Institute of Energy
University of Dhaka

Syllabus for
Masters in Renewable Energy Technology

(3 Semesters, Total Credits: 45, Duration: 1.5 Yr.)

First Semester (July-December) = 15 Credits
Second Semester (January-June) = 15 Credits
Third Semester (July-December) = 15 Credits
Total= 45 Credits

1st Semester

Semester: 01 (15 credits)

Course Name	Credit
MRET101: Foundation of Energy Engineering	03
MRET102: Electrical and Electronic Devices	03
MRET103: Climatology	03
MRET104: Renewable Energy Technologies	03
MRET105: Technology and Energy Management for Buildings	03
Total =	**15**

2ndSemester

Semester: 02 (15 credits)

Course Name	Credit
MRET201: Project Management and Research Methodology	03
MRET202: Energy Economics and Environment	03
MRET203: Solar Photovoltaic Energy and Systems	03
MRET204: Practical and Laboratory Experiments	06
Total =	**15**

3rd Semester

Semester: 03 (15 credits)

Course Name	Credit
MRET301: Advanced Electronics of Solar Photo Voltaic System	03
MRET302: Solar Thermal Energy and System	03
MRET303: Non Renewable Energy Technologies	03
MRET304: Thesis/ Project (60+40)	04
MRET305: Internship/ Field Visit and Viva Voce (50)	02
Total =	**15**

Detail Course Syllabus

1st Semester

MRET-101: Foundation of Energy Engineering (3 Credits)

1. Laws of Thermodynamics: 1st and 2nd law and its application, Entropy, Irreversibility, Refrigerators, Air Conditioners, and Heat Pumps
2. Heat Transfer: Conduction, convection, Radiation
3. Heat Engines: Working principle and classification of Internal Combustion Engine, Two stroke and four stroke cycle (Diesel and petrol engine)
4. Basic Power generation Cycles: Carnot and Rankine Cycle
5. Thermionic conversion and Magneto hydrodynamic Generator
6. Fluid Mechanics: Stress-Strain, Viscosity, Bernoulli's Equation

Text/References:

- M. W. Zemansky, Heat and Thermodynamics (4th Edition), McGraw Hill,
- L. Prasuhn, Fundamentals of Fluid Mechanics, Prentice Hall
- S.P Sukhatme, A text book on Heat Transfer, Orient Longman

MRET-102: Electrical and Electronic Devices (3 Credits)

1. Electronic Devices: Semiconductor Materials, PN junction diode, BJT-construction and operation, BJT as a switch, MOSFET- types, construction, operation, MOSFET as a switch, IGBT- construction, construction, advantages and disadvantages of IGBT switch compared to others, Solar Cell-construction, operation and properties. Student will learn the detailed construction and operation of common electronics devices and their applications
2. Electrical Machines: Transformer, Induction motor and generators, Synchronous generators, DC motor; Introduction to modern speed control techniques,
3. Fuel cell- Introduction to the principles and operation of fuel cells, stack configurations and fuel cell systems. Fuel cell system design, optimization and economics. Overview of fuel cell technology. Thermodynamics of fuel cells, introduction to electrochemical kinetics, transport-related phenomena and conservation equations for reacting multicomponent systems.
4. Power Transmission and Distribution, Power Quality and controls, Power factor Improvements
5. Remote Sensing: Definition: Ideal Remote Sensing System, Sensors and Types, Remote Sensing Satellite, IRS and INSAT specifications, Applications of remote sensing, DIP Techniques. Electrical and Electronic Sensors
6. GIS: Definition: Data and Types, Sources of data, Global Positioning System (GPS), Data Structure, Types of Analysis, Errors, Applications of GIS
7. Sustainable Urban Development Planning using GIS. Environmental Degradation Assessment using RS and GIS.

Texts/References:

- P. C. Sen, Modern Power Electronics, Wheeler, New Delhi, 1998.
- N. Balbanian, T. A. Bickart, Electrical network theory, John Wiley, New York, 1969
- B. L. Theraja, A. K. Theraja, Text-book of electrical technology: in S.I. units: v.2 AC and DC machines, Nirja Construction & development, New Delhi, 1988.
- Hand book Batteries and Fuel Cells. Linden, McGraw Hill, 1984.
- GIS for Land Resource Assessment, Burrough P.A., (1986), Oxford University Press, U.K.
- Geographic Information Systems; An Introduction, Star J.L., and Estes J.E., (1990), Prentice Hall Publications.
- Fundamentals of Spatial Information Systems, Laurini R. and Thompson D., (1992), Academic Press.
- Remote Sensing and GIS, Anji Reddy, (2001), B.S. Publications, Hyderabad
- Remote Sensing– Principles and Interpretations, Floyd F.Sabins,(1996) W.H. Freeman & Co.
- Fundamentals of GIS, Michael N. Demas, (2000), John Wiley & Sons, Inc.

