and Biomass Energy**

**Unit 1: Geothermal Energy**

**Unit 2: 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, Binary cycle Liquid dominated GTEP Plant, and Liquid dominated Total Flow GTEP Plant, Geothermal (Hot Dry Rock) GTEP Plant, and Scope for Geothermal Energy systems in India

**Unit 3 Biomass Energy Resources and Conversion Processes**

Unit 4 Biogas Plants for Urban Waste and Rural Waste to Energy
Introduction, Raw Biomass materials for Conversion to Biogas, Agriculture waste and Agriculture Crops, Fruit Farms, Aquatic Biomass, Raw materials for Biogas Production, Significance of Biogas Plants, Average Composition of Biogas, Anaerobic Fermentation and Digestion Process used in Biogas Plants, Biogas Plants and its Types, Technical data Calculation for Biogas Plant, Large Biogas Plants, Uhde-Schwarting Process of Two Stage Wet Fermentation, Dry Anaerobic Digestion Process of MSW, Ocean Biomass energy Conversion, Principal Marine Bio energy Resources, Kelp Bio energy Conversion Process

Text Book:

2. Energy Technology-Nonconventional, Renewable & Conventional

3. Solar Energy Utilization

4. Non-Conventional Energy Sources

References Books:

1. Nonconventional energy sources
   Domkundwar,Dhanpat rai & Co.

2. Biomass- Application, technology & production

   Lynn Ellen Doxon

   Donald L. Klass, Reed Elsevier India Private Limited

   K. Gupta and Roy Sukanta.

   William E. Glassley.

   Ernst Huenges (Editor), Patrick Ledru (Editor).

   Karl Oschner.

   Ronald DiPippo.

10. Geothermal Energy: Utilization and Technology by
    Mary H. Dickson.
PS01EREN01: Wind Energy
Unit 1 Wind Energy – Fundamentals and Applications

Unit 2 Wind Turbine- Generator Units
Introduction, Various terms and definitions, Types of Wind Turbine Generator(WTG) Units, Planning of a Wind Farm, Horizontal Axis Propeller type Wind Turbine Generator, Three Blade Horizontal Axis Wind Turbine(HAWT), Dimensioning of Horizontal Axis Wind Turbine, Vertical Axis Wind Turbine, Vertical Axis Darrieus Rotor Wind Turbine, Vertical Axis Wind Turbine with H-Rotor, Wind Turbine Rotor Speed, Practical PV Characteristics, Power Coefficients Versus Tip Speed Ratio, Operation and Control of a HAWT, Economic Consideration

Unit 3 Wind Energy Farm and Energy Conversion System
Wind to Electric Energy Conversion System, Power Versus Velocity of WTG, Power Duration Curves Types of Wind Energy System, Wind to Electrical Energy Conversion Alternatives, Grid Connection, Energy Storage Requirements with Wind Energy System, Wind Turbine Generator Unit with Battery Storage Facility, Wind Turbine Generator Unit with Diesel Generator, Solar-Wind Hybrid (Futuristic), Electrical Main Circuit by a Wind Farm, Control and Monitoring System of a Wind Farm, Wind Farm Siting, Wind Map of India, Wind-Electric Energy Stations in India, Indigenously Developed Wind Turbine Generators by BHEL, India

Unit 4 Wave Energy

References:
1. Energy Technology-Nonconventional, Renewable & Conventional
2. Solar Energy Utilization
3. Non-Conventional Energy Sources

PS01CREN04: Practical
1. Measurement of Solar Radiation
2. Measurement of Solar Angles
3. Measurement of total and Diffused solar radiation on a horizontal surface and comparison of computed values of total solar radiation on an inclined plane with experimentally measured values
4. Determination of thermal efficiency of Solar Water Heater
5. Performance of Solar Air Heater (Forced Dryer)
6. Performance Evaluation of Solar Still
7. Thermal testing of a Box-type Solar Cooker and determination of first and second figure of merit.
8. To study the transmissivity of given solar flat plate collector glass
9. Measurement of power of wind mill
10. Energy Content in Wind. (Prototype Wind Mill of 100W)

PS01CREN05: Practical
1. Study and determination of proximate analysis of biomass
2. Study of ultimate analysis of biomass
3. Measurement of calorific value of different biomass (at least two types)
4. Measurement of load and power factor for the electrical utilities
5. Study of various types of bio-gas plants
6. Determination of thermal efficiency of biogas burner
7. Study of diesel generator set
8. Performance evaluation of blower
9. Performance evaluation of air compressors
M. Sc. Renewable Energy (UNDER CBCS)

SEMESTER-II

PS02CREN01: Renewable Energy: Conversion, Storage and Environmental aspects

Unit 1 Energy Conversion Technologies and Electrical Power Plants
Introduction, Energy Conversion process and devices, Summary of energy and Conversion devices, Electrical energy route, Unit of energy and power in electrical form, Electrical energy supply system (power system), Basic objectives of electrical energy supply undertaking, Difficulties in electrical energy route, Electrical load curves and peak load, Energy conversion plant for base load intermediate load peak load and energy displacement, Suitable type of energy conversion plant for various primary energy sources, Coal fired steam thermal power plant, Gas turbine power plant, Combined coal gasification combined cycle power plant (ICGCC), Diesel electric power plant, Plant factors and reserves, Magneto hydro dynamics(MHD), Nuclear fusion energy Conversion, Fuel cells and chemical to electrical energy Conversion, Thermionic Converters, Heat pumps, Energy densities in primary resources, Net energy analysis of electrical route/plant

Unit 2 Energy Storage and Distribution-I
Introduction, Energy storage systems, Mechanical Energy storage, pumped hydroelectric storage, compressed air storage, Energy storage via flywheels Electric storage :The lead acid battery, Chemical storage- Introduction, Energy storage via hydrogen, ammonia, reversible chemical reactions

Unit 3 Energy Storage and Distribution-II
Electromagnetic Electric storage, Thermal Energy storage, Sensible heat storage, latent heat storage, Biological storage, Distribution of energy- Introduction, gas pipelines, electricity transmission, batch transport, Heat, chemical heat pipe

