Course Duration:
2 Years – 4 Semesters

Eligibility Criteria:

✓ B.E. / B.Tech. / AMIE or
✓ PG Science with Diploma / Post Diploma in Renewable Energy
   with minimum of 55% marks or CGPA of 5.5 on a 10 point scale in the qualifying examination (50% marks or CGPA of 5.0 on a 10 point scale for SC/ST candidates) from UGC / AICTE recognized Institute / University.

The selection will be as per Gandhigram Rural Institute Norms.

Category A

Based on GATE Score. However no scholarship is available right now.

Category B

Based on the Written Examination Conducted by Rural Energy Centre, Gandhigram Rural Institute – Deemed University if GATE qualified candidates is not available.

The evaluation is as follows:
The marks obtained by the qualifying examination
from I semester to Pre Final Semester - 50% Weightage
(for the benefit of Result Awaiting Students)
Entrance Examination - 50% Weightage

Maximum number of Seats: 20
# Curriculum Outline:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>No. of Credits</th>
<th>Maximum Marks</th>
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<tr>
<td><strong>Semester I</strong></td>
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<tr>
<td>MRE 0101</td>
<td>Introduction to Energy Studies</td>
<td>4</td>
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<tr>
<td>MRE 0102</td>
<td>Solar Energy</td>
<td>4</td>
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<tr>
<td>MRE 0103</td>
<td>Thermal Engineering</td>
<td>4</td>
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<tr>
<td>MRE 0104</td>
<td>Energy Auditing and Management</td>
<td>4</td>
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<tr>
<td>MRE 0105</td>
<td>Applied Mathematics</td>
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<tr>
<td>MRE 0106</td>
<td>Solar Energy Laboratory</td>
<td>2</td>
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<tr>
<td>MRE 0107</td>
<td>VPP/VSR (Energy Resource Mapping)</td>
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<td><strong>Total</strong></td>
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<td>MRE 0201</td>
<td>Waste to Energy Conversion Technologies</td>
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<td>MRE 0202</td>
<td>Wind Energy, Small Hydro and New Renewable Energy Technologies</td>
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<td>MRE 0203</td>
<td>Solar Passive Architecture</td>
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<td>MRE 0204</td>
<td>Power Systems for Renewable Energy Sources</td>
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<td>MRE 0205</td>
<td>Energy Economics</td>
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<td>MRE 0207</td>
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<td>MRE 0301</td>
<td>Research Methodology and Statistical Methods</td>
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<td>MRE 0302</td>
<td>Environmental Impact Assessment</td>
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<td>Elective I (Intra)</td>
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<td>Wind Energy Laboratory</td>
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<td>MRE 0306</td>
<td>Minor Project on Renewable Energy</td>
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<td>MRE 0307</td>
<td>VPP/VSR (Rural Energy planning)</td>
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**Electives:**
- MRE E001. Rural Electrification : Technologies and Economics
- MRE E002. Renewable Energy & Sustainable Development
- MRE E003. Smart Grid
- MRE E004. Energy Modeling and Project Management
- MRE E005. New Energy Technologies
- MRE E006. Intellectual Property Rights
- MRE E007. Fuels and Combustion Technology
- MRE E008. Optimum Utilization of Heat and Power
- MRE E009. Energy Auditing Instrumentation
- MRE E010. Solar Photovoltaic Systems
MRE 0101 INTRODUCTION TO ENERGY STUDIES

Unit I

Unit II

Unit III

Unit IV

Unit V

References:
MRE 0102 SOLAR ENERGY

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 and applications.
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, design and performance parameters; 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

Unit III
Solar Heating & Cooling System - Liquid based solar heating system; Natural, forced and gravity flow, mathematical modeling, 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; Solar passive heating and cooling systems: Trombe wall; Greenhouse technology: Fundamentals, design, modeling and applications.

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:
MRE 0103 THERMAL ENGINEERING

Unit I
Steam Power Cycles

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

Unit V
Heat Transfer

REFERENCES:
MRE 0104 ENERGY AUDITING AND MANAGEMENT

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.

