M.Tech. -Energy Studies

(4 Semester, Academic Flexibility, Credit System)

(L – No. of Lectures, C- Credits, Per Credits 10 Lectures)

SEMESTER-I

Course No.	Course Name	Name of Units/Topics	Credits	Total No. Lectures
EN-111	**Energy Scenario & Bridge Courses**	UNIT-01: Global & Indian Energy	2	20
		Scenario	1	10
		UNIT-02: Heat & Thermodynamics	1	10
		UNIT-03: Mechanical and	1	10
		Electrical Energy		
		UNIT-04: Bio-Energy OR Engineering Drawings & Designs		
EN-112	**Energy Conversion and Systems –I**	UNIT-01: Energy Classification	1	10
		UNIT-02: Thermal and Mechanical	1	10
		Energy	2	20
		UNIT-03: Thermal Energy Utility	1	10
		Systems		
		UNIT-04: Co-generation and Waste		
		Heat Recovery		
EN-113	**Energy Conversion and Systems –II**	UNIT-01: Electrical Energy	1	10
		UNIT-02: Electrical Energy Systems	3	30
		UNIT-03: Bio Energy	1	10

EN-114	**Energy Instrumentation**	UNIT-01: Energy Audit Instruments UNIT-02: Control Systems UNIT-03: Computerisation	2 2 1	20 20 10
EN-115	**Laboratory**	Part-A : General Part B: - Computers	5	20 (Hrs/Wk)
SEMESTER-II				
EN-121	**Renewable sources of Energy-I**	UNIT-01: New & Renewable Energy Source UNIT-02: Solar Thermal Energy UNIT-03:Bio-mass UNIT-04: Bio-gas	1 2 1 1	10 20 10 10
EN-122	**Renewable Sources of Energy-II**	UNIT-01: Photovoltaic UNIT-02: Wind energy UNIT-03: Hydrogen and Fuel cell UNIT-04: Hydle & Integrated Energy systems	1 2 1 1	10 20 10 10
EN-123	**Environmental Impact of Energy Systems**	UNIT-01: Environmental impacts UNIT-02: Pollution- Thermal plants UNIT-03: Pollution – Nuclear and Hydro plants UNIT-04: Industrial Waste UNIT-05: Global Environmental	1 1 1 1 1	10 10 10 10 10

		Concern		
EN-124	**Energy Audit & Management-I**	UNIT-01: General Aspects UNIT-02: Procedures & Techniques UNIT-03: Energy Policy Planning & Implementation UNIT-04: Energy balance and MIS	1 2 1 1	10 20 10 10
EN-125	**Laboratory**	Part-A: Thermal Part-B: Electrical and Other	5	20 (Hrs/Wk)
SEMSTER-III				
EN-211	**Energy Audit & Management-II**	UNIT-01: Economic analysis and Financial management UNIT-02: Project Management UNIT-03: Energy Monitoring, Targeting, Review and Evaluation UNIT-04: Energy Audit/ Management-Case studies	1 1 1 2	10 10 10 20
EN-212	**Energy Conservation-I**	UNIT-01: General Aspects UNIT-02: Waste Heat Recovery UNIT-03: Energy Storage UNIT-04: Energy conservation in Buildings	1 1 1 1 1	10 10 10 10 10

		UNIT-05: Case Studies : Thermal Energy Conservation		
EN-213	**Energy Conservation-II**	UNIT-01: General Aspects UNIT-02: Illumination UNIT-03:Electrical Systems UNIT-04: Case Study: Electrical Energy conservation	1 1 1 2	10 10 10 20
EN-214	**Industrial Training**	Training Report	10	24 (Hrs/Wk)
SEMESTER-IV				
EN-221	**Project**	Project Report	25	36 (Hr/WK)

Under the academic flexibility and the credit system adopted for the course minimum 75 % credits shall be obtained from the M.Tech. Energy studies course work. These credits should essentially cover EN- 214 and EN-221 course. While 25 % credits shall be obtained from any other discipline from . However Laboratory courses, Industrial training and project work shall be compulsory.

Syllabus for M.Tech. -Energy Studies

(4 Semester, Academic Flexibility, Credit System)

(L – No. of Lectures, C- Credits, Per Credits 10 Lectures)

SEMESTER-I

EN-111: ENERGY SCENARIO & BRIDGE COURSE :

Unit-01 *: Global & Indian Energy Scenario (C-2, L-20)*

- 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 for security and Security of Energy, Energy Consumption and its impact on environmental climatic change.
- Future Energy Options: Sustainable Development, Energy Crisis : Transition from carbon rich and nuclear to carbon free technologies, parameters of transition ,

Indian Energy Scenario

- Energy resources & Consumption: Commercial and non-commercial 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 and its features, Electricity Bill-2003 & features.

Unit –02 *: Heat and Thermodynamics (C-1, L-10)*

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

Unit –03 *: Mechanical & Electrical Energy (C-1, L-10)*

Mechanical Energy

- 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.