Unit 4 Environmental Aspects of Energy and Pollution Control
Introduction, Terms and definitions, Pollution from use of energy, Combustion products of fossil fuels, Particulate matter, Fabric filter and bag house, Electro-statics precipitator, Carbon dioxide, Greenhouse effect and global warming, Emission of carbon monoxide, Pollution by sulphur dioxide and hydrogen sulphide, Emission of nitrogen oxides, Acid rains,acid snow ,acidic fog and dry acidic deposits, Acid fog, Dry acidic deposition, FGD and SCR systems for cleaning flue gases

References:
1. Energy Technology-Nonconventional, Renewable & Conventional
2. Solar Energy Utilization
   G. D. Rai, Khanna Publishers
3. Non-Conventional Energy Sources
5. Thermal Energy Storage: Systems and Applications,
   Ibrahim Dincer, Marc A. Rosen
6. Energy Storage
7. Alternative Energy Resources: The Quest for Sustainable Energy
   Paul Kruger.
8. Nonconventional energy sources
   Domkundwar, Dhanpat Rai & Co.
9. Nonconventional Energy Sources
   S. Hasan Saeed, Sharma, D K,

PS02CREN02: Ocean Energy and Tidal Energy

Unit 1 Ocean Energy Technologies
Introduction to Energy form oceans, Oceans energy Resources, Off shore and on-shore oceans energy conversion technology, Advantage and limitation of oceans energy conversion technology, The guidelines for oceans energy conversion plant, Ocean energy routes, High voltage direct current power transmission from Off shore oceans energy conversion plant to land based load centers

Unit 2 Ocean Thermal Energy Conversion
Introduction, Principle of OTEC, Ocean surface temperature, Deep water temperature, Efficiencies of OTEC plants and their influence on plants size, Open cycle, Limitation of Open cycle OTEC system, Historical review of Open cycle OTEC plants, India’s first oceans thermal energy conversion, Modified Open cycle OTEC plants, Cogeneration of electricity and fresh water from open cycle OTEC, Closed cycle OTEC

Unit 3 Ocean Wave Energy Conversion
Introduction, Ocean waves, Parameters of a progressive wave, Equation of a progressive wave, Energy and power in ocean waves, Summary of Equation Motion of water particles in the waves, Wave data collection, Routes of energy conversion of wave energy, Wave machines, Dolphin-buoy type of ocean wave energy converter, Oscillating float-air pump type wave machine Three-raft energy converter, Nodding duck Oscillating cam wave machine

Unit 4 Tidal Energy Conversion
Introduction tidal Current, High and Low Tides, Tidal Energy conversion, Tidal power, Average theoretical Power per tide (rise and fall), Summary of Expressions Tidal Work or Energy Conversion, Ocean tidal energy conversion schemes, Terms and definitions, Single basin tidal schemes, Double basin scheme and multi basin scheme, Details about plant and equipment, Economic aspects about tidal energy conversion plant, Tidal power plant in the world, Tidal energy resources in India, The range tidal power plants in france, Kislaya guna plants Russia, Interaction between tidal power plant and electrical grid

Text Book:
1. Energy Technology-Nonconventional, Renewable & Conventional
2. Solar Energy Utilization
3. Non-Conventional Energy Sources
4. Nonconventional energy sources
   Domkundwar, Dhanpat Rai & Co.

References Books:
2. Alternative Energy Resources: The Quest for Sustainable Energy
Paul Kruger.

3. Non conventional Energy Sources
   S.Hasan Saeed, Sharma, D K,

**PS02CREN03: Hydro Energy and Chemical Energy Sources**

**Unit 1 Hydropower**
Introduction, Power Equation, Classification of Small Hydropower (SHP) Stations, Classification of Water Turbines, Impulse Turbines, Specific Speed Range of Application of Various Types of Turbines for a small Hydro Project Civil Works for Small Hydropower Facilities, Major Components of Small Hydropower Projects, Low-Head Small Hydro Projects, Electric Generators Examples of Small Hydroelectric Project Installation with Unique Features Global Scenario of Small Hydro

**Unit 2 Fuel Cells**
Introduction, Principal of operation of an acidic fuel cell, Technical of parameter of a fuel cell, Fuel processor, Hydrogen for fuel cells from renewable source, Methanol fuel cell, Fuel cell types, -alkaline fuel cells (AFCs), -polymer electrolyte membrane fuel cells (PEMFC), -Phosphoric acid fuel cell (PAFC), -molten carbonate fuel cell (MCFC), - solid oxide fuel cell (SOFC), Advantages of fuel cell power plants, Fuel cell battery –powered bus system, Comparison between acidic and alkaline hydrogen –oxygen fuel cells, State of the art fuel cells, Microbial fuel cell, World’s first fuel cell gas turbine, Energy output of a fuel cell, Efficiency and EMF of a fuel cell, Gibbs-Helmholts equation, free energy change in chemical reaction, - Helmholts free energy, -Gibbs free energy, Hydrogen fuel cell analysis with thermodynamic potential, Comparison of electrolysis and fuel cell process, Operating characteristics of fuel cell, Thermal efficiency of fuel cell, Future potential of fuel cell

**Unit 3 Hydrogen Energy Systems**
Utilization of Hydrogen gas, Hydrogen as an alternative fuel for motor vehicles, Safety and management, Hydrogen technology development in India

**Unit 4 Hybrid Energy Systems**

**PS02EREN01: Alternate Energy Sources**

**Unit 1 Magneto Hydro Dynamic (MHD) Power Generation**

**Unit 2 Thermo Electric Power**
Introduction, Basic principles of thermoelectric power generation, Thermoelectric power generator, Performance analysis of Thermoelectric power generator, Thermoelectric materials, Selection of materials
Unit 3 Thermionic Generation
Introduction, Thermionic emission and work function, Basic thermionic generator, Analysis of thermionic generator

Unit 4 Thermo Nuclear Fusion Energy
Introduction, The basic nuclear fusion and reactions, Requirements for nuclear fusion, Plasma confinement, Magnetic confinement fusion, Inertial confinement fusion, Muon catalyzed fusion, Characteristics of D-T reaction Advantages of Nuclear Fusion, Fusion hydrid, Cold fusion

