M.TECH – RENEWABLE ENERGY

SYLLABUS

(with effect from June 2015)

RURAL ENERGY CENTRE

The Gandhigram Rural Institute – Deemed University

Gandhigram – 624 302 Tamil Nadu

M.Tech. - Renewable Energy

Course Code	Course Title	No. of Credits	L	T	P	Maximum Marks		
						CFA	ESE	Total
Semester I								
15REEP0101	Introduction to Energy Studies	4	4	0	0	40	60	100
15REEP0102	Solar Energy Conversion Technologies	4	3	1	0	40	60	100
15REEP0103	Thermal Engineering	4	3	1	0	40	60	100
15REEP0104	Energy Auditing and Management	4	4	0	0	40	60	100
15REEP0105	Advanced Numerical Methods	4	3	1	0	40	60	100
15REEP0106	Renewable Energy Laboratory – I	3	0	0	6	60	40	100
15GTPP0001	Gandhi in Every Day Life (Compulsory Non Credit Course)	2	2	0	0	50		50
	Total	**25**	**19**	**3**	**6**			**600**
Semester II								
15REEP0207	Waste to Energy Conversion Technologies	4	3	1	0	40	60	100
15REEP0208	Wind Energy, Small Hydro and New Renewable Energy Technologies	4	3	1	0	40	60	100
15REEP0209	Power Systems for Renewable Energy Sources	4	3	1	0	40	60	100
15REEP0210	Energy Economics and Policies	4	4	0	0	40	60	100
15APRM0201	Research Methodology	4	4	0	0	40	60	100
15REEP0211	Renewable Energy Laboratory – II	3	0	0	6	60	40	100
15ENGP00C1	Communication & Soft Skills (Compulsory Non Credit Course)	2	2	0	0	50		50
15REEP0212	Summer Internship	2				50	0	50
	Total	**25**	**19**	**3**	**6**			**650**
Semester III								

15REEP03EX	Major Elective I	4	4	0	0	40	60	100
15REEP03EY	Major Elective II	4	4	0	0	40	60	100
15REEP0313	Rural Energy Planning (Field Visit)	3	0	0	6	60	40	100
15REEP0314	Technical Seminar	1	2	0	0	50	0	50
15REEP0315	Mini Project	4	0	0	8	60	40	100
	Non Major Elective	4	4	0	0	40	60	100
15EXNP03V1	Village Placement Programme	2				50	0	50
	Total	**22**	**14**	**0**	**14**	**340**	**260**	**600**
Semester IV								
15REEP0416	Dissertation	**12**				**150**	**50**	**200**
	Total	**84**						

Curriculum Outline:

List of major Electives for 15REEP03EX and 15REEP03EY:

15REEP03E1 Rural Electrification :Technologies and Economics

15REEP03E2 Renewable Energy & Sustainable Development

15REEP03E3 Smart Grid

15REEP03E4 Modeling and Project Management

15REEP03E5 Optimum Utilization of Heat and Power

15REEP03E6 Energy Auditing Instrumentation

15REEP03E7 Green Buildings

15REEP03E8 Environmental Impact Assessment

15REEP03E9 Technology Management

15REEP0101INTRODUCTION TO ENERGY STUDIES

Objective:

- To Inculcate the students about various forms of energy sources, Government Schemes and Polices related to Energy, Energy Efficiency and Environment

Specific Objectives of Learning

At the end of the course learner will be able to

- ✓ Understand the various forms of energy along with energy demand and efficiency of different energy conversion technology.
- ✓ Know about the Ministry and schemes of renewable energy in India.
- ✓ Learn about extraction of Bio fuels from crops.

Unit I

Energy Science & Technology - Forms of Energy – Advantages and Limitations - Mechanical Energy - Chemical Energy and Fuels - Nuclear Energy - Hydro Energy - Renewable Energy –Energy Demand- Comparison of Fuels such as Wood, Charcoal, Coal, Kerosene, Diesel, Petrol, Furnace Oil, LPG, Biogas and Electricity on calorific value and cost basis -Efficiencies of various Energy production

Unit II

Nodal Agencies for power generation – Ministry of Power – Role – Ministry of New and Renewable Energy Sources – Role – other implementing agencies – Energy Auditing and Management – Energy Conservation Act – Bureau of Energy Efficiency – PCRA – Schemes – Policies – Planning

Unit III

Load Duration Curve –Load factor – Capacity factor – Reserve factor – Demand Factor – Diversity factor –Plant use factor – Location of power plants – Power Plant Economics – Indian Energy Scenario – problems – solutions -power plant sizing based on screening curve method

Unit IV

Decentralized power generation – concept –Cogeneration – definition – need - application - advantages- classification - saving potentials -Waste heat recovery - Classification- advantages and applications - commercially viable waste heat recovery devices - saving potential – Combined Heat and Power.

Unit V

Bio fuels – Edible –Petro crops – Analysis of Indian non edible oil sources – Example of biodiesel crop – Jatropha curcas – Tree description – Jatropha curcas for rural development – environmental protection – Bio ethanol – production from conventional as well as unconventional sources. - Bio diesel – Technology for production of bio diesel - Transesterification – Process – Usage of Methanol – Glycerine – Storage and Characterisation of biodiesel – Biodiesel engine development – modification – Environmental and health effects of biodiesel – R&D in biodiesel – disposal of cake – value addition of byproducts

References:

1. Koushika M.D., "*Solar Energy Principles and Applications*", IBT publications, 1988.
2. Mital K.M, "*Biogas systems: Priciples and Applications*", New Age International Publishers (P) Ltd., 1996
3. Venkata Ramana P and Srinivas S.N., "*Biomass Energy Systems*", TERI, 1996.
4. Rai, G.D., "*Non-Conventional Sources of* Energy", Khanna Publishers, Delhi 1995.
5. Rao S, Parulekar B.B, "*Energy Technology – Non conventional, Renewable and Conventional*" Khanna Publishers, 1999.
6. H.G. Stoll, Least Cost Electrical Utility / Planning, John Wiley & Sons, 1989.

15REEP0102 SOLAR ENERGY CONVERSION TECHNOLOGIES

Objective:

Describe the fundamentals of Solar Physics and demonstrate the solar thermal and electrical gadgets for the societal needs

Specific Objectives of Learning

At the end of the course learner will be able to

- ✓ Understand the physics of solar energy
- ✓ Evaluate the solar thermal devices.
- ✓ Optimize the solar thermal power generating system.
- ✓ Design the solar PV system for rural households.
- ✓ Interpret from field experience for solar PV market analysis including government schemes & policies.

Unit I

Solar angles, day length, angle of incidence on tilted surface; Sunpath diagrams; Shadow determination; Extraterrestrial characteristics; Effect of earth atmosphere; Measurement & estimation on horizontal and tilted surfaces; Analysis of Indian solar radiation data andapplications.

Flat-plate Collectors - Effective energy losses; Thermal analysis; Heat capacity effect; Testing methods; Evacuated tubular collectors; Air flat-plate Collectors: types; Thermal analysis; Thermal drying.

Selective Surfaces -Ideal coating characteristics; Types and applications; Anti-reflective coating; Preparation and characterization.

Unit II

Concentrating Collector Designs - Classification, Tracking systems; Compound parabolic concentrators; Parabolic trough concentrators; Concentrators with point focus; Heliostats; Comparison of various designs: Central receiver systems, parabolic trough systems; Solar power plant; Solar furnaces - Vapour absorption refrigeration cycle; Water, ammonia & lithium bromide-water absorption refrigeration systems; Solar operated refrigeration systems; Solar desiccant cooling. -Solar Thermal Energy Storage - Sensible storage; Latent heat storage; Thermo-chemical storage. Solar still; Solar cooker: Solar pond;

Unit III

Solar Passive Building - Thermal comfort; Criteria and various parameters; Calculation of solar radiation on buildings; building orientation; Introduction to design of shading devices; Overhangs; Factors that effects energy use in buildings; Ventilation and its significance; Air-conditioning systems; Passive Cooling And Heating Concepts - Passive heating concepts: Direct heat gain, indirect heat gain, isolated gain and sunspaces; Passive cooling concepts: Evaporative cooling, radiative cooling; Application of wind, water and earth for cooling; Shading, paints and cavity walls for cooling; Roof radiation traps; Earth air-tunnel.