Electrical Energy :

- 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-05 *: Bio-Energy Conversion (C-1, L-10) - (For Engineering Students)*

- Concept of Bioenergy : Photosynthesis process, Biofuels, Biomass resources Bio based chemicals and materials
- Thermochemical Conversion: Pyrolysis, Combustion, Gasification, Liquification.
- Bio-Chemical Conversion : Aerobic and Anaerobic conversion, Fermentation etc.
- Biofuels: Importance, Production and applications.

OR

Unit-05 *: Engineering Drawing and Design (C-1, L-10) – (For Science students)*

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, Springer-2002.
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.)

EN-112 : ENERGY CONVERSION & SYSTEMS-I

Unit-01 *: Energy Classification (C-1,L-10)*

Energy Classification, Principle fuels for energy conversion: Fossil fuels, nuclear fuels, Conventional

& Non-conventional 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, L-10)*

- Production of Thermal energy using fossil fuels, Bio-mass and Solar energy.
- Production of Mechanical energy using thermal energy, electric energy (electric motors),
- Turbines : Steam turbines, Hydraulic turbines and wind turbines.

Unit-03 *: Thermal Energy Utility Systems (C-2, L-20)*

- 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.
- Boilers - Types, combustion in boilers, performance evaluation, analysis of losses, feed water treatment, blow down.
- Steam Systems: Properties of steam, assessment of steam distribution losses, steam leakages, steam trapping, condensate and flash steam recovery system.
- Furnaces: Classification, general fuel economy measures in furnaces, excess air heat distribution, temperature control, draft control, waste heat recovery.
- Insulation and Refractories: Insulation types and application, economic thickness of insulation, heat saving and application criteria, Refractory types, selection and application of refractories, heat losses.
- FBC Boilers: Introduction, mechanism of fluidized bed combustion, advantages, types of FBC boilers, operational features, retrofitting FBC system to conventional boilers.

Unit–04*: Cogeneration & Waste Heat Recovery (C-1, L-10)*

- Cogeneration: Definition, need, application, advantages, classification, saving potentials
- Waste Heat Recovery: Concept of conversion efficiency, energy waste, waste heat recovery classification, advantages and applications, commercially viable waste heat recovery devices.

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 (McGraw-Hill 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. Nortan,(John Wiley Publication.)

8. Refractories and their Uses – Kenneth Shaw, (Applied Science Publishers Ltd. .)
9. Refractory Material- G.B. Rotherberg , (Noyes data Coorp. 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. Burkhadt (Mc-Graw hill Publication)
13. The efficient use of steam – Oliver Lyle, (HMSO London)
14. Boilers – Types, Characteristics and functions – Carl D. Shields (Mc-graw 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, USA-1976)

EN-113: ENERGY CONVERSION AND SYSTEMS-II

Unit-01 *: Electrical Energy (C-1, L-10)*

- Importance of Electrical energy in modern industrial society, Production of electricity using coal, oil, natural gas, nuclear fuels and hydle,- its relative advantages and disadvantages (i.e. conversion of Themal, 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 .

Unit-02 *: Electrical Energy Systems (C-3, 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.
- 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, 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.
- 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-03** : Bio-Energy (C-1, L-10)*

- Biofuels : Types of Bio-fuels, Production processes and technologies, Bio fuel applications, Ethanol as a fuel for I.C. engines, Relevance with Indian Economy.
- Biobased Chemicals and Materials : Commercial and Industrial Products, Biomass Feed stocks, Chemicals, Plastics, Fibres etc .
- Govt Policy and Status of Bio fuel technologies in

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, .

EN-114: ENERGY INSTRUMENTATION

***Unit-01** : Energy Audit Instruments (C-2, L-20)*

- 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-02** : Control Systems : (C-2 , L-20)*

- Transducers used for energy related parameter measurements
- Various ways of conversion and modification of signals
- Analog to digital signal conversion and advantages of digital signal
- Digital systems for indication and control
- Microprocessor introduction and architecture
- Microprocessors and their use in process control
- Data acquisition systems.

***Unit–03:** Computerisation (C-1, L-10)*

- Use of computers in energy audit and management
- Analysis of data using numerical and statistical methods, spread sheets etc.
- Energy optimization using computers, Energy management software and their use in industry,
- Report writing & Presentation.

Books :

1. The Watt Committee on Energy (Reports)

2. Energy Management Workbook - .
3. NIFES Report - Computers in Energy Audits.
4. Efficient Use of Energy : I.E.C.Dryden (Butterworths)
5. Instrument Engineers handbook (Vol-I,II,III)– B.G. Liptak Chintan Book company/CRC Publiation
6. Analysis and design of Energy Systems - Hogde b.K. (Prentice hall- 1988)
7. `Energy management and control system –Vol-I, II – M.C.Macedo (john Wiley and Sons)
8. Energy Conservation guide book- Patrick/Patrick/Fardo (Prentice hall-1993)
9. Handbook on Energy efficiency – .
10. ASHRAEE- Energy Use (4 Volumes),
11. CIBSI –guide –Users Manual (U.K.)