Unit II:
Energy management and audit: Definition, energy audit – need, types of energy audit, energy management (audit) approach – understanding energy costs, benchmarking, energy performance

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:
Energy action planning: Key elements, force field analysis, energy policy purpose, perspective contents, formulation, ratification, organising, location of energy management, top management support, managerial function, roles and responsibilities of energy manager, accountability, motivating – motivation of employees, information system designing barriers, strategies, marketing and communicating, training & planning.

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:
2. Hamies, Energy Auditing and Conservation; Methods, Measurements, Management & Case study, Hemisphere, Washington, 1980
UNIT I
Applications of Fourier Transform

UNIT II
Calculus of Variations
Concept of variation and its properties – Euler’s equation – Functionals dependant on first and higher order derivatives – Functionals dependant on functions of several independent variables – Variational problems with moving boundaries – Direct methods – Ritz and Kantorovich methods.

UNIT III
Conformal mapping and applications

UNIT IV
Finite difference methods for parabolic equations

UNIT V
Finite difference methods for elliptic equations
Solutions of Laplace and Poisson equations in a rectangular region – Finite difference in polar coordinates – Formulae for derivatives near a curved boundary while using a square mesh.

REFERENCES:
MRE 0106 SOLAR ENERGY LABORATORY

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.
MRE 0107 VPP/VSR (ENERGY RESOURCE MAPPING)

As per Gandhigram Rural Institute – Deemed University Norms

Student should work on Energy Resource Mapping in a selected village.
MRE 0201 WASTE TO ENERGY CONVERSION TECHNOLOGIES

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

Unit IV

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:
5. Bhide AD., Sundaresan BB, Solid Waste Management in Developing Countries, INSDOC, New Delhi,1983.
MRE 0202 WIND ENERGY, SMALL HYDRO AND NEW RENEWABLE ENERGY TECHNOLOGIES

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 C-WET 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

References:
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:
MRE 0204 POWER SYSTEMS FOR RENEWABLE ENERGY SOURCES

Unit I
Introduction to renewable energy grid integration, concept of mini/micro grids, and smart grids.

Unit II
Introduction to induction machines: electrical characteristics, slip, speedtorque characteristics etc. Self excited induction generator, Constant speed Induction generators, Variable speed Induction generators, Doubly fed Induction generators.

Unit III
Introduction to power electronic devices, AC/DC converters, PWM, THD. Permanent magnet synchronous generator, solar PV systems, fuel cell, aquaelectrolizer

Unit IV
Issues in integration of synchronous generator based, induction generator based and converter based sources together. Network voltage management (discusses the issue of voltage levels).

Unit V

References

MRE 0205 ENERGY ECONOMICS

UNIT I: INTRODUCTION TO ENERGY ECONOMICS


UNIT II: ENERGY AND DEVELOPMENT


UNIT III: ENERGY AND ENVIRONMENT


UNIT IV: ENERGY CONSERVATION AND ENERGY MANAGEMENT


UNIT V: INDIA’S ENERGY PROFILE


References
MRE 0206 WASTE TO ENERGY CONVERSION TECHNOLOGIES LABORATORY

1. Estimation of Physical and chemical properties of waste materials
2. Study on sources of waste materials
3. Proximate analysis of solid wastes
4. Ultimate analysis of solid wastes
5. Calorific value of solid wastes
6. Combustion characteristics of solid wastes
7. Study of Mechanical handling of solid waste
8. Study of Composting of solid wastes
9. Estimation of energy recovery potential of solid wastes
10. Waste heat recovery
11. Study of refuse derived fuel (RDF)
12. Estimation of BOD, DO level in effluent
13. Estimation of COD level in effluent
15. Estimation of Calorific Value of Gaseous fuels
MRE 0207 SUMMER INTERNSHIP  
(ENERGY AUDITING OF RURAL INDUSTRIES / RURAL ENERGY SECURITY)

Student should undergo an inplant training in a process / product industry / NGO in energy related area focusing on rural energy planning 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*.