Unit IV

Solar Cell Physics –P-N junction: homo and hetro junctions, Metal-semiconductor interface; Dark and illumination characteristics; Figure of merits of solar cell; Efficiency limits; Variation of efficiency with band-gap and temperature; Efficiency measurements; High efficiency cells, Tandem structure.

Unit V

SPV Applications - Centralized and decentralized SPV systems; Stand alone, hybrid and, grid connected system, System installation, operation and maintenances; Field experience; PV market analysis and economics of SPV systems – Government Schemes and Polices

References:

1. Garg H P., Prakash J., *Solar Energy: Fundamentals & Applications*, Tata McGraw Hill, New Delhi, 1997
2. S P Sukhatme, *Solar Energy,* Tata McGraw Hill, 2008
3. J F Kreider and Frank Kreith, *Solar Energy Handbook*, McGraw Hill, 2000
4. D Y Goswami, Frank Kreith and J F Kreider,*Principles of Solar Engineering*, Taylor& Francis, 1998
5. Tiwari G.N., Suneja S., *Solar Thermal Engineering System*, Narosa Publishing House, New Delhi, 1997.
6. Alan L Fahrenbruch and Richard H Bube , *Fundamentals of Solar Cells: PV Solar Energy Conversion,*Academic Press, New York , 1983
7. Larry D Partain (ed.), *Solar Cells and their Applications,*John Wiley and Sons, Inc, New York, 1995
8. Richard H Bube, *Photovoltaic Materials*, ImperialCollege Press, 1998
9. H S Rauschenbach, *Solar Cell Array Design Handbook*, Van Nostrand Reinfold Company, New York, 1980.

15REEP0103 THERMAL ENGINEERING

Objective:

To understand the theory and applications of thermodynamics, thermodynamic properties, fuels & combustion and Heat transfer to the Renewable Energy Gadgets design and operation

Specific Objectives of Learning

At the end of the course students will be able to

- ✓ Understand the basic principles of thermodynamics, fuels and combustion, and heat transfer.
- ✓ Describe how thermal engineering is applied in renewable energy conversion practice.
- ✓ Optimize the performance of thermal energy utility system.

Unit I

Steam Power Cycles

Steam power plant – Rankine Cycle – Carnot Cycle – Mean Temperature of Heat addition – Effect of variation of steam condition on thermal efficiency of steam power plant – Reheating of Steam – Regeneration – Feed water heaters – Carnotization of Rankine Cycle – optimum degree of regeneration – optimum degree of regeneration – Deaerator –Efficiencies in a steam power plant - Organic Rankine Cycle

Unit II

Gas power cycles

Carnot cycle - Stirling cycle - Ericsson cycle - Air standard cycle - Otto cycle - Diesel Cycle-limited pressure cycle - Dual cycle - Comparison of Otto, diesel & dual cycles - Brayton cycle - Air standard cycle for jet propulsion

Unit III

Refrigeration cycle

Refrigerators - Heat pumps - Thee reversed Carnot cycle - Refrigeration by non-cyclic process - Reversed heat engine cycle - Ideal & actual vapor compression Refrigeration cycle-absorption refrigeration cycle - gas refrigeration cycle - Absorption refrigeration systems

Unit IV

Fuels and Combustion

Fuels & Fuel Analysis-Combustion Stoichiometry, theoretical & actual combustion processes –Air fuel ratio. - Combustion Thermodynamics- calculation of heat of formation & heat of combustion – First law analysis of reacting systems

Unit V

Heat Transfer

Conduction - General 3D equation - Heat generation problems – Fins - Unsteady state conduction. - Radiation Laws. Black and Gray bodies. Radiation exchange between surfaces. Radiation –shields - Forced Convection. Boundary layer theory. External and internal flows. Free convection. Correla-tions.

REFERENCES:

1. Nag. P.K., "Engineering Thermodynamics", Tata McGraw-Hill Publishing Co., Ltd., 1994.
2. Moran, Shapiro, Munson and Dewitt, “Introduction to Thermal Systems Engineering: Thermodynamics, Fluid Mechanics and Heat Transfer”, John Wiley, N. Y 2003
3. Sonntag, R.E and Van Wylen, G.J.., "Fundamentals of Thermodynamics”, Sixth Edition, 2003.
4. Bacon, D.H., “Engineering Thermodynamics ", Butterworth & Co., London, 1989.
5. Saad, M.A., “Thermodynamics for Engineers ", Prentice-Hall of India Pvt. Ltd., 1989.
6. Mayhew, A. and Rogers, B., " Engineering Thermodynamics ", Longman Green & Co. Ltd., London, E.L.B.S. 4th Edition, 1994
7. Ganesan, Y., *Internal Combustion Engines*, Tata McGraw-Hill, 2003.
8. Heywood, J.B., *Fundamentals of Internal Combustion Engines*, McGraw-Hill, 1988
9. Ballaney, P.L., *Thermal Engineering*, Khanna Publishers, 1996.

15REEP0104 ENERGY AUDITING AND MANAGEMENT

Objective:

Familiarizing with energy management and to increase the rational use of energy in process / product industries.

Specific Objectives of Learning

At the end of the course learner will be able to

- ✓ Describe and formulate basic –auditing terms.
- ✓ Define and analyze the auditing approaches for a selective industry.
- ✓ Evaluate the performance analysis and optimization of thermal utilities.
- ✓ Formulate energy action planning for various types of industry.
- ✓ Describe and categorize the global environmental concerns for effective energy conservation and compare with international standards.

Unit I:

Basics of energy & its various forms : Electricity basics – DC and AC currents, electricity tariff, load management and maximum demand control, power factor. Thermal basics – fuels, thermal energy content of fuels, temperature and pressure, heat capacity, sensible & latent heat, evaporation, condensation, steam, moist air, humidity and heat transfer, units and conversion. -Energy Conservation Act-2001 and its Features.

Unit II:

Energy management and audit : Definition, energy audit – need, types of energy audit, energy management (audit) approach – understanding energy costs, benchmarking, energy performance Matching energy use to requirement, Maximizing system efficiencies,Optimizing the input energy requirements, Fuel and energy substitution, Energy auditinstruments

Unit III:

Boilers : Types, combustion in boilers, performance evaluation, analysis of losses, feed water treatment, blow down, energy conservation opportunities. Furnaces : Classification, general fuel economy measures in furnaces, excess air, heat distribution, temperature control, draft control, waste heat recovery.

Unit IV:

Electric motors:Types, Losses in induction motors, Motor efficiency, Factors affecting motor performance, Rewinding and motor replacement issues, Energy saving opportunitieswith energy efficient motors. Energy Efficient Technologies in Electrical Systems**:** Maximum demand controllers, Automatic power factor controllers, Energy efficient motors, Soft starters with energy saver, Variable speed drives, Energy efficient transformers

Unit :V

Global environmental concerns : United nations framework convention on climate change (UNFCC), Kyoto protocol, conference of parties (COP), clean development mechanism (CDM), prototype carbon fund (PCF), sustainable development.

References:

1. CB Smith, *Energy Management Principles*, Pergamon Press, NewYork, 1981
2. Hamies, *Energy Auditing and Conservation; Methods, Measurements, Management & Case study*, Hemisphere, Washington, 1980
3. D Patrick and S W Fardo, *Energy Management and Conservation*, Prentice Hall Inc., 1996
4. Thuman A and Mehta D Paul, *Handbook of Energy Engineering*, The Fairmount Press., 1998
5. Kennedy, Turner and Capehart, *Guide to Energy Management*, The Fairmount Press., 1996
6. Wayne C Turner, *Energy Management Handbook*, The Fairmount Press., 2000
7. Kao Chen, *Energy Management in Illumination System*, CRC Press, 2000
8. Gellingn, Chamberli, *Demand Side Management: Concepts and methods*, Penwell, 1998
9. Charles M Cotlschalk, *Industrial Energy Conservation*, John Wiley & Sons, 2002
10. Bureau of Energy Efficiency: *Study material for Energy Managers and Auditors Examination*: *Paper I to IV*.2006

15REEP0105ADVANCED NUMERICAL METHODS

Objective:

Developments of theory and practice in the use of advanced numerical computational methods for efficient solution of differential equation in renewable energy engineering.

Specific Objectives of Learning

At the end of the course learner will be able to

- ✓ Apply mathematical concepts and principles in renewable energy technology.
- ✓ Perform abstract mathematical reasoning.
- ✓ Understand the application of Fourier transform in engineering application.
- ✓ Apply conformal mapping for heat flow & fluid flow problems.
- ✓ Develop Finite difference methods for elliptical and parabolic equations.