Text Books:
1. Non-Conventional Energy Sources
2. Energy Technology-Nonconventional, Renewable & Conventional
3. Solar Energy Utilization

References Books:
2. Thermal Energy Storage: Systems and Applications,
   Ibrahim Dincer, Marc A. Rosen
3. Energy Storage
4. Alternative Energy Resources: The Quest for Sustainable Energy
   Paul Kruger.
5. Nonconventional energy sources
   Domkundwar,Dhanpat rai & Co.
6. Non conventional Energy Sources
   S.Hasan Saeed, Sharma, D K,

PS02CREN04: Practical
1. Study of Electrical load curves & peak load & plant efficiency
2. Study of Modern Thermal Power Plant
3. To study different energy storage devices
4. To study the thermal performance of parabolic solar cooker
5. To study different OTEC system
6. To study different ocean wave energy conversion system
7. To study different Tidal Energy conversion system
8. To prepare a seminar report on prospectus of above energy conservation system in India

PS02CREN05: Practical
1. Performance evaluation of biomass cook stove
2. Performance evaluation of downdraft biomass gasifier
3. Study of different small Hydro-electric project installation with unique features
4. To study principle & operation of different types of fuel cells
5. To study Hydrogen as an alternative fuel for different application
6. To study different Hybrid System
7. To study different MHD Power generation systems
8. To study Thermo-Electric and Thermionic Power generation
9. To study Nuclear Fusion Energy System
10. To study biomass briquetting technologies
Note:

1. Student can choose any one discipline from three specializations i.e. System Technology, Environmental Modeling and Energy Management for 2nd year (3rd and 4th semester)

M. SC. RENEWABLE ENERGY AND SYSTEM TECHNOLOGY (UNDER CBCS)

SEMESTER-III

PS3CRESYT1: Energy Audit and Energy Conservation

Unit 1 Definition, Need for Energy Audit, Types of Energy Audit and Approach, Preliminary Energy Audit, Targeted Energy Audit, Detailed Energy Audit, Ten Step Methodology for Conducting Detailed Energy Audit, Pre Audit Phase, Detailed Energy Audit Phase, Preparing Process Flow Diagram, Identification of ENCON Opportunities, Technical and Economical feasibility, classification of ENCON Measures, Energy Audit report, Post Audit Phase,


Unit 3 Instrument and Metering for Energy Audit, Key Performance parameters for Energy Audit, Bureau of Energy Efficiency, Interval of Time for Conduct Energy Audit, Manner of Energy Audit-Verification of data- Scope of Energy Audit-Monitoring and Analysis of the use of energy data for energy audit, Preparation of Energy saving measures and its benefits, Prioritization and preparation of action plan, Structure of the energy Audit Report


Text Book:

2. NPC Energy Audit Manual and reports, NCP
5. Guide to Energy Management, Cape Hart, Turner and Kennedy
7. www.eeae.gov.nz
8. www.energyyusernews.com

PS3CRESYT2 Energy Policy and Regulation Act- India

Unit 1

Central Agency and State Agencies for Energy, Sate Nodal Agencies and their function, Energy policy in India, Need for renewable energy policy in India
Energy Act,
Energy sector reformation,
Energy conservation code for Building,
Greenhouse Effect
Clean Development mechanism (CDM)

Unit 2
Solar Power policy- Objectives, Tariff for solar PV and Solar thermal, Transmission/wheeling charges, Subsidy charges, CDM benefits,
Wind Power Policy-Operative Period, Eligible Unit:, Eligible Sites:, Wheeling of Electricity:, exemptions, sale of energy, third part sale, land, plant and machinery, metering electricity, reactive power charges

Unit 3
National Policy on biofuel- Vision and goal, definition and scope, strategy and approach, intervention and enabling mechanism, Distribution and marketing biofuel, Quality standard, Import and export of biofuel, Roles of state
Biomass Power Policy-Capital cost, Evacuation Cost, Tenure of Loan, Interest on loan,Return on Equity, Life of plant and machinery and agreement period, Depreciation, Debt-Equity Ratio, Operations and Maintenance expenses, Interest on Working Capital, Plant Load Factor (PLF), Auxiliary Energy Consumption, Station Heat Rate (SHR)

Unit 4
Jawaharlal Nehru National Solar mission- objectives,
Strategic plan for, New and renewable energy sector for the period 2011-17

Text Book:
4. State Government and central Governments and regulations regarding non-conventional sources and utilization implemented by Gujarat Govt. and Govt. of India time to time.
6. www.mnre.gov.in
7. Strategic plan for, new and renewable energy sector for the period 2011-17
11. www.gedagujarat.gov.in

PS3CRESYT3 Solar Thermal Technology
Unit 1: Solar Thermal Systems

Unit: 2 Solar Thermal Systems Applications

Unit: 3 Solar Power Plants

Unit: 4 Solar Process Economics

Text Books:

PS3ERESYT1 Solar Photovoltaic Technology

Unit 1 Electricity from the sun
Introduction, why need photovoltaic’s, Basics principles, operating principles, Types of solar cells, Features and Limitations of Solar Photovoltaic system

Unit 2 Solar Cell and Applications

Unit 3 Silicon & Thin-film Solar cell
Introduction, From sand to pure silicon, Growth of silicon crystals, typical solar cell fabrication process, Module fabrication. Energy storage-introduction, Battery operation in PV systems, Lead-acid batteries. Introduction, Amorphous silicon cells, Thin polycrystalline silicon on low-cost substrates, Copper indium telluride’s cells, cadmium telluride cells, Integrally interconnected Modules.

Unit 4 Photovoltaic Technology
Introduction, Crystal Structure, Cell Physics, Energy Bands, More about Electrons and Their Energy, Electrons and Holes, Direct and Indirect Band-Gap Materials, Doping, Transport, Generation and

Text Books:
   Tomas Markvart (2009)

Reference Book:
   G.D.Rai. (2011)

PS3CRESYT4 Practical
1. To study the effect of number of glazing on the optical efficiency factor of a flat plate solar collector
2. Determination of time constant of a flat plate solar collector
3. Stagnation temperature measurement of Flat plate solar collector
4. To determine the heat loss factor $F_R U_L$ of FPC by zero testing
5. Determination of optical efficiency of a seasonally adjusted linear solar concentrator
6. Heating and cooling tests on a paraboloid concentrator solar cooker to determine its $F'\eta$ and $F' U_L$
7. To determine the top heat loss factor of a box type solar cooker
8. Study of wind induced heat losses from outer cover of a flat plate solar collector
9. To determine the top heat loss factor of a box type solar cooker
10. To measure the reflectance and absorptance of surfaces

PS3CRESYT5 Practical
1. To study the voltage and current of the solar cell in series and parallel combination
2. To calculate the efficiency of the solar cell
3. To study the I-V Characteristics of a Si solar cell with varying temperature at constant irradiation
4. Performance study of a solar cell with different irradiation
5. Performance evaluation of Photovoltaic thermal Tile.
6. To study the $P_{max}$ characterization of solar cell with different insolation.
7. To study of the application of solar cell of providing electrical energy to the domestic appliance such as lamp etc.
8. Energy audit of any one residential building
9. Energy audit of any one institutional or commercial building,

PS3CRESYT6 Viva
M. SC. RENEWABLE ENERGY AND ENVIRONMENTAL MODELING (UNDER CBCS)
SEMESTER III

PS3CREEMO1: Energy Audit and Energy Conservation

Unit 1 Definition, Need for Energy Audit, Types of Energy Audit and Approach, Preliminary Energy Audit, Targeted Energy Audit, Detailed Energy Audit, Ten Step Methodology for Conducting Detailed Energy Audit, Pre Audit Phase, Detailed Energy Audit Phase, Preparing Process Flow Diagram, Identification of ENCON Opportunities, Technical and Economical feasibility, classification of ENCON Measures, Energy Audit report, Post Audit Phase,


Unit 3 Instrument and Metering for Energy Audit, Key Performance parameters for Energy Audit, Bureau of Energy Efficiency, Interval of Time for Conduct Energy Audit, Manner of Energy Audit-Verification of data- Scope of Energy Audit-Monitoring and Analysis of the use of energy data for energy audit, Preparation of Energy saving measures and its benefits, Prioritization and preparation of action plan, Structure of the energy Audit Report


References:
1. NPC Energy Audit Manual and reports
2. Energy Management Handbook, John and Sons –Wayne C Turner
5. www.eeae.gov.nz
6. www.energyusernews.com
8. Energy Technology-Nonconventional, Renewable & Conventional

PS3CREEMO2 Energy Policy and Regulation Act- India

Unit 1 Central Agency and State Agencies for Energy, Sate Nodal Agencies and their function, Energy policy in India, Need for renewable energy policy in India
Energy Act,
Energy sector reformation,
Energy conservation code for Building, 
Greenhouse Effect 
Clean Development Mechanism (CDM)

Unit 2 
Solar Power policy- Objectives, Tariff for solar PV and Solar thermal, Transmission/wheeling charges, Subsidy charges, CDM benefits,
Wind Power Policy-Operative Period, Eligible Unit:, Eligible Sites:, Wheeling of Electricity:, exemptions, sale of energy, third part sale, land, plant and machinery, metering electricity, reactive power charges

Unit 3 
National Policy on biofuel- Vision and goal, definition and scope, strategy and approach, intervention and enabling mechanism, Distribution and marketing biofuel, Quality standard, Import and export of biofuel, Roles of state
Biomass Power Policy-Capital cost, Evacuation Cost, Tenure of Loan, Interest on loan,Return on Equity, Life of plant and machinery and agreement period, Depreciation, Debt-Equity Ratio, Operations and Maintenance expenses, Interest on Working Capital, Plant Load Factor (PLF), Auxiliary Energy Consumption, Station Heat Rate (SHR)

Unit 4 
Jawaharlal Nehru National Solar mission- objectives,
Strategic plan for, New and renewable energy sector for the period 2011-17

References
4. State Government and central Governments and regulations regarding non-conventional sources and utilization implemented by Gujarat Govt. and Govt. of India time to time.
6. www.mnre.gov.in
7. Strategic plan for, new and renewable energy sector for the period 2011-17
11. www.gedagujarat.gov.in

PS3CREEMO3 Environmental modeling 
Unit 1 Measurement of central tendency - mean (Geometric and Harmonic), median, mode, Measurement of dispersion moments, standard deviation, skewness and kurtosis, Correlation and linear regression of one independent variable, Basic laws and concepts of probability
Unit 2 Role of modelling in environmental sciences, Model classification deterministic models, stochastic models, steady state models, dynamic models, different stages involved in model building. Simple microbial growth kinetics monod equation, methods for formulation of dynamic balance equations mass balance procedures

Unit 3 Introduction to environmental modeling, Pollutant properties, behavior, and reactivity, Interphase transfer, Transport fundamentals, Numerical Methods for solution of ordinary and partial differential equations, Probabilistic Methods for modeling, Model Evaluation, Analysis and Optimization, Atmospheric chemical transport modeling, Atmospheric chemical transport and transformation modeling, Overview of modeling of other media, Exposure and risk assessment modeling

Unit 4 Models of population growth and interactions Lotka Volterra model, Leslies matrix model, Point source stream pollution, Box model, Gaussian plume model, Linear, simple and multiple regression models, validation and forecasting.

Text Books:
1. Integrated Environmental Modeling
   A. Ramaswami et al, John Wiley & Sons, 2005
2. Environmental Modeling,
3. Fundamentals of Atmospheric Modeling
   M.Z. Jacobson, Cambridge University Press, 2005
4. Handbook of Environmental Economics in India
   Vikram Dayal & Kanchan Chopra
   Nick Hanley, Jason Shogren and Ben White, Palgrave Macmillan
6. Dynamics of Environmental Bioprocesses-Modelling and simulation-
   Snape and Dunn.
7. Environmental Modeling
   Jorgensen

PS3EREEMO1 Environmental Control
Unit 1 Elementary Concept of Physical Environment
Definition, Principles and scope of Environmental Science, Earth, Man and Environment, Ecosystem, Pathways in Ecosystems, Physico-chemical and biological factors in the Environment, Geographical classification and zones, Structure and composition of Biosphere, General, relationship between landscapes, biomes and climates, Primary differentiation and formation of core, mantle and crust. Igneous, sedimentary and, metamorphic rocks, weathering, erosion, transportation and deposition of earth’s material by running water, wind and glaciers, Mass and energy transfer across the various interphases, Material Balance, Heat Transfer processes, Scales of Meteorology, various kinds of lapse rates, vertical stability of atmosphere, cloud classification & formation.

Unit 2 Air pollution- natural and anthropogenic sources of pollution, primary and secondary pollutants, transport and diffusion of pollutants, gas laws governing the behavior of pollutants in the atmosphere, Methods of monitoring and control of air pollution, SO2, NOx, CO, SPM, Water pollution - types sources and consequences of water pollution, physico-chemical and bacteriological sampling, Analysis of water quality, standards, sewage and wastewater treatment and recycling, water quality and standards.

Unit 3 Soil pollution chemical and bacteriological sampling as analysis of soil quality, soil pollution control, industrial waste effluents and heavy metals and their interactions with soil components, Noise pollution -
sources of noise pollution, measurement and indices, Marine pollution, sources of marine pollution and its control, Effects of pollutants on human beings, plants, animals and climate, air quality standards and air pollution.

**Unit 4 Environmental Laws**


**References**

1. Ecology
   P.D. Sharma
2. Concepts of physical environment-
   Savinder Singh
3. The Atmosphere- an Introduction-
   F.K. Lutagens
4. Atmospheric weather and climate
   Navarra
5. Introduction to Environmental Modeling,
   Jo Smith & Pete Smith,
6. Basics of Environmental Studies
   R. Rajagopalan, (GTU),
7. Environmental administration & law
   Paras Diwaa.
8. Environmental planning, policies & programs in India
   K.D. Saxena
9. Air pollution and control
   K.V.S.G. Murlikrishan
10. Industrial noise control
    Bell & Bell
11. Environmental engineering
    Peary
12. Introduction to environmental engineering and science
    Gilbert Masters

**PS3CREEMO4 Practical**

1. Experiments related to water Sampling and Data Analysis
2. Study water pollution control methods
3. Experiments related to Air Sampling and Data Analysis
4. Study air pollution control methods
5. Experiments related to soil Sampling and Data Analysis
6. Use of computer for analysis of environmental data
7. Study Principle component analysis of environmental variable.
8. Determination of turbidity of water of different sources
9. Experiments based on the use of Noise Level meter and weather equipments
10. Experiments based on microbiological analysis of waste water

**PS3CREEMO5 Practical**
1. To study instruments and metering for energy audit
2. Methodology for detailed energy audit
3. Study on preparation of Energy Audit report
4. Practical based on environmental modeling
5. Determination of time constants of flat plate collector
6. Stagnation Temperature measurement of flat plate collector
7. To measure the voltage and current of solar cell in series and parallel combination
8. To calculate efficiency of solar cell
9. Energy Audit of residential/institutional building
10. Field work - Fieldwork related to any local ecosystem

**PS3CREEMO6 Viva**
M. SC. RENEWABLE ENERGY AND ENERGY MANAGEMENT (UNDER CBCS)

SEMESTER-III

PS3CREEMA1 Energy Audit and Energy Conservation

Unit 1 Definition, Need for Energy Audit, Types of Energy Audit and Approach, Preliminary Energy Audit, Targeted Energy Audit, Detailed Energy Audit, Ten Step Methodology for Conducting Detailed Energy Audit, Pre Audit Phase, Detailed Energy Audit Phase, Preparing Process Flow Diagram, Identification of ENCON Opportunities, Technical and Economical feasibility, classification of ENCON Measures, Energy Audit report, Post Audit Phase,


Unit 3 Instrument and Metering for Energy Audit, Key Performance parameters for Energy Audit, Bureau of Energy Efficiency, Interval of Time for Conduct Energy Audit, Manner of Energy Audit-Verification of data, Scope of Energy Audit-Monitoring and Analysis of the use of energy data for energy audit, Preparation of Energy saving measures and its benefits, Prioritization and preparation of action plan, Structure of the energy Audit Report


References:
1. NPC Energy Audit Manual and reports
2. Energy Management Handbook, John and Sons –Wayne C Turner
5. www.eeae.gov.nz
6. www.energyusernews.com
8. Energy Technology-Nonconventional, Renewable & Conventional

PS3CREEMA2 Energy Policy and Regulation Act- India

Unit 1 Central Agency and State Agencies for Energy, Sate Nodal Agencies and their function, Energy policy in India, Need for renewable energy policy in India

Energy Act, Energy sector reformation,
Energy conservation code for Building,
Greenhouse Effect
Clean Development mechanism (CDM)

Unit 2
Solar Power policy- Objectives, Tariff for solar PV and Solar thermal, Transmission/wheeling charges, Subsidy charges, CDM benefits,
Wind Power Policy-Operative Period, Eligible Unit:, Eligible Sites:, Wheeling of Electricity:, exemptions, sale of energy, third part sale, land, plant and machinery, metering electricity, reactive power charges

Unit 3
National Policy on biofuel- Vision and goal, definition and scope, strategy and approach, intervention and enabling mechanism, Distribution and marketing biofuel, Quality standard, Import and export of biofuel, Roles of state
Biomass Power Policy-Capital cost, Evacuation Cost, Tenure of Loan, Interest on loan,Return on Equity, Life of plant and machinery and agreement period, Depreciation, Debt-Equity Ratio, Operations and Maintenance expenses, Interest on Working Capital, Plant Load Factor (PLF), Auxiliary Energy Consumption, Station Heat Rate (SHR)

Unit 4
Jawaharlal Nehru National Solar mission- objectives,
Strategic plan for, New and renewable energy sector for the period 2011-17

References
4. State Government and central Governments and regulations regarding non-conventional sources and utilization implemented by Gujarat Govt. and Govt. of India time to time.
6. www.mnre.gov.in
7. Strategic plan for, new and renewable energy sector for the period 2011-17
11. www.gedagujarat.gov.in

PS3CREEMA3 Energy Management and Energy Planning


References:
1. Energy Technology-Nonconventional, Renewable & Conventional
2. Financial Management. Tata McGraw hill,
   Prasanna Chandra
4. Principles of project Management, NPC Publication
5. Project Management, Chodhury S., Tata McGraw Hill
6. Project Mangement-Step by Step (Amacom)
   Richman Larry
7. Energy Management,
   WR Murphy, C McKay, Elsevier, ISBN-978-0-408-00508-1
8. Handbook on Energy Audit and Environment Management,

PS3EREEMA1 Solar Thermal Technology

Unit 1 Solar Thermal Systems

Unit 2 Solar Thermal Systems Applications
Drying: Food Drying Case of an Active Solar Chemical Process: Water Detoxification, Solar cooling- combined solar heating and cooling.