EN-115 : LABORATORY WORK (First Semester)

PART-A- General

1. Determination of efficiency of boiler and analysis of flue gases.
2. Heat balance of a furnace and determination of efficiency.
3. COP for air-conditioning and refrigeration system.
4. Study of heat exchangers.
5. Study of variable speed drives
6. COP of cooling towers.
7. Efficiency of electrical motors.
8. Study of diesel generator set.
9. Measurement of load and power factor for the electrical utilities.
10. Determination of efficiency of pumping system.
11. Performance evaluation of blower
12. Performance evaluation of air compressors
13. Determining efficiency of lighting system/loads

PART-B - Computers

14. Computer programming
15. Programs based on Numerical & Statistical methods
16. Experiments based on Micro-processors.
17. Experiments based on Energy conservation / management software and their utilization in electrical and mechanical systems

SEMESTER-II

EN- 121 : RENEWABLE SOURCES OF ENERGY - I.

Unit-01 : *New and Renewable energy sources (C-1, L-10)*

- Solar, bio-mass, wind, tidal, geothermal, microhydel etc. - their availability and potential.
- Conversion of solar energy into various forms of energy (heat, electricity, mechanical etc.)
- Geothermal and Tidal Energy : Basic principles, Systems used in practice and

applications, Resource assessment criteria, Status in .

Unit-02: *Solar Thermal Energy (C-2,L-20)*

- Solar thermal devices: Radiation geometry, Various types of solar collectors, Flat plate and Concentrating collectors, their construction, working and applications, hot water and hot air systems, industrial hot water systems, low pressure steam generation, solar dryers, solar pond, space heating and space conditioning, Design criteria and methodologies for solar thermal applications.
- Solar concentrator and their applications, Solar Thermal power generation.
- Use of solar thermal systems with existing systems, economic analysis of solar thermal systems, examples of hybrid systems.

Unit-03*: Bio-mass (C-1, L-10)*

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

Unit-04: *Biogas : (C-1,-L10)*

- Importance of bio-gas technology, Different Types of biogas Plants,
- Aerobic and anaerobic bio-conversion processes, various substrates used to produce bio-gas (cow dung, human and other agricultural waste, municipal waste etc.)
- Individual and community bio-gas operated engines and their use.

Books :

1. Renewable Energy Sources and Conversion Technology - N.K. Bansal, M.K. Kaleemann.
2. Principles of Solar Thermal Process - Duffie and Beckman (J.Wiley).
3. Power Generation Through Renewable Sources of Energy - B.R. Pai, M.S. Ramaprasad (Tata McGraw Hill).
4. Solar Power Engineering - B.S. Magal (Tata-McGraw Hill).
5. Principles of Solar Engineering – F. Kreith and J.F. Kreider, (Mc-Graw Hill Pub.)
6. Soalr Energy Handbook – Kreider and Kreith (Mc-Graw Hill Book Company)
7. Biomass Renegerable Energy – D.O.hall and R.P. Overeed (John Wiley and Sons, New york, 1987)
8. Biomass for enrgy in the developing countries – D.O.Hall, G.W.barnard and P.A.Moss (pergamon Press Ltd. 1982)
9. Thermochemical processing of Bio-mass , Bridgurater A V.
10. Biomass as Fuel – L.P.White (Academic press-1981)
11. Biomass Gasification Principles and Technology, Energy technology review No. 67, - T.B. Read (Noyes Data Corp. , 1981)
12. Energy Management and Agriculture – D.W.Robionson and R.C.Mollan (Elsevier Science Publishers, 1982)

13. Solar Distillation : Malik, tiwari etc. (Pergamon Press-1982)
14. Solar Energy Engineering – A.A.M. Sayigh

EN-122 : RENEWABLE SOURCES OF ENERGY –II

Unit-01 : Photovoltaics (C--1,L-10)

- Solar Photovoltaic conversion: Basic principle of SPV conversion, types of solar cells, fabrication of SPV cells, modules.
- SPV systems: Different configurations, SPV system components and their characteristics, applications, Hybrid SPV system.
- SPV system designing: Block diagram of general SPV system, load estimation, selection of inverter, battery sizing, array sizing, wiring for SPV system,
- Case studies

Unit-02 : *Wind Energy (C-2,L-20)*

- Wind Energy: Conversion technologies, Aerodynamics of wind turbine rotor, Site selection, Wind resource assessment, various models to predict wind pattern and their analysis, concept of wind farms, Various aspects of wind turbine design, Hybrid wind energy systems - wind + diesel power, wind + conventional grid, wind + Photovoltaic system etc.

Unit-03: Hydrogen and Fuel cell (C-1, L-10)

- Hydrogen as a renewable energy source, Sources of Hydrogen, Fuel for Vehicles.
- Hydrogen Production : