INSTITUTE OF STUDIES AND RESEARCH IN RENEWABLE ENERGY (ISRRE),
NEW VALLABH VIDYANAGAR
SARDAR PATEL UNIVERSITY, VALLABH VIDYANAGAR, GUJARAT
FACULTY OF SCIENCE
COURSE OF STUDY III and IV SEMESTER PROPOSED

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) (ii) The record of the test examinations as well as seminars and quizzes will be maintained by the department.
(iii) (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."

Sardar Patel University

Syllabus (Effective from the academic year June, 2013)

M. Sc. (Renewable Energy: SYSTEM TECHNOLOGY)

Structure for Semester System & Choice Based Credit System (CBCS)

M. Sc. in Renewable Energy (UNDER CBCS)

SEMESTER-III: RENEWABLE ENERGY:SYSTEM TECHNOLOGY								
No	Course	Teaching Scheme				Marks		
	Code & Title	Theory (T)/ Practical (P)	Credit	Theory hr/week	Exam Duration, hrs	Internal Total/ Passing	External Total/ Passing	Total Total/ Passing
CORE COURSES								
1	PS03CREST1: Solar Photovoltaic Technology	T	4	4	3	30/12	70/28	100/40
2	PS03CREST2: Numerical Method and Computer Programming	T	4	4	3	30/12	70/28	100/40
3	PS03CREST3: Advances in Biomass Gasification	T	4	4	3	30/12	70/28	100/40
4	PS03CREST4: Practical	P	4	6	3	30/12	70/28	100/40
5	PS03CREST5: Practical	P	4	6	3	30/12	70/28	100/40
6	PS03CREST6: Viva Voce	-	1	-	-	-	50/20	50/20
ELECTIVE COURSE (Any one elective will be offered)								
7	PS03EREST1: Optimum Utilization of Heat and Power	T	4	4	3	30/12	70/28	100/40
8	PS03EREST2: Energy Economic, Policy & Regulation act	T	4	4	3	30/12	70/28	100/40
9	PS03EREST3: Solar Thermal Technology	T	4	4	3	30/12	70/28	100/40
	TOTAL		**25**					

SEMESTER-IV: RENEWABLE ENERGY-SYSTEM TECHNOLOGY								
No	**Course**	**Teaching Scheme**				**Marks**		
	Code & Title	**Theory (T)/ Practical (P)**	**Credit**	**Theory hr/week**	**Exam Duration, hrs**	**Internal**	**External**	**Total**
						Total/ Passing	**Total/ Passing**	**Total/ Passing**
CORE COURSES								
1	PS04CREST1: Wind Energy Technology	T	4	4	3	30/12	70/28	100/40
2	PS04CREST2: Practical	T	4	6	3	30/12	70/28	100/40
3	PS04CREST3: Project/ Dissertation	T	12	12	-	-	-	300
4	PS04CREST4: Viva Voce	-	1	-	-	-	50/20	50/20
ELECTIVE COURSE (Any one elective will be offered)								
5	PS04EREST1: Research Methodology	T	4	4	3	30/12	70/28	100/40
6	PS04EREST2: Modeling of Solar Thermal system	T	4	4	3	30/12	70/28	100/40
7	PS04EREST3: Biofuel Technology	T	4	4	3	30/12	70/28	100/40
8	PS04EREST4: Advanced Thermal Storage Technologies	T	4	4	3	30/12	70/28	100/40
9	PS04EREST5: Green Building	T	4	4	3	30/12	70/28	100/40
	TOTAL		**25**					

Note:
Project will be offered in forth semester to student who will have to complete the courses PS04CREST1, PS04CREST2, PS04CREST4 and any one elective course only

RENEWABLE ENERGY-SYSTEM TECHNOLOGY

SEMESTER-III

CORE COURSES

PS03CREST1: Solar Photovoltaic Technology
PS03CREST2: Numerical Method and Computer Programming
PS03CREST3: Advances in Biomass Gasification
PS03CREST4: Practical
PS03CREST5: Practical
PS03CREST6: Viva Voce

ELECTIVE COURSES

PS03EREST1: Optimum Utilization of Heat and Power

PS03EREST2: Energy Economic, Policy & Regulation act

PS03EREST3: Solar Thermal Technology

SEMESTER-IV

CORE COURSES

PS04CREST1: Wind Energy Technology

PS04CREST2: Practical

PS04CREST3: Project/ Dissertation

PS04CREST4: Viva Voce

ELECTIVE COURSES

PS04EREST1: Research Methodology

PS04EREST2: Modeling of Solar Thermal system

PS04EREST3: Biofuel Technology

PS04EREST4: Advanced Thermal Storage Technologies

PS04EREST5: Green Building

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Note: Student can choose any one discipline in final year from three specializations i.e. System Technology, Environmental Modeling and Energy Management from 3rd semester

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

SEMESTER-III

PS03CREST1 Solar Photovoltaic Technology

Unit 1: Electricity from the sun

Introduction, Need photovoltaic's, Basics principles, operating principles, Types of solar cells, Features and Limitations of Solar Photovoltaic system

Unit 2: Solar Cell and Applications

Introduction, what are solar cells, How solar cells work- introduction, Electronic structure of semiconductors-the solar cell-power losses solar cells-Temperature and irradiation effects. Application of solar PV system **-**Introduction, Rural electrification-domestic supply, Health care system, Lighting, Battery charging. Water pumping- water pumping technology – sizing and cost, Professional applications- telecommunications and remote monitoring. Electric power generation in SPACE- Satellite PV system- PV generator. Grid connected system- PV power station- PV in buildings.

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 Recombination, The p–n Junction, Solar Cell Equations, Characterization, Efficiency- Temperature-Light, Type and Purity of Material, Parasitic Resistances, Current Research, Concentrating Solar Cells, Tandem Cells, Thin Film Technologies, Quantum Dots, Cell Applications, Utility Power Generation, Space Systems, Solar-Powered Products. Photovoltaic Power Generation**:** Principles, Technical description, Economic and environmental analysis, Some Case Studies.

Unit 5 Economic analysis of Solar energy Systems

Life cycle analysis of Solar Energy Systems, Time Value of Money, Evaluation of Carbon Credit of Solar Energy Systems.

Reference Book:

1. Tomas Markvart (2009) Solar Electricity, Second edition, John Wiley & Sons Ltd, p.280.

Text Book:

1. S.Hasan Saeed and D.K.Sharma. (2013). Non-conventional Energy Resources, S.K. Kataria & Sons, p.314
2. G.D.Rai. (2011). Solar Energy Utilization, Fifth Edition, Khanna Publishers, p.644.

PS03CREST2 Numerical Method and Computer Programming

Unit 1 Iterative Methods

Bisection, False Position, Secant, Newton-Raphson Method Iterative Method (Including Extended), Newton-Raphson Method For Non Linear Equations In Two Variables, Convergence Of Iterative Methods, algorithms & Computer programming for all these Methods, Polynomial Equations, Descartes Rule of Sign

Unit 2 Finite Differences and Interpolation

Finite Differences: Forward, Backward and Divided Differences. Differences Table, Newton's Forward, Backward and Divided Differences Interpolation Formula. Lagrange Interpolation Formula, Inverse Interpolation, Error Propagation In Difference Table, Estimate Of Errors In Interpolation, Computer programming of the same

Unit 3 Curve Fitting and Method of Least Squares

Method of Least Squares, Fitting A Straight Line And Polynomial Fitting A Non- Linear, Function: Fitting A Geometric And Exponential Curve, Fitting A Hyperbola At Fitting A. Trigonometric Function. Approximation of Function by Taylor Series And Chebyshev Polynomials, Computer programming of curve fitting methods

Unit 4 Numerical Differentiation and Integration

Differentiation Formula Based On Functions Tabulator At Equal And Unequal Intervals Newton-Cotes Integration Formulae: Trapezoidal Rule, Simpson's 1/3 And 3/8th Rule, algorithms & Computer programming for all these Methods

Unit 5 Solution of Simultaneous Linear Equation

Solution of Systems of Linear Equations: Gauss Elimination Maths Pivots, Ill Conditions Equations, Gauss-Seidal And Gauss Jacobi Iterative Methods, computer programming of the same

Unit 6 Numerical Solution of Ordinary Differential Equation

Taylor Series And Euler's Methods, Rangekutta Method Of 4th Order, Milnes's Predictor – Corrector Methods,. Algorithms & Computer programming for all these Methods.

Reference book

1. Computer Oriented Numerical Methods

   V Rajaraman, , - Prentice – Hall of India , Delhi
2. Introduction to Numerical Analysis

S. S. Sastry, , PHI , Delhi.

3. Numerical Methods for Scientific & Engineering Computation

   M. K . Jain , S.R.K. Lyenger , R. K. Jain, Wiley Eastern Ltd.

4. A test book on Computational Methods

   Br. G. T. Kochav, , Nirali Prakashan , Pune

PS03CREST3 Advances in biomass gasification

Unit 1: Biomass gasification

Historical background, Biomass and Its Products, Biomass Conversion-Bio-chemical and thermo-chemical conversion, Motivation for Biomass Conversion, Commercial Attraction of Gasification, Comparison of Gasification and Combustion, constituents of biomass cell, properties of biomass, Ultimate and proximate analysis of biomass and its importance in gasification, Gasification and reaction involved, gasifying medium, The Gasification reaction Process, Design of Biomass Gasifiers, Gasifier Types- Fixed-Bed/Moving-Bed Gasifiers, Fluidized-Bed Gasifiers- Entrained-Flow Gasifiers, Plasma Gasification, Process Design-Mass Balance, Energy Balance, hydrothermal gasification of biomass, Performance evaluation of biomass gasifier, advances in biomass gasification technology

Unit 2: Gas cleaning and conditioning

Basics of tar, acceptable limits for tar, Tar formation, tar composition, tar reduction, In-Situ tar reduction, post-gasification—secondary reduction of tar, The power theory of gas cleanup, gas cleanup goals-gas contaminant characteristics-typical dirty gas- gas cleanup-cleanup design target, classification of particles, particle movement and capture mechanisms , dry collectors-gravity settling chambers- cyclone separators-bag house filter- electrostatic precipitators, wet scrubbers- principles of wet scrubbers -scrubber - auxiliary equipment, disposal of captured contaminants-char-ash- tar- condensate

Unit 3: Power from producer Gas

Burners for producer gas, Operation with diesel engines, Efficiency and energy distribution, Emissions, operation with gas engines, performance on lubrication, emissions, test on small gas engines and load variations, large gas engines, independent power plants, tri-generation possibilities, gas turbines, manufacture and commercial status, fuel cells

Unit 4: Pyrolysis and torrefication

Introduction, historical background, pyrolysis, pyrolysis products, types of pyrolysis, pyrolysis product yield, effect of biomass composition on pyrolysis, effect of pyrolysis temperature, effect of heating rate, pyrolysis kinetics-physical aspects-chemical aspects, heat transfer in a pyrolyzer-mass transfer effect, pyrolyzer types-fixed-bed pyrolyzer-bubbling-bed pyrolyzer-circulating fluidized-bed pyrolyzer-ultra-rapid pyrolyzer-ablative

pyrolyzer-rotating-cone pyrolyzer-vacuum pyrolyzer, pyrolyzer design considerations, torrefaction, advantages of torrefaction, mechanism of torrefaction, design considerations for torrefaction

Reference Books

1. **Biomass gasification and pyrolysis-practical designs and theory**
   Prabir Basu, ISBN 978-0-12-374988-8, Elsevier
2. **Handbook on biomass downdraft gasifier engine system**
   Thomas B Reed and Agua Das, ISBN 1-890607-00-2, Solar Energy Research Institute
3. **Understanding clean energy and fuel from biomass**
   Dr. H S Mukunda, ISBN 978-81-265-2969-8, Wiley-India

Text Books

1. **Biomass for Renewable Energy, Fuels, and Chemicals**
   Donald L Class, ISBN-10: 81-312-0237-2, Academic Press, Elsevier
2. **Combustion and Gasification in Fluidized Bed**
   Prabir Basu, ISBN-10: 81-312-0237-2, CRC, Taylor and Francis
3. **Wood Gas as Engine Fuel**
   FAO document, ISBN 92-5-102436-7

PS03EREST1 Optimum Utilization of Heat and Power

Unit 1 Combined Heat and Power (CHP)

Basic concepts of CHP, The benefits and problems with CHP, Balance of energy demand, Types of prime movers, Economics, CHP in various sectors.

Unit 2 Fundamentals of Heat & Power Integration:

Pinch Technology, significance, Selection of pinch temperature difference, composite curves, Stream splitting, Process retrofit, Heat Exchange Network Synthesis and it's optimization for minimum utility targets, Maximum energy recovery and minimum number of heat exchangers, Minimum Area and Operating cost, Optimum approach Temperature, Heat pumps, heat engines.

Unit 3 Applications of Heat & Power Integration

Heat Integration of evaporators and dryers, Distillation columns, Optimum design of multistage refrigeration system, Compression Refrigeration and Adsorption Refrigeration System.

Unit 4 Energy Losses & Waste Heat Recovery:

Insulation, Sources of waste heat, Recuperative heat exchanger, Run, around coil systems, Regenerative heat exchangers, Heat pipes, Waste Heat Recovery

Unit 5 Steam Systems and Cogeneration:

Steam and Power balance, Site composite curves, Cogeneration targets, Optimizing steam systems, Application & techno economics of Cogeneration, Cogeneration Performance calculations, Part load characteristics- financial considerations - Operating and Investments, Combined Cycles, Rankine Cycles, Kalina Cycle, Advantages Of Cogeneration Technology.

Reference Books:

1. Product & Process Design Principles
   Warren D. Seider, J.D. Seader, Daniel R. Lewin, 2nd edition, John Wiley & Sons, Inc.
2. Chemical Process – Design and Integration
   Robin Smith, John Wiley & Sons, Inc.
3. Systematic Methods of Chemical Process Design
   Biegler LT, Grossmann IE and Westerberg AW (1997), Prentice Hall.
4. Energy efficiency for engineers and Technologists,
   Eastop, T.D. & Croft D.R, 2nd edition, Longman Harlow, 1990.
5. Design and Management for energy conservation
   O'Callaghan, Paul W,", Pergamon, 1993.
6. Handbook of energy data and calculations including directory of products and services
   Osborn, peter D, , Butterworths, 1980.
7. Cogeneration
   Charles H.Butler, McGraw Hill Book Co., 1984.
8. Cogeneration - Heat and Power, Thermodynamics and Economics
   Horlock JH, , Oxford, 1987

PS03EREST2 Energy Economic, Policy & Regulation act

Unit 1 Global Energy Scenario:

Role of energy in economic development and social transformation, Energy & GDP, GNP and its dynamics, Discovery of various energy sources, Energy Sources and Overall Energy demand and availability, Energy Consumption in various sectors and its changing pattern, Exponential increase in energy consumption and projected future demands, Non conventional and conventional energy Resources: Coal, Oil, Natural Gas, Nuclear Power and Hydroelectricity, Solar and Other Renewable etc., Depletion of energy sources and impact on exponential rise in energy consumption on economies of countries and on international relations. Energy Security, Energy Consumption and its impact on environmental climatic change, International Energy Policies of G-8 Countries, G-20 Countries, OPEC Countries, EU Countries. International Energy Treaties (Rio, Montreal, Kyoto), INDO-US Nuclear Deal. Future Energy Options, Sustainable Development, Energy Crisis.

Unit 2 Indian Energy Scenario

Energy resources & Consumption, Commercial and noncommercial forms of energy, Fossil fuels, Renewable sources including Bio-fuels in India and their utilization pattern in the past, present and future projections of consumption pattern, Sector wise energy consumption, Impact of Energy on Economy, Development and Environment, Energy for Sustainable Development, Energy and Environmental policies, 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, Energy Conservation Act-2001 & its features, Electricity Act-2003 & its features. Framework of Central Electricity Authority (CEA), Central & States Electricity. Regulatory Commissions (CERC & ERCs)

Unit 3 Energy Policy

Global Energy Issues, National & State Level Energy Issues, National & State Energy Policy, Industrial Energy Policy, Energy Security, Energy Vision, Energy Pricing & Impact of Global Variations. Energy Productivity (National & Sector wise productivity).

Reference Books:

1. Energy for a sustainable world: Jose Goldenberg, Thomas Johansson, A.K.N.Reddy,
2. Energy policy B.V.Desai (Weiley Eastern),
3. Modeling approach to long term demand and energy implication J.K.Parikh.
4. Energy Policy and Planning B.Bukhootsow.
5. International Energy Outlook' -EIA annual Publication
6. Principles of Energy Conversion A.W. Culp (McGraw Hill International edition.)
7. 10 BEE Reference book: no.1/2/3/4
8. Environmental Law and Policy in India: Cases, Materials and Statutes Shyam Divan & Armin Rosencranz, Second edition
9. Energy Policy Analysis and Modeling, Cambridge University Press. M.Munasinghe and P. Meier (1993):
10. The Econometrics of Energy Demand: A Survey of Application, New York. W.A.Donnelly (1987)
11. State Government and central Governments and regulations regarding non-conventional sources and utilization implemented by Gujarat Govt. and Govt. of India time to time.
12. Internet website for related topics

PS03EREST3 Solar Thermal Technology

Unit 1: Solar Thermal Systems

Introduction, Solar Collectors-Flat-Plate Collectors-Flat-Plate Collector -Thermal Testing Collector - Efficiency Curve-Evacuated-Tube Solar Collectors, Concentrating Collectors-Optic Fundamentals for Solar Concentration-Parabolic Concentrators-Compound Parabolic Concentrators (CPCs)-Fresnel Lens Concentrators-Heliostats-Tracking Systems, Solar Thermal Systems-Passive and Active Solar Thermal Systems.

Unit 2: Solar Thermal Systems Applications

Solar Thermal Application: Water Heating for-Domestic Use-Solar Thermal Application: Water Heating for Industrial Use, Case of Active Solar Drying: Sludge Drying, Solar Thermal Application: Solar Distillation, Case of Passive Direct and Indirect Solar Distillation: Water Desalination, Case of Passive Solar Indirect 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

Introduction, Costs of Solar Process systems-Investment-Operating costs-Solar savings, Design Variables, Economic Figures of Merit-LC solar energy-LCC-LCS-ALCC-Payback time-ROI, Discounting inflation, Present-Worth factor, Life cycle Saving Method, Evaluation of other Economic Indicators, The P1, P2 Method, Uncertainties in Economic Analyses, Economic Analysis using solar saving fraction.

Reference Book:

1. Principles of Solar Engineering,
   D.Y. Goswami, F.Kreith and J.F. Kreider. (2003) 2nd Edition, Taylor & Francis, p.694.
2. Renewable Energy Resources
   J.Twidell & T. Weir. (2010)., Second edition, Taylor & Francis, p.601.
3. Solar Engineering of Thermal Process
   Duffie and Beckman. ((2013)., Fourth edition, Wiley Publications, p.910.
4. Solar Energy- Fundamentals, Design, Modelling and Applications
   G.N.Tiwari. (2013), Revised edition 2013, Narosa Publishing house Pvt.Ltd, p.525.

PS03CREST4 Practical

1. To study the voltage and current of the solar cell in series and parallel combination
2. To determine the heat loss factor $F_R U_L$ of FPC by zero testing
3. To study the I-V Characteristics of a Si solar cell with varying temperature at constant irradiation
4. To determine the top heat loss factor of a box type solar cooker
5. To study the effect of number of glazing on the optical efficiency factor of a flat plate solar collector
6. To study the $_{Pmx}$ characterization of solar cell with different insolation.
7. Heating and cooling tests on a paraboloid concentrator solar cooker to determine its $F'\eta$ and $F' U_L$
8. To study I-V characteristic of solar PV modules under indoor simulation
9. To study PV applications: (i) battery charging (ii) water pumping (iii) hydrogen generation.
10. Testing of a solar dryer with different mass flow rate

PS03CREST5 Practical

1. To study different routes of biomass conversion
2. To evaluate performance operation of the engine on producer gas
3. To study working and performance of producer gas burner
4. To study producer gas cooling and cleaning systems
5. Case study of biomass gasifier based power plant
6. Analysis of waste water generated from biomass gasifier system
7. To study pyrolysis and different pyrolyzer
8. To study torrefication of biomass

PS03CREST6 Viva Voce

INSTITUTE OF STUDIES AND RESEARCH IN RENEWABLE ENERGY (ISRRE)

NEW VALLABH VIDYANAGAR

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

SEMESTER-IV

PS04CREST1 Wind Energy Technology

Unit 1: Properties of Wind

Introduction, how wind is generated, statistical distribution of wind speed-Mean and mode of weibull distribution for wind speed, power density, wind classes, wind shear-understanding wind shear, density of air as a function of elevation, density of air as a function of humidity, wind resource assessment, overview of wind resource assessment, source of wind data, resource estimation models-mesoscale models, phases of resource assessment, preliminary wind resource assessment, wind energy map lookup, advanced wind resource assessment-extreme wind speed, WAsp model, optimal layout of turbines in wind farms, wind turbine class selection

Unit 2: Deploying wind turbines to grid

Introduction, what happens on grid when there is no wind, scheduling and dispatch of wind resource, single line diagram, transmission and distribution, standards for interconnections, power factor and reactive power, low voltage ride through, power quality-flicker and harmonics short circuit power, wind farm topographies, protection systems, grounding for over voltage and lightning protection, transformers for wind applications, wind plant interconnection and transmission study, transmission bottlenecks, SCADA system-data acquisition- reporting-control

Unit 3: Planning and execution of wind projects

High level project plan and time line, development, prospecting, wind measurement and detailed wind assessment, project sitting, interconnection and PPA, project engineering and procurement, project financing, Construction, installation and commissioning-construction of infrastructure-site preparation-foundation construction-turbine erection-collection system-substation construction-commissioning, operation

Unit 4: Offshore Wind Energy power

Introduction, development and investment cost of offshore wind power, cost of energy generated by offshore wind power, offshore wind farms under construction and planning stage, future technological development, scenario for the future offshore development of wind power, new offshore concepts, National Offshore Wind Energy Policy of India-development in India, maritime zones-challenges-objectives-geographical coverage-essential components of development offshore wind energy

Textbooks:

1. Wind Energy Engineering
   Pramod Jain, ISBN-10: 0071714774, ISBN-13: 978-0071714778, McGraw-Hill Professional; 1 edition (September 1, 2010)
2. Offshore Wind Power
   John Twidell and Gaetano Gaudiosi, ISBN-13: 978-0906522639, Multi-Science Publishing Co. Ltd. (April 1, 2009)
3. Draft National Offshore Wind Energy Policy, 2013. National Policy for Offshore Wind Energy in India, Government of India. www.mnre.gov.in

Reference Books:

1. Wind Energy Handbook
   Tony Burton, David Sharpe, Nick Jenkins, Ervin Bossanyi
   ISBN-13: 978-0471489979, Wiley; 1 edition (November 15, 2001)
2. Wind Energy: Renewable Energy and the Environment
   Vaughn Nelson, ISBN-13: 978-1420075687, CRC Press (March 16, 2009)

PS04EREST1 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

Qualitative Methods: Types of hypothesis and characterization. Quantitative Methods: Statistical methods for testing and evaluation. Characterization of experiments: Accuracy, reliability, reproducibility, sensitivity, Documentation of ongoing research.

Unit 3Research Publication & Presentation

Thesis, Research paper, Review Article & Technical Reports: Organization of thesis and reports, formatting issues, citation methods, references, effective oral presentation of research. Quality indices of research publication: impact factor, immediacy factor, H- index and other citation indices.

Unit4 Research Ethics and Morals

Issues related to plagiarism, collaborative models and ethics, acknowledgements. Intellectual Property Rights: copy rights, copy left: patents, Industrial designs, Trademarks.

Reference Books

1. Research Methodology, Methods & Techniques, C.R. Kothari, Viswa Prakashan, 2nd Edition, 2009.
2. Research Methods- A Process of Inquiry, Graziano, A.M., Raulin, M.L, Pearson Publications, 7th Edition, 2009.
3. How to Write a Thesis:, Murray, R. Tata McGraw Hill, 2nd Edition, 2010.
4. Writing For Academic Journals, Murray, R., McGraw Hill International, 2009.
5. Writing for Publication, Henson, K.T., Allyn &Bacon, 2005.
6. What is this thing called Science, Chalmers, A.F., Queensland University Press, 1999.
7. Methods &Techniques of Social Research, Bhandarkar & Wilkinson, Himalaya publications, 2009.
8. Doing your Research project, Bell J., Open University Press, Berkshire, 4thEdition, 2005
9. A Handbook of Academic Writing, Murray, R. and Moore, S., Tata McGraw Hill International

PS04EREST2 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. Performance and Thermal analysis for Air heater. Solar concentrator, characteristic parameters, Aperture area, Acceptance angle, Geometric concentration ratio, Intercept factor, Optical efficiency, Thermal efficiency, concentration ratio, Thermal analysis of Concentrating collector.

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.

Unit4: Design of Active, Passive and Hybrid Heating Systems

Design of active systems by utilizability methods- hourly utilizability, daily utilizability, the φ-Chart, f-chart method. Approaches to Passive Design, Solar – Load ratio method, Solar-Load Ratio method,

Unutilizability Design method: direct gain, Unutilizability Design method: Collector-Storage walls. Hybrid systems: Active Collection with Passive storage, other hybrid systems

Reference Book:

1. D.Y. Goswami, F.Kreith and J.F. Kreider. (2003) Principles of Solar Engineering, 2nd Edition, Taylor & Francis, p.694.
2. J.Twidell & T. Weir. (2010). Renewable Energy Resources, Second edition, Taylor & Francis, p.601.
3. Duffie and Beckman. ((2013). Solar Engineering of Thermal Process, Fourth edition, Wiley Publications, p.910.
4. G.N.Tiwari. (2013) Solar Energy- Fundamentals, Design, Modelling and Applications, Revised edition 2013, Narosa Publishing house Pvt.Ltd, p.525.

PS04EREST3 Bio-fuel Technology

Unit 1 Bio-mass Resources

Formation of Bio- mass, Photosynthesis, Biomass Resources and classification, Physio -chemical characteristics, Biomass productivity: Energy plantation for power programme, International and National Potential and Status of Bio-fuels, Petro crops, Jatropa, Algae,

Unit 2 Chemical Conversion

Hydrolysis and hydrogenation, Solvent extraction of hydrocarbons, Solvolysis of wood, Chemicals from biomass

Unit 3 Thermo chemical Conversion

Thermal Decomposition Mechanisms of Bio-Renewable, Hydrothermal Liquefaction of Bio-renewable Feed stocks, Direct Liquefaction, Biomass briquetting

Unit 4 Liquid Bio-fuels

History, Production methods of Bio-diesel: Fuel quality, standards and Properties, Availability of Raw materials for bio-diesel, Applications, Bio-diesel potential in India Bio-ethanol**:** Bio-ethanol feedstocks, Fuel Properties of ethanol, Ethanol from Biomass, Bio-ethanol production by fermentation of Carbohydrates, Alternate fuels to Gasoline: Analysis of gasoline-alcohol mixtures, vegetable oil and diesel fuel mixtures, Hydrogen, Methane and Other Energy Fuels Energy from Algae: Algae Cultivation, Photo-bioreactors, Harvesting, Sewage and Waste water growth conditions, algae biomass, algal meal/cake, Integration of CO2 emitting industries for growth of Algae, Industrial production and Marketing strategy , Other applications of Algae : food, pigment etc.

Unit 5 Environmental Impact of Bio- fuels on Agriculture in India and World wide

Unit 6 Bio-fuel Economy and Policy

Text Books/ References

1. Bio-fuels, Solar and Wind as renewable energy systems: Benefits and Risks
   D Pimentel, Springer, 2008
2. Bio-fuels: biotechnology, chemistry, and sustainable development
   DM Mousdale, CRC Press, 2008
3. Bio-diesel: A realistic fuel alternative for diesel engines
   A Demirbas, Springer, 2008
4. Biochemical and Photosynthetic aspects of Energy Production
   Anthony San Pietro, Academic Press, New York, 1980
5. Renewable energy: sources for fuels and electricity
   Thomas B Johansson et.al, (Ed), Earthscan Publishers, London, 1993
6. Algal Culturing Techniques
   Robert A Andersen (Editor), University of Wisconsin Press, ISBN 0-299-10560-1, USA (3rd edition), 1987
7. Algal Culture, from laboratory to pilot plant
   JS Burlew, Carnegie Institution of Washington, 1964
8. The Algae: a review
   GW Prescott, Houghton Mifflin, 1968

PS04EREST4 Advances in Thermal Energy Storage

Unit 1 Thermal Energy Storage methods

Introduction to thermal energy storage, basic principle, benefits of TES, Sensible TES, Latent TES, Cold Thermal Energy Storage (CTES), Working Principle, Design Considerations, CTES Storage Media Selection and Characteristics, Potential Benefits of CTES, Electric Utilities and CTES. Seasonal TES for Heating Capacity, Seasonal TES for Cooling Capacity

Unit 2 Energy and Exergy Analyses of Thermal Energy Storage Systems

Introduction, Theory: Energy and Exergy Analyses, Thermodynamic Considerations in TES Evaluation, Exergy Evaluation of a Closed TES System, Appropriate Efficiency Measures for Closed TES Systems, Importance of Temperature in Performance Evaluations for Sensible TES Systems, Exergy Analysis of Aquifer TES Systems, Exergy Analysis of Thermally Stratified Storages, Energy and Exergy Analyses of Cold TES Systems, Exergy-Based Optimal Discharge Periods for Closed TES Systems, Exergy Analysis of Solar Ponds.

Unit 3 Numerical Modeling and Simulation of Thermal Energy Storage Systems

Introduction, Approaches and Methods, Selected Applications, Numerical Modeling, Simulation, and Analysis of Sensible TES Systems, Numerical Modeling, Simulation, and Analysis of Latent TES Systems, Illustrative Application for a Complex System: Numerical Assessment of Encapsulated Ice TES with Variable Heat Transfer Coefficients.

Unit 4 Recent Advances in TES Methods, Technologies, and Applications

Introduction, Recent TES Investigations, Developments in TES Types and Performance Developments in PCM/HTF Material Selection Shape, Nano- to Macro-Size Storage Media or PCM Particles and Capsules, Recent Advances in TES Types and Storage Techniques, Micro- and Macro-Level Advances in TES Systems and Applications, Micro-Level Advances in TES Systems, Modeling Methods, Contact Melting Driven by Temperature and Pressure Differences, Supercooling, Superheating, and Hysteresis, Geometry and Performance Optimization, Other Micro-Level Phenomena Affecting TES Performance Developments in Stratification Analysis, Macro-Level Advances in TES Systems and Applications, Mode of Cooling/Heating: Passive or Active, Operating Strategies and Installation Configurations, Modeling, Control, Programming, and Optimization Methods, Measurement and Visualization Methods, Auxiliaries, Performance Enhancement Techniques, Conductivity-Enhancing Techniques, Thermal Batteries, Other Techniques, Innovative Applications of TES Systems, Advanced Applications of Exergy Methods, Illustrative Examples, Use of Effectiveness to Complement TES Energy and Exergy Efficiencies, Thermal Battery Ice-Storage System, Use of Artificial Neural Networks in TES, Future Outlook for TES.

References:

1. Thermal Energy Storage System and Application
   Ibrahim Dincer, Marc A Robsen, Second Edition, Willey Publication
2. Thermal Energy Storage for Sustainable Energy Consumption, Fundamentals, Case Studies and Design
   Halime O Paksoy, Springer Publication
3. Solar Thermal Energy Storage
   H P Garg, S C Mullick and AK Bhargava, D Reidel Publication Company

PS04EREST5 Green Building

Unit 1 Green Building Process and Ecological Design

Conventional versus green building delivery systems - Green building project execution - the integrated design process - green building documentation requirements - design versus ecological design - historical perspective -contemporary ecological design - future ecological design - green design to regenerative design.

Unit 2 Green Building Systems

Sustainable sites and landscaping – enhancing ecosystems - building envelop –selection of green materials - products and practices - passive design strategy –internal load reduction – indoor environment quality – building water and waste management – relevance to LEED / IGBC standards.

Unit 3 Green Building Implementation

Site protection planning - health and safety planning - construction and demolition waste management - reducing the footprint of construction operations – maximizing the value of building commissioning in HVAC System, lighting and non mechanical Systems - costs and benefits relevance to LEED / IGBC standards.

Unit 4 Green Building Assessment

USGBC LEED building assessment standard - LEED certification process – green globes building assessment protocol- international building assessment systems -LEED-NC Platinum / gold / silver building case studies – trends in building rating systems – IGBC standards – ECBC compliances.

UNIT 5 Economics of Green Buildings

Business case for high-performance green buildings - the economics of green building - benefits - managing initial costs - cost barrier in project management – long term environment benefits.

TEXT BOOKS:

1. Jerry Yudelson, Green building A to Z, Understanding the buildings, 2008.
2. Green building guidelines: Meeting the demand for low-energy, resource efficient homes. Washington, D.C.: Sustainable Buildings Industry Council, 2004.

REFERENCES:

1. Jerry Yudelson, Green Building through Integrated Design, McGraw Hill, 2008
2. Means, R.S., Green building: project planning & cost estimating: a practical guide for constructing sustainable buildings: cost data. Kingston, Mass., 2006.
3. Means, R.S., Green building: project planning & cost estimating: a practical guide to materials, systems and standards; green, 2nd Edition. Kingston, Mass., 2006.
4. Alex Wilson and Mark Peipkorn., Green Building Products: the Green Spec guide to residential building materials, 2nd Edition, Gabriola Island.
5. Jane Anderson, David E. Shiers, and Mike Sinclair. The green guide to specification: an environmental profiling system for building materials and components, 3rd Edition, Oxford; Malden, MA: Blackwell Science, 2002.
6. Charles J. Kibert, Sustainable Construction: Green Building Design and Delivery, 2nd Edition, Wiley, 2007.
7. ECBC 2007 Manual, Bureau of Energy Efficiency, New Delhi

PS04CREST2 Practical

1. Testing of a solar cabinet dryer
2. Determination of bond conductance of a flat plate solar collector
3. To study the performance of lead acid battery under charging and discharging mode

4. Steady State Conductive Heat Transfer Analysis in a cubical block using ANSYS
5. Performance analysis of Solar PV panel using TRNSYS
6. Performance analysis of Flat Plate Collecting System using TRNSYS
7. To study the performance of single basin solar still with different input temperature
8. To study the performance of 100 W wind turbine with different tail angle.
9. To study the performance of wind and PV hybrid based system with a loading capacity of 200W
10. To study the performance of 100 W wind turbine with different velocity of air.

PS04CREST3 Project/ Dissertation

PS04CREST4 Viva Voce

Sardar Patel University

Syllabus (Effective from the academic year June, 2013)

M. Sc. (RENEWABLE ENERGY: ENVIRONMENTAL MODELING)

Structure for Semester System & Choice Based Credit System (CBCS)

M. Sc. in Renewable Energy (UNDER CBCS)

SEMESTER-III: RENEWABLE ENERGY AND ENVIRONMENTAL MODELING								
No	Course	Teaching Scheme				Marks		
	Code & Title	Theory (T)/ Practical (P)	Credit	Theory hr/week	Exam Duration, hrs	Internal Total/ Passing	External Total/ Passing	Total Total/ Passing
CORE COURSES								
1	PS3CREENM1: Fuel and Combustion Technology	T	4	4	3	30/12	70/28	100/40
2	PS3CREENM2: Environmental and Pollution Control Technology	T	4	4	3	30/12	70/28	100/40
3	PS3CREENM3: Numerical Method and Computer Programming	T	4	4	3	30/12	70/28	100/40
4	PS3CREENM4: Practical	P	4	6	3	30/12	70/28	100/40
5	PS3CREENM5: Practical	P	4	6	3	30/12	70/28	100/40
6	PS3CREENM6: Viva Voce	-	1	-	-	-	50/20	50/20
ELECTIVE COURSE (Any one elective will be offered)								
7	PS3EREENM1: Green Energy Technology	T	4	4	3	30/12	70/28	100/40
8	PS3EREENM2: Energy Economic, Policy & Regulation act	T	4	4	3	30/12	70/28	100/40
9	PS3EREENM3: Energy and Environment	T	4	4	3	30/12	70/28	100/40
	TOTAL		**25**					

SEMESTER-IV: RENEWABLE ENERGY AND ENVIRONMENTAL MODELING								
No	**Course**	**Teaching Scheme**				**Marks**		
	Code & Title	**Theory (T)/ Practical (P)**	**Credit**	**Theory hr/week**	**Exam Duration, hrs**	**Internal**	**External**	**Total**
						Total/ Passing	**Total/ Passing**	**Total/ Passing**
CORE COURSES								
1	PS4CREENM1: Clean Development Mechanism	T	4	4	3	30/12	70/28	100/40
2	PS4CREENM2: Practical	T	4	6	3	30/12	70/28	100/40
3	PS4CREENM3: Project/ Dissertation	T	12	12	-	-	-	300
4	PS4CREENM4: Viva Voce	-	1	-	-	-	50/20	50/20
ELECTIVE COURSE (Any one elective will be offered)								
5	PS4EREENM1: Research Methodology	T	4	4	3	30/12	70/28	100/40
6	PS4EREENM2:Environment Policy and Environment Impact Assessment	T	4	4	3	30/12	70/28	100/40
7	PS4EREENM3: Energy and Climate Change	T	4	4	3	30/12	70/28	100/40
8	PS4EREENM4: Carbon Sequestrations and Trading	T	4	4	3	30/12	70/28	100/40
	TOTAL		**25**					

Note:

Project will be offered in forth semester to student who will have to complete the courses PS4CREENM1, PS4CREENM2, PS4CREENM4 and any one elective course only

RENEWABLE ENERGY-ENVIRONMENTAL MODELING

SEMESTER-III

CORE COURSES

PS3CREENM1: Fuel and Combustion Technology

PS3CREENM2: Environmental and Pollution Control Technology

PS3CREENM3: Numerical Method and Computer Programming

PS3CREENM4: Practical

PS3CREENM5: Practical

PS3CREENM6: Viva Voce

ELECTIVE COURSES

PS3EREENM1: Green Energy Technology

PS3EREENM2: Energy Economic, Policy & Regulation act

PS3EREENM3: Energy and Environment

SEMESTER- IV

CORE COURSES

PS4CREENM1: Clean Development Mechanism

PS4CREENM2: Practical

PS4CREENM3: Project/ Dissertation

PS4CREENM4: Viva Voce

ELECTIVE COURSES

PS4EREENM1: Research Methodology

PS4EREENM2:Environment Policy and Environment Impact Assessment

PS4EREENM3:Energy and Climate Change

PS4EREENM4: Carbon Sequestrations and Trading

PS3CREENM1 Fuel and Combustion Technology

Unit 1 Introduction: Historical perspective of combustion science - perspective of fuels and combustion technology. Types and general characteristics of fuels - proximate and ultimate analysis of fuels. ROM, DMMF, DAF and bone dry basis. Moisture and heating value determination - gross and net heating values – claorimetry. DuLong's formula for HV estimation. Flue gas analysis - Orsat apparatus.

Unit 2 Thermodynamics Combustion: Properties of mixture, Stoichiometry and thermodynamics, Combustion stoichiometry, Combustion thermodynamics, Calculation of heat of Formation & Heat of Combustion, First Law analysis of reacting system, Combustion of Oil, Combustion of Coal, Combustion of Gas, Draft System, Combustion Appliances, Gas burners, Functional requirement of burners, Gas burner Classification, Stoker firing, pulverized system of firing, Fluidized bed combustion process, Combustion Controls, Heat Treatment Furnaces, Industrial furnaces, process furnaces, Kilns, Batch & continuous furnaces.

Unit 3 Stoichiometry of combustion

Estimation of minimum amount of air required for a fuel of known composition, Theoretical & actual combustion processes - Air Fuel Ratio, Estimation of dry flue gases for known fuel composition, Calculation of the composition of fuel & excess air supplied, from exhaust gas analysis, Dew point of products, Flue gas analysis (O_2, CO_2, CO, NOx, SOx), Combustion using pure oxygen generated by Pressure Swing Adsorption(PSA).

Reference Books

1. Fuels & Combustion,
   S.P. Sharma & Chander Mohan, Tata McGraw Hill Publishing Co. Ltd., 1984
2. Elements of Fuels, Furnaces & Refractories
   Gupta O.P, 3rd edition, Khanna Publishers, 1996.
3. Fuels & Combustion
   Dr. Samir Sarkar, 2nd Edition, Orient Longman, Second edition, 1990.
4. Stoichiometry
   B. I Bhatt & S. B. Thakore, 5th Edition, McGraw Hill.ss 5. James G, Chemistry and Technology of Petroleum, Marcel Dekker, NY
5. Fuels and Petroleum Processing
   B. K. Sharma, 1st ed. Goel publishing, Meerut,1998
6. Heat Transmission in Steam Boiler furnaces

Blokh A.G, Hemisphere Publishing Corpn.ISBN-089-116-626-2

7. Name of Book
   D.O. hall & R.P. Overeed, John Willey and Sons, New York, 1987

PS3CREENM2 Environmental and Pollution Control Technology

Unit 1: Introduction

Global atmospheric change – green house effect – Ozone depletion - natural cycles- mass and energy transfer – material balance – environmental chemistry and biology – impacts – environmental. Legislations.

Unit 2: Air Pollution

Pollutants - sources and effect – air pollution meteorology – atmospheric dispersion– indoor air quality - control methods and equipments - issues in air pollution control – air sampling and measurement.

Unit 3: Water Pollution

Water resources - water pollutants - characteristics – quality - water treatment systems – waste water treatment - treatment, utilization and disposal of sludge - monitoring compliance with standards.

Unit 4: Waste Management

Sources and Classification – Solid waste – Hazardous waste - Characteristics –Collection and Transportation - Disposal – Processing and Energy Recovery – Waste minimization.

Unit 5: Other Types of Pollution From Industries

Noise pollution and its impact - oil pollution - pesticides - instrumentation for pollution control - water pollution from tanneries and other industries and their control –environment impact assessment for various projects – case studies.

Text Books

1. G. Masters: Introduction to Environmental Engineering and Science, Prentice Hall of India Pvt Ltd, New Delhi, 2003
2. Peavy, H.S. and D.R. Rowe, G.Tchobanoglous: Environmental Engineering - McGraw- Hill BookCompany, NewYork, 1985

References

1. Ludwig, H. W.Evans: Manual of Environmental Technology in Developing Countries, International Book Company, Absecon Highlands, N.J, 1991
2. Arcadio P Sincero and G. A. Sincero, Environmental Engineering – A Design Approach, Prentice Hall of India Pvt Ltd, New Delhi, 2002

PS3CREENM3 Numerical Method and Computer Programming

Unit 1: Iterative Methods
Bisection, False Position, Secant, Newton-Raphson Method Iterative Method (Including Extended), Newton-Raphson Method For Non Linear Equations In Two Variables, Convergence Of Iterative Methods, algorithms & Computer programming for all these Methods, Polynomial Equations, Descartes Rule of Sign

Unit 2: Finite Differences and Interpolation
Finite Differences: Forward, Backward and Divided Differences. Differences Table, Newton's Forward, Backward and Divided Differences Interpolation Formula. Lagrange Interpolation Formula, Inverse Interpolation, Error Propagation In Difference Table, Estimate Of Errors In Interpolation, Computer programming of the same

Unit 3: Curve Fitting and Method of Least Squares
Method of Least Squares, Fitting A Straight Line And Polynomial Fitting A Non- Linear, Function: Fitting A Geometric And Exponential Curve, Fitting A Hyperbola At Fitting A. Trigonometric Function. Approximation of Function by Taylor Series And Chebyshev Polynomials, Computer programming of curve fitting methods

Unit 4: Numerical Differentiation and Integration
Differentiation Formula Based On Functions Tabulator At Equal And Unequal Intervals Newton-Cotes Integration Formulae: Trapezoidal Rule, Simpson's 1/3 And 3/8th Rule, algorithms & Computer programming for all these Methods

Unit 5: Solution of Simultaneous Linear Equation
Solution of Systems of Linear Equations: Gauss Elimination Maths Pivots, Ill Conditions Equations, Gauss-Seidal And Gauss Jacobi Iterative Methods, computer programming of the same

Unit 6: Numerical Solution of Ordinary Differential Equation
Taylor Series And Euler's Methods, Rangekutta Method Of 4th Order, Milnes's Predictor – Corrector Methods,. Algorithms & Computer programming for all these Methods.

Reference book

1. Computer Oriented Numerical Methods
   V Rajaraman, , - Prentice – Hall of India , Delhi
2. Introduction to Numerical Analysis,
   S. S. Sastry, PHI , Delhi.
3. Numerical Methods for Scientific & Engineering Computation,
   M. K . Jain , S.R.K. Lyenger , R. K. Jain, Wiley Eastern Ltd.
4. A test book on Computational Methods,
   Br. G. T. Kochav Nirali Prakashan , Pune

PS3EREENM1 Green Energy Technology

Unit 1 Basic concepts and Fundamentals of Green Energy

Introduction, Energy Systems: Their Composition, Energy Systems: Their Adverse Impacts, Energy Systems: The Dilemma, Green Energy and Sustainability: The Target and Solution, Diversification and Localization of Energy Systems: A Means to Sustainability and Energy Security.

Unit 2 Energy Analysis of Green Energy Systems

Introduction, Green Energy and Sustainable Development, Importance of Energy Analysis, Energy and Energy Analyses, Case Study 1: Energy Analysis of Solar Ponds, Case Study 2: Energy Analysis of Wind Energy Systems

Unit 3 Energy Economics and Taxonomy

Principles of Economics**:** Scarcity, opportunity cost, Efficiency - Resource allocation through market mechanism - Market failure and role of state

Energy Taxonomy**-**Types of energy: oil (including the implications of OPEC), natural gas, coal, solar, wind), their merits and demerits, economic issues (effect of price controls, costbenefit) and environmental perspectives - Renewable and non-renewable energy – Commercial and non-commercial energy - The McCkelvey classification of energy resources.

Unit 4 Energy Policies & Issues

Energy Demand, Global and Indian trends ,Determinants of energy demand, energy productivity and management of energy demand ,Policy toward Electricity in India: pricing, implications of state subsidies, case for and against privatization in electricity generation and distribution, relevance to India of California experience in privatization of electricity distribution - Potential for renewable energy use in India (solar and wind energy).

Reference Books

1. High Economic Growth, Equity and Sustainable Energy Development
   Kanchan Chopra and VikramDayal (2009), Oxford Handbook of Environmental Economics, Oxford University Press, New Delhi.
2. Natural Resource Economics
   Parry C Field (2001), Mcraw Hill.
3. Introduction to Environmental Economics
   Nick Hanely, Jason F Shogren and Ben White (2001), Oxford University Press.
4. Green Energy Basic concepts and Fundamentals
   Xianguo Li Energy Audi and Energy Management(Vol-1),CRC Press

PS3EREENM2 Energy Economic, Policy & Regulation act

Unit 1 Global Energy Scenario:

Role of energy in economic development and social transformation, Energy & GDP, GNP and its dynamics.

Discovery of various energy sources, Energy Sources and Overall Energy demand and availability, Energy Consumption in various sectors and its changing pattern, Exponential increase in energy consumption and projected future demands.

Non conventional and conventional energy Resources: Coal, Oil, Natural Gas, Nuclear Power and Hydroelectricity, Solar and Other Renewable etc.

Depletion of energy sources and impact on exponential rise in energy consumption on economies of countries and on international relations. Energy Security, Energy Consumption and its impact on environmental climatic change.

International Energy Policies of G-8 Countries, G-20 Countries, OPEC Countries, EU Countries. International Energy Treaties (Rio, Montreal, Kyoto), INDO-US Nuclear Deal. Future Energy Options, Sustainable Development, Energy Crisis

Unit 2 Indian Energy Scenario

Energy resources & Consumption, Commercial and noncommercial forms of energy, Fossil fuels, Renewable sources including Bio-fuels in India and their utilization pattern in the past, present and future projections of consumption pattern, Sector wise energy consumption.

Impact of Energy on Economy, Development and Environment, Energy for Sustainable Development, Energy and Environmental policies, 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. Energy Conservation Act-2001 & its features, Electricity Act-2003 & its features. Framework of Central Electricity Authority (CEA), Central & States Electricity. Regulatory Commissions (CERC & ERCs)

Unit 3 Energy Policy

Global Energy Issues, National & State Level Energy Issues, National & State Energy Policy, Industrial Energy Policy, Energy Security, Energy Vision.

Energy Pricing & Impact of Global Variations. Energy Productivity (National & Sector wise productivity)

Reference Books:

1. Energy for a sustainable world: Jose Goldenberg, Thomas Johansson, A.K.N.Reddy,
2. Book Name
   Robert Williams (Wiley Eastern).
3. Energy policy
   B.V.Desai (Weiley Eastern),
4. Modeling approach to long term demand and energy implication
   J.K.Parikh.
5. Energy Policy and Planning
   B.Bukhootsow.
6. International Energy Outlook
   EIA annual Publication
7. Principles of Energy Conversion
   A.W. Culp (McGraw Hill International edition.)

8. BEE Reference book: no.1/2/3/4
9. Environmental Law and Policy in India: Cases, Materials and Statutes,
   Shyam Divan & Armin Rosencranz, Second edition
10. Energy Policy Analysis and Modeling
    M.Munasinghe and P. Meier (1993): Cambridge University Press.
11. The Econometrics of Energy Demand: A Survey of Application, New York.
    W.A.Donnelly (1987)
12. State Government and central Governments and regulations regarding non-conventional sources and utilization implemented by Gujarat Govt. and Govt. of India time to time.

PS3EREENM3 Energy and Environment

Unit 1 Earth Energy Systems

Origin of the earth; Earth's temperature and atmosphere; Sun as the source of energy; Biological processes; photosynthesis; food chains; Energy sources: classification of energy sources, quality and concentration of energy sources; Overview of world energy scenario; Fossil fuel reserves - estimates, duration, overview of India's energy scenario, energy and development linkage.

Unit 2 Ecological Principles

Ecological principles of nature; Concept of ecosystems; Different types of ecosystems; ecosystem theories; energy flow in the ecosystems; biodiversity

Unit 3 Energy systems and Environment

Environmental effects of energy extraction, conversion and use; Sources of pollution; primary and secondary pollutants; Consequence of pollution growth; Air, water, soil, thermal, noise pollution- cause and effect; Causes of global, regional and local climate change; Pollution control methods; Environmental laws on pollution control.

Unit 4 Sustainability

Global warming; Green House Gas emissions, impacts, mitigation; Sustainability; Externalities; Future Energy Systems; Clean energy technologies; United Nations Framework Convention on Climate Change (UNFCC); Sustainable development; Kyoto Protocol; Conference of Parties (COP); Clean Development Mechanism (CDM); Prototype Carbon Fund (PCF).

References:

1. Ecology and the Environment

R Wilson & W J Jones, Energy, Academic Press Inc.

2. Energy: Its Physical Impact on the Environment,

   D W Davis, John Wiley & Sons

3. Energy and the Challenge of Sustainability, World Energy assessment, UNDP, N York, 2000.

4. Renewable Energy and Environment – A Policy Analysis for India,

   Ravindranath N.H., Usha Rao K., Natarajan B., Monga P., Tata McGraw Hill, 2000

5. Energy and the Environment,

   Fowler, J.M., 2nd Ed. ,McGraw Hill, New York, 1984

PS3CREENM4 Practical

1. To determine performance parameters K1 and K2 of bag filter for particulate matter collection
2. To measure suspended particulate matter emission (SPM) in stack gas from wood combustion stove
3. To study comparative evaluation of performance and emission characteristics of 4 stroke diesel engine fuelled by bio-diesel (B20) and base diesel
4. To study performance and emission characteristics of a 4 stroke spark ignition engine with different throttles for gasoline fuel
5. To examine potential of different bio-adsorbents (Bagasse, Sawdust and Orange peel) for waste water treatment (removal of Remazol Black B Dye from aqueous solution)
6. Analysis of solid waste/sludge for moisture content
7. Analysis of solid waste/sludge for calorific value

PS3CREENM5 Practical

1. To determine ultimate carbon, nitrogen, hydrogen and sulphur by ultimate analysis of fuels
2. To measure fly ash resistivity for different temperature
3. To evaluate thermal diffusivity of soil from observed daily temperature distribution in ground at various depths using Fourier analysis.
4. Determination of efficiency of boiler and analysis of flue gases.
5. Flue gas analysis of petrol, diesel and LPG Engines
6. Determination of Calorific Value of gaseous Fuels using Junker's gas Calorimeter
7. Analysis of solid waste /s ludge for particle size,
8. Determination of N in the sample of Solid waste

PS3CREENM6 Viva Voce

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

M.SC. IN RENEWABLE ENERGY AND ENVIRONMENTAL MODELING

SEMESTER IV

PS4CREENM1 Clean Development Mechanism

Unit 1: Climate Science

World energy scenario - observed and modeled changes in climate - role of Aerosols - climate change scenarios - global warming – factors contributing – comparison of global warming potential of GHG – impacts

Unit 2: Kyoto Protocol: Formation

Historical perspectives from the industrial revolution to the United Nations framework convention on climate change and the Kyoto protocol, the intergovernmental panel on climate change (IPCC)

Unit 3: Kyoto Protocol

Article 1 through 28 - accounted GHGs in Kyoto protocol – source categorization of GHG emissions – reduction commitment of Annexe B countries – C D M, joint implementation and emissions trading

Unit 4: Clean Development Mechanism and Baseline Study Scenario

CDM and its economic viability for renewable energy projects – advantages for developing countries – emission and efficiency scenario of different energy sources for power generation. Baseline Study – methodology – boundary conditions – base line Fixing – typical case studies.

Unit 5: Recent Advancements

Recent advancements in the CDM technologies, issues and protocols, Emission certification norms and methods

Text Books

1. The Forgiving Air: Understanding Environmental Change

Somerville, Richard C.J., Los Angeles: University of California Press, 1996.
2. Global Warming: The Complete Briefing
   John Houghton, Cambridge University Press, and Cambridge, UK, 1997.
3. Global Warming: Opposing Viewpoints,
   Roleff, T.L S. Barbour and K.L. Swisher, Greenhaven Press, and San Diego, 1997.
4. Caring for Climate: a guide to the climate change convention and the Kyoto protocol - UNFCC – 2003

Reference Book

1. Counting Emissions and Removals Greenhouse Gas Inventories Under The UNFCCC
2. Climate Change – Information Kit: Published by UNEP and UNFCCC
3. Kyoto Protocol Reporting on Climate Change: Manual For The Guidelines On National Communications From Non-Annex I Parties
4. Understanding Climate Change: A beginner's guide to UNFCC and its Kyoto Protocol 2002

PS4CREENM1 Research Methodology

Unit1: 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

Qualitative Methods: Types of hypothesis and characterization. Quantitative Methods: Statistical methods for testing and evaluation. Characterization of experiments: Accuracy, reliability, reproducibility, sensitivity, Documentation of ongoing research.

Unit 3: Research Publication & Presentation

Thesis, Research paper, Review Article & Technical Reports: Organization of thesis and reports, formatting issues, citation methods, references, effective oral presentation of research. Quality indices of research publication: impact factor, immediacy factor, H- index and other citation indices.

Unit 4: Research Ethics and Morals

Issues related to plagiarism, collaborative models and ethics, acknowledgements. Intellectual Property Rights: copy rights, copy left: patents, Industrial designs, Trademarks.

Reference Books

1. Research Methodology, Methods & Techniques
   C.R. Kothari, Viswa Prakashan, 2nd Edition, 2009.

2. Research Methods- A Process of Inquiry
   Graziano, A.M., Raulin, M.L, Pearson Publications, 7th Edition, 2009.
3. How to Write a Thesis
   Murray, R. Tata McGraw Hill, 2nd Edition, 2010.
4. Writing For Academic Journals
   Murray, R., McGraw Hill International, 2009.
5. Writing for Publication
   Henson, K.T., Allyn &Bacon, 2005.
6. What is this thing called Science
   Chalmers, A.F., Queensland University Press, 1999.
7. Methods &Techniques of Social Research
   Bhandarkar & Wilkinson, Himalaya publications, 2009.
8. Doing your Research project
   Bell J., Open University Press, Berkshire, 4thEdition, 2005
9. A Handbook of Academic Writing
   Murray, R. and Moore, S., Tata McGraw Hill International

PS4EREENM2 Environment Policy and Environment Impact Assessment

Unit 1 Overview of Environment Policies and Programmes

Global**,** National Conservation Strategy and Policy on Environment,

Unit 2 Environmental Impact Assessment

Principles, Origin and development of EIA Environmental Impact Analysis, Essential components of EIA, Project Screening , Baseline study , Impact Identification, Impact prediction , Evaluation and Mitigation. Methodology matrix method, Network, Overlay, Problems of EIA in developing countries

Unit 3 Environmental Impact of large Projects Positive and Negative Impacts, Primary and Secondary Impacts, Impacts on Physical, Chemical, Biotic and Social Environment, Environmental Impact Statement and Environmental Management Plan for Selected Industries, Impact of Hydro projects and Cement Plants on Ecology and Environment in Himalayan Region

Unit 4 Case Studies

EIA Case Studies of Major Hydro power Projects and Cement Plants

Unit 5 Concepts of the Environmental Audit

Environmental Audit: Definition, Benefits, Objectives, Need for Environmental Audit. **Legislation:** Rules and Regulations, Gazette, Notification on Environmental Statement, Latest Amendments, Guidelines for Environmental Audit.

Methodology-Pre-audit activities, Preliminary Information, Audit Team-Activities at the site, Material Balance Waste Flow, Monitoring, Field Observations, Draft Report-Post-Audit Activities, Synthesis of Data Evaluation of Waste Treatment Facilities, Final report, Action plans, Follow up actions-Material and Energy Flow Assessment, Preparation of Audit Report-Water Consumption

Guidelines to Environmental Safe Layouts to Minimize Losses and Waste :Control Mechanism :Waste water reduction, Air emission reduction-Preparation of Audit Report,Case Studies

Text Books/References

1. Environmental Impact Assessment
   Clark D Brain, Biesel Donald
2. EIA for Developing Countries
   Biswas Asit K
3. EIA Guidelines, Notification of Govt of India Impact Assessment Methodologies and Procedures, 1994
4. Environmental Impact Assessment
   W Canter (2nd Edition)
5. Auditing for Environmental Quality Leadership Willing
   T-Johan
6. Environmental Audit
   Mhastear A K
7. A Guide to local Environmental Auditing, Earthscan Publications Ltd, 1995
   H Barton and N Brudes

PS4EREENM3 Energy and Climate Change

Unit 1Energy

Energy Sources: Definition, Units, Forms of Energy, Power, Origin of Fossil fuels**,** World and Indian Resources of Coal, Oil, Natural gas, Nuclear, Geothermal, Renewable Energy potential : Solar Energy, Wind Energy, Bio-Energy, Hydro, Tidal, Ocean , Nuclear Energy, Nuclear Fission and Fusion , Geothermal Energy, Magneto-hydro-dynamic (MHD) energy conversion, Fuel Cells ,Waste to Energy Conversion, Hydrogen energy **Energy Scenario**: Global Energy Scenario: Energy consumption pattern in various sectors, Impact on economy, India`s Energy Scenario, Urban and Rural energy consumption patterns, Impact of Energy on Development, Energy Infra structure in India, India's Solar Energy Mission Programmes , Targets and Present Status

Unit 2 Energy Policy

Review of Energy policies of various countries**, I**ndian Energy Policy, Renewable Energy Policy and Programmes, Review of State Energy Policies and Programmes in India

Unit 3 Impact of Energy Projects on Environment

Overview of global environmental problems, Environmental degradation due to Energy production and use, Pollution due to thermal power stations , Environmental aspects of Wind Energy Farms ,Environmental aspects of Nuclear power generation, Nuclear waste disposal, Impact of Hydro power generation on Ecology and Environment, Guidelines for Environmental impact assessment (EIA) of Energy Projects

Unit 4 Climate Change Concerns

Green House Gas Emissions, Depletion of Ozone layer, Global Warming, Climate Change Concerns, Climate Change in India, Kyoto protocol, Clean Development Mechanism [CDM], Carbon Fund Concept of Carbon credit

Unit 5 Climate Change Policy Issues

Impact of Climate Change on Glaciers, Rivers and Water Resources, Climate Change Policy Issues in Himalayas, International Status of Climate Change Policies, Indian Action Plan on Climate Change

Text Books /References

1. Energy and Environment: A Primer for Scientists and Engineers
   EH Thorndike, Addison-Wisley Publishing Company
1. Energy, Ecology and the Environment
   R Wilson and W J Jones, Academic Press Inc
2. Energy: Its Physical Impact on the Environment
   DW Davis, John Wiley and Sons
3. Energy and the Challenge of Sustainability, World Energy assessment, UNDP, N York, 2000
4. Energy after Rio, Prospects and challenges
   AKN Reddy, RH Williams, TB Johansson, UNDP, United Nations Publications, New York, 1997
5. Global Energy Perspectives
   N Nakicenovic, A Grubler and A McDonald (Ed), Cambridge University Press, 1998
6. Renewable Energy and Environment – A Policy Analysis for India
   NH, Ravindranath, K Usha Rao, B Natarajan, P Monga, Tata McGraw Hill, 2000
7. Energy and the Environment
   JM Fowler, 2nd Ed, McGraw Hill, New York, 1984
8. Renewable Energy Resources,
   T widell and T Weir, E and F N Spon Ltd, London, 1986
9. Geothermal Energy
   ER Berman, Noyes Data Corporation, New Jersey

PS4EREENM4 Carbon Sequestrations and Trading

Unit 1: Greenhouse Gas

Stabilization of greenhouse gas concentrations – Geenhouse gas risks and reservoirs – Green gas mitigation – Carbon-dioxide and climate change, acid rain, global warming, impacts of global warming – Kyeto-procal.