**Unit 3 Solar Power Plants**
Solar Thermal Power Plants - Principles, Solar tower power stations, Parabolic trough power plants, Dish/Stirling systems, Solar updraft tower power plant, Solar pond power plants, Solar Chimney Power plant, Some Case Studies

**Unit 4 Solar Process Economics**

**Text Book:**
   Duffie and Beckman. (2013)
   G.N.Tiwari. (2013)

**PS3CREEM4 Practical**
1. Methodology for detailed energy audit
2. Example on energy auditing
3. Energy audit of any one residential, institutional or commercial building
4. Prepare energy audit report for institutional
5. Prepare energy conservation measures for institutional building
6. Study on simple payback period, return on investments
7. Study on net present value, internal rate of return, sensitive analysis
8. Examples on Energy Managements
9. Preparing energy audit for institutional/ Residential/industrial building
10. Study on chart representation of energy consumption

**PS3CREEM5 Practical**
1. Study different instrument for energy audit
2. To study measure to maximize system efficiency
3. To study instruments and metering for energy audit
4. Study of Gantt chart and
5. Study of CPM project
6. Determination of time constants of flat plate collector
7. Stagnation Temperature measurement of flat plate collector
8. To measure the voltage and current of solar cell in series and parallel combination
9. To calculate efficiency of solar cell
10. To determine top heat loss factor for solar cooker

**PS3CREEM6 Viva**
M. Sc. Renewable Energy: SYSTEM TECHNOLOGY (UNDER CBCS)
SEMESTER-IV

PS4CRESYT1 Research Methodology

Unit 1 General introduction and Research problem Formulation
History of Science & Technology: Importance of research, role of research, aims & objectives, research process, phases of research. Review of Research Literature: Purpose and use of literature review, locating relevant information, use of library & electronic databases, preparation & presentation of literature review, research article reviews, theoretical models and frame work. Identification of gaps in research, formulation of research problem, definition of research objectives.

Unit 2 Research Design

Unit 3 Research Publication & Presentation

Unit 4 Research Ethics and Morals

Reference Books
   C.R. Kothari
   Graziano, A.M., Raulin, M.L
   Murray
   Murray, R
5. Writing for Publication, Henson, 2005
   K.T., Allyn &Bacon
6. What is this thing called Science, Queensland University Press, 1999
   Chalmers, A.F
   Bhandarkar & Wilkinson
   Bell J
Modelling of Solar Thermal system

Unit 1: Solar Collector System Thermal Calculations

Unit 2: Simulation in Solar Process Design
Introduction, Simulation program, Utility simulations, Information from Simulations, Thermal process simulation program, Simulation and Experiments, Meteorological Data, Limitations of Simulations. Thermal modelling of Open sun drying, Computational procedure for convective heat transfer, Prediction of crop temperature and moisture evaporation, Analysis for steady state condition, Experimental setup for open sun drying, Methodology and input parameters for computation, Equivalent solar air temperature, Thermal Analysis of Cabinet Dryer, Energy balance for indirect solar drying system

Unit 3: Design of Active systems
Introduction to active and passive solar system, Review of Design Methods, The f-chart method, the f-chart for liquid systems, the f-chart for Air system, Service water heating system, the f-chart results, Parallel solar energy- heat pump systems.

Unit 4: Design of Active, Passive and Hybrid Heating Systems

Text Book:
   D.Y. Goswami, F.Kreith and J.F. Kreider
   Duffie and Beckman.
   G.N.Tiwari.

PS4ERESYT1: Solar Heating and Cooling of Building

Unit 1 Solar Architecture
Thermal comfort, sun motion, Building orientation and design, passive heating and cooling concepts, Thumb rules, heat transfer in buildings; thermal modelling of passive concepts, evaporative cooling, energy efficient window and day lighting, Earth air tunnel and heat exchanger, zero energy building concept and rating systems, Energy conservation building codes, software for building simulation, Automation and energy management of buildings.

Unit 2 Active Building Heating Systems
Introduction, Solar heating system, Heating system parametric study, solar energy- heat pump systems, phase change storage systems, seasonal energy storage system, solar and off-peak electric systems, solar systems overheating, solar heating economics.

Unit 3 Passive and Hybrid heating of building
Introduction, Concepts of Passive heating, Comfort criteria and heating loads, movable insulation and controls, shading: overhangs and Wing walls, Direct-Gain system, Collector storage and Roofs, Sunspaces, Active collection-Passive storage hybrid systems, Other hybrid system, Passive applications, Heat distribution in passive buildings, cost and economics of passive heating.

Unit 4 Solar Refrigeration and Air-conditioning

Text Book:
   D.Y. Goswami, F.Kreith and J.F. Kreider
   J.Twidell & T. Weir
   Duffie and Beckman
   G.N.Tiwari.

PS4ERESYT2: Energy Storage and Distribution
Unit: 1 Introduction to Energy Storages and Distribution
Introduction and overview of Energy storages, Types of storages -Mechanical, Electrical, Chemical, Electromagnetic, Thermal, Biological. Introduction to distribution system. Comparison of ES Technologies

Unit: 2 Mechanical and Electrical Energy storage
Introduction, Pumped hydroelectric storage, compressed air storage, energy storage via flywheels. Introduction electrical Energy storages- Types of batteries, lead acid battery storages, Merit and demerits of mechanical and electrical energy storages.

Unit: 3 Hydrogen Energy Storages
Introduction to Hydrogen energy systems, Hydrogen storage- Physical and chemical properties- general storage methods, compressed storage- composite cylinders-Glass micro sphere storage-Zeolites, Metal hydride storage, chemical hydride storage and cryogenic storage. Overview of hydrogen utilization.