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<tr>
<td>Report</td>
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<tr>
<td>Seminar</td>
<td>25 marks</td>
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<tr>
<td>Viva-Voce</td>
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Unit I

Unit II
Research Design and Methods: Purpose and dimensions of research design, steps in formulation of a design - Types of research design – Historical, Descriptive, Experimental – true experimental, quasi experimental ands expose facto designs. Field surveys, diagnostic and evaluation research.- Qualitative and Quantitative methods in research, Need and relevance of Interdisciplinary research.

Unit III

Unit IV
Analysis of Data – Categorization, Presentation of data and Frequency distributions - Descriptive Statistics - central measures, dispersion, skewness and kurtosis - Correlation and regression, analysis of time – series, index numbers and trend analysis

Unit V
Inferential Statistics - Testing of hypothesis, concept of sampling distribution and standard Error – Type I and Type II errors- large sample and small sample tests - Test of significance for attributes Non-parametric tests – chi –square test, run and median regression - Analysis of variance and factor analysis - Structure and qualities of a research report – dissemination of research findings – evaluation of research report.

References:
MRE 0302 ENVIRONMENTAL IMPACT ASSESSMENT

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.

Unit II

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 protocol, stages of Environmental Audit, onsite activities, evaluation of Audit data and preparation of Audit report.

Unit V

References:
4. Dr H.S. Bhatia *Environmental Pollution and Control*, Galgotia Publication (P) Ltd, Delhi, 1996
MRE 0305 WIND ENERGY LABORATORY

1. Wind Rose Diagram
2. Effect of Blade angles on the performance of wind turbine
3. Performance evaluation of horizontal axis wind turbine
4. Performance evaluation of vertical axis wind turbine
5. Performance evaluation of wind water pumping system
6. Study of power electronics system on grid interaction
7. Synchronization of wind electric generators
8. Study of thermogram of wind rotor system and gear box
9. Noise level study of wind turbine system
10. Study on tower design
MRE 0306  MINOR PROJECT ON RENEWABLE ENERGY

A group of 2 or 3 Students should develop a cost effective renewable energy gadget / Biomass Assessment Study / Village Level Energy Planning / Evaluation of Renewable Energy Plants
Evaluation is based on the product, report and *viva voce*.

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<td>Product / Report</td>
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MRE 0307 VPP/VSR (RURAL ENERGY PLANNING )

As per Gandhigram Rural Institute – Deemed University Norms

Student should work on Rural Energy Planning in a selected village with renewable energy gadgets and energy conservation technologies.
MRE 0401 DISSERTATION

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:

| 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 Examine | 75 marks |

Total - 150 marks

Viva Voce [jointly conducted by internal examiner (internal guide only) and external examiner]

| Total | 50 marks |
|       |         |

Total - 200 marks
MRE E001 RURAL ELECTRIFICATION : TECHNOLOGIES AND ECONOMICS

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:
MRE E002 RENEWABLE ENERGY & SUSTAINABLE DEVELOPMENT

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

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:

MRE E003 SMART GRID

Unit I
Introduction – driving the move towards Smart Grids globally and in India. 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), 6 Automation 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 renewables Connecting/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
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/
MRE E004 ENERGY MODELING AND PROJECT MANAGEMENT

Unit I

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

Unit III

Unit IV

Unit V

References:
4. UN-ESCAP Sectoral Energy Demand Studies: Application of the END-USE Approach to Asian Countries, New York 1991
6. S.Makridakis , Forecasting Methods and Applications. Wiley 1983
MRE E005 NEW ENERGY TECHNOLOGIES

Unit I

Unit II

Unit III

Unit IV

Unit V
Thermoelectric converter - Thermionic converter – Magneto Hydra Dynamic system (MHD) - Electro gas dynamics (EGD) principles - types.

References:
MRE E006 INTELLECTUAL PROPERTY RIGHTS

Unit I
Introduction to IPR, Importance, need of IPR, Intellectual assets and value realization, Forms of IPR, Patent, Copyright, Trademarks, Protection of IC layout designs, geographical indicators, Protection of undisclosed information, control of anti-competitive practices and Industrial design.