Unit I

Systems of linear equations: Gauss Elimination method, pivoting techniques, Thomas algorithm fortridiagonal system – Jacobi, Gauss Seidel, SOR iteration methods - Systems of nonlinear equations:Fixed point iterations, Newton Method, Eigenvalue problems: power method, inverse power method,Faddeev – Leverrier Method.

Unit II

Runge Kutta Methods for system of IVPs, numerical stability, Adams-Bashforth multistep method,solution of stiff ODEs, shooting method, BVP: Finite difference method, orthogonal collocationmethod, orthogonal collocation with finite element method, Galerkin finite element method.

Unit III

Parabolic equations: explicit and implicit finite difference methods, weighted average approximation -Dirichlet and Neumann conditions – Two dimensional parabolic equations – ADI method; First orderhyperbolic equations – method of characteristics, different explicit and implicit methods; numericalstability analysis, method of lines – Wave equation: Explicit scheme- Stability of above schemes.

Unit IV

Laplace and Poisson's equations in a rectangular region: Five point finite difference schemes,Leibmann's iterative methods, Dirichlet and Neumann conditions – Laplace equation in polarcoordinates: finite difference schemes – approximation of derivatives near a curved boundary whileusing a square mesh.

Unit V

Partial differential equations – Finite element method - orthogonal collocation method, orthogonalcollocation with finite element method, Galerkin finite element method.

REFERENCES

1. Saumyen Guha and Rajesh Srivastava, “Numerical methods for Engineering and Science”, OxfordHigher Education, New Delhi, 2010.
2. Gupta S.K., “Numerical Methods for Engineers”, New Age Publishers, 1995
3. Burden, R.L., and Faires, J.D., “Numerical Analysis – Theory and Applications”, CengageLearning, India Edition, New Delhi, 2009.
4. Jain M. K., Iyengar S. R., Kanchi M. B., Jain , “Computational Methods for Partial DifferentialEquations”, New Age Publishers,1993.
5. Morton K.W. and Mayers D.F., “Numerical solution of partial differential equations”, CambridgeUniversity press, Cambridge, 2002.

15REEP0106RENEWABLE ENERGY LABORATORY I

Objective:

To carryout the performance evaluation of solar thermal, solar photovoltaic and wind energy conversion devices

Specific Objectives of Learning

At the end of the course learner will be able to

Evaluate the performance of

- ✓ Solar thermal system
- ✓ Solar PV system
- ✓ Wind Electric
- ✓ Wind Pumping

1. Study on green house effect on solar flat plate collector
2. Estimation of instantaneous efficiency of a solar liquid flat plate collector
3. Study on solar flat plate collector in series and parallel combination
4. Estimation of efficiency of solar air heaters
5. Estimation of efficiency of solar still
6. Performance evaluation of concentrating solar collector
7. Performance evaluation of solar cooker
8. Estimation of efficiency of solar photovoltaic panels
9. Effect of Shadow & tilt angle on solar photo voltaic panel
10. Study on solar photo voltaic panel in series and parallel combination
11. Study on charging characteristics of a lead acid battery using solar photo voltaic panel.
12. Performance Evaluation of Wind Electric Generator
13. Performance Evaluation of Wind Water Pumping System
14. Study on Grid Integration of Wind Electric Generator

15GTPP0001 GANDHI IN EVERYDAY LIFE

Unit I

Understanding Gandhi: Child hood days, Student days, influence of Books and individuals, Religion, Family, and Social factors, Gandhi as rebel, acquaintance with vegetarianism, as lawyer, encountering and transforming humiliation: in India. In south Africa-train incident, Coach incident, on path way, at court, attack by protesters. Gandhi as political leader and reformer.

Unit II

Management: Gandhi's experiments in managing family-Eleven vows, non-possession and sacrifice begin at home – Managing Ashram – community living, service and financial ethics – Managing Social movements – Transvaal March and Salt Satyagraha and nonattachment to position (Nishkama Seva).

Unit III

Conflict Reduction: Pursuance of truth and nonviolence ends and means, openness, transparence, love and kindness in handling relationship, nonviolent communication, practicing nonviolence in social and political issues (Satyagraha), conflict resolution practices, art of forgiveness and reconciliation and shanty sena.

Unit IV

Humanism: Trust in goodness of human nature, respect for individual and pluralistic nature of society, dignity of differences, equal regard for all religions (Sarvadharma Samabhava), castes, races, cclours, languages etc., simple and ethical life, swadeshi and unity of humankind.

Unit V

Constructive programmes and contemporary issues: Concept of Sarvodaya, poverty, terrorism. Environmental degradation, problems in sharing common resources, health systems and education, science and technology and centralization of power and governance.

References:

1. M.K Gandhi, An Autobiography or The Story of My Experiments with Truth, Navajivan Publishing House, Ahmedabad.
2. ---. Satyagraha in South Africa, Navajivan Publishing House, Ahmedabad.
3. ---. Constructive Programme: Its Meaning and Place, Navajivan Publishing House, Ahmedabad.
4. ---. Key to Health, Navajivan Publishing House, Ahmedabad
5. ---. Diet and Diet Reform, Navajivan Publishing House, Ahmedabad.
6. ---. Basic Education, Navajivan Publishing House, Ahmedabad.
7. ---. Village Industries, Navajivan Publishing House, Ahmedabad.
8. ---. Hind Swaraj, Navajivan Publishing House, Ahmedabad.
9. ---. Trusteeship, Navajivan Publishing House, Ahmedabad.
10. ---. India of my Dreams, Navajivan Publishing House, Ahmedabad.
11. Vinoba, Shanti Sena, Sarva Seva Sangh Prakashan, Varanasi.
12. V.P. Varma, Political Philosophy of Mahatma Gandhi and Sarvodaya, Lakshmi Narain Agarwal, Agra.
13. Louis Fisher, Gandhi: His Life and Message.
14. B.R. Nanda. Mahatma Gandhi: A Biography, Allied Publishers Private Ltd., New Delhi.
15. N.K. Bose. Studies in Gandhism, Navajivan Publishing House, Ahmedabad.
16. Gopinath Dhawan, The Political Philosophy of Mahatma Gandhi, Navajivan Publishing House, Ahmedabad.
17. N. Radhakrishnan, Gandhi's Constructive Programmes: An Antidote to Globalized Economic Planning? Gandhigram Rural Institute, 2006

15REEP0207WASTE TO ENERGY CONVERSION TECHNOLOGIES

Objective

Compare and evaluate the conversion technologies available to create energy or energy carriers from waste including policy and government schemes

Specific Objectives of Learning

At the end of the course learner will be able to

- ✓ Predict the best suited method for solid waste disposal.
- ✓ Select and assess various waste treatment processes.
- ✓ Develop ideas in the context of generating energy from various wastes.
- ✓ Characterize the biomass and its application in rural area for fulfilling energy demands.
- ✓ Analyze the Gasification process for various biomass wastes.

Unit I

Solid Waste -Definitions: Sources, types, compositions; Properties of Solid Waste; Municipal Solid Waste: Physical, chemical and biological property; Collection, transfer stations; Waste minimization and recycling of municipal waste

Landfill method of solid waste disposal; Landfill classification; Types, methods & siting consideration; Layout & preliminary design of landfills: Composition, characteristics, generation; Design of Sanitary Land fill - Movement and control of landfill leachate &gases; Environmental monitoring system for landfill gases.- Gas Recovery – Applications

Unit II

Waste Treatment & Disposal Size Reduction: incineration; Furnace type & design; Types of Incinerators – Fuel Economy - Medical /Pharmaceutical waste / Hazardous waste / Nuclear Waste incineration .; Environmental impacts; Measures of mitigate environmental effects due to incineration;

Unit III

Energy Generation From Waste Types: Biochemical Conversion: Sources of energy generation, Industrial waste, agro residues; Anaerobic Digestion: Biogas production; Determination of BOD, DO, COD, TOC, & Organic loading, Aerobic & Anaerobic treatments – types of digester – factors affecting biodigestion - Activated sludge process. Methods of treatment and recovery from the in industrial waste water – Case Studies in sugar, distillery, dairy, pulp and paper mill, fertilizer, tanning, steel industry, textile, petroleum refining, chemical and power plant.

Unit IV

Rural applications of biomass –Combustion - Chulas - improved Chulas- Biomass – Physical - Chemical composition – properties of biomass – TGA – DSC characterization – Ash Characterization - Preparation of biomass – Size reduction – Briquetting of loose biomass- Briequtting machine

Unit V

Thermochemical Conversion -Basic aspects of biomass combustion - heat of combustion - different types of grates - Co combustion of biomass –Gasification - Fixed and Fluidized bed gasifier - Gasification technologies for the selected waste like Rice Husk, Coir pith, Bagasse, Poultry litter etc., - Pyrolysis

References:

1. Parker, Colin, & Roberts, *Energy from Waste - An Evaluation of ConversionTechnologies*, Elsevier Applied Science, London, 1985
2. Shah, Kanti L., *Basics of Solid & Hazardous Waste Management Technology*, Prentice Hall, 2000
3. Manoj Datta, *Waste Disposal in Engineered Landfills*, Narosa Publishing House, 1997
4. Rich, Gerald et.al., *Hazardous Waste Management Technology*, Podvan Publishers, 1987
5. Bhide AD., Sundaresan BB, Solid *Waste Management in Developing Countries*, INSDOC, New Delhi,1983.

15REEP0208WIND ENERGY, SMALL HYDRO AND NEW RENEWABLE ENERGY TECHNOLOGIES

Objective:

Describe the fundamentals and main characteristics of wind, small hydro, fuel cell, geothermal energy and other new renewable energy technologies

Specific Objectives of Learning

At the end of the course learner will be able to

- ✓ Develop basic knowledge about Wind energy conversion Technology and its terminologies.
- ✓ Design and assess the small wind turbine and its performance.
- ✓ Enumerate the Small mini Hydro plants for Energy generation.
- ✓ Selecting the Hydro power plant capacity for the given circumstances.
- ✓ Develop the basic technological idea about various New & Renewable energy conversion Technology.

Unit I

Wind Energy Conversion - Wind energy conversion principles; General introduction; Types and classification of WECS; Power, torque and speed characteristics. – Site Selection Criteria – Advantages – Limitations – Wind Rose Diagram – Indian Wind Energy Data – Organizations like NIWE etc., Wind Energy Conversion System - Design - Aerodynamic design principles; Aerodynamic theories; Axial momentum, blade element and combine theory; Rotor characteristics; Maximum power coefficient; Prandlt's tip loss correction.

Unit II

Design of Wind Turbine - Wind turbine design considerations; Methodology; Theoretical simulation of wind turbine characteristics; Test methods. Wind Energy Application - Wind pumps: Performance analysis, design concept and testing; Principle of WEG; Stand alone, grid connected and hybrid applications of WECS; Economics of wind energy utilization; Wind energy in India; Case studies.

Unit III

Small Hydropower Systems - Overview of micro, mini and small hydro systems; Hydrology; Elements of pumps and turbine; Selection and design criteria of pumps and turbines; Site selection and civil works

Unit IV

Speed and voltage regulation; Investment issues load management and tariff collection; Distribution and marketing issues: case studies; Potential of small hydro power in India. – SHP – Renovation and Modernization – Testing Methods

Unit V

OTEC- Tidal Energy- Geothermal- MHD - Thermionic- Thermoelectric energy conversion system- Fuel Cells – Batteries – Micro Alge – Biodiesel from Alge

References:

1. G L Johnson, *Wind Energy Systems*, Prentice Hall Inc, New Jersey, 1985.
2. David A. Spera, (Editor) *Wind Turbine Technology: Fundamental Concepts of Wind Turbine Engineering,*American Society of Mechanical Engineers; (1994)
3. Erich Hau,*Wind Turbines: Fundamentals, Technologies, Application and Economics,* Springer Verlag; (2000)
4. Paul Gipe , Karen Perez, *Wind Energy Basics: A Guide to Small and Micro Wind Systems,* Chelsea Green Publishing Company; (1999)
5. J. F. Manwell, J. G. McGowan, A. L. Rogers, *Wind Energy Explained ,* John Wiley & Sons; 1st edition (2002)
6. Tony Burton, David Sharpe, Nick Jenkins, Ervin Bossanyi, *Wind Energy Handbook ,* John Wiley & Sons; 1st edition (2001)
7. Mukund R. Patel, *Wind and Solar Power Systems ,* CRC Press; (1999)
8. Tong Jiandong(et al.) , *Mini Hydropower ,* John Wiley, 1997
9. John F. Walker and Nicholas Jenkins, *Wind Energy Technology,* John Wiley, 1997

15REEP0209POWER SYSTEMS FOR RENEWABLE ENERGY SOURCES

Objective:
To get familiarized with the power quality management issues in Renewable Energy Sector

Specific Objectives of Learning
At the end of the course Learner will be able to

- ✓ Understand the Power system components for Renewable Energy grid integration
- ✓ Describe the application of Power electronic devices in Renewable Energy System
- ✓ Assess the Role of Power System in Wind Power integration and PV power integration
- ✓ Power Quality issues in Power System
- ✓ Recommended IEEE/IEC/BIS standards in Power System

Unit I
Concept of mini, micro and smart grids. Basics of Voltage stability issues in Power system. Synchronous Machines: basic principles, construction, speed and frequency, synchronous reactance, regulation, induced EMF, basic vector diagram, parallel operation. Elementary problems on synchronous machines, Permanent magnet synchronous generator (PMSG), Power Factor issues, and economics of power Factor, reactive power, apparent power and active power

Unit II
Introduction to Induction Machines: principle of operation, construction, classification,expression for induced EMF, Torque/slip characteristics, Vector diagram, losses and efficiency of the machine, related problems. Induction Generator: Grid connected, self-excited, Doubly Fed induction generator, estimation of capacitance requirements for self-excited IGs, problems on IGs

Unit III
Solar photovoltaic(PV) modules: series parallel connection of cells, Batteries for PV system, photovoltaic system design and applications, rating of PV systems, sizing of wires in PV system illustrative examples, maximum power point tracking (MPPT), charge controllers, DC to DC converters, DC to AC converters, hybrid PV systems ,issues with hybrid systems, grid connected PV systems, Lifecycle costing(LCC)

Unit IV
Issues of Embedded generation, common attributes of embedded generation, basic power conversion of wind turbine system, scenario of power conversion structure of wind turbine system, wind to electric conversion alternatives: choice of Electrical output. Grid requirements of PV and Wind Turbine System

Unit V
Power Quality: basic terminologies, impact of power quality on power factor, true RMS value of current, voltage and power factor(PF), elementary problems, impact of power quality on power system, design of transformers & cables in an harmonic environment with illustrations, point of common coupling(PCC),linear and non-linear load, sequence components of harmonics, impact of harmonics on neutral sizing, power quality audit, power quality analyzers, power quality issues of solar and wind power integration with grid , power quality standards. Power Quality Mitigation

References

1. Chetan Singh Solanki: Solar Photovoltaics fundamentals, Technologies and Applications, PHI Learning Private Limited- Eastern Economy Edition
2. Nick Jenkin,Ron Allan,Peter Crossley,DanielKrischen and Goran Strbac: Embedded Generation, IET power and Energy series-31
3. Remus Teodorescu,Marco Liserre and Pedro Rodriguez: Grid Converters for Photovoltaic and Wind Power Systems, Wiley and sons Ltd
4. Janaka Ekanayake,Kithsiri Liyanage,Jianzhong Wu,Akihiko Yokoyama,Nick Jenkin: Smart Grid Technology and Applications, A John Wiley & Sons Ltd
5. C.Sankaran: Power Quality, CRC Press
6. Roger C.Dugan, Mark F. McGranaghan,Surya Santoso& H.Wayne Beaty: Electrical Power Systems Quality, Tata McGraw-Hill
7. Dr.P.S.Bimbhra: Electrical Machinery, Khanna Publishers

15REEP0210ENERGY ECONOMICS AND POLICIES

Objective

To help the students to understand the basics of energy economics so as to address to energy problems and issues.

Specific Objectives of Learning

- ✓ The students would have understood the importance of energy in economic development and need for energy conservation.
- ✓ They also be able to take up research in energy economics.

UNIT I: INTRODUCTION TO ENERGY ECONOMICS

Natural Resources – Classification – Importance – Role of Natural Resources in Economic Development – Energy Resources – Classification – Properties and Forms of Energy –Energy Economics – origin, Scope and Nature.

UNIT II: ENERGY AND DEVELOPMENT

Role of Energy in Economic Development – Energy Indicators - Energy Intensity and Energy Elasticity – National and International Comparison – Role of International Institutions – OPEC, OAPEC, IEA, and World Bank.

UNIT III: ENERGY AND ENVIRONMENT NEXUS

Energy Environment Nexus Crisis – Causes and Consequences – Remedial Measures –Impact of Energy Consumption and Production on Environment with illustrations – Role of Energy Economists in solving Energy Crises.

UNIT IV: ENERGY PLANNING AND MANAGEMENT

Energy Planning and Energy Conservation – Meaning, Objectives and Importance – Energy Management – Meaning, Objectives and Importance – Recent Developments: Energy Auditing – Energy Accounting – Energy conservation - Energy Pricing and Taxes – Role of Economists in Sustainable Energy Management.

UNIT V: INDIA'S ENERGY PROFILE

Indian Energy Sector – Organizational Structure – Energy Supply sources and trends in production – Energy Demand on sectoral consumption trend – Renewable Energy Sources and Technologies - Renewable Energy Programmes in India

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References

1. Agarwal, M.C. and Monga, J.R. (1992): **Economic and Commercial Geography**, National Publishing House, New Delhi.
2. Agarwal, S.K. (1985): **Environment and Natural Resources Economics**, Scott Foresman & Co., London.
3. Common, M. (1985): **Environmental and Resource Economics**, Longman, London.
4. David Pearct et al., (1990): **Sustainable Development – Economics and Environment in the Third World**, Earths Can Publications, London.
5. Karpagam, M. (1991): **Environmental Economics**, Sterling, New Delhi.
6. Kneese. A.V and Sweeny, J.L, 1993): **Handbook of Natural Resource and Energy Economics**, North Holland.
7. Munasinghe, M and Meier, P (1993): **Energy Policy and Modeling**, Cambridge University Press, UK.
8. Richard Eden (1981): **Energy Economics – Growth, Resources and Policies**, Cambridge University Press, London.
9. TERI (2015): **Teri Energy Data Directory and Year Book 2014-15**, The Energy Research Institute, New Delhi.

15APRM0001 RESEARCH METHODOLOGY

Objectives

To develop expertise and skills to undertake independent research in the area of specialization and application of statistical tools

Specific Objectives of Learning:

Upon completion of the course, the scholars will be able to:

- identify and formulate a problem for research.
- prepare suitable research design,choose appropriate tools and techniques of data collection
- process the data collected and do analysis using appropriate statistical methods
- write research report independently and professionally

Unit - 1:

Scientific basis of Research – methods of acquiring knowledge - Inductive and Deductive Reasoning, scientific method and its applications.selection of problem for Research, review of literature, formulation of Hypotheses, nature and types of variable.

Unit - 2:

Research Design and Methods: Purpose and preparation of research design. Types of research design – Historical, Descriptive, and Experimental. Field surveys, diagnostic and evaluation research. Qualitative and quantitative methods, problem-solving, development and inter-disciplinary research.

Unit - 3:

Sampling and Data Collection: Probability and non-probability sampling techniques, sampling and non-sampling errors.Tools and techniques of data collection – Observation, interview, Inquiry Forms, Psychological tests, Projective techniques, rating scales, Likert and Thurstone, Guttman type scales. Sociometry, Focus Group discussion, and PRA. Validity, reliability and feasibility. Structure and qualities of a Research Report, Dissemination of research findings, Evaluation of Research Report.

Unit - 4:

Data Analysis – Categorization, Presentation of data: Diagrams and Frequency distributions. Central measures, Dispersion measures, Skewness and kurtosis.
Correlation and regression analysis, multiple correlation and regression, Factor analysis, and Discriminant analysis.

Unit - 5:

Testing of Hypothesis: Basics and steps in hypothesis testing; Concept of Sampling distribution and Standard Error. Statistical Tests – large and small sample tests, Chi-square test of significance, ANOVA

REFERENCES

1. Vijayalakshmi G. & Sivapragasam C., *Research Methods: Tips and Techniques*, Chennai : MJP Publishers, 2009.
2. R.S.Dwivedi : *Research Methods in Behavioral Sciences* Delhi : Macmillan, 1997.
3. Dooley, David, *Social Research Methods,* New Delhi : Prentice Hall, 1996.
4. Runyon, R.Petal, *Fundamentals of Behavioural Statistics,* New Delhi : McGraw Hill, 1996.
5. Britaha Mikkelson, *Methods for Development work and Research and a Guide for practitioners.* New Delhi : Sage Publications, 1995.
6. Kuttan Mahadeven and Parameswara Krishnan, *Methodology for Population Studies and Development*. New Delhi : Sage Publications, 1993.
7. Arun Kumar Singh, Tests, *Measurements and Research Methods in Behavioural Sciences,* New Delhi : Tata McGraw Hill, 1986.
8. Y.P.Aggarwal : *Statisttical Methods: Concepts, Applications and Computations,* New Delhi: Sterling Publishing Company, 1988.
9. N.Kerlinger : *Foundations of Behavioural Research,* Delhi : Surjeet Publications, 1983.
10. H.E.Garett: *Statistics in Psychology and Education,* Bombay: Vakils, Feffer and Simons, 1981.

15REEP0211RENEWABLE ENERGY LABORATORY II

Objective

Performance evaluation of biogas generators, gasifiers, wood stove and Fuel Cell

Specific Objectives of Learning

At the end of this course learner will be able to,
Evaluate the performance of

- ✓ Biochemical Conversion technologies
- ✓ Thermochemical conversion technologies
- ✓ Alternate Energy Sources

1. Proximate analysis of solid wastes
2. Calorific value of solid wastes
3. Combustion characteristics of solid wastes
4. Study of Composting of solid wastes
5. Estimation of energy recovery potential of solid wastes
6. Study of refuse derived fuel (RDF)
7. Estimation of BOD, DO level in effluent
8. Estimation of COD level in effluent
9. Evaluation of Fixed Dome biogas plant
10. Evaluation of Floating Drum biogas plant
11. Performance analysis of gasifier
12. Performance analysis various wood stoves
13. Estimation of Calorific Value of Gaseous fuels
14. Characteristics of Fuel Cell
15. Analysis of Non Edible oil as alternate energy source

15ENGP00C1 COMMUNICATION&SOFT SKILLS

Specific Objectives of Learning

i). To develop inter personal skills and be an effective goal oriented team player.
ii). To develop professionals with idealistic, practical and moral values.
iii). To develop communication and problem solving skills.
Iv). To re-engineer attitude and understand its influence on behavior.

UNIT I

SELF ANALYSIS - SWOT Analysis, Who am I, Attributes, Importance of Self Confidence, Self Esteem

UNIT II

ATTITUDE - Factors influencing Attitude, Challenges and lessons from Attitude. Change Management Exploring Challenges, Risking Comfort Zone, Managing Change

UNIT III

MOTIVATION - Factors of motivation, Self talk, Intrinsic & Extrinsic Motivators.

UNIT IV

GOAL SETTING - Wish List, SMART Goals, Blue print for success, Short Term, Long Term, Life Time Goals. Time Management Value of time, Diagnosing Time Management, Weekly Planner To do list, Prioritizing work.

UNIT V

CREATIVITY - Out of box thinking, Lateral Thinking Presentation.

15REEP0212SUMMER INTERNSHIP

Objective

To sensitize students to the nuances of a work place by assigning time-bound projects in a company / R&D organization or NGO working on Renewable Energy

Specific Objectives of Learning

At the end of the course learner will be able to

Get exposure in

- ✓ Renewable Energy Industrial Exposure
- ✓ Rural Industries Energy Auditing
- ✓ Role of NGO's in Energy planning

Student should undergo an inplant training in a process / product industry / NGO in energy related area or should undergo an energy auditing in any rural industries and submit a report along with certificate (details of the training undergone) from the industry where he / she undergone the training for a period of 30 calendar days. Student should present a seminar about the energy saving potential / case study of the industry or energy planning. Evaluation is based on the report, Seminar Performance and *viva voce*.

ESE:

Report	-	50 marks
Seminar	-	25 marks
Viva-Voce	-	25 marks

15REEP0313RURAL ENERGY PLANNING

Objective:

To learn about the Rural Energy related issues and gives exposure to the students to prepare a Detailed Project Report

Specific Objectives of Learning

At the end of the course learner will be able to

Get exposure in

- ✓ Rural Energy related issues to inconformity with the Constitutional Provisions
- ✓ Planning of present and future energy requirement of village
- ✓ Govt. Schemes and polices implemented or to be implemented
- ✓ Developing evaluation indicators for the Govt. Schemes
- ✓ Detailed Project Report (DPR) preparation

Group of Students (Maximum of 5 to 6) will be provided to undergo a 100% Energy related survey in a selected village panchayat and analyze the present energy consumption and the future energy requirement. Based on the survey report the student must submit a Detailed Project Report (DPR) incorporating all the polices and schemes of the Govt. to be implemented in the selected villagewhich will enable to create a '*Model Energy Village'.*

ESE:

DPR	-	75 marks
Viva-Voce	-	25 marks

15REEP0314TECHNICAL SEMINAR

Objective:

Motivate the student to read research papers on renewable energy and critically examine and summaries the findings. Also it improves their presentation skill

Specific Objectives of Learning

At the end of the course learner will be able to

- ✓ Improve his / her presentation skill
- ✓ Get exposed a recent advancement in the Renewable Energy Area

Individual student should present a Technical Seminar (Minimum of 4) in recent trends in Renewable Energy Area.

CFA:

The evaluation based on the understanding of recent issues on renewable energy, slide preparation (including all latest modes of computer based presentation skills ex. Animation, Video Editing etc), Presentation Skill and Answering of Question raised.

15REEP0315MINI PROJECT

A group of 5 to 6Students should develop a cost effective renewable energy gadget /Evaluation of bottlenecks of existing devices / Evaluation of Renewable Energy Plants / Market Potential Analysis of Renewable Energy Devices etc,

Evaluation is based on the product, report and *viva voce*.

CFA:

Product / Report	-	50 marks
Seminar	-	25 marks

ESE:

Viva-Voce	-	25 marks

15VPPP0301 VILLAGE PLACEMENT PROGRAMME

As per Gandhigram Rural Institute – Deemed University Norms.

15REEP0416DISSERTATION

Student should take up project related to renewable energy and work at GRI or they should obtain a permission to take up industry / institute related project where the external guide will be made available in the organization. However the evaluation is only based on the internal guide. No financial commitment will be given to the external guide. The evaluation of Dissertation is as follows:

CFA:

Seminar I (Identification of Problem & Literature Review) [Month of December]	-	25 marks
Seminar II (Report on the progress of the project) [Month of February]	-	25 marks
Seminar III (Findings and interpretation of results) [Month of April]	-	25 marks
Report Evaluation by External Examiner	-	75 marks
Total	-	150 marks

ESE:

Viva Voce [jointly conducted by internal examiner and external examiner]	-	50 marks
Total	-	200 marks

15REEP03E1RURAL ELECTRIFICATION :TECHNOLOGIES AND ECONOMICS

Objective:
To inculcate the rural energy related issues and technological options with cost benefit analysis

Specific Objectives of Learning
At the end of the course learner will be able to

- ✓ Describe the decentralized power generation technologies and can perform the cost benefit calculations.
- ✓ Evaluate the economic and financial analysis of stand-alone electrification projects.
- ✓ Identify and analysis the power generation from renewable energy sources.
- ✓ Gain knowledge about mini and micro girds that includes economics and environmental factors.

Unit I
Decentralized generation technologies; Costs and choice of technology, Demand and benefits forecasting and program development, Principles of cost-benefit calculations

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

Unit III
Basic gas turbine generator concepts; Utility system turbine generators; Mini and micro gas turbine generators; Solar thermal power generation, utility scale photovoltaic (USPV) generation; Wind-powered generation;

Unit IV
Biomass based generation; DG Evaluation: Cost from past, present, and future, basic DG cost analysis, cost Evaluation and schedule of demand.

Unit V

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

References:

1. H. Lee Willis and W.G. Scott: *Distributed Power Generation: Planning and Evaluation*, Marcel Dekker, 2000.
2. J. J. Burke: *Power Distribution Engineering, Fundamentals and Applications*, Marcel Dekker, 1994.
3. T. Gonen: *Electric Power Distribution System Engineering*, McGraw-Hill 1986.
4. M Mohan: *Rural electrification for development: policy analysis and applications.*Boulder : Westview Press, 1987
5. G. Saunier: *Rural electrification guidebook for Asia and the Pacific,* Asian Institute of Technology, 1992.

15REEP03E2 RENEWABLE ENERGY & SUSTAINABLE DEVELOPMENT

Objective:
To illustrate the role of renewable energy for achieving Millennium Development

Specific Objectives of Learning
At the end of the course learner will be able to

- ✓ Understand the concept of load profile in rural areas.
- ✓ Interpret the environmental impacts of traditional rural energy practises.
- ✓ Understand the government schemes such as NPBD, NPIC, VESP, RGGVY etc.
- ✓ Interpret appropriate renewable technology for sustainable development.
- ✓ Formulate Integrated Rural Energy Planning (IREP).

Unit I
Traditional and modern energy use; Methods of accounting the role of traditional energy in the overall energy system. Energy consumption patterns in rural areas . Trends of rural energy consumption.Need and development of rural energy data bases (REDB); methodologies for building REDB. Case studies of REDB

Unit II
Integrated Rural Energy Planning (IREP): Origin, implementation, case studies, critique. Socio-economic and environmental issues of traditional energy use. Health impacts of biomass burning in cookstoves. The debate of black carbon from biomass burning. The energy ladder for cooking. Gender issues in biomass collection and processing.

Unit III
Rural electrification: Overview, current status and future perspectives. Linkages with rural livelihoods, rural industries and social development. Issues of subsidization, last mile access and paying capacity.

Unit IV
Review and critique of various programs of government: National Program for Biogas Development (NPBD), National Program for Improved Cookstoves (NPIC), Village Energy Security Plan (VESP), Rajiv Gandhi Grameen Vidyutikaran Yojana (RGGVY) etc

Unit V
Use of efficient/appropriate/renewable energy technologies for rural areas. Technologies/products for cooking, water heating, drying, irrigation pumping, small/micro enterprises, lighting, motive power etc.

References:

1. Report by a Panel of Experts, *Rural electrification in Asia and the Far East New York* United Nations, 1963.
2. B. Kaye and William S: Pintz, *Rural electrification issue papers*Honolulu: Pacific Islands Development. 2004
3. Chambers, Ann, *Distributed Generation: A Non-technical guide*, 4th Ed., Penn well, Oklahoma, 2001
4. Devadas, *Planning for Rural Energy System: Part I & II, V* Renewable and Sustainable Energy Reviews, 5 (2001), 203-226, 227-270.
5. T.C. Kandpal, H. P. Garg, *Financial Evaluation of Renewable Energy Technology,* Macmilan, New Delhi, 2003.

15REEP03E3 SMART GRID

Objective:

Understanding the main issues of smart grid development and the critical technologies that underpin the development

Specific Objectives of Learning

At the end of the course students will be able to

- ✓ Lead students towards a clear understanding and firm grasp of the basic principles of smart grid.
- ✓ Understand the structure of an electricity market in either regulated orderegulated market conditions.
- ✓ Understand how (wholesale) electricity is priced in a transmission network.
- ✓ Evaluate the trade-off between economics and reliability of an electric power system.
- ✓ Understand the impacts of renewable resources to the grid and the variousissues associated with integrating such resources to the grid.
- ✓ Evaluate various investment options (e.g. generation capacities,transmission, renewable, demand-side resources, etc) in electricity markets.
- ✓ Understand the concepts and principles of Smart Grid, technology enabling, and demand participation.

Unit I

Introduction –driving the move towards Smart Grids globally and in India Smart Grid. Overview of how Indian power market is organised, operated and challenges being faced. Overview of how the Indian GENERATION, TRANSMISSION and DISTRIBUTION business is operated and controlled and some of the challenges being faced.How software can manage generation and optimise generator performance, Software to support integration of renewables, System planning & condition monitoring based maintenance, Forecasting & basic trading, Demand response, Performance management

Unit II

Overview of power sector communications, Generic model of communication network needed for Smart-grid, Introduction to different communication technologies available in the market (Latest standards.Emphasis on importance of inoperability and standardization of communication protocols), Matrix of different technologies against the smart-grid communication needs in a given utility environment, AMI, AMR & MDA: How it works and how it will help to; reduce peaks manage networks more efficiently and contribute towards smarter grids, Communication Standards IEC6150, Wide Area Situation Awareness (WASA), Network stability and Phasor Measurement Unit (PMU), 6Automation and Integration of Distributed Generation / Renewable Energy, Automation and Micro-grids

Unit III

Distribution Management Systems (DMS) and Meter Data Management (MDM) are improving energy efficiency and security of supply in Distribution Systems, Overview of Power Electronics in

Electrical T&D Systems, Power Electronics in emerging Smart Grids, Transmission (DC Super Grids) , Distribution (PE facilitating the integration of, (Distributed Generation, Renewables, Microgrids, Virtual Power Plants (VPP), Storage, Fault Current Limitation, Power Electronics, Super Conducting and Magnetic types)

Unit IV

Developing technology and systems that will enable grids to work smarter in the future: Storage: Organic and Inorganic Salts & Synthetic Heat Storage, Developing technology and systems that will enable grids to work smarter in the future (Smart Meters, Recording consumption, Advanced payback options for load-management, Communication between the utility and customer's home (for home automation)), In-home controls, Demand Side Management (DSM).Power Trading & the India Energy Exchange : Encouraging Markets, Regulation enabling grids to work smarter in India, Project Financing:Financial Incentives to Enable Smart Grids in India, Smart Grid Economics: Making Smarter Grids Financially Viable, Planning for Smarter Grids

Unit V

Challenges faced by the Transmission System Developing technology and systems that will enable smarter transmission of bulk energy (Metering, Trading mechanisms, AC – FACTS (Statcom)
DC – HVDC, Fault Current Limiters), Challenges faced by the Distribution Networks:(How to be more energy efficient, stable, reliable and environmentally friendly, Reducing losses, Integration of renewablesConnecting/disconnecting micro-grids and virtual power plants, manage bi-directional energy flows), Developing technology and systems that will enable smarter distribution networks (DC – MVDC, Fault Current Limiters, Others (AC/DC TXs etc))

References:

1. Join Gridwise & Smartgrids groups in LinkedIn http://www.linkedin.com/
2. Sign up to Smart Grid News www.smartgridnews.com
3. US DoE Smart Grid Book
   http://www.oe.energy.gov/DocumentsandMedia/DOE_SG_Book_Single_Pages(1).pdf
4. Technology enabling the transformation of India's power distribution
   http://www.infosys.com/newsroom/features/power-sector-report.pdf
5. Gridwise Alliance website http://www.gridwise.org/
6. European Union Smart Grids Technology Platform http://www.smartgrids.eu/

15REEP03E4 ENERGY MODELING AND PROJECT MANAGEMENT

Objective:

To be able to use relevant tools and model for energy engineering in view of proposing the most efficient energy systems mix

Specific Objectives of Learning

At the end of the course learner will be able to

- ✓ Identify and select the effective energy modelling with interpreting the economics and investment planning.
- ✓ Calculate the energy demand and customize the best suited methods /option.
- ✓ Interpret the data and compare the various renewable energy options along with energy conservation technologies.
- ✓ Select appropriate project evaluation technique and plan the methodology of evaluation.

Unit I

Macroeconomic Concepts - Measurement of National Output - Investment Planning and Pricing - Economics of Energy Sources - Reserves and Cost Estimation.

Unit II

Multiplier Analysis - Energy and Environmental Input / Output Analysis - Energy Aggregation –Econometric

Unit III

Energy Demand Modeling - Overview of Econometric Methods. Methodology of Energy Demand Analysis - Methodology for Energy Technology Forecasting -Methodology for Energy Forecasting - Sectoral Energy Demand Forecasting.

Unit IV

Solar Energy - Biomass Energy - Wind Energy and other Renewable Sources of Energy - Economics of Waste - Heat Recovery and Cogeneration - Energy Conservation Economics.

Unit V

Cost Analysis - Budgetary Control - Financial Management - Techniques for Project Evaluation.

References:

1. M.Munasinghe and P.Meier *Energy Policy Analysis and Modeling,*CambridgeUniversity Press 1993
2. W.A.Donnelly *The Econometrics of Energy Demand: A Survey of Applications*, New York.1987
3. S.Pindyck and Daniel L.Rubinfeld *Econometrics Models and Economic Forecasts, 3rd edition* MC Graw -Hill, New York 1990
4. UN-ESCAP *Sectoral Energy Demand Studies: Application of the END-USE Approach to Asian Countries,* New York 1991
5. UN-ESCAP *Guide Book on Energy -Environment Planning in Developing Countries:Methodological Guide on Economic Sustainability and Environmental Betterment Through Energy Savings and Fuel Switching in Developing Countries*, New York1996
6. S.Makridakis , *Forecasting Methods and Applications.*Wiley 1983

15REEP03E5 OPTIMUM UTILIZATION OF HEAT AND POWER

Objectives:

To impart importance of o5ptimum utilization of heat and power in process and product industry

Specific Objectives of Learning

At the end of the course learner will be able to

- ✓ List and analyze the possibilities of combined Heat and power generation methodology for various sectors.
- ✓ Develop and assess pinch technology with process retrofits.
- ✓ Enumerate and evaluate the critical thickness of insulation.
- ✓ List the economical features & factors involving in cogeneration techniques.

Unit I

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

Unit II

Pinch Technology–significance– Selection of pinch temperature difference – Stream splitting – Process retrofit – Installation of heat pumps, heat engines - Grand composite curve.

Unit III

Insulation – Recuperative heat exchanger – Run –around coil systems – Regenerative heat exchangers – Heat pumps – Heat pipes –.Waste Heat Recovery -Cogeneration Technology

Unit IV

Sources of waste heat, Cogeneration - Principles of Thermodynamics - Combined Cycles- Topping -Bottoming - Organic Rankine Cycles- Advantages of Cogeneration Technology

Unit V

Application & techno economics of Cogeneration- Cogeneration - Performance calculations, Part load characteristics- financial considerations - Operating and Investments

REFERENCES:

1. Eastop, T.D. & Croft D.R, "Energy efficiency for engineers and Technologists", 2nd edition, Longman Harlow, 1990.
2. O'Callaghan, Paul W, "Design and Management for energy conservation", Pergamon, 1993.
3. Osborn, peter D, "Handbook of energy data and calculations including directory of products and services", Butterworths, 1980.
4. Charles H.Butler, Cogeneration, McGraw Hill Book Co., 1984.
5. Horlock JH, Cogeneration - Heat and Power, Thermodynamics and Economics, Oxford, 1987

15REEP03E6 ENERGY AUDITING INSTRUMENTATION

Objective:

To give the comprehensive knowledge on instrumentation and data handling systems related to energy auditing

Specific Objectives of Learning
At the end of the course learner will be able to

- ✓ Assess the energy needs in the residential, commercial and industrial facilities for better energy management.
- ✓ Measure thermo-physical properties of boilers, furnaces, etc., using intelligent instrumentations.
- ✓ Analyze power quality issues of electrical system.
- ✓ Analyze composition of various gases using online gas analyzers.

Unit I
Instrument classification, Characteristics of Instruments - Static and dynamic, experimental error analysis,systematic and random errors, Statistical analysis, Uncentainity, Experimental planning and selection ofmeasuring instruments, Reliability of instruments.

Unit II
Data logging and acquisition, use of intelligent instruments for error reduction, element of micro-computerinterfacing, intelligent instruments in use.

Unit III
Measurement of thermo-physical properties, instruments for measuring temperature, pressure and flow, use ofintelligent instruments for the physical variables.
Electrical measurement – Power analyzer – harmonic analyzer – power factors

Unit IV
Techniques, shadow graph, Schlieren, interferometer, Laser Doppler anemometer, heat flux measurement,Telemetry in engines.

Unit V
Chemical, thermal, magnetic and optical gas analysers, measurement of smoke, dust and moisture, gaschromatography, spectrometry, measurement of pH, Review of basic measurement techniques.

References:

1. Holman, J.P., *Experimental methods for engineers*, McGraw-Hill, 1988.
2. Barney, *Intelligent Instrumentation*, Prentice Hall of India, 1988.
3. Prebrashensky, V., *Measurements and Instrumentation in Heat Engineering,* Vol.1 and 2, MIR Publishers,1980.
4. Raman, C.S., Sharma, G.R., Mani, V.S.V., *Instrumentation Devices and systems,* Tata McGraw Hill, NewDelhi, 1983.
5. Doeblin, *Measurements System Application and Design*, McGraw Hill, 1978.
6. Morris. A.S, *Principles of Measurements and Instrumentation,* Prentice Hall of India, 1998.