Unit 2: Carbon

Practices for sequester carbon – Carbon sequestration types – Carbon credits –Carbon testing – potential for carbon sequestration.

Unit 3: Management

Risk management and risk reduction – Carbon economics – Verification of carbon change.

Unit 4: Case Studies

Carbon trading model – Century model – Case studies.

Unit 5 Rules And Regulations

Implication – Nitrous oxide – Carbon bank – Best Management Practices in Public issues – Policies.

Text Book

1. Emission Trading: Environmental Policies New Approach
   Richard F. Kosobud, Douglas L. Schreder., John Wiley and Sons, Holly M. Biggs Published 2000.

References

1. Agricultural Practices and Policies for Carbon Sequestration in Soil
   John M. Kimble, Rattan Lal, CRC Press, Published 2002.
2. The Impact of Carbon Dioxide and Other
   David F. Karnosky

PS4CREENM2 Practical

1. Emission Test Using Combustion Gas Analyzer
2. To determine moisture, volatile matter, ash and fixed carbon contents in a given coal lignite solid fuel.
3. To determine the caloric value of given solid fuel.
4. Determination of dissolved Oxygen, suspended, volatile and fixed Solids
5. Determination of B.O.D and C.O.D
6. Determination of Flash and Fire Point using Pensky Marten Apparatus
7. Determination of Flash and Fire Point using Abel Apparatus
8. Determination of Density and Dynamic Viscosity of oil using Redwood Viscometer

PS4CREENM3 Project/ Dissertation

PS4CREENM4 Viva

Sardar Patel University

Syllabus (Effective from the academic year June, 2013)

M. Sc. (RENEWABLE ENERGY: ENERGY MANAGEMENT)

Structure for Semester System & Choice Based Credit System (CBCS)

M. Sc. in Renewable Energy (UNDER CBCS)

SEMESTER-III: RENEWABLE ENERGY- ENERGY MANAGEMENT								
No	**Course**	**Teaching Scheme**				**Marks**		
	Code & Title	**Theory (T)/ Practical (P)**	**Credit**	**Theory hr/week**	**Exam Duration, hrs**	**Internal**	**External**	**Total**
						Total/ Passing	**Total/ Passing**	**Total/ Passing**
CORE COURSES								
1	PS03CREEM1: Energy Audit and Management	T	4	4	3	30/12	70/28	100/40
2	PS03CREEM2: Energy Conservation in Thermal Systems	T	4	4	3	30/12	70/28	100/40
3	PS03CREEM3: Numerical Method and Computer Programming	T	4	4	3	30/12	70/28	100/40
4	PS03CREEM4: Practical	P	4	6	3	30/12	70/28	100/40
5	PS03CREEM5: Practical	P	4	6	3	30/12	70/28	100/40
6	PS03CREEM6: Viva Voce	-	1	-	-	-	50/20	50/20
ELECTIVE COURSE (Any one elective will be offered)								
7	PS03EREEM1: Demand Side Management of Energy	T	4	4	3	30/12	70/28	100/40
8	PS03EREEM2: Energy Economic, Policy & Regulation act	T	4	4	3	30/12	70/28	100/40
9	PS03EREEM3: Waste Management and Energy Recovery	T	4	4	3	30/12	70/28	100/40
	TOTAL		**25**					

SEMESTER-IV: RENEWABLE ENERGY –ENERGY MANAGEMENT								
No	**Course**	**Teaching Scheme**				**Marks**		
	Code & Title	**Theory (T)/ Practical (P)**	**Credit**	**Theory hr/week**	**Exam Duration, hrs**	**Internal**	**External**	**Total**
						Total/ Passing	**Total/ Passing**	**Total/ Passing**
CORE COURSES								
1	PS04CREEM1: Energy Management in Buildings	T	4	4	3	30/12	70/28	100/40
2	PS03CREEM2: Practical	T	4	6	3	30/12	70/28	100/40
3	PS03CREEM3: Project/ Dissertation	T	12	12	-	-	-	300
4	PS03CREEM4: Viva Voce	-	1	-	-	-	50/20	50/20
ELECTIVE COURSE (Any one elective will be offered)								
5	PS04EREEM1: Research Methodology	T	4	4	3	30/12	70/28	100/40
6	PS04EREEM2: Energy Economics	T	4	4	3	30/12	70/28	100/40
7	PS04EREEM3: Energy Efficient Devices	T	4	4	3	30/12	70/28	100/40
8	PS04EREEM4: Heat Recovery and Cogeneration System	T	4	4	3	30/12	70/28	100/40
	TOTAL		**25**					

Note:
Project will be offered in forth semester to student who will have to complete the courses PS04CREEM1, PS03CREEM2, PS03CREEM4 and any one elective course only

RENEWABLE ENERGY-ENERGY MANAGEMENT
SEMESTER-III

CORE COURSES

PS03CREEM1: Energy Audit and Management

PS03CREEM2: Energy Conservation in Thermal Systems

PS03CREEM3: Numerical Method and Computer Programming

PS03CREEM4: Practical

PS03CREEM5: Practical

PS03CREEM6: Viva Voce

ELECTIVE COURSES

PS03EREEM1: Demand Side Management of Energy

PS03EREEM2: Energy Economic, Policy & Regulation act

PS03EREEM3: Waste Management and Energy Recovery

SEMESTER-IV

CORE COURSES

PS04CREEM1: Energy Management in Buildings

PS03CREEM2: Practical

PS03CREEM3: Project/ Dissertation

PS03CREEM4: Viva Voce

ELECTIVE COURSES

PS04EREEM1: Research Methodology

PS04EREEM2: Energy Economics

PS04EREEM3: Energy Efficient Devices

PS04EREEM4: Heat Recovery and Cogeneration System

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

M. SC. RENEWABLE ENERGY AND ENERGY MANAGEMENT (UNDER CBCS)
SEMESTER-III

PS03CREEM1 Energy Audit and Management

Unit 1: Energy Audit Methodology and Recent trends.

General Philosophy and need of Energy Audit and Management.

Definition and Objective of Energy Management, General Principles of Energy Management, Energy Management Skills, Energy Management Strategy. Economics of implementation of energy optimization projects, it's constraints, barriers and limitations, Report-writing, preparations and presentations of energy audit reports ,Post monitoring of energy conservation projects, MIS , Case-studies / Report studies of Energy Audits. Guidelines for writing energy audit report, data presentation in report, findings recommendations, impact of renewable energy on energy audit recommendations. Case studies of implemented energy cost optimization projects in electrical utilities as well as thermal utilities. Instruments for Audit and Monitoring Energy and Energy Savings, Types and Accuracy.

Unit 2: Electrical Distribution and Utilization

Electrical Systems, Transformers loss reductions, parallel operations, T & D losses, P.F. improvements, Demand Side management (DSM), Load Management, Harmonics & its improvements, Energy efficient motors and Soft starters, Automatic power factor Controllers, Variable speed drivers, Electronic Lighting ballasts for Lighting, LED Lighting, Trends and Approaches. Study of 4 to 6 cases of Electrical Energy audit and management (Power factor improvement, Electric motors, Fans and blowers, Cooling Towers, Industrial/Commercial Lighting system, etc.)

Unit 3: Thermal Systems

Boilers- performance evaluation, Loss analysis, Water treatment and its impact on boiler losses, integration of different systems in boiler operation. Advances in boiler technologies, FBC and PFBC boilers, Heat recovery Boilers- it's limitations and constraints .Furnaces- Types and classifications, applications, economics and

quality aspects, heat distributions, draft controls, waste heat recovering options, Furnaces refractory- types and sections. Thermic Fluid heaters, need and applications, Heat recovery and its limitations. Insulators- Hot and Cold applications, Economic thickness of insulation, Heat saving and application criteria. Steam Utilization- Properties, steam distribution and losses, steam trapping, Condensate, Flash steam recovery.

Unit 4: System Audit of Mechanical Utilities

Pumps, types and application, unit's assessment, improvement option, parallel and series operating pump performance. Energy Saving in Pumps & Pumping Systems.

Bloomers (Blowers) types & application, its performance assessment, series & parallel operation applications & advantages. Energy Saving in Blowers Compressors, types & applications, specific power consumption, compressed air system,& economic of system changes. Energy Saving in Compressors & Compressed Air Systems Cooling towers, its types and performance assessment & limitations, water loss in cooling tower. Energy Saving in Cooling Towers .Study of 4 to 6 cases of Energy Audit & Management in Industries (Boilers, Steam System, Furnaces, Insulation and Refractories, Refrigeration and Air conditioning, Cogeneration, Waste Heat recovery etc.)Study of Energy Audit reports for various Industries and Organizations

PS03CREEM2 Energy Conservation in Thermal Systems

Unit 2: Introduction

Energy Scenario - world and India. Energy Resources availability in India. Energy consumption pattern. Energy conservation potential in various Industries and commercial establishments. Energy intensive industries - an overview. Energy conservation and energy efficiency – needs and advantages. Energy auditing - types, methodologies, barriers. Role of energy manager – Energy audit questionnaire - energy Conservation Act 2003

Unit 2: Instruments for Energy Auditing

Instrument characteristics – sensitivity, readability, accuracy, precision, hystersis. Error and calibration. Measurement of flow, velocity, pressure, temperature, speed, Lux, power and humidity. Analysis of stack, water quality, power and fuel quality.

Unit 3: Thermal Utilities: Operation and Energy Conservation

(i) Boilers (ii) Thermic Fluid Heaters (iii) Furnaces (iv) Waste Heat Recovery Systems (v) Thermal Storage

Unit 4: Thermal Energy Transmission / Protection Systems

Steam traps– refractory's – optimum insulation thickness– insulation – piping design

Unit 5: Financial Management

Investment - need, appraisal and criteria, financial analysis techniques - break even analysis- simple payback period, return on investment, net present value, internal rate of return, cash flows, DSCR, financing options, ESCO concept.

Text Books

1. Energy Management Principles
   Smith, CB, Pergamon Press, NewYork, 1981
2. Energy Auditing and Conservation; Methods Measurements, Management and Case study, Hamies, Hemisphere, Washington, 1980

References

1. Energy Management
   Trivedi, PR, Jolka KR, Commonwealth Publication, New Delhi, 1997
2. Industrial Energy Management and Utilization
   Write, Larry C, Hemisphere Publishers, Washington, 1988
3. Total Energy
   Diamant, RME, Pergamon, Oxford, 1970
4. Handbook on Energy Efficiency, TERI, New Delhi, 2001
5. Guide book for National Certification Examination for Energy Managers and Energy Auditors

PS03CREEM3 Numerical Method and Computer Programming

Unit 1: Iterative Methods

Bisection, False Position, Secant, Newton-Raphson Method Iterative Method (Including Extended), Newton-Raphson Method For Non Linear Equations In Two Variables, Convergence Of Iterative Methods, algorithms & Computer programming for all these Methods, Polynomial Equations, Descartes Rule of Sign

Unit 2: Finite Differences and Interpolation

Finite Differences: Forward, Backward and Divided Differences. Differences Table, Newton's Forward, Backward and Divided Differences Interpolation Formula. Lagrange Interpolation Formula, Inverse Interpolation, Error Propagation In Difference Table, Estimate Of Errors In Interpolation, Computer programming of the same

Unit 3: Curve Fitting and Method of Least Squares

Method of Least Squares, Fitting A Straight Line And Polynomial Fitting A Non- Linear, Function: Fitting A Geometric And Exponential Curve, Fitting A Hyperbola At Fitting A. Trigonometric Function. Approximation of Function by Taylor Series And Chebyshev Polynomials, Computer programming of curve fitting methods

Unit 4: Numerical Differentiation and Integration

Differentiation Formula Based On Functions Tabulator At Equal And Unequal Intervals Newton-Cotes Integration Formulae: Trapezoidal Rule, Simpson's 1/3 And 3/8th Rule, algorithms & Computer programming for all these Methods

Unit 5: Solution of Simultaneous Linear Equation

Solution of Systems of Linear Equations: Gauss Elimination Maths Pivots, Ill Conditions Equations, Gauss-Seidal And Gauss Jacobi Iterative Methods, computer programming of the same

Unit 6: Numerical Solution of Ordinary Differential Equation

Taylor Series And Euler's Methods, Rangekutta Method Of 4th Order, Milnes's Predictor – Corrector Methods,. Algorithms & Computer programming for all these Methods.

Reference book

1. Computer Oriented Numerical Methods
   V Rajaraman, - Prentice – Hall of India , Delhi
2. Introduction to Numerical Analysis
   S. S. Sastry, PHI , Delhi.
3. Numerical Methods for Scientific & Engineering Computation
   M. K . Jain , S.R.K. Lyenger , R. K. Jain, Wiley Eastern Ltd.
4. A test book on Computational Methods
   Br. G. T. Kochav, Nirali Prakashan , Pune

PS03EREEM1 Demand Side Management of Energy

Unit 1 Concept and Methods of DSM, Load Control

Load control - energy efficiency - load management - DSM planning – design –marketing - impact assessment – direct – distributed - and local control – interruptible load - configuration of control system for load control - assessment of impact on load shape.

Unit 2 Strategic Conservation and Load Management Technologies

Strategic conservation via improving building envelope - air-conditioning – lighting -electric motor - and other industrial processes and equipment - load shifting and load leveling through thermal energy storage.

Unit 3 Assessment of Impact on System Load Shape

Energy audit and assessment of customers load shape for different customer groups - impact of DSM programs on load shapes in customer groups - categorized in economic sub sectors and by geographical location.

Unit 4 Cost / Benefit Analysis and Feasibility of DSM Program

DSM program costing and Load Shape Impact on system - DSM program cost/benefit and feasibility - environmental benefits - type of customer incentives and programs - program design - use of analytic hierarchical process for assessment of customer acceptance and program penetration.

Unit 5 Integrated Electric Utility Service Under Deregulated Situation

Institutional – legal - and political environments and the stages of development of electric utility Service - the mechanism of competition and development of the financial environment for economic utilization of resources for electric service.

Text Books

1. Demand-Side Management: Concepts & Methods
   Gellings, C.W. and Chamberlin, J. H., Firmont Press, 1993.
2. Demand-Side Management Planning
   Gellings, C.W. and Chamberlin, J. H., Firmont Press, 1993.

References

1. International Load Management: Methods to Practice
   Limaye, D. R and Rable, V., Firmont Press, 1988.
2. Demand-Side Management of the Electric Power Industry in Japan
   Hiroshi, Central Research Institute of Electric Power Industry, 1998.
3. Industrial Load Management: Theory, Practice and Simulations
   Bjork, C.O., Amsterdam, 1989.

PS03EREEM2 Energy Economic, Policy & Regulation act

Unit 1 Global Energy Scenario:

Role of energy in economic development and social transformation, Energy & GDP, GNP and its dynamics.

Discovery of various energy sources, Energy Sources and Overall Energy demand and availability, Energy Consumption in various sectors and its changing pattern, Exponential increase in energy consumption and projected future demands.

Non conventional and conventional energy Resources: Coal, Oil, Natural Gas, Nuclear Power and Hydroelectricity, Solar and Other Renewable etc.

Depletion of energy sources and impact on exponential rise in energy consumption on economies of countries and on international relations. Energy Security, Energy Consumption and its impact on environmental climatic change.

International Energy Policies of G-8 Countries, G-20 Countries, OPEC Countries, EU Countries. International Energy Treaties (Rio, Montreal, Kyoto), INDO-US Nuclear Deal. Future Energy Options, Sustainable Development, Energy Crisis

Unit 2 Indian Energy Scenario

Energy resources & Consumption, Commercial and noncommercial forms of energy, Fossil fuels, Renewable sources including Bio-fuels in India and their utilization pattern in the past, present and future projections of consumption pattern, Sector wise energy consumption.

Impact of Energy on Economy, Development and Environment, Energy for Sustainable Development, Energy and Environmental policies, 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. Energy Conservation Act-2001 & its features, Electricity Act-2003 & its features. Framework of Central Electricity Authority (CEA), Central & States Electricity. Regulatory Commissions (CERC & ERCs)

Unit 3 Energy Policy

Global Energy Issues, National & State Level Energy Issues, National & State Energy Policy, Industrial Energy Policy, Energy Security, Energy Vision.

Energy Pricing & Impact of Global Variations. Energy Productivity (National & Sector wise productivity)

Reference Books:

1. Energy for a sustainable world: Jose Goldenberg, Thomas Johansson, A.K.N.Reddy,
2. Book Name
   Robert Williams (Wiley Eastern).
3. Energy policy
   B.V.Desai (Weiley Eastern),
4. Modeling approach to long term demand and energy implication
   J.K.Parikh.
5. Energy Policy and Planning
   B.Bukhootsow.
6. International Energy Outlook

EIA annual Publication

7. Principles of Energy Conversion
   A.W. Culp (McGraw Hill International edition.)
8. BEE Reference book: no.1/2/3/4
9. Environmental Law and Policy in India: Cases, Materials and Statutes,
   Shyam Divan & Armin Rosencranz, Second edition
10. Energy Policy Analysis and Modeling
    M.Munasinghe and P. Meier (1993): Cambridge University Press.
11. The Econometrics of Energy Demand: A Survey of Application, New York.
    W.A.Donnelly (1987)
12. State Government and central Governments and regulations regarding non-conventional sources and utilization implemented by Gujarat Govt. and Govt. of India time to time.

PS03EREEM3 Waste Management and Energy Recovery

Unit 1 Solid Waste – Characteristics and Perspectives

Definition - types – sources – generation and estimation. Properties: physical, chemical and biological – regulation

Unit 2 Collection, Transportation and Processing Techniques

Onsite handling, storage and processing – types of waste collection mechanisms -transfer Stations : types and location – manual component separation – volume reduction : mechanical, thermal – separation : mechanical, magnetic electro mechanical

Unit 3 Energy Generation Techniques

Basics, types, working and typical conversion efficiencies of composting – anaerobic digestion – RDF – combustion – incineration – gasification – pyrolysis

Unit 4 Hazardous Waste Management

Hazardous waste – definition - potential sources - waste sources by industry –impacts – waste control methods – transportation regulations - risk assessment -remediation technologies – Private public paternership – Government initiatives.

Unit 5 Ultimate Disposal

Landfill – classification – site selection parameters – design aspects – Leachate control – environmental monitoring system for Land Fill Gases.

Text books:

1. Integrated Solid Waste Management
   Tchobanoglous, Theisen and Vigil, 2d Ed. McGraw-Hill, New York, 1993.

2. Environmental Engineering
   Howard S. Peavy etal, McGraw Hill International Edition, 1985

References:

1. Hazardous Waste Management
   LaGrega, M., et al., McGraw-Hill, c.1200 pp., 2nd ed., 2001.
2. Hazardous Waste Chemistry, Toxicology and Treatment
   Stanley E. Manahan, Lewis Publishers, Chelsea, Michigan, 1990
3. Energy from Waste – An Evaluation of Conversion Technologies
   Parker, Colin and Roberts, Elsevier Applied Science, London, 1985.
3. Waste Disposal in Engineered Landfills
   Manoj Datta, Narosa Publishing House, 1997

PS03CREEM4 Practical

1. Boiler efficiency testing
2. Motor and Pump efficiency testing
3. Energy consumption measurement of lighting systems
4. Energy audit of any one residential, or commercial building
5. Prepare energy audit report for institutional level
6. Prepare energy conservation measures for institutional building
7. Study on simple payback period, return on investments
8. Study on net present value, internal rate of return, sensitive analysis
9. Preparing energy audit for institutional/ Residential/industrial building
10. Study on representation of energy consumption

PS03CREEM5 Practical

1. Performance Test of Parallel flow and Counter flow Heat Exchanger
2. Energy consumption measurement of lighting systems
3. Performance Test on Vapor Compression Refrigeration Systems
4. Performance Test on Air conditioning Systems
5. Performance analysis of Concentrated Solar Thermal Collecting System using TRNSYS
6. Analysis of flow in a System of Pipes to compute the velocity distribution using ANSYS

PS03CREEM6 Viva Voce

INSTITUTE OF STUDIES AND RESEARCH IN RENEWABLE ENERGY (ISRRE)

NEW VALLABH VIDYANAGAR

M. SC. RENEWABLE ENERGY: ENERGY MANAGEMENT (UNDER CBCS)

SEMESTER-IV

PS04CREEM1 Energy Management in Buildings

Unit 1 The economics of space heating plants

Introduction, The economics , Energy consumption, Estimation of indoor heat gains, Standard Degree Days, Calculation of Standard Degree Days, Standard Degree Days to different, Base temperatures, Research into Standard Degree Days , Limitations of the SDD method of estimating annual energy consumption

Unit 2 Estimating energy consumption – Continuous space heating

Introduction, Estimating procedures for continuously heated buildings, Adoption of equivalent hours of operation at full load.

Unit 3 Intermittent space heating

Introduction, The estimation of annual energy demand, The estimation of annual fuel consumption for offices, The estimation of annual fuel costs for a school, The estimation of annual fuel consumption for a factory, The estimation of annual fuel cost for a house, The estimation of annual fuel cost for a tempered air system, Reducing fossil fuel consumption in the existing building stock, Further qualifying remarks relating to the case studies, Limitations related to Standard Degree Days

Unit 4 Estimating the annual cost for the provision of hot water supply

Introduction, Factors to be considered, Hot water supply requirements and boiler power, The annual estimate calculation process, Estimating annual energy consumption, An alternative method of estimating annual energy consumption.

Unit 5 Energy consumption for cooling loads

Introduction, External heat gains, Factors affecting the estimation of external heat gains, Estimation of the indoor heat gains, Annual energy consumption – A more detailed analysis, Free cooling

Unit 6 Performance Indicators

Introduction, Performance Indicators, Building benchmarks, Further analysis of Case study, Carbon dioxide emissions, Annual carbon dioxide emission benchmarks/indices (CDI), Further analysis of Case studies.

Unit 7 Energy conservation strategies

Introduction, Energy transfer from point of extraction to point of use, Efficiency of space heating plants, Seasonal and base load demand and consumption, The energy conservation programme, The energy survey, The energy audit, Areas for energy saving, Heat recovery

Unit 8 Cost–benefit analysis

Introduction, Simple payback, Discounted cash flow and present value, Effects of fuel inflation Case study, Effects of general inflation and fuel inflation, Net present value and comparison of different schemes, Loans, Whole life costs, Repair or replace.

Unit 9 Energy audits

Introduction, Preliminaries to an energy audit, Outcomes of the energy audit, Measurement of primary energy consumption, Primary energy tariffs, Presentation of data – A simple audit, Auditing a primary school, An energy audit for a small museum, Auditing a mixed use building,
Presentation of data – A more detailed audit, Auditing a two-bed bungalow Case study.

Unit 10 Monitoring and targeting

Introduction , Monitoring procedures, Monitoring equipment, Correlation and linear regression analysis, Continuous performance monitoring using Degree Days, Continuous performance monitoring using mean daily outdoor temperature, Correcting fuel/energy consumption to a common time base, Performance monitoring using cumulative sum deviation

Unit 11 Regulations relating to greenhouse gas emissions 167

Introduction, The Climate Change Levy, The Energy Technology List, Enhanced Capital Allowances, The Carbon Trust, Carbon or carbon dioxide?, Emissions Trading Scheme
Levy Exemption Certificates, Renewable Obligation Certificates, The EU Energy Performance in Buildings Directive, Domestic dwellings, Contraction and convergence, British Electricity Trading and Transmission Arrangements, Towards sustainable reporting

Unit 12 Trends in building services

Introduction, Sustainable development, Whole life costing, Rethinking design and installation, Prefabrication, An energy-saving product, Energy-saving systems, Sustainable systems.

Reference Book:

1. Energy Management in Buildings
   Keith J. Moss, Second edition (2006), by Taylor & Francis
2. Building Energy Management Systems
   Geoff Levermore, Spon Press
3. Energy Auditing and Conservation; Methods Measurements, Management and Case study, Hamies, Hemisphere, Washington, 1980

PS04EREEM1 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

Qualitative Methods: Types of hypothesis and characterization. Quantitative Methods: Statistical methods for testing and evaluation. Characterization of experiments: Accuracy, reliability, reproducibility, sensitivity, Documentation of ongoing research.

Unit 3Research Publication & Presentation

Thesis, Research paper, Review Article & Technical Reports: Organization of thesis and reports, formatting issues, citation methods, references, effective oral presentation of research. Quality indices of research publication: impact factor, immediacy factor, H- index and other citation indices.

Unit4 Research Ethics and Morals

Issues related to plagiarism, collaborative models and ethics, acknowledgements. Intellectual Property Rights: copy rights, copy left: patents, Industrial designs, Trademarks.

Reference Books

1. Research Methodology, Methods & Techniques, C.R. Kothari, Viswa Prakashan, 2nd Edition, 2009.

2. Research Methods- A Process of Inquiry, Graziano, A.M., Raulin, M.L, Pearson Publications, 7th Edition, 2009.
3. How to Write a Thesis:, Murray, R. Tata McGraw Hill, 2nd Edition, 2010.
4. Writing For Academic Journals, Murray, R., McGraw Hill International, 2009.
5. Writing for Publication, Henson, K.T., Allyn &Bacon, 2005.
6. What is this thing called Science, Chalmers, A.F., Queensland University Press, 1999.
7. Methods &Techniques of Social Research, Bhandarkar & Wilkinson, Himalaya publications, 2009.
8. Doing your Research project, Bell J., Open University Press, Berkshire, 4thEdition, 2005
9. A Handbook of Academic Writing, Murray, R. and Moore, S., Tata McGraw Hill International

PS04EREEM2 Energy Economics

Unit 1- Introduction to Energy Economics

Introduction, Energy and Multidimensional Interactions, Energy Demand Analysis and Forecasting-Introduction to the Energy System- Energy Accounting Framework- Accounting of Traditional Energies-Special Treatments of Some Entries in the Energy Balance-Analysis of Energy Balance Information-Alternative Presentation of Energy Accounting Information.

Unit 2 Understanding and Analyzing Energy Demand

Introduction, Evolution of Demand Analysis, Overview of Energy Demand Decisions, Consumer Demand for Energy: Utility Maximization Problem, Cost Minimization Problem of the Producer, Descriptive for Energy Demand Analysis, Factor (or Decomposition) of Change in Total Energy Demand, Analysis of Changes in Energy Intensity, Analysis Using Physical Indicators, Energy Demand Analysis Using the Econometric Approach, Energy Demand Analysis at a Disaggregated Level-Disaggregation of Demand- Sectoral Energy Accounting, Analysis at the Sectoral Level-Industrial Energy Demand Analysis- Energy Demand Analysis in the Transport Sector- Energy of Energy Demand in the Residential and Commercial Sectors.

Unit 3 Energy Demand Forecasting

Simple Approaches, Advanced or Sophisticated Techniques, Econometric Approach to Energy, Demand Forecasting, End-Use Method of Forecasting, Input–Output Model, Scenario Approach, Artificial Neural Networks, Hybrid Approach, Review of Some Common Energy Demand ,Analysis Models, MAED Model, LEAP Model, Demand Module in NEMS (National Energy Modeling System), Demand Modelling in WEM (World Energy Model).

Unit 4 Economics of Energy Supply

Economic Analysis of Energy Investments, Main Characteristics of Energy Projects, Basics of the Economic Analysis of Projects, Identification of Costs, Identification of Benefits, Valuation of Costs and Benefits, Economic Versus Financial Investment Analysis , Indicators of Cost-Benefit Comparison , Methods Without Time Value, Methods Employing Time Value, Uncertainty and Risk in Projects, Economics of Non-

Renewable Resource Supply-Depletion Dimension: Now or Later- A Simple Model of Extraction of Exhaustible Resources-Effect of Monopoly on Depletion- Effect of Discount Rate on Depletion Path,

Unit 5 Economics of Electricity Supply

Basic Concepts Related to Electricity Systems, Alternative Electricity Generation Options, Generation Capacity Reserve, Economic Dispatch, Merit Order Dispatch, Incremental Cost Method, Unit Commitment, Investment Decisions in the Power Sector, Levelised Bus–Bar Cost, Screening Curve Method, Sophisticated Approaches to Electricity Resource Planning, Economics of Renewable Energy Supply-The Economics of Bio-fuels- Bio-Ethanol Cost Features- Bio-Diesel Costs-Support Mechanisms

Unit 6 Energy Markets and Principles of Energy Pricing

Introduction: Basic Competitive Market Model, Extension of the Basic Model, Indivisibility of Capital, Depletion of Exhaustible Resources, Asset Specificity and Capital Intensiveness, Market Failures, Monopoly Problems, Natural Monopoly, Existence of Rent, Externality and Public Goods, Government Intervention and Role of Government in the Sector, Energy Pricing and Taxation-Introduction- Basic Pricing Model-Tradability of Energy Products and Opportunity Cost- Peak and Off-Peak Pricing- Peak Load Pricing Principle- Short-Run Versus Long-Run Debate- Energy Taxes and Subsidies- Principles of Optimal Indirect Taxation- Equity Considerations- Issues Related to Numerical Determination of an Optimal Tax .

Reference

1. Subhes C. Bhattacharyya. Energy Economics, Conceptes, Issues, Markets and Governance. Springer publication, 2011, p.673.
2. Yiming Wei ,Lancui Liu, Gang Wu, Lele Zou, Energy Economics:CO2 Emissions in China, Springer publication, 2011, p.354.
3. André Dorsman • John L. Simpson, Wim Westerman, Energy Economics and Financial Markets, Springer publication, 2013, p.248.

PS04EREEM3 Energy Efficient Devices

Unit 1 Significance of Induction motor in Industries:

Importance of 3-phase Induction motor in Industry. Industrial motor population and uses. Annual Electric motor sales volume. Comparison of Induction motor with other motors. Types of Enclosures and Protection used for three Phase motor. Zone wise classification of three phase motors.

Unit 2 Basic Concepts of Three Phase Induction motor

Introduction, working principle, Classification of AC motors, Synchronous Speed, speed of rotor field, slip, various methods of measurement of slip, Starting & running torque, torqueslip characteristics, maximum torque, Effect of change in voltage & frequency on torque, speed & slip, various power losses in three phase induction motor. Motor operation under abnormal conditions. Preventive maintenance of three phase motor.

Unit 3 Energy Efficient Motors:

Basic concepts of Energy Efficient motor. Motor losses and loss reduction techniques Energy efficient Stator design. Energy efficient Rotor design. Motor Efficiency test standards. Comparison between conventional and Energy Efficient motor. When to buy Energy Efficient Motor. Understanding utility rate schedule. Payback period and IRR for installing EEM. Motor purchase prices. Accessing Economic feasibility. Case studies. Utility of energy efficient motor and recommendations for motor purchaser.

Unit 4 Soft Starters for three phase motors.

Introduction to soft starter for three phase Induction motor. Comparison of soft starters with conventional starters used for three phase Induction motor. Comparison of characteristics of soft starter with other three phase motor starters.

Unit 5 Energy Efficiency in Lightning System

Introduction, Basic Parameters and Terms, Light Source and Lamp Types-Incandescent lamp-Halogen Lamp-Fluorescent Tube Lamp-Compact Fluorescent Lamp-Sodium vapor Lamp- Mercury Vapor Lamp-Metal Halide Lamp-Light Emitting Diode, Recommended Illuminance Levels for Various Tasks/Activities/location, Metod of Calculating Illuminancs-Lightning Design for Interiors-For Indoor and Outdoor, Energy Saving Opportunities, Energy Efficient Lightning Controls, Standard and Labeling Programme for FTL Lightning System

Unit 6 Energy Efficiency in Fans and Blowers

Introduction, Fan Types, Centrifugal Fans-Types, Common Blower Types, Fan Performance Evaluation-System Characteristics-fan Characteristics-System Characteristics and Curves-Fan Laws, Fan Design and Selection Criteria-Fan Performance and Efficiency, Safety Margins, installation of Fan, Impeller Inlet Seal Clearance, System Resistance and Pressure Drop, Flow Control Strategies-Pulley Change-Damper Controls-Inlet Guide Vanes-Variable Speed Drives-Series and Parallel Operation, Factors for Selection of Flow Control Methods, Fan Performance Assessment-Air Flow Measurement, Measurements and Calculations, Calculation Gas Density, Fan Efficiency, Energy Savings opportunities-Minimizing Demand on Fan

Reference Books:

1. Electrical Machines
   Nagarath & Kothari, TMH Publications
2. Performance and Design of A.C. machines
   M. G. Say, CBC Publication
3. Generalized theory of Electrical Machines

P S Bhimbra, Khanna publications
4. Electrical Machines
   J. B. Gupta, Kataria Pub
5. Electrical Machines
   Samarjit Singh, Pearson Education
6. Energy Efficiency in Electrical systems volume-II, IEEC Press
7. Energy Efficient motor selection handbook by Department of Energy United states of America.

PS04EREEM4 Heat Recovery and Cogeneration System

Unit 1 Introduction

Introduction - principles of thermodynamics – cycles - topping - bottoming –combined cycle - organic rankine cycles – performance indices of cogeneration systems – waste heat recovery – sources and types – concept of tri generation.

Unit 2 Cogeneration Technologies

Configuration and thermodynamic performance – steam turbine cogeneration systems – gas turbine cogeneration systems – reciprocating IC engines cogeneration systems – combined cycles cogeneration systems – advanced cogeneration systems: fuel cell, Stirling engines etc.,

Unit 3 Issues and Applications of Cogeneration Technologies

Cogeneration plants electrical interconnection issues – utility and cogeneration plant interconnection issues – applications of cogeneration in utility sector – industrial sector – building sector – rural sector – impacts of cogeneration plants – fuel, electricity and environment

Unit 4 Waste Heat Recovery Systems

election criteria for waste heat recovery technologies - recuperators - Regenerators -economizers - plate heat exchangers - thermic fluid heaters - Waste heat boilers classification, location, service conditions, design Considerations - fluidized bed heat exchangers - heat pipe exchangers - heat pumps – sorption systems.

Unit 5 Economic Analysis

Investment cost – economic concepts – measures of economic performance –procedure for economic analysis – examples – procedure for optimized system selection and design – load curves - sensitivity analysis – regulatory and financial frame work for cogeneration and waste heat recovery systems.

Text books:

1. Cogeneration - Heat and Power

Horlock JH, Thermodynamics and Economics, Oxford, 1987.

2. Institute of Fuel, London, Waste Heat Recovery, Chapman and Hall Publishers, London, 1963

References:

1. Cogeneration
   Charles H.Butler,McGraw Hill Book Co., 1984.
2. EDUCOGEN – The European Educational tool for cogeneration, Second Edition, 2001
3. Waste Heat Utilization and Management, Hemisphere
   Sengupta Subrata, Lee SS EDS, Washington, 1983.
4. Air Pollution Control Engineering
   De Nevers, Noel, McGrawHill, New York, 1995.

PS03CREEM2 Practical

1. Energy balance test on given steam boiler
2. Determination of heating/cooling load for the given space to be air conditioned
3. Performance analysis of heat transfer equipments
4. Performance Test of Parallel flow and Counter flow Heat Exchanger
5. Energy consumption measurement of lighting systems,
6. Development of VB Programme for the design of Heat Exchangers

PS03CREEM3 Project/ Dissertation

PS03CREEM4 Viva Voce