Unit II

Unit III
Industrial Designs: Registration, concept of novelty, originality, utility, obviousness, rights, obligations and limitations of registration of design, offenses and penalties.
Trade Marks: Introduction, registration, concept of deceptive similarity, rights and limitation of trade marks, Offenses and penalties.

Unit IV
Copyright: Introduction, nature of copyright, subject matter of Copyrights rights, obligations and limitations, registration.
International treaties: Introduction to international treaties, conventions and organizations; TRIPS, Paris convention, PCT, Budapest Treaty, Washington Treaty, Berne Convention, WIPO, EPO, UPOV.

Unit V

References:
MRE E007 FUELS AND COMBUSTION TECHNOLOGY

Unit I
Solid, Liquid and Gaseous Fuels - General: Coal; Family, origin, classification of coal; Analysis and properties; Action of heat on coal; Gasification; Oxidation; Hydrogenation and liquefaction of coal; Efficient use of solid fuels; Manufactured fuels; Agro fuels; Solid fuel handling; Properties related to combustion, handling, and storage

Unit II
Origin and classification of petroleum; Refining; Properties & testing of petroleum products; Various petroleum products; Petroleum refining in India; Liquid fuels from other sources; Storage and handling of liquid fuels. Types of gaseous fuels: natural gases, methane from coal mines, manufactured gases, producer gas, water gas, biogas, refinery gas, LPG; Cleaning and purification of gaseous fuels.

Unit III
Theory of Combustion Process Stoichiometry and thermodynamics; Combustion stoichiometry; Combustion thermodynamics, burners; Fluidized bed combustion process. Stoichiometry relations; Estimation of air required for complete combustion; Estimation of minimum amount of air required for a fuel of known composition; 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, NO_x, SO_x).

Unit IV
Burner Design Ignition: Concept, auto ignition, ignition temperature; Burners: Propagation, various methods of flame stabilization; Basic features and design of burners for solid, liquid, and gaseous fuels;

Unit V
Furnaces: Industrial furnaces, process furnaces, batch & continuous furnaces; Advantages of ceramic coating; Heat source; Distributions of heat source in furnaces; Blast furnace; Open hearth furnace, Kilns; Pot & crucible furnaces; Waste heat recovery in furnaces: Recuperators and regenerators; Furnace insulation; Furnace heat balance computations; Efficiency considerations.

References:
MRE E008 OPTIMUM UTILIZATION OF HEAT AND POWER

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

Unit III

Unit IV

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

REFERENCES:
MRE E009 ENERGY AUDITING INSTRUMENTATION

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

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

Unit III
Measurement of thermo-physical properties, instruments for measuring temperature, pressure and flow, use of intelligent 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, gas chromatography, spectrometry, measurement of pH, Review of basic measurement techniques.

References:
MRE E010 SOLAR PHOTOVOLTAIC SYSTEMS

Unit I
Review of Semiconductor Physics: Electrons and holes in semiconductors, doping, electrical transport, Photo carrier generation and recombination Junctions; p-n, p-i-n and metal semiconductor contacts, band bending, Ohmic and rectifying contacts, Surface and interface states, homo and hetero-junctions

Unit II
Analysis of p-n and p-i-n junction: Depletion region, depletion capacitance, Carrier and current densities, Current voltage characteristics in dark and light Device Physics of Solar Cells: Solar radiation, conversion efficiency, p-n junction model,

Unit III
Effect of Parasitic resistance, irradiation and temperature on I-V characteristics. Numerical solar cell modeling Principle of cell design: Cell type, Optical design, surface and bulk recombination losess, design and fabrication of metal contacts

Unit IV
Crystalline Silicon and III-V Solar cells: Single, tandem and multi-junction solar cells Thin Film Solar cells: Amorphous silicon, cadmium telluride and copper indium gallium diselenide based solar cells Organic photovoltaic Devices

Unit V
Photovoltaic System Engineering: Thermo-photovoltaic generation of electricity, Concentration and storage of electrical energy, photovoltaic modules, system and application

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