15REEP03E7 GREEN BUILDINGS

Objective:

To assert the need, opportunities and demand of green buildings

Specific Objectives of Learning

At the end of the course learner will be able to

- ✓ Classify different climatic zones and comfort environment.
- ✓ Incorporate and assess various passive solar techniques in building design.
- ✓ Modeling of heat distribution in the built environment.
- ✓ Design & assess the energy efficient landscape through modification of microclimate.

Unit I:

Introduction to architecture; Building science and its significance; Energy management concept in building - Thermal Analysis And Design For Human Comfort - Thermal comfort; Criteria and various parameters; Psychometric chart; Thermal indices, climate and comfort zones; Concept of sol-air temperature and its significance; Calculation of instantaneous heat gain through building envelope;

Unit II:

Calculation of solar radiation on buildings; building orientation; Introduction to design of shading devices; Overhangs; Factors that effects energy use in buildings; Ventilation and its significance; Air-conditioning systems; Energy conservation techniques in air-conditioning systems

Passive Cooling And Heating Concepts - Passive heating concepts: Direct heat gain, indirect heat gain, isolated gain and sunspaces; Passive cooling concepts: Evaporative cooling, radiative cooling; Application of wind, water and earth for cooling; Shading, paints and cavity walls for cooling; Roof radiation traps; Earth air-tunnel.

Unit III:

Heat Transmission In Buildings - Surface co-efficient: air cavity, internal and external surfaces, overall thermal transmittance, wall and windows; Heat transfer due to ventilation/infiltration, internal heat transfer; Solar temperature; Decrement factor; Phase lag. Design of daylighting

Unit IV:

Estimation of building loads: Steady state method, network method, numerical method, correlations; Computer packages for carrying out thermal design of buildings and predicting performance.

Bioclimatic Classification - Bioclimatic classification of India; Passive concepts appropriate for the various climatic zones in India; Typical design of selected buildings in various climatic zones; Thumb rules for design of buildings and building codes.

Unit V:

Energy Efficient Landscape Design -Modification of microclimatic through landscape element for energy conservation; Energy conservation through site selection, planning, and design; Siting and orientation – GRIHA – Certification of Green Buildings

References:

1. M.S.Sodha, N.K. Bansal, P.K. Bansal, A. Kumar and M.A.S. Malik, *Solar Passive Building, Science and Design,* Pergamon Press, 1986.
2. J.R. Williams, *Passive Solar Heating,* Ann Arbar Science, 1983.
3. R.W.Jones, J.D. Balcomb, C.E. Kosiewiez, G.S. Lazarus, R.D. McFarland and W.O. Wray, *Passive Solar Design Handbook, Vol. 3, Report of U.S. Department of Energy (DOE/CS-0127/3),* 1982.
4. J Krieder and A Rabi *Heating and Cooling of Buildings : Design for Efficiency,* McGraw-Hill (1994)
5. R D Brwon, T J Gillespie, *Microclimatic Landscape Design,* John Wiley & Sons, New York, 1990.
6. D.S. Lal, Sharda Pustak Bhawan, *Climatology,*Allahabad, (2003)
7. Majumder Milli, *Energy Efficient Buildings,* TERI, New Delhi 2002
8. T A Markus, E N Morris*, Building, Climate and Energy,* Spottwoode Ballantype Ltd. London, 1980.
9. Sanjay Prakash (et al.), *Solar architecture and earth construction in the NorthWest Himalaya,*Vikas, New Delhi,1991
10. Energy Research Group, CD Rom Version 2 , LIOR Ireland, *Solar Bioclimatic Architecture,*1999

15REEP03E8 ENVIRONMENTAL IMPACT ASSESSMENT

Objective:

Critical understanding of the use, strengths, and limitations of EIA; and develop working familiarity with EIA methods and analytic techniques.

Specific Objectives of Learning

At the end of the course learner will be able to

- ✓ Understand the process of environmental impact assessment (EIA).
- ✓ Discuss current trends in EIA.
- ✓ Predict the environmental consequences (positive or negative) of a plan, policy, program, or project prior the implementation decision.
- ✓ Investigate new technological solution based on the Environmental Audit.

Unit I

Basic concept of EIA : Initial environmental Examination, Elements of EIA, - factors affecting E-I-A Impact evaluation and analysis, preparation of Environmental Base map, Classification of environmental parameters.

E I A Methodologies: introduction, Criteria for the selection of EIA Methodology, E I A methods, Ad-hoc methods, matrix methods, Network method Environmental Media Quality Index method, overlay methods, cost/benefit Analysis.

Unit II

Impact of Developmental Activities and Land use: Introduction and Methodology for the assessment of soil and ground water, Delineation of study area, Identification of actives.

Procurement of relevant soil quality, Impact prediction, Assessment of Impact significance, Identification and Incorporation of mitigation measures.

Unit III

E I A in surface water, Air and Biological environment: Methodology for the assessment of Impacts on surface water environment, Air pollution sources, Generalized approach for assessment of Air pollution Impact.

Assessment of Impact of development Activities on Vegetation and wildlife, environmental Impact of Deforestation – Causes and effects of deforestation.

Unit IV

Environmental Audit & Environmental legislation objectives of Environmental Audit, Types of environmental Audit, Audit protocel, stages of Environmental Audit, onsite activities, evaluation of Audit data and preparation of Audit report.

Unit V

Post Audit activities, The Environmental pollution Act, The Water Act, The Air (Prevention & Control of pollution Act.), Mota Act, Wild life Act.Case studies and preparation of Environmental Impact assessment statement for various Industries.

References:

1. Y. Anjaneyulu,*Environmental Impact Assessment Methodologies,* B.S. Publication, Sultan Bazar, Hyderabad. 2002
2. J. Glynn and Gary W. Hein Ke *Environmental Science and Engineering*, Prentice Hall Publishers 2000
3. Suresh K. Dhaneja – S.K.,*Environmental Science and Engineering,* Katania & Sons Publication., New Delhi.1998
4. Dr H.S. Bhatia *Environmental Pollution and Control,* Galgotia Publication (P) Ltd, Delhi, 1996

15REEP03E9TECHNOLOGY MANAGEMENT

Objective

Strive for excellence in the area of management education and training with focus on technology management, conforming to challenging standards expected by contemporary technology- driven organization

Specific Objectives of Learning

At the end of the course learner will be able to

- ✓ To bridge the knowledge gap in management education with the focused inputs on technology management to meet the challenging requirements of contemporary technology driven organisations.
- ✓ To equip the students with analytical frame of mind to comprehend and handle complex issues in relation to Management of Technology, viz., Technology Forecasting, Search, Selection, Transfer and Creation of New Technology.

Unit I

Introduction & Technology Policy Definition ,Technology and society ,Definition of technology ,Classifications of technology,Definition of management ,Management of technology MOT),The conceptual frame work for (MOT), - Drivers of MOT- Significance and Scope of MOT

Unit II

Role of ChiefTechnology Officer – Responding to Technology challenges. Technology Policy –Determinants of Nation's Capability – Role of Government – Science and Technology policy– Status of Technology in India – Future of India

Unit III

Technology Planning and Strategy Tools, Technology Acquisition Technology Planning – Tools for Company Technology Analysis – Tools for industryTechnology Analysis – Trajectories of Technology, Alliances: Formal versus InformalAlliances, Duration of an Alliance, Location: Domestic versus International Alliances Concerns in Alliances

Unit IV

Mergers and Acquisitions of Technology, Strategic Reasons forMergers and Acquisitions, Types of Mergers and Acquisitions, Technology Acquisition - Methods Acquisition - Internal Development - External acquisition Sources - Acquisitiondecisions

Unit V

Innovation Management, Technology Transfer Definition of Innovation, Definition of Management of Innovation, The Process of ManagingInnovation, Making Decisions for Managing Innovation, Tools for Managing Innovation,Process Innovations – Concept and types of process - Process Management Concerns - Types of Process innovations- Process improvement techniques – Organizing forimprovements , Technology Transfer – Definition – Classification and Significance - Elementsof transfer process - Types of Technology transfer

References:

1. Management of Technology – Track Khalil – TMH
2. The management of technology and innovation-A strategic approach,White,Cengage
3. Innovation Management, S Moikal, Sage