MRET-103: Climatology (3 Credits)

1. Meteorology: Instrumentation, siting and measurement of solar radiation, sunshine duration, cloud cover, humidity, rainfall, temperature, wind speed and direction, dust, greenhouse gases, etc.
2. Solar energy resource assessment: Solar constant, sun path, day length, solar and clock time, sunrise and sunset time, extraterrestrial radiation, estimation of hourly and daily terrestrial radiation using different isotropic and anisotropic models, estimation of solar radiation on different tilted surfaces
3. Wind energy resource assessment: Wind power density, turbulence intensity, gust, air density, wind speed variation with height: log law and power law, power coefficient of a wind turbine, Lancheter Betz limit, Weibull distribution of wind data: shape factor and scale factor, wind rose
4. Atmospheric turbidity: spectral distribution of solar radiation at the top of the atmosphere and at the earth's surface, air mass, aerosols, attenuation and scattering of solar radiation, atmospheric turbidity: Linke and Angstrom's turbidity coefficients
5. Climate system and climate change: climate system and its components, atmospheric layers, vertical temperature and pressure profile of the atmosphere, lapse rate, global radiation balance, radiative forcing, natural and manmade radiative forcing, natural greenhouse effect and enhanced greenhouse effect, Necked planet and other anthropogenic climate models
6. Greenhouse gases: chemical bond, stretching and bending vibration of bonds, types and sources of greenhouse gases, carbon cycle, water vapor window, band saturation effect, earth system climate sensitivity, global warming, global warming potential of greenhouse gases, models for GHG, global warming, global warming potential of greenhouse gases, models for GHG emission estimation
7. Climate change mitigation policies and institution: UNEP, IPCC, WMO, UNFCCC, Kyoto protocol and carbon trading mechanisms, international emission trading, clean development mechanism, joint implementation, sequestering atmospheric Carbon di Oxide, carbon capture and storage

Texts/References:

- Guide to Meteorological Instruments and Methods of Observation, seventh edition, WMO, 2008.
- M. Iqbal, An Introduction to Solar radiation , New York: Academic Press, 1983
- J. A. Duffie and W. A. Beckman, Solar Engineering of Thermal Processes, second edition, John Wiley, New York, 1991
- S. P. Sukhatme, Solar Energy - Principles of thermal collection and storage, second edition, Tata McGraw-Hil, New Delhi, 1996
- H. P.Garg, Treatise on Solar Energy, Wiley and Sons, N Y 1982
- G. D.Rai, Solar Energy Utilization, Khanna Publishers, Delhi 2000
- G. N. Tiwari, Solar energy, Narosa Publishing House, New Delhi 2002
- J.F. Manwell, J. G. McGowan, A. L. Rogers. Wind Energy Explained: Theory, Design and Application, Second Edition , John Wiley & Sons Ltd., 2009
- Mukund R. Patel, Wind and solar power systems, CRC press LLC, 1999
- Wind resource assessment handbook, NREL and AWS Scientific, Inc., NY, 1997
- Andrze J. Wortman, Introduction to Wind Turbine Engineering, Butterworth Publishers, 1983
- Revised 1996 IPCC guidelines for national GHG inventories: Reference manual, IPCC, Switzerland
- David Archer, Global Warming: Understanding the Forecast, second Edition, Wiley

MRET-104: Renewable Energy Technologies (3 Credits)

1. Solar Energy: Introduction, Solar Radiation, Collectors, Solar Cells, Applications of Solar Energy
2. Wind Power plant: Introduction ,Wind power density, Site selection
3. Biomass Energy: Introduction, Biomass Conversion and Direct Combustion, Waste management, Biogas power plants
4. Geothermal Energy: Introduction, Geothermal Resource Types, Resource Base, Applications for Heating and Electricity Generation.
5. Tidal Energy: Introduction, Origin of Tides, Power Generation Schemes.
6. Wave Energy: Introduction, Basic Theory, Wave Power Devices.
7. Ocean Thermal Energy Conversion (OTEC)

Text/References:

