



University of Pune

Revised Syllabus

For

M.Tech (Energy Studies)

**School Of Energy Studies
Pune -7**

**School of Energy Studies
University of Pune
Pune 411 007**

**M.Tech (Energy Studies)
Revised Syllabus**

The course consists of four semesters, each semester having five courses. The semester wise courses are given below.

Semester –I	
EN-111	Energy Scenario and Energy Policy
EN-112	Energy Conversion Systems-I
EN-113	Energy Conversion Systems-II
EN-114	Renewable Energy Systems -I
EN-125	Practical-I
Semester –II	
EN-211	Energy Audit and Management- I
EN-212	Energy Conservation
EN-213	Renewable Energy Systems-II
EN-214	Environmental Impact of Energy Systems
EN-225	Practical-II
Semester –III	
EN-311	Energy Audit and Management -II
EN-312	Energy Audit Procedures and Techniques
EN-313	Elective / Special Course (Any one) a) Advanced Solar Thermal and PV b) Wind Energy c) Advanced Energy Management
EN-324	Industrial Training (Duration: 6 weeks, 2 Credits for Energy Awareness Program)
Semester-IV	
EN-421	Project Work

Semester-I

Distribution of Credits, Units, Lectures and Marks

Course Code	Course Title and Units	Credits	Lectures	Marks Int + TE	Total Marks
EN-111	Energy Scenario and Energy Policy	5	50	50 + 50	100
	Unit No.1: Global Energy Scenario	1.5	15	15	
	Unit No.2: Indian Energy Scenario	1.0	10	10	
	Unit No.3: Energy Policy	1.0	10	10	
	Unit No.4: Basics of Thermodynamics	1.5	15	15	
EN-112	Energy Conversion Systems-I	5	50	50 + 50	100
	Unit No.1: Classification of Energy Sources	0.5	05	05	
	Unit No.2: Thermal and Mechanical Energy	1.0	10	10	
	Unit No.3: Thermal Energy & Mechanical Utility Systems	2.0	20	20	
	Unit No.4: Basics of Mechanical Engineering (Energy Related)	0.5	05	05	
	Unit No.5: Co-generation, Tri-generation & Waste Energy Recovery	1.0	10	10	
EN-113	Energy Conversion Systems-II	5	50	50 + 50	100
	Unit No.1: Basics of Electrical Engineering (Energy Related)	0.5	05	05	
	Unit No.2: Electrical Energy Sources	0.5	05	05	
	Unit No.3: Electrical Energy & Mechanical Utility Systems	3.0	30	30	
	Unit No 4: Energy Audit Instruments	0.5	05	05	
	Unit No 5: Energy Measurement & Verification	0.5	05	05	
EN-114	Renewable Energy Systems-I	5	50	50 + 50	100
	Unit No.1: Solar Energy	2.0	20	20	
	Unit No.2: Biomass	1.0	10	10	
	Unit No.3: Biomethanation	0.5	05	05	
	Unit No.4: Wind Energy	1.5	15	15	
EN-125	Practical-I (15 Experiments, 1Unit= 3Experiments)	5	50	50 + 50	100

Syllabus for Semester-I

EN-111: Energy Scenario and Energy Policy (C-5, L-50)

Unit-01: Global Energy Scenario (C-1.5, L-15)

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

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

Energy Resources: Coal, Oil, Natural Gas, Nuclear Power and Hydroelectricity, Solar and Other Renewable etc. Depletion of energy sources and impact exponential rise in energy consumption on economies of countries and on international relations.

Energy Security: Chemical and Nuclear: Non Proliferation, Energy Security, Energy Consumption and its impact on environmental climatic change.

International Energy Policies of G-8 Countries, G-20 Countries, OPEC Countries, EU-Countries.

International Energy Treaties (Rio, Montreal, Kyoto), INDO-US Nuclear Deal.

Future Energy Options: Sustainable Development, Energy Crisis: Transition from carbon rich and nuclear to carbon free technologies, parameters of transition.

Unit-02: Indian Energy Scenario (C-1.0, L-10)

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

Impact of Energy on Economy, Development and Environment, Energy for Sustainable Development, Energy and Environmental policies, Need for use of new and renewable energy sources.

Status of Nuclear and Renewable Energy: Present Status and future promise

Energy Policy Issues: Fossil Fuels, Renewable Energy, Power sector reforms, restructuring of energy supply sector, energy strategy for future.

Energy Conservation Act-2001 & its features, Electricity Act-2003 & its features.

Framework of Central Electricity Authority (CEA), Central & States Electricity Regulatory Commissions (CERC & ERCs)

Unit-03: Energy Policy (C-1.0, L-10)

Global Energy Issues, National & State Level Energy Issues,

National & State Energy Policy, Industrial Energy Policy,

Energy Security, Energy Vision.

Energy Pricing & Impact of Global Variations.

Energy Productivity (National & Sector wise productivity).

Unit-04: Basics of Thermodynamics (C-1.5, L--15)

Basic Units, Dimensions and Conversions For Energy, Concepts of Energy, Heat and Work, Ideal gas law, Ist and II law of thermodynamics (Closed and Open Systems)

Thermodynamics power cycles, Reversible heat Engine cycle, I.C. engine cycles, Carnot Cycle, Rankine Cycle, Otto Cycle, Vapor Refrigeration & power Cycle etc.

Reference Books:

1. Energy for a sustainable world: Jose Goldenberg, Thomas Johansson, A.K.N.Reddy, Robert Williams (Wiley Eastern).
2. Energy policy for : B.V.Desai (Weiley Eastern),
3. Modeling approach to long term demand and energy implication : J.K.Parikh.
4. Energy Policy and Planning : B.Bukhootsow.
5. TEDDY Year Book Published by Tata Energy Research Institute (TERI),
6. World Energy Resources : Charles E. Brown, Springer2002.
7. 'International Energy Outlook' -EIA annual Publication
8. Heat and Thermodynamics – M.W. Zemansky (McGraw Hill Publication)
9. Principles of Energy Conversion: A.W. Culp (McGraw Hill International edition.)
- 10.BEE Reference book: no.1/2/3/4.

EN-112: Energy Conversion Systems-I (C-5, L-50)
(Thermal and Mechanical Energy Utility Systems)

Unit-01: Classification of Energy Sources (C-0.5, L-05)

Classification of Energy Sources,

Principle fuels for energy conversion: Fossil fuels, Nuclear fuels.

Conventional & Renewable Energy

Energy Sources: prospecting, extraction and resource assessment and their peculiar characteristics.

Direct use of primary energy sources, Conversion of primary into secondary energy sources such as Electricity, Hydrogen, Nuclear energy etc.

Energy Conversion through fission and fusion, Nuclear power generation etc.

Unit-02: Thermal and Mechanical Energy (C-1.0, L-10)

Thermal energy using fossil fuels.

Conversion of Thermal Energy to Mechanical energy & Power.

Turbines: Steam turbines, Hydraulic turbines.

Unit-03: Thermal and Mechanical Energy Utility systems (C-2.0, L-20)

Boilers -Types, combustion in boilers, performance evaluation, analysis of losses, feed water treatment, blow down.

FBC Boilers: Introduction, mechanism of fluidized bed combustion, advantages, types of FBC boilers, operational features, retrofitting FBC system to conventional boilers.

HVAC, Refrigeration and Air Conditioning: Vapor compressor refrigeration cycle, refrigerants, coefficient of performance, capacity, factors affecting refrigeration and air conditioning system performance, Vapor absorption refrigeration systems: Working principle, type and comparison with vapor compressor system.

Unit -04: Basics of Mechanical Engineering (Energy Related) (C-0.5, L-05)

Sterling Engines, Steam Engine, Internal Combustion systems and external combustion system, Overview of different types of turbines.

Mechanical Engineering and Overview: Basic Engineering concepts and design considerations, Governing regulations and codes and standards,

Strength of Materials, mechanical properties of materials, mechanics of materials

Torque and Power: Basic theory, Shafts, Flywheels etc.

Power Transmission: Concepts of Belts Drives, Gearing, Coupling etc.

Bearing and Lubricants as Energy Saving Measures

Electromechanical energy: Electric to mechanical energy conversion, Electric Motors.

Unit No.5: Co-generation, Tri-generation & Waste Energy Recovery (C-1.0, L-10)

Co-generation & Tri-generation: Definition, need, application, advantages, classification, saving Potential.

Waste Heat Recovery: Concept of conversion efficiency, energy waste, waste heat recovery classification, advantages and applications, commercially viable waste heat recovery devices.

Reference Books:

1. Direct Energy Conversion : W.R.Corliss
2. Aspects of Energy Conversion : I.M.Blair and B.O.Jones
3. Principles of Energy Conversion : A.W.Culp (McGrawHill International
4. Energy conversion principles : Begamudre , Rakoshdas
5. Fuel Economy Handbook, NIFES,
6. Industrial Furnaces (Vol I & II) and M.H. Mawhinney, (John Wiley Publications)
7. Refractories – F.H. Norton,(John Wiley Publication.)
8. Refractories and their Uses – Kenneth Shaw, (Applied Science Publishers Ltd.)
9. Refractory Material G.B. Rotherberg , (Noyes data Coop. N.I)
10. The storage and handling of Petroleum liquid
(John R. Hughes, Charles Griffin & Co. Ltd.)
11. Fuels and fuel Technology Wilfred Francis, (Pergamon press)
12. Domestic and commercial oil Burners Charles H. Burkhardt (McGraw Hill Publication)
13. The efficient use of steam – Oliver Lyle, (HMSO London)
14. Boilers – Types, Characteristics and functions – Carl D. Shields (Mcgraw Hill book)
15. The Efficient use of steam generation – General editor – P.M.Goodall
16. Principles of Refrigeration R.J. Dossat (Wiley Estern Limited.)
17. Stoichiometry – Bhatt, Vora (Tata Mc.Graw Hill)
18. Practical Heat Recovery – Boyen J.L. (John Wiley, New York, USA1976)

EN 113: Energy Conversion Systems-II (C-05, L-50)
(Electrical and Mechanical Energy Utility Systems)

Unit-01: Basics of Electrical Engineering (Energy Related) (C-0.5, L-05)

Fundamentals of Electricity: Concepts of different electrical parameters like voltage, current, frequency, D.C and A.C circuits, Electrical power and energy.

Electrical loads – Resistive, Inductive and Capacitive.

Phasor Notation, Power in A.C. Circuits, Single and Three Phase A.C. Power, Star and Delta connections, Voltage levels.

Transformers, Generators, Alternators etc.

Conversion of Thermal, Chemical, Electromagnetic and Mechanical energy into electricity.

Unit-02: Electrical Energy Sources (C-0.5, L-05)

Importance of Electrical energy in modern industrial society, Production of electricity using coal, oil, natural gas, nuclear fuels and hydel ,-its relative advantages and disadvantages (i.e. conversion of Thermal, Nuclear, hydel energy into electric energy)

Electricity generation using Renewable Energy Sources: Basic Principles and Applications. (Conversion of Electromagnetic energy and natural energy sources like solar radiation, Wind, Ocean waves, Solid waste etc. to electricity)

Conversion of chemical energy into electrical energy (fuel cell)

Thermal power plant, nuclear power plants and hydroelectric power plant, Transmission and distribution of electricity, Villages electrification program and problems in India.

Unit-03: Electrical and Mechanical Energy Utility Systems (C-03, L-30)

Transmission and Distribution losses, Pilferage, Transformer losses. Electricity tariff, Load management and maximum demand control, power factor improvement and its benefits, Selection and location of capacitors etc.

Conversion of Electrical Energy to Mechanical Energy (Electric Motors).

Electric Motors: Types, Losses in induction motors, motor efficiency, factors affecting motor performance, rewinding and motor replacement issues, Energy efficient motors.

Compressed Air System: Types of air compressors, compressors efficiency, efficient compressors operation, Compressed air system components, capacity assessment, and leakage test, factors affecting the performance.

Fans and blowers: Types, performance evaluation, efficient system operation, flow control strategies.

Pumps and Pumping Systems: Types, performance evaluation, efficient system operation, flow control strategies, variable speed drives.

Cooling Towers: Types and performance evaluation, efficient system operations, flow control strategies, assessment of saving opportunities.

Illumination / Lighting Systems: Light source, choice of lighting, luminance requirements, electronic ballast, occupancy sensors, energy efficient lighting control.

Diesel generating systems: Factors affecting selection, energy performance assessment of diesel conservation avenues.

Unit-04: Energy Audit Instruments (C-0.5, L-05)

Basic measurements – Electrical measurements, Light, Pressure, Temperature and heat flux, Velocity and Flow rate, Vibrations, etc.

Instruments Used in Energy systems: Load and power factor measuring equipments, Wattmeter, flue gas analysis, Temperature and thermal loss measurements, air quality analysis etc.

Mathematical and statistical modeling and analysis.