Unit: 4 Thermal, Biological Energy Storages & Distribution of Energy

Reference Book:
   D.Y. Goswami, F.Kreith and J.F. Kreider

PS4CRESYT3 Practical
1. To measure the remittance of given sample
2. Heat loss test on a built in storage solar water heater
3. Performance monitoring of a simple solar greenhouse
4. Determination of bond conductance of a flat plate solar collector
5. To study the effect of wind on thermal performance of a praboloid concentrator solar cooker
6. To measure the solar reflectance and absorptance of surfaces
7. Performance evaluation of single basin solar still
8. To study the performance of single basin solar still with different input temperature

PS4ERESYT4 Practical
1. To study the effect of number of glazing on the optical efficiency factor of a flat plate solar collector
2. Determination of incidence angle modifier constant of a flat plate solar collector
3. Performance study of heat pump system
4. To study a heat pipe heat exchanger and to find its effectiveness
5. To study the time variation of water temperature in a built-in –storage solar water heater
6. Testing of solar cabinet dryer
7. Determination of heat loss factor for linear solar absorber using an indoor test set-up

PS4CRESYT5 : Project/Dissertation

PS4CRESYT6 : Viva
INSTITUTE OF STUDIES AND RESEARCH IN RENEWABLE ENERGY (ISRRE)
NEW VALLABH VIDYANAGAR

SEMESTER IV

M.Sc. in Renewable Energy and Environmental Modeling

PS4CREEMO1 Research Methodology

Unit 1 General introduction and Research problem Formulation

History of Science & Technology: Importance of research, role of research, aims& objectives, research process, phases of research. Review of Research Literature: Purpose and use of literature review, locating relevant information, use of library & electronic databases, preparation & presentation of literature review, research article reviews, theoretical models and frame work. Identification of gaps in research, formulation of research problem, definition of research objectives.

Unit 2 Research Design


Unit 3 Research Publication & Presentation


Unit 4 Research Ethics and Morals


Reference Books

   C.R. Kothari
   Graziano, A.M., Raulin, M.L
   Murray, R.
   Murray, R.
5. Writing for Publication, Henson, 2005\K.T., Allyn &Bacon
6. What is this thing called Science, Queensland University Press, 1999
   Chalmers, A.F
   Bhandarkar & Wilkinson,
   Bell J
PS4CREEMO2 Environmental Management and Planning

Unit 1 Role of NGO’s public participation in environmental movements, Concepts of Environmental education and awareness Internationals environmental initiatives – the club of Rome report, Stockholm Declaration, environmental ethics.


Unit 3 Basic concepts of environmental planning, Environmental priorities in India, Land use planning: The land use plan (India). Soil surveys in relation to land use planning, Methods of site selection and evaluation, global imperatives, soil erosion, Formation and reclamation of Usar, alkaline and saline soil, waste lands and their reclamation, Desertification and its control.

Unit 4 Urban planning and rural planning for India. Sustainable development- principles and practices in relation to economics and ecology. Cost-benefit analysis- its relevance. Ramsar convention on wetlands, Vienna convention and Montreal Protocol, Kyoto protocol, Earth Summit, Agenda-21

References
  1. Natural Resource Conservation
     Owen and Chiras.
  2. Environmental planning, policies and programs in India
     K.D. Saxena.
  3. Conservation Ecology
     G.W.Cox.
  4. Global Biodiversity
     W.R. L. IUCN.

PS4EREEMO1 Statistical and Research Methods: Theory and Practical

Sampling, Data collection and recording, Central tendency – concept; arithmetic mean, mode, median for ungrouped and, grouped data, Measures of dispersion: absolute and relative measures; range, standard deviation (grouped and ungrouped data), variance, quartile deviation, coefficient of variability.

Skewness, Kurtosis, Probability - normal, poisson and binomial, Statistical Methods: Hypothesis testing, significance and correlation, Correlation, Matrices, simultaneous linear equations; tests of hypothesis and significance.

Linear models and regressions, Pearson and other correlation coefficients, Multiple regressions, Distribution-Normal, t and chi square test, Difference among means: F-test: 1 way ANOVA; F-test: 2 ways ANOVA.


References:
     Zar, Jerrold H.
     Sokal, Robert and James Rohlf
     Walpole, R. and R. Myers
     Wayne, R. Ott
PS4EREEMO2 Modelling of Solar Thermal system
Unit 1: Solar Collector System Thermal Calculations
Introduction, Component Models, Collector heat exchanger factor, Duct and Pipe loss factors, Control system, Collector arrays: Series Connection, Performance of Partially Shaded collectors, Series arrays with sections having different orientations, Use of Modified Collectors Equations, System Models, Solar fraction and solar saving fraction.

Unit 2: Simulation in Solar Process Design
Introduction, Simulation program, Utility simulations, Information from Simulations, Thermal process simulation program, Simulation and Experiments, Meteorological Data, Limitations of Simulations.

Unit 3: Design of Active systems
Introduction to active and passive solar system, Review of Design Methods, The f-chart method, the f-chart for liquid systems, the f-chart for Air system, Service water heating system, the f-chart results, Parallel solar energy- heat pump systems.

Unit 4: Design of Active, Passive and Hybrid Heating Systems

Reference Book:

PS4CREEMO3 Practical
1. Study of basic principles of environmental contaminant fate and transport modeling
2. Analyze the physical, chemical, biological and numerical theory underlying environmental models
3. Develop mass-balance-based mathematical and numerical models of contaminant fate across multiple media
4. Apply an environmental model to evaluate pollutant interactions with the environment and human health
5. Apply tools and data appropriately for model evaluation
6. To study F test
7. To study t test and chi square Test
8. To Study Air pollution control measures
9. To study water pollution control method
10. To study solid water pollution control measures
**PS4EREEMO4 Practical**

1. Prepare report on the analysis, (development), application, testing, and evaluation of an environmental fate and transport model
2. Study examples on skewness, kurtosis and probability
3. Study of statistical methods
4. Study computer application for environmental modeling
5. Practical on Research design
6. Practical on Publication and presentation
7. Heat loss test on built in storage water heater
8. Performance of single basin solar still
9. Testing solar cabinet dryer
10. Case study on any one dam

**PS04CREN05 Project Work Dissertation Work**

**PS04CREN06 Viva**
INSTITUTE OF STUDIES AND RESEARCH IN RENEWABLE ENERGY (ISRRE)
NEW VALLABH VIDYANAGAR


SEMESTER-IV
PS4CREEMA1 Research Methodology

Unit 1 General introduction and Research problem Formulation
History of Science & Technology: Importance of research, role of research, aims & objectives, research process, phases of research. Review of Research Literature: Purpose and use of literature review, locating relevant information, use of library & electronic databases, preparation & presentation of literature review, research article reviews, theoretical models and frame work. Identification of gaps in research, formulation of research problem, definition of research objectives.