- Powering Planet Earth – Energy Solutions for the Future
- Reinventing Fire: Bold Business Solutions for the New Energy Era (2011) by Amory Lovins
- Renewable Electricity and the Grid
- Renewable Energy Sources and Climate Change Mitigation (2011) by the IPCC
- Renewable Energy Systems: A Smart Energy Systems Approach to the Choice and Modeling of 100 % Renewable Solutions
- Renewable energy. Technology, economics and environment
- Small is Profitable: The Hidden Economic Benefits of Making Electrical Resources the Right Size
- Solar Electricity Handbook IPCC
- Harnessing Solar Heat
- Solar Energy Perspectives (2011) by the International Energy Agency
- Straight Up
- Surviving the Century: Facing Climate Chaos and Other Global Challenges
- Sustainable Energy - Without the Hot Air
- Ten Technologies to Fix Energy and Climate
- The Energy Imperative: 100 Percent Renewable Now
- The Fourth Revolution: Energy
- Understanding Renewable Energy Systems
- What Will Work: Fighting Climate Change with Renewable Energy, Not Nuclear Power

MRET-105: Technology and Energy Management for Buildings (3 Credits)

1. Introduction to Green Buildings:
   A. Impacts of Building Construction, Operation and Disposal Methods and Tools for Building Assessment
   B. The green building process Design and construction relationships
   C. Site and Landscape strategies
   D. Codes and standards of Green Buildings
2. Thermal Properties of Building Materials:
   A. Psychrometrics
   B. Thermal comfort
   C. Thermal properties and energy content of building materials
   D. Heating and cooling load analysis
   E. Thermal Insulation
3. Energy Conservation Technologies:
   A. Energy audit: evaluation of energy performance of existing buildings
   B. Energy efficiency measures in buildings: approaches, materials and equipment, operating strategies, evaluation methods of energy savings.
   C. Renewable energy sources: passive or active solar systems, geothermal systems, free-cooling
4. Devices for Indoor Environmental Quality Management:
   A. Energy conservation in Pumps, Fans (flow control), Compressed Air Systems, Refrigeration & air conditioning systems
   B. Waste heat recovery: heat wheels, heat pipes, heat pumps.
   C. Energy Efficient Boilers
5. Acoustics and Lighting in Buildings:
   A. General introduction to the aural and visual environment. (Photometry, brightness, luminance and illumination)
   B. Concept of natural lighting in building. Artificial lighting; light sources; luminaries.
   C. Room acoustic assessment. Transmission of sound, passive control of noise in buildings, transmission loss, absorption and reverberation time.
6. Economic analysis and Protocols:
   A. Demand Side Management (DSM) in Energy
   B. Use of the Green Strategies Estimating Future directions in green high performance building technologies
   C. Building Energy System Strategy
   D. Building Material Selection Strategy
   E. INDC, COP
   F. Clean Development Mechanism (CDM)

Texts/References:

- 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.
- J.R. Williams, Passive Solar Heating, Ann Arbar Science, 1983.
- 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.
- J.L. Threlkeld, Thermal Environmental Engineering, Prentice Hall, 1970.
- L.C.Witte, P.S.Schmidt, D.R.BrownIndustrial Energy Management and Utilisation, Hemisphere Publ, Washington,1988.
- Industrial Energy Conservation Manuals, MIT Press, Mass, 1982.
- I.G.C.Dryden, Butterworths, The Efficient Use of Energy, London, 1982
- W.C.Turner, Wiley, Energy Management Handbook, New York, 1982.

2nd Semester

MRET-201: Project Management and Research Methodology (3 Credits)

1. Educational Research: Meaning, aims, nature and scope of educational research, Characteristics and prerequisites of educational research, Types of educational research, Research needs in different subjects of education.
2. Research Problem: Meaning of research problem, Sources of research problem, Criteria / Characteristics of a good research problem, Errors in selecting a research problem.
3. Methods of Educational Research: Qualitative research. phenomenological studies, Ethnographical studies, Case studies, Historical studies, Philosophical studies; Quantitative research, experimental research, Quasi- experimental research, Surveys, Correlation studies, Action research
4. Developing a Research Proposal: Format of research proposal, Individual research proposal, Institutional proposal,
5. Hypothesis: Meaning, Types of hypothesis; Sampling: Sampling and Population, Techniques sampling selection, Characteristics of a good sample, Sampling errors and how to reduce them
6. Tools and Techniques of Data Collection: Checklist, Data schedule, Observation, Opinionnaire, Interview, Sociometric techniques, Questionnaire, Rating scales, Interview schedules, Reliability and validity of various tools and techniques
7. Research Report: Format of the Research Report, Style of writing the report, References and Bibliography; Evaluation of Research: Criteria of evaluation
8. Project Management tools and techniques, Strategic and people leadership skills

Texts/References:

- Research in Education . Best John W. and James V. Kahn
- Elements of Educational Research .Sukhia, S.P., P.V. Mehrotra and R.N. Mehrotra.
- A Handbook on Educational Research . N.C.T.E.
- Educational Tests and Measurement, An Introduction . Anthony J.Nitco
- Methodology of Research Education .Sidhu, K.S.
- Fundamentals of Educational Research .Aggarwal
- Methodology of Educational Research .Koul, Lokesh.
- Methodology of Educational Research . Sharma, R.N. and Sharma, R.L.
- Research Methodology . Methods &Techniques : Kothari, C.R.
- Tests, Measurements and Research Methods in BehaviouralSciences . Singh, A.K.
- Statistical Methods . Y.P. Aggarwal.
- Conducting Educational Reseach . Bruce W. Tuckman
- Methods of Statistical Analysis . P.S. Grewal
- Fundamentals of Statistics . S.C. Gupta and V.K.Kapoor

MRET-202: Energy Economics and Environment (3 Credits)

Course Content:

1. Basic Economics: Principles of Economics; Nature of Market, Marginal Analysis

2. Economic Systems of Modern World: Capitalism, Socialism and Islamic Economic System; Global Financial Meltdown 2008

3. Economic Analysis of Energy Investments: Cost Benefit Analysis

4. Environmental Impact Assessment: Current status, legal framework, concepts, processes and principles of EIA and associated studies

Recommended Books/Publication:

1. Energy Economics: S. C Bhattacharrya
2. Energy Economics: Planck Foundation

MRET-203: Solar Photovoltaic Energy and Systems (3 Credits)

1. Electrochemical Storage for Photovoltaics: General Concept of Electrochemical Batteries, Classification of Batteries in PV Systems; Lead Acid Battery: Construction, Chemical reaction, efficiency, effect of charging and discharging on available energy, DoD and effect of DoD on life cycle, Deep cycle and shallow cycle battery, VRLA, NiCd Batteries, Nickel-metal Hydride (NiMH) Batteries, Lithium-ion and Lithium-polymer Batteries, Double-layer Capacitors, ECS.
2. Solar Cells and Modules**:** Construction and operation of solar cell, manufacturing process of solar cells, Equivalent circuits, I V curves, Effect of temperature, series resistance and shunt resistance, properties of efficient solar cells, Solar cells in series and parallel, construction of PV module, Shading effect and bypass diode.
3. Power Conditioning for Photovoltaic Power Systems: Charge Controllers- classification, various set points of charge controller, circuit and operation of series, shunt and microcontroller based charge controller, Maximum power point trackers, Inverters- Principle of operation, half bridge, full bridge, modified sine wave, sine wave inverter using PWM, specifications of inveter, Grid-connected Inverters
4. PV in Architecture: PV in Architecture, Architectural Functions of PV Modules, PV as Part of "Green Design", PV Integrated as Roofing Louvres, Facades and Shading, Well-integrated Systems, Integration of PV Modules in Architecture, BIPV Basics
5. Stand-Alone PV Systems: Solar Home Systems, Hybrid Systems their design and operations,
6. Solar Water Pumping: Types of water pumping, Heads, different configurations of pump-motor systems, types of motors and pumps, design of solar water pumping system
7. Utility interface PV systems: Decentralized Grid-Connected PV Systems, Central Grid-Connected PV Systems, Standardization of Interconnection Requirements, PV System Installation Considerations, Metering of PV System Output, Technical Considerations for Connecting to the Grid, IEEE Standard Issues, National Electrical CodeConsiderations, Other Issues; Small (<10 kW) Utility Interactive PV Systems-Array Installation, PCU Selection and Mounting, Other Installation Considerations
8. Efficiency and Performance of PV Systems: Stand-Alone PV Systems, Grid-Connected PV Systems-Final Yield, Performance Ratio, Possibilities of Quality Control and Control of Energy Yield of Grid-Connected PV Systems, Long-Term Behavior of Grid-Connected PV Systems
9. Economic Analysis: Key Concepts, General Methodology, Life cycle analysis of power production chains, LCA of greenhouse gas emissions, Case Studies

Texts/References:

- Handbook of photovoltaic science and engineering, **A Luque; StevenHegedus; NetLibrary, Inc.**
- Solar Electricity: engineering of photovoltaic systems, Eduardo Lorenzo, G Araujo, A. Cuevas, M Egido, J. Minano, R Zilles
- Photovoltaic Solar Energy Generation, Adolf Goetzberger, Volker U. Hoffmann
- The Physics of Solar Cells: Photons In, Electrons Out, Jenny Nelson
- Practical Handbook of Photovoltaics: Fundamentals and Applications, T. Markvart, Luis Castañer
- Solar Electricity, Wolfgang Palz, Butterworth Publications 1960
- Solar Engineering of Thermal Processes, J A Duffie and W A Backman, Wiley N Y 1980
- Treatise on Solar Energy, H P Garg, Wiley and Sons, N Y 1982

MRET-204: Practical and Laboratory Experiments (6 Credits)

The target of this course is to give practical concept of the theory described in various courses. Some example areas are mentioned below:

1. Practical based on solar radiation measurement.
2. Practical based on solar cells and PV modules.
3. Practical based on charge controllers.
4. Practical based on inverters.
5. Practical based on water pumping system.
6. Practical based on solar thermal systems.
7. Practical based on solar home system/off-grid system.
8. Practical based on Grid-Tied power system.
9. Practical based on ICS performance study
10. Practical based on biogas plant/Biomass
11. Practical based on wind turbine and hybrid systems
12. Practical based on Hydro/OTEC
13. Practical based on EV, Fuel Cells
14. Practical based on energy efficiency, energy audit, energy management, etc.
15. Practical based on Power Electronics
16. Practical based on system design using RET screen/HOMER

3rd Semester

MRET-301: Advanced Electronics of Solar Photovoltaic System (3 Credits)

1. The pn junction: Periodic table, Crystal structure, the energy momentum diagram, density states function, statistical mechanics, the semiconductor in equilibrium, the extrinsic semiconductor, built in potential barrier of a pn junction, pnjunction as a diode, pn junction as a photovoltaic cell, efficiency limits, losses and measurement: spectral response of solar cells, quantum efficiency analysis, dark conductivity, I-V characterization
2. Crystalline solar cell preparation technology: standard and improved mono crystalline and poly crystalline silicon solar cell module technology, Module fabrication and testing, design of silicon solar cells
3. Thin film solar cells: Amorphous silicon solar cells, micro morph, tandem and multi-junction solar cells, Concentrating solar cells, High efficiency solar cells, III-V, II-VI thin-film solar cells (GaAs, Cu(In,Ga)Se_2, CdTe), PERL cells, (DSSC), Pervoskite thin film solar cells, etc.
4. Thin film solar cell preparation technology: diffusion, oxidation, photolithography, sputtering, physical vapor deposition, chemical vapor deposition (CVD), atmospheric pressure CVD, low pressure CVD, plasma assisted CVD, plasm enhanced CVD, high density plasma CVD, hot wire CVD, Epitaxy, MOCVD, MBE, VPE, etc.
5. Characterization of solar cells: Scanning Electron Microscope (SEM), Secondary-Ion Mass Spectrometry (SIMS), Atomic Force Microscope (AFM), Transmission Electron Microscope (TEM), etc.
6. Materials and devices for energy storage: Batteries, CNT in energy storage, Ultra-capacitors, Fuel cells, Superconducting Magnetic Energy Storage (SMES)

Texts/ References:

- Solar cells: Operating principles, technology and system applications, Martin A Green, Prentice-Hall Inc, Englewood Cliffs, NJ, USA, 1981.
- Solid State electronic devices, Ben G Streetman, Prentice-Hall of India Pvt. Ltd., New Delhi 1995.
- Semiconductor physics and devices, Donald A Neaman
- VLSI technology, S M Sze
- Semiconductor devices, physis and technology, S M Sze
- Semiconductor manufacturing technology, Michael Quirk
- Integrated Circuits, K R Botkar
- Thin Film Solar Cells, K L Chopra and S R Das
- Thin Film Solar Cells Fabrication Characterization applications, J Poortmass and V Arkhipov
- Handbook of Photovoltaic Science and Engineering, Antonio Luque and Steven Hegedus, WILEY
- Direct energy conversion, M A Kettani, Addison-Wesley, Reading, Mass, 1970
- Direct Energy Conversion, S W Angrist, 4th Ed. Allyn And Bacon, Boston, 1982
- Semiconductors for solar cells, H J Moller, Artech House Inc, MA, USA, 1993
- Fundamentals of Nanotechnology, G Hornyak, J J Moore, H F Tibbals and J Dutta, C R C press
- Carbon nanotubes and related structures: New material for twenty-first century, P J F Harris, Cambridge University Press, 1999.
- Thin-film crystalline silicon solar cells: Physics and technology, R Brendel, 2003.
- Clean electricity from photovoltaics, M D Archer, R Hill, Imperial College Press, 2001.
- Organic photovoltaics: Concepts and realization, C Barbec, V Dyakonov, J Parisi, N S Saricifttci, Springer- Verlag 2003.

MRET-302: Solar Thermal Energy and System (3 Credits)

1. Solar Water Heating:
   A. Types of Solar Water Heater
   B. Natural and Forced Circulation
2. Flat Plate Collector:
   A. Description of the components of Flat plate collectors
   B. Performance analysis (energy balance equation, heat transfer coefficient, temperature distribution and time constant)
3. Solar Cookers:
   A. Types of solar cookers, performance of box-type solar cooker, testing of a solar cooker
   B. Natural and Forced Circulation
4. Solar Desalination:
   A. Simple solar still, basics of solar still, material problems in solar stills, performance prediction of basin-type still, solar disinfection
5. Solar Dryers:
   A. Basics of solar dryer, types of solar dryers-natural convection or direct type solar dryers, mixed mode type solar dryer; forced circulation type dryers-hybrid dryer, bin-type grain dryers, solar timber drying
6. Passive Heating and Cooling:
   A. Passive heating of buildings-direct gain, thermal storage wall, attached greenhouse (sunspace), thermal storage roof, convective loop; passive cooling of building-shading, ventilation, evaporation, radiation cooling, ground coupling, dehumidification
7. Solar Refrigeration and Air Conditioning:
   A. Carnot refrigeration cycle, Reverse Carnot Cycle
   B. Absorption cooling- principles of absorption cooling, basics of absorption cooling, Lithium Bromide-Water absorption refrigeration system, Aqua-ammonia absorption refrigeration system, intermittent absorption refrigeration system
   C. Vapor compression refrigeration, desiccant cooling
8. Solar Thermal Energy Storage:
   A. Need of thermal energy storage, size and duration of storage, thermal energy storage-sensible heat storage, storage in phase change materials; storage in reversible chemical reactions
   B. Mechanical Energy Storage
9. Economic Analysis of Solar Thermal Technology:
   A. Net present value concept- investment with money from hand, investment with money from loan; life cycle cost method- residential systems, commercial systems; cost benefit comparison method, pay-back period method

Texts/References:

- S. P. Sukhatme, Solar Energy - Principles of thermal collection and storage, second edition, Tata McGraw-Hil, New Delhi, 1996
- J. A. Duffie and W. A. Beckman, Solar Engineering of Thermal Processes, second edition, John Wiley, New York, 1991
- D. Y. Goswami, F. Kreith and J. F. Kreider, Principles of Solar Engineering, Taylor and Francis, Philadelphia, 2000
- M. S. Sodha, N. K. Bansal, P. K. Bansal, A. Kumar and M. A. S. Malik, Solar Passive Building: science and design, Pergamon Press, New York, 1986
- M. A. S. Malik, G. N. Tiwari, A. Kumar and M.S. Sodha, Solar Distillation. Pergamon Press, New York, 1982.

MRET-303: Non Renewable Energy Technologies (3 Credits)

1. Types of Fossil Fuels (Coal, Gas, Oil), Reserve and Extraction Process
2. Conventional Power plants
3. Fossil Energy Technologies: Combustion, Gasification, Power Generation,
4. Nuclear Power Plants : Operation, Risk and opportunity
5. Climate change and Carbon Trading

Texts/References:

- UNDP: World Energy Assessment: Energy and the Challenge of Sustainability United Nations Development Programme, United Nations Department of Economics and Social Affairs and World Energy Council, United Nations Publication, New York, 2000.
- BP Statistical Review of World Energy, June 2001.
- T. B. Yohansson, H. Kelly, A. K. N. Reddy, and R.H. Williams (eds.): Renewable Energy Sources for Electricity and Fuels, Island press, Washington, D.C., 1993.
- World Energy Council: New Renewable Energy Resources, Kogan Page, London, 1994.
- Fuel Cell System, edited by Leo J.M.J. Blomen and michael N. Mugerwa, New York, Plenum Press, 1993.
- Fuel Cell Handbook, by A. J. Appleby and F. R. Foulkers, Van Nostrand, 1989.

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