Unit-05: Energy Measurement & Verification (C-0.5, L-05)

Electrical Energy Measurements, Thermal Energy Measurements, Mechanical & Utility System Measurements, Measurement & Verification, M & V Protocol,

Reference Books:

1. Principles of Energy Conversion : A.W. Culp.
2. Direct Energy Conversion : M.A. Kettani
3. Energy Conversion systems : Begamudre, Rakoshdas
4. Direct Energy Conversion : W.R. Corliss
5. Alternative Liquid fuels : B.V. Desai
6. TEDDY year book published by TERI, .
7. The Watt Committee on Energy (Reports)
8. Energy Management Workbook -

9. NIFES Report -Computers in Energy Audits.
10. Efficient Use of Energy : I.E.C.Dryden (Butterworths)
11. Instrument Engineers handbook (VolI,II,III)– B.G. Liptak Chintan Book Comp /CRC Publiation
12. Analysis and design of Energy Systems - Hogde b.K. (Prentice hall 1988)
13. Energy management and control system –Vol-I, II –M.C.Macedo (John Willy)
14. Energy Conservation guide book Patrick/Patrick/Fardo (Prentice hall1993)
15. Handbook on Energy efficiency – .
16. ASHRAEE Energy Use (4 Volumes),
17. CIBSI –guide –Users Manual (U.K.)

EN 114: Renewable Energy Systems-I (C-05, L-50)

Unit-01: Solar Energy (C-2.0, L-20)

Sun as Source of Energy, Availability of Solar Energy, Nature of Solar Energy, Solar Energy & Environment.

Various Methods of using solar energy –Photothermal, Photovoltaic, Photosynthesis, Present & Future Scope of Solar energy.

Hybrid wind energy systems - wind + diesel power, wind + conventional grid, wind + Photovoltaic system etc.

Unit-02: Bio-mass (C-0.1, L-10)

Biomass: Generation and utilization, Properties of biomass, Agriculture Crop & Forestry residues used as fuels.

Biochemical and Thermo-chemical Conversion, Combustion, Gasification, Biomass gasifiers and types etc.

Applications of Gasifiers to thermal power and Engines, Biomass as a decentralized power generation source for villages

Concept of Bio-energy: Photosynthesis process, Bio-fuels, Biomass resources Bio based chemicals and materials

Thermo-chemical Conversion: Pyrolysis, Combustion, Gasification, Liquefaction.

Bio-Chemical Conversion: Aerobic and Anaerobic conversion, Fermentation etc.

Bio-fuels: Importance, Production and applications.

Bio-fuels: Types of Bio-fuels, Production processes and technologies, Bio fuel applications, Ethanol as a fuel for I.C. engines, Relevance with Indian Economy.

Bio-based Chemicals and Materials: Commercial and Industrial Products, Biomass, Feed stocks, Chemicals, Plastics, Fibres etc.

Government Policy and Status of Bio fuel technologies in

Unit-03: Biomethanation (C-0.5, L-05)

Importance of biogas technology, Different Types of Biogas Plants.

Aerobic and anaerobic bioconversion processes, various substrates used to produce Biogas (cow dung, human and other agricultural waste, municipal waste etc.)

Individual and community biogas operated engines and their use.

Removal of CO₂ and H₂O, Application of Biogas in domestic, industry and vehicles.

Bio-hydrogen production.

Isolation of methane from Biogas and packing and its utilization.

Unit-04: Wind Energy(C-1.5, L-15)

Wind Energy: Basics & Power Analysis,

Wind resource assessment,

Power Conversion Technologies and applications,

Wind Power estimation techniques,

Principles of Aerodynamics of wind turbine blade,

Various aspects of wind turbine design,

Wind Turbine Generators: Induction, Synchronous machine, constant V & F and variable V & F generations, Reactive power compensation.

Site Selection,

Concept of wind farm & project cycle,

Cost economics & viability of wind farm,

Reference Books :

1. Biomass Renewable Energy – D.O.hall and R.P. Overeed
(John Wiley and Sons, New york, 1987)

2. Biomass for energy in the developing countries – D.O.Hall, G.W.barnard and P.A.Moss
(Pergamon Press Ltd. 1982)
3. Thermo chemical processing of Biomass, Bridgurater A V.
4. Biomass as Fuel – L.P.White (Academic press1981)
5. Biomass Gasification Principles and Technology, Energy technology review No. 67, -
T.B. Read (Noyes Data Corp. , 1981)
6. Wind energy Conversion Systems – Freris L.L. (Prentice Hall1990)
7. Wind Turbine Technology: Fundamental concepts of wind turbine technology
Spera D.A. (ASME Press, NY, 1994)
8. Wind Energy Systems – G.L. Johnson (Prentice Hall, 1985)
9. Wind Energy Explained – J.F.Manwell, J.G. McGowan and A.L. Rogers
(John Wiley & Sons Ltd.)

EN125: Practical-I (C-5.0, L-50) (15 Experiments, 1 Unit: 3 Experiments)

Atleast 12 practicals should be done during a semester.

- 1) Determination of efficiency of boiler and analysis of flue gases.
- 2) Study of heat exchangers.
- 3) Study of variable speed drives
- 4) COP of cooling towers.
- 5) Efficiency of electrical motors.
- 6) Study of diesel generator set.
- 7) Measurement of load and power factor for the electrical utilities.
- 8) Determination of efficiency of pumping system.
- 9) Performance evaluation of blower
- 10) Performance evaluation of air compressors
- 11) Determining efficiency of lighting system/loads
- 12) Measurement of Intensity of solar radiation
- 13) Energy Content in Wind. (Prototype Wind Mill of 500W)
- 14) Bio-gas Production from Kitchen waste.
- 15) Performance of Gasifire.