Unit 2 Research Design

Unit 3 Research Publication & Presentation

Unit 4 Research Ethics and Morals

Reference Books
   C.R. Kothari
   Graziano, A.M., Raulin, M.L
   Murray, R
   Murray, R
5. Writing for Publication, Allyn & Bacon, 2005
   Henson, K.T
6. What is this thing called Science, Queensland University Press, 1999
   Chalmers, A.F
   Bhandarkar & Wilkinson
   Bell J
   Murray, R. and Moore, S
Energy Efficiency and Analysis in Electrical Systems I

Unit 1 Energy Efficiency in Electrical System

Unit 2 Electrical Efficiency in Electrical Motors

Unit 3 Energy Efficiency in Lightning System
Introduction, Basic Parameters and Terms, Light Source and Lamp Types, Recommended Illuminance Levels for Various Tasks/Activities/location, Method of Calculating Illuminance-Lightning Design for Interiors-For Indoor and Outdoor, Energy Saving Opportunities, Energy Efficient Lightning Controls, Standard and Labeling Programme for FTL Lightning System,

Unit 4 Energy Efficiency in Fans and Blowers

References:
1. Technology Menu on Energy Efficiency, NPC
2. NPC –In House Case Study
3. Electrical Energy Conservation Modules of AIP-NCP, Chennai
4. Technical Paper-18th International Conference on Electricity, Distribution, Turin 6-9 June 2005
5. DSM-www.tatpower.com
7. BEE Publication
8. PCRA Publication
9. Office of Industrial Technologies, Department of Energy, USA
11. Lightning Handbook
12. SADC Industrial Energy management Project
13. www.bee-india

Energy Efficiency and Analysis in Electrical Systems II

Unit 1 Energy Efficiency in Compressed Air System
Introduction, Compressor types, Compressor Performance, Compressed Air System Components, Factors for Efficient Operation of Compressor-Location-Cool Air Intake-Dust Free Air Intake-Dry Air Intake-Elevation-Cooling Water Circuit-Pressure Setting-Capacity Control of Compressors, Avoiding misuse of compressed air and Air Leaks, Wastage, Leak Quantification, Leak Detections by Ultrasonic Leak Detector, Line Moisture
separaror and Traps, Compressed Air, Filters, Regulators, Lubricators, Dryer Compressor Capacity Assessment, Check List for Efficiency

**Unit 2 Energy Efficiency in HVAC and Refrigeration System**

**Unit 3 Energy Efficiency in Pump and Pumping System**
Pump System, Centrifugal Pump, System characteristics, Pump Curve, Factor Affecting Pump Performance, Efficient Pumping System Operation, Flow Control Strategies, Pumps in Parallel Switched to meet Demand, Stop/Start Control, Flow Control Valve, Bypass Control, Fixed Flow Reduction, Meeting Variable Flow Reduction-Variable Speed Drives (VSD), and Energy Conservation Opportunities

**Unit 4 Energy Efficiency in Cooling Tower**

**References:**
1. Technology Menu for Energy Efficiency, NCP
2. PCRA Publication
3. www.hydraulicpneumatic.com
4. ASHRAE Handbook
5. British Pump manufacturer Association
6. Energy Audit Report, NPC
7. BEE –EMC Inputs
8. ITT-Goulds Pumps
10. Case Studies, NPC
11. http://www.energymanagertraining.com

**PS4EREEMA2 Energy Efficiency and Analysis in Thermal Utilities**

**Unit 1 Fuel and Combustion**

**Unit 2 Energy Efficiency in Boiler**
Unit 3 Energy Efficiency in Furnace

Unit 4 Cogeneration and Waste Heat Recovery

References:
3. Steam Boiler Room Questions and Answers, Third Edition Stephen M. Elonka and Alex Higgs
8. Technical Papers, Boiler Congress-2000 Seminar 11-12 January
10. Efficient operation of Boiler by National Productivity Council
11. www.eren.doe.gov
12. www.oit.doe.gov/bestpractices
13. www.pcra.org
14. www.energyefficiency.gov.uk
15. www.actionenergy.org.uk
16. www.altenergy.com
17. NPC Study report
18. Cogeneration-Training Material by NIFES, UK
20. www.unescap.org/enurd/energy/co-gen
22. www.energysolution.org/distgen/appguid.microturbine
23. Fuel Economy in Furnaces and Waste Heat recovery-PCRA
   DA Reay
25. www.bhes.com/frbbohome.htm
26. www.portalenergy.com

**PS4CREEMA3 Practical**
1. Study on research design methodology
2. Study on publication and presentation
3. To write technical paper on renewable energy for publication
4. Study on electrical motor and example on electrical motor
5. Study on fans and blowers and examples on fans and blower
6. Study on compressed air system and examples on compressed air system
7. Estimation of net refrigeration capacity (HVAC)
8. Study on pumps and examples on pumps
9. Study on cooling tower and examples cooling tower
10. Study on compressor modulation

**PS4EREEMA4 Practical**
1. Study on stochiometry calculations and examples on stochiometry
2. Study and examples on boiler
3. Study on furnace and examples on furnace
4. Study on cogeneration and examples on cogeneration
5. Study on waste heat recovery
6. Study material and energy balance and examples
7. Performance assessment of lightning system
8. To study major areas and equipments in thermal power plant
9. Study of heat exchangers and its types

**PS4CREEMA5** Project Work/ Dissertation
**PS4CREEMA6** Viva