Semester-II

Distribution of Credits, Units, Lectures and Marks

Course Code	Course Title	Credits	Lectures	Marks Int + TE	Total Marks
EN-211	Energy Audit and Management- I	5	50	50 + 50	100
	Unit No.1: General Aspects	1.5	15	15	
	Unit No.2: Procedures and Techniques	1.5	15	15	
	Unit No.3: Energy Policy Planning and Implementation	1.0	10	10	
	Unit No.4: Energy Balance & MIS	0.5	05	05	
	Unit No.5: Energy Audit Instruments	0.5	05	05	
EN-212	Energy Conservation	5	50	50 + 50	100
	Unit No.1: General Aspects	0.5	05	05	
	Unit No.2: Waste Heat Recovery	1.0	10	10	
	Unit No.3: Energy Efficiency in Buildings & ECBC-2007	1.0	10	10	
	Unit No 4: Energy Storage	1.0	10	10	
	Unit No 5: Case Studies-Thermal Energy Conservation	1.5	15	15	
EN-213	Renewable Energy Systems-II	5	50	50 + 50	100
	Unit No.1: Geothermal, Tide and Wave Energy	1.0	10	10	
	Unit No.2: Hydrogen Energy	1.0	10	10	
	Unit No.3: Fuel Cells	1.0	10	10	
	Unit No.4: Hydel- Energy	1.0	10	10	
	Unit No.5: Nuclear Energy	1.0	10	10	
EN-214	Environmental Impact of Energy Systems	5	50	50 + 50	100
	Unit No.1: Impact of Energy systems on Environment	0.5	05	05	
	Unit No.2: Pollution due to Thermal, Hydel and Nuclear Power Plants	1.5	15	15	
	Unit No.3: Pollution due to Vehicles and Utilities	0.5	05	05	
	Unit No.4: Industrial and Urban Waste & Waste Energy Recovery	1.0	10	10	
	Unit No 5: Environmental and Pollution Control Laws	1.0	10	10	
	Unit No 6: Global Environmental Concern	0.5	05	05	
EN-221	Practical-II (15 Experiments, 1Unit= 3Experiments)	5	50	50 + 50	100

Syllabus for Semester-II

EN-211: Energy Audit and Management- I (C-5, L-50)

Unit -01: General Aspects (C-1.5, L-15)

General Philosophy and need of Energy Audit and Management.
Definition and Objective of Energy Management, General Principles of Energy Management, Energy Management Skills, Energy Management Strategy.
Energy Audit: Need, Types, Methodology and Approach.
Energy Management Approach, Understanding Energy Costs, Bench marking, Energy performance, Matching energy usage to requirements, Maximizing system efficiency, Optimizing the input energy requirements, Fuel and Energy substitution.

Unit -02: Procedures and Techniques (C-1.5, L-15)

Data gathering : Level of responsibilities, energy sources, control of energy and uses of energy get Facts, figures and impression about energy /fuel and system operations, Past and Present operating data, Special tests, Questionnaire for data gathering.

Analytical Techniques: Incremental cost concept, mass and energy balancing techniques, inventory of Energy inputs and rejections, Heat transfer calculations, Evaluation of Electric load characteristics, process and energy system simulation.

Evaluation of saving opportunities: Determining the savings in Rs, Noneconomic factors, Conservation opportunities, estimating cost of implementation.

Energy Audit Reporting: The plant energy study report- Importance, contents, effective organization, report writing and presentation.

Unit -03: Energy Policy Planning and Implementation (C-1.0, L-10)

Key Elements: Force Field Analysis, Energy Policy-Purpose, Perspective, Contents and Formulation.

Format and Ratification, Organizing: Location of Energy Manager, Top Management Support, Managerial functions, Role and responsibilities of Energy Manager, Accountability. Motivating – Motivation of employees, Requirements for Energy Action Planning.

Information Systems: Designing, Barriers, Strategies, Marketing and Communicating Training and Planning.

Unit -04: Energy Balance & MIS (C-0.5, L-05)

First law of efficiency and Second law of efficiency, Facility as an Energy system, Methods for preparing process flow, Materials and Energy Balance diagram, Identification of losses, Improvements.

Energy Balance sheet and Management Information System (MIS)

Energy Modeling and Optimization.

Unit -05: Energy Audit Instruments (C-0.5, L-05)

Instruments for Audit and Monitoring Energy and Energy Savings, Types and Accuracy

Reference Books:

1. Energy Management: W.R.Murphy, G.Mckay (Butterworths).
2. Energy Management Principles: C.B.Smith (Pergamon Press).
3. Efficient Use of Energy : I.G.C.Dryden (Butterworth Scientific)
4. Energy Economics -A.V.Desai (Wiley Eastern)
5. Industrial Energy Conservation : D.A. Reay (Pergamon Press)
6. Energy Management Handbook – W.C. Turner (John Wiley and Sons, A Wiley Interscience Publication)
7. Industrial Energy Management and Utilization – L.C. Witte, P.S. Schmidt, D.R. Brown (Hemisphere Publication, Washington)
8. Industrial Energy Conservation Manuals, MIT Press, Mass, 1982
9. Energy Conservation guide book Patrick/Patrick/Fardo (Prentice Hall)
10. Handbook on Energy efficiency –
11. ASHRAEE Energy Use (4 Volumes)
12. CIBSI Guide –Users Manual (U.K.)
8. CRC Handbook of Energy Efficiency – CRC Press.

EN-212: Energy Conservation (C-5, L-50)

Unit-01: General Aspects (C-0.5, L-05)

Introduction to ENCON, Approach and modern techniques, benefits, trends.
Energy Conservation Technology (Thermal Energy).
Energy Conservation in Energy Intensive Industries.
Techno-Economic evaluation of conservation technologies, Efficiency Improvements
Thermal Utilities: Boilers, Steam System, Thermic Fluid Heating Systems, Furnaces,
Heating and Melting Applications, Refractories etc.,
Fuel Shift: Oil, Gas, Coal, Bio-mass, and Renewable.

Unit-02: Waste Heat Recovery (C-1.0, L-10)

Sources of waste heat and its potential applications, Waste heat survey and measurements, Data collection, Limitations and affecting factors
Heat recovery equipment and systems, Heat Exchangers, Incinerators
Regenerators and Recuperates.
Waste Heat boilers.
System Integration.

Unit-03: Energy Efficiency in Buildings & ECBC-2007 (C-1.0, L-10)

Introduction, Definition and concepts, Energy and Water as a resource, Criticality of resources and needs of modern living. Envelop heat loss and heat gain and its evaluation, Thermal Comfort improvement methods, Optimum performance, Other building comforts, IAQ requirements,

Electrical Energy Conservation, Opportunities and Techniques for energy conservation in Buildings.

Adoption to sustainable resources, process and Technologies.

Green Buildings, Intelligent Buildings, Rating of Buildings, Efficient Use of Buildings, Solar Passive Architecture.

Eco-housing concepts and National and International norms.

Unit-04: Energy Storage (C-1.0, L-10)

Need and importance of Energy storage in Conventional and Nonconventional Energy Systems. Technical Aspects (Measurements, Quantify)

Various forms of Energy Storage: Thermal, Chemical, Mechanical, Electrical and Nuclear

Techno Commercial Analysis (Economical aspects),

Energy Storage: Devices and Systems.

Unit-05: Case Studies: Thermal Energy Conservation (C-1.5, L-15)

Case studies of Commercial/ Industrial/ Residential thermal energy conservation systems and their economical analysis.

Books:

1. Energy Management: W.R.Murphy, G.Mckay (Butterworths).
2. Energy Management Principles: C.B.Smith (Pergamon Press).
3. Efficient Use of Energy : I.G.C.Dryden (Butterworth Scientific)
4. Energy Economics -A.V.Desai (Wiley Eastern)
5. Industrial Energy Conservation : D.A. Reay (Pergamon Press)
6. Energy Management Handbook – W.C. Turner (John Wiley and Sons, A WileyInterscience publication)
7. Industrial Energy Management and Utilisation –L.C. Witte, P.S. Schmidt, D.R. Brown (Hemisphere Publication, Washington)
8. Industrial Energy Conservation Manuals, MIT Press.
9. Energy Conservation guide book Patrick/Patrick/Fardo (Prentice Hall)
10. Handbook on Energy Efficiency.
11. ASHRAEE Energy Use (4 Volumes),
12. CIBSI Guide and Users Manual (U.K.)
13. Handbook of Energy Efficiency – CRC Press

EN-213: Renewable Energy Systems-II (C-5, L-50)

Unit-01: Geothermal, Tide and Wave Energy (C-1.0, L-10)

Availability of Geothermal Energy-size and Distribution, Recovery of Geothermal Energy, Various Types of Systems to use Geothermal Energy, Direct heat applications, Power Generation using Geothermal Heat, Sustainability of Geothermal Source, Status of Geothermal Technology, Economics of Geothermal Energy.

Unit-02: Hydrogen Energy (C-1.0, L-10)

Hydrogen as a renewable energy source, Sources of Hydrogen, Fuel for Vehicles.

Hydrogen Production: Direct electrolysis of water, thermal decomposition of water, biological and biochemical methods of hydrogen production.

Storage of Hydrogen: Gaseous, Cryogenic and Metal hydride

Unit-03: Fuel Cell (C-1.0, L-10)

Fuel cell – Principle of working, construction and applications.

Unit-04: Hydel Energy (C-1.0, L-10)

Hydro power: Potential, Hydropower Generation and Distribution, Mini and Microhydel Power (MHP) Generation: Classification of hydel plants, Concept of micro hydel, merits, MHP plants: Components, design and layout, Turbines, efficiency, Status in India. Integrated Energy systems and their cost benefit analysis.

Unit-05: Nuclear Energy (C-1.0, L-10)

Potential of Nuclear Energy, International Nuclear Energy Policies and Regulations. Nuclear Energy Technologies – Fuel enrichment, Different Types of Nuclear Reactors, Nuclear Waste Disposal, and Nuclear Fusion.

Reference Books :

1. Renewable Sources of Energy and Conversion Systems:
N.K.Bansal and M.K.Kleeman.
2. Principles of Thermal Process : Duffie -Beckman.
3. Solar Energy Handbook: Kreith and Kreider (McGrawHill)
4. Solar Cell : Marteen A. Green
5. Solar Hydrogen Energy Systems -T. Ohta (Ed.) (Pergamon Press)
6. Hydrogen Technology for Energy – D.A.Maths (Noyes Data Corp.)
7. Handbook : Batteries and Fuel cell – Linden (Mc.Graw Hill)
8. Batteries Volume (I) and (II) - Collins

EN-214: Environmental Impact of Energy Systems (C-5, L-50)

Unit-01: Impact of Energy Systems on Environment (C-0.5, L-05)

Environmental degradation due to energy production and utilization, Primary and Secondary pollution such as SO_x, NO_x, SPM in air, thermal and water pollution, depletion of ozone layer, global warming, biological damage due to environmental degradation. Sociological and Economical problems due to Thermal and other energy projects. Physiological, ecological and environmental and health problems due to energy plants.

Methods of Environmental Impact Assessment.

Unit-02: Pollution due to Thermal, Hydel and Nuclear Power Plants (C-1.5, L-15)

Potential sources of Pollution in thermal power plant, Air, water, land pollution due to estimation for thermal power plant.

Environmental pollution limits guidelines for thermal power plant pollution control. Various pollution control equipments such as dust collector, bag filter, electrostatic separator, working principle and selection criteria, designing the pollution control system, methods and limitation.

Water pollution in thermal power plant, physical and chemical methods of pollution control, Land pollution effect of land pollution, measurement of land pollution.

Limitations and advantages of pollution control systems.

Hydrothermal plant environmental assessment, hydrothermal plant and rehabilitation measures for hydrothermal plant.

Nuclear power plants and environmental pollution, pollution control measures.

Unit-03: Pollution due to Vehicles and Utilities (C-0.5, L-05)

Pollution due to vehicles and utilities, Methods to Control emission from Vehicle, Boilers, Furnaces etc, International Standards for Quality of air and norms for exhaust gases.

Effect of Hydro electric power stations on ecology and environment.

Unit-04: Industrial and Urban Waste & Waste Energy Recovery (C-1.0, L-10)

Industrial waste, Waste and effluent treatment,

Waste as a source of energy: Industrial, domestic and solid waste as a source of energy.

Pollution control: Causes, process and exhaust gases and its control, mechanism and devices for pollution control.

Unit-05: Environmental and Pollution Control Laws (C-1.0, L-10)

United Nations Framework Convention on Climate Change (UNFCCC), Protocol, Conference of Parties (COP)

Clean Development Mechanism (CDM), Prototype Carbon Funds(PCF)
Carbon Credits and it's trading, Benefits to developing countries, Building a CDM project.

Unit-06: Global Environmental Concern (C-0.5, L-05)

Global Environmental Issues, ozone layer depletion, Global Warming, Green House Gases Emission

Books:

1. Management of Energy Environment Systems -W.K.Foell (John Wiley and Sons).
2. Energy Management and Control Systems -M.C.Macedo Jr. (John Wiley and Sons).
3. Environmental Impact Analysis Handbook -J.G.Rau, D.C.Wood (McGraw Hill).
4. Energy & Environment – J.M. Fowler, (McGrawHill)

EN-215: Practical-II (C-5.0, L-50) (15 Experiments, 1 Unit: 3 Experiments)

Atleast 12 practicals should be done during a semester.

- 1) Study of solar collector.
- 2) Study of solar hot water systems (FPC and ETC)
- 3) Study of solar hot air collector/ solar dryer.
- 4) Performance evaluation of box type and concentrating type solar cooker.
- 5) Study of heat pipe
- 6) Characteristics of SPV system.
- 7) Determination of efficiency of DC/AC inverter.
- 8) Study of Chulla and Gas Stove.
- 9) Study of Lead Acid Battery as a energy storage.
- 10) Study of Performance of Solar Lamp.
- 11) Determination of “Star Rating” of Refrigerator.
- 12) Flue gas analysis of petrol, diesel and LPG Engines.
- 13) Wind power and annual energy estimation from wind data.
- 14) Pay back analysis, financial work sheet of a renewable energy project.
- 15)
 - a) Find COP of 1.5 TR window / Split AC.
 - b) Find COP with Heat Balance method.
 - c) Effect of Condenser coding on COP of AC.
 - d) Effect of desuperheater (Hot water generation)

Semester-III
Distribution of Credits, Units, Lectures and Marks

Course Code	Course Title	Credits	Lectures	Marks Int + TE	Total Marks
EN-311	Energy Audit and Management- II	5	50	50 + 50	100
	Unit No.1: Economic Analysis and Financial Management	1.5	15	15	
	Unit No.2: Project Management	0.5	5	5	
	Unit No.3: Energy Monitoring, Targeting Review and Evaluation	1.5	15	15	
	Unit No.4: Energy Policy	0.5	5	5	
	Unit No.5: Energy Management –Case Studies	1.0	10	10	
EN-312	Energy Audit Procedures and Techniques	5	50	50 + 50	100
	Unit No.1: Energy Audit Methodology & Recent Trends	1.0	10	10	
	Unit No.2: Electrical Distribution & Utilisation	1.0	10	10	
	Unit No.3: Thermal Systems	1.0	10	10	
	Unit No.4: Cogeneration	1.0	10	10	
	Unit No.5: System Audit of Mechanical utilities	1.0	10	10	
EN-313	Elective Course (Any one of the following)				100
	A) Advanced Solar Thermal and PV	5	50	50 + 50	
	Unit No.1: Solar Radiation	0.5	05	05	
	Unit No.2: Photothermal Systems	2	20	20	
	Unit No.3: Photovoltaic Systems	1.5	15	15	
	Unit No 4: Design and Modeling of Solar Energy Systems	0.5	05	05	
	Unit No 5: Economic Analysis of Solar Energy Systems	0.5	05	05	
	B) Wind Energy	5	50	50 + 50	100
	Unit No.1: Wind Energy Fundamentals	0.5	05	05	
	Unit No.2: Wind Measurements, Analysis and Energy Estimates	1	10	10	
	Unit No.3: Aerodynamics Theory	0.5	05	05	
	Unit No 4: Wind Turbines Technology & Components of MW series WTGs	1	10	10	
	Unit No 5: Modern Wind Turbine Control & Monitoring System	0.5	05	05	
	Unit No.6: Concept of Wind Farms and Project Cycle	1	10	10	
	Unit No 7: Cost Economics	0.5	05		
	C) Advanced Energy Management	5	50	50 + 50	100
	Unit No.1: EC Act 2001, Electricity Act 2003, Revisions and their Present Status of Implementation	1.0	10	10	
	Unit No.2: Energy Conservation in Buildings, Energy Efficiency Ratings for Buildings & ECBC-2008	1.5	15	15	
	Unit No.3: Financing of Energy Efficiency Projects	0.5	5	5	
	Unit No 4: Energy Performance Contracts & Energy Services Company (ESCO)	1.0	10	10	
	Unit No. 5 CDM Benefits for EC Projects, Methodology & Procedure	1.0	10	10	
EN-324	Industrial Training (Duration: 6 weeks, 2 Credits for Energy Awareness Program)	10	100	100+ 100	200

Syllabus for Semester-III

EN-311: Energy Audit and Management- II (C-5, L-50)

Unit No.01: Economic Analysis and Financial Management (C-1.5, L-15)

Objectives, Investment needs, appraisal and criteria, sources of funds.

Anatomy of investment – Initial investment, Return on Investment, Economic life, Basic income equations.

Tax considerations: Depreciation, types and methods of depreciation, Income tax Considerations.

Financial analysis: Simple pay back period, Return on investment (ROI), Net Present value (NPV), Internal Rate of Return (IRR), and Annualized cost, Time value of money, Cash flows, Discounting, Inflation Risk and sensitivity analysis, financing options.

Pros and cons of the common methods of analysis.

Unit No.02: Project Management (C-0.5, L-05)

Definition and scope of project, technical design, financing, contracting, implementation and performance monitoring.

Implementation plan for top management, Planning budget, Procurement procedures, construction, Measurements and verification

Unit No.03: Energy Monitoring, Targeting Review and Evaluation (C-1.5, L-15)

Definition – Monitoring and targeting, elements of monitoring and targeting, data and information analysis, techniques energy consumption, production, cumulative sum of difference (CUSUM), Review and evaluation.

Unit No.04: Energy Policy (C-0.5, L-05)

Need for Energy Policy for Industries, Formulation of Policy by any industrial Unit, Implementation in Industries, National & State level Policies.

Unit No.05: Energy Management –Case Studies (C-1.0, L-10)

Study of 4 to 6 cases of Successful Energy Management in Industries.

Reference Books:

1. Energy Management: W.R.Murphy, G.Mckay (Butterworths).
2. Energy Management Principles: C.B.Smith (Pergamon Press).
3. Efficient Use of Energy: I.G.C.Dryden (Butterworth Scientific)
4. Energy Economics - A.V.Desai (Wiley Eastern)
5. Industrial Energy Conservation: D.A. Reay (Pergamon Press)
6. Energy Management Handbook – W.C. Turner (John Wiley and Sons, A Wiley Interscience publication)
7. Industrial Energy Management and Utilisation –L.C. Witte, P.S. Schmidt, D.R. Brown (Hemisphere Publication, Washington, 1988)
8. Industrial Energy Conservation Manuals, MIT Press, Mass, 1982
9. Energy Conservation guide book Patrick/Patrick/Fardo (Prentice hall1993)

10. Handbook on Energy efficiency.
11. ASHRAEE Energy Use (4 Volumes),
12. CIBSI –guide –Users Manual (U.K.)
13. CRC Handbook of Energy Efficiency – CRC Press

EN-312: Energy Audit Procedures and Techniques (C-5, L-50)

Unit No.01: Energy Audit Methodology & Recent Trends (C-1.0, L-10)

Current Practices, Integration of two or more systems, Switching of Energy Sources, Economics of implementation of energy optimisation projects, it's constraints, barriers and limitations, Report-writing, preparations and presentations of energy audit reports, Post monitoring of energy conservation projects, MIS ,Case-studies / Report studies of Energy Audits.

Guidelines for writing energy audit report, data presentation in report, findings recommendations, impact of renewable energy on energy audit recommendations.

Case studies of implemented energy cost optimization projects in electrical utilities as well as thermal utilities.

Unit No.02: Electrical Distribution and Utilisation (C-1.0, L-10)

Electrical Systems, Transformers loss reductions, parallel operations, T & D losses, P.F. improvements, Demand Side management (DSM), Load Management, Harmonics & its improvements, Energy efficient motors and Soft starters, Automatic power factor Controllers, Variable speed drivers, Electronic Lighting ballasts for Lighting, LED Lighting, Trends and Approaches.

Unit No.03: Thermal Systems (C-1.0, L-10)

Boilers- performance evaluation, Loss analysis, Water treatment and its impact on boiler losses, integration of different systems in boiler operation.

Advances in boiler technologies, FBC and PFBC boilers, Heat recovery Boilers- it's limitations and constraints.

Furnaces- Types and classifications, applications, economics and quality aspects, heat distributions, draft controles, waste heat recovering options, Furnaces refractories- types and sections.

Thermic Fluid heaters, need and applications, Heat recovery and its limitations.

Insulators- Hot and Cold applications, Economic thickness of insulation, Heat saving and application criteria.

Steam Utilization- Properties, steam distribution and losses, steam trapping, Condensate, Flash steam recovery.

Unit No.04: Cogeneration (C-1.0, L-10)

Integrated analysis of steam base co-gen system, Gas turbine combine cycle operation, IC engine base co-generation and tri-generation, extraction turbines and steam cycle of co-generation.

Unit No.05: System Audit of Mechanical Utilities (C-1.0, L-10)

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

Blowers,(Blowers) types & application, its performance assessment, series & parallel operation applications & advantages. Energy Saving in Blowers

Compressors, types & applications, specific power consumption, compressed air system, & economic of system changes. Energy Saving in Compressors & Compressed Air Systems

Cooling towers, its types and performance assessment & limitations, water loss in cooling tower. Energy Saving in Cooling Towers

HVPC & Psychometric, vapour compression cycles & comfort cooling, refrigerants new trends, COP, Capacity assessment, Vapor absorption refrigeration's – Li Br & Ammonia Cycles, working principle and system analysis, comparison of different cooling systems, heat pump off ions for HVPC systems improvements and its analysis. Energy Saving in HVAC Systems

Water system and water analysis for power generation, water audit and its utilization, Hydro-pneumatic applications for optimization of water pumping cost

Study of 4 to 6 cases of Energy Audit & Management in Industries (Boilers, Steam System, Furnaces, Insulation and Refractories, Refrigeration and Air conditioning, Cogeneration, Waste Heat recovery etc.)

Study of 4 to 6 cases of Electrical Energy audit and management (Power factor improvement, Electric motors, Compressed air systems, Pumping systems, Fans and blowers, Cooling Towers, Industrial/Commercial Lighting system, Diesel based power Generation system etc.)

Study of Energy Audit reports for various Industries and Organizations

Reference Books:

1. Energy Management: W.R.Murphy, G.Mckay (Butterworths).
2. Energy Management Principles: C.B.Smith (Pergamon Press)
3. Efficient Use of Energy: I.G.C.Dryden (Butterworth Scientific)
4. Energy Economics -A.V.Desai (Wiley Eastern)
5. Industrial Energy Conservation: D.A. Reay (Pergamon Press)
6. Energy Management Handbook – W.C. Turner (John Wiley and Sons, A WileyInterscience publication)
7. Industrial Energy Management and Utilization –L.C. Witte, P.S. Schmidt, D.R. Brown (Hemisphere Publication, Washington, 1988)
8. Industrial Energy Conservation Manuals, MIT Press, Mass, 1982
9. Energy Conservation guide book Patrick/Patrick/Fardo (Prentice hall1993)

10. Handbook on Energy efficiency –
11. ASHRAEE Energy Use (4 Volumes),
12. CIBSI –guide –Users Manual (U.K.)
13. CRC Handbook on Energy Efficiency – CRC Press

EN-313: Special Course (Any one of the following) (C-5, L-50)

A) ADVANCED SOLAR THERMAL AND PV: (C-5, L-50)

Unit No.01: Solar Radiation (C-0.5, L-05)

Nature of Solar Radiation, Global, Beam and Diffuse Radiation, Hourly, Daily and Seasonal variation of solar Radiation, Estimation of Solar Radiation, Measurement of Solar Radiation.

Unit No.02: Photo thermal Systems (C-2.0, L-20)

Flat Plate Collector, Hot Air Collector, Evacuated Tube Collector, Parabolic , Compound Parabolic and Fresnel Solar Concentrators, Central Receiver System, Thermal Analysis of Solar Collectors Performance of Solar Collectors, Solar Water Heating Systems(Active & Passive), Solar Space Heating & Cooling Systems, Solar Industrial Process Heating Systems, Solar Dryers & Desalination Systems, Solar Thermal Power Systems.

Unit No.03:- Photovoltaic systems (C-1.5, L-15)

Solar cells & panels, performance of solar cell, estimation of power obtain from solar power, solar panels PV systems, components of PV systems, performance of PV systems, design of PV systems, applications of PV systems, concentrating PV systems, P{V power plants, power plant with fuel cells

Unit No.04:- Design & modeling of solar energy systems (C-0.5, L-05)

F Chart method, ϕ - F Chart method, Utilizability modeling & simulation of Solar Energy Systems,

Unit No.05:- Economic analysis of Solar energy Systems (C-0.5, L-05)

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

Reference Books:

J.A.Duffie & W.A. Beckman: Solar Engineering of Thermal Process
S.A.Kalogirou: Solar Energy Engineering

B) WIND ENERGY (C-5, L-50)

Unit No.01: Wind Energy Fundamentals (C-0.5, L-05)

Wind Energy Basics, Wind Speeds and scales, Terrain, Roughness, Wind Mechanics, Power Content, Class of wind turbines, Atmospheric Boundary Layers, Turbulence.

Unit No.02: Wind Measurements, Analysis and Energy Estimates (C-1.0, L-10)

Instrumentation for wind measurements, Wind data analysis, tabulation, Wind resource estimation, Betz's Limit, Turbulence Analysis

Unit No.03: Aerodynamics Theory (C-0.5, L-05)

Airfoil terminology, Blade element theory, Blade design, Rotor performance and dynamics, Balancing technique (Rotor & Blade), Types of loads; Sources of loads

Unit No.4: Wind Turbines Technology & Components of MW series WTGs.

(C-1.0, L-10)

Wind turbines types:

Vertical Axis Type, Horizontal Axis, Constant Speed Constant Frequency, Variable speed Variable Frequency, Up Wind, Down Wind, Stall Control, Pitch Control, Gear Coupled Generator type, Direct Generator Drive /PMG/Rotor Excited Sync Generator

Wind Turbine Technology & Components of WTG

- 1) Gear Coupled Generator Type [Const. Speed]
- 2) Direct Coupled Generator Type [Variable Speed Variable Frequency]: Multipole Synchronous / PMG Generators.

Gear Coupled Generator Wind Turbine Components and their construction

Electronics Sensors /Encoder /Resolvers, Wind Measurement : Anemometer & Wind Vane, Grid Synchronisation System, Soft Starter, Switchgear [ACB/VCB], Transformer, Cables and assembly, Compensation Panel, Programmable Logic Control, UPS, Yaw & Pitch System : AC Drives, Safety Chain Circuits, Generator Rotor Resistor controller (Flexi Slip), Differential Protection Relay for Generator, Battery/Super Capacitor Charger & Batteries/ Super Capacitor for Pitch System, Transient Suppressor / Lightning Arrestors, Oscillation & Vibration sensing.

Direct Rotor Coupled Generator (Multipole) [Variable Speed ,Variable Freq.]

Excited Rotor Synch.Generator / PMG Generator, Control Rectifier, Capacitor Banks, Step Up / Boost Converter (DC-DC Step Up), Grid Tied Inverter, Power Management, Grid Monitoring Unit (Voltage and Current), Transformer, Safety Chain Circuits

Doubly Fed Induction Generator and Power Control

Unit No5: Modern Wind Turbine Control & Monitoring System (C-0.5, L-05)

Details of Pitch System & Control Algorithms, Protections used & Safety Consideration in Wind turbines, Wind Turbine Monitoring with Error codes, SCADA & Databases: Remote Monitoring and Generation Reports, Operation & Maintenance for Product Life

Cycle, Balancing technique (Rotor & Blade), FACTS control & LVRT & New trends for new Grid Codes.

Unit No.06: Concept of Wind Farms and project cycle (C-1.0, L-10)

Project planning, Site selection, Project execution, Operation and maintenance

Environmental concerns: Pollution free power; Noise; birds; Aesthetics; Radio waves interference; Rainfall

Unit No.07: Cost Economics (C-0.5, L-05)

Wind resource assessment and R & D costs, Fixed and variable costs, Value of wind energy, Life cycle costing and cash flow of wind power projects, Wind project owners / developers, Wind energy market

Reference Books:

Anna Mani : Wind Energy Data for India

C-Wet : Wind Energy Resources Survey in India VI

S. Rangrajan : Wind Energy Resources Survey in India V

Sathyajith Mathew : Wind Energy

Prepared by WISE: Wind Power in India (5000MW BY 2015)

B.H.Khan: Non-Conventional Energy Sources

C) ADVANCED ENERGY MANAGEMENT (C-5, L-50)

Unit No.01: Rules, Regulations & Laws governing Energy Conservation in India

(C-1.0, L-10)

Energy Conservation Act 2001, Revisions and Present State of Implementation Standardization & Labeling, Electricity Act 2003, Revisions and Present Status of Implementation

Unit No.02: Energy Conservation in Buildings, Energy Efficiency Ratings & ECBC-2007 (2008 Edition)

(C-1.5, L-15)

Energy Efficient Buildings, Green Buildings, Intelligent Buildings, Energy Conservation Opportunities in Public and Private Buildings

Various Energy Efficiency Rating Systems for Buildings- LEEDS, BEE & GRIHA Rating Systems

Energy Conservation Building Code – 2007 (2008 Edition)

Unit No.03:- Energy Efficiency Projects & Financing of Energy Efficiency Projects

(C-0.5, L-05)

Energy Efficiency Projects, Evaluation of Energy Efficient Projects, Various ways of Financing Energy Efficiency Projects, Role of Financial Institutions and Corporate Banks, Deferred Payment Financing,

Unit No.04:- Energy Performance Contracts & Energy Service companies
(C-1.0, L-10)

Types of Energy Performance Contracts, Energy Service Companies (ESCOs) and their
Role, Emphasis on ESCOs

**Unit No.05:- Clean Development Mechanism Benefits for Energy Conservation
Projects, Methodology & Procedure**
(C-1.0, L-10)

What is CDM? Methodology & Procedures for CDM, Eligibility Criteria, UNFCCC,
Role of UNFCCC & Government of India,

Reference Books:

ECBC Code 2007 (Edition 2008) published by Bureau of Energy Efficiency, New Delhi
Bureau of Energy Efficiency Publications-Rating System, TERI PUBLICATIONS –
GRIHA Rating System, LEEDS Publications

EN-324: Industrial Training

Course No	Course Title	Credits	Duration	Int + Ext Marks	Total Marks
EN-324	Industrial Training (Duration: 1.5 months / 06 weeks)	10	1.5Months or 6 weeks	100+ 100	200

The Industrial Training should be carried out in a Industry or Research Laboratory engaged in the R & D activities in Energy Field. The NGO's undertaking pilot projects in the Field of Energy can also impart training to the M.Tech student. The training shall be for a period of six weeks and student should spend approximately 100 hours on training. A brief report of training activities certified by authorities imparting training shall be submitted at least one month before the end of semester.

The assement of training shall be done as follows.

- 1) Evaluation by Training Institute of Student- 2.5 Credits (50 Marks)
- 2) Mid-Term Evaluation of Training (including Energy Awareness programme) – 2.5 Credits (50 Marks)
- 3) Final Viva Voce Examination – 5 Credits (100 Marks)

Semester-IV

Distribution of Credits, Units, Lectures and Marks

Course No	Course Title	Credits	Duration	Int + Ext Marks	Total Marks
EN-421	Project Work (Duration: 5 months / 20 weeks, 36 hrs/ week)	25	5 months/ 20 weeks	250+ 250	500

Industrial Project or Research Project equivalent to 25 Credits shall be completed by the student during fourth semester. A project report giving details of work done under the project should be submitted one month before the end of the semester. The project work shall be monitored by internal guide and / or a authorized / qualified person from the industry where student is doing the work.

The topic of the project and work-plan shall be approval by the internal committee formed under the chairmanship of Director, School of Energy Studies. Mid-Term and pre-submission viva-voce examination shall be compulsory to every student.

Distribution of Credits fro Project work shall be as follows.

- 1) Selection of Topic and Work-Plan- 2.5 Credits, 50 Marks
- 2) Mid-Semester presentation – 5 Credits, 100 Marks
- 3) Pre- Submission Presentation - 5 Credits, 100 Marks
- 4) Find Viva- Voce Examination- 12.5 Credits , 250 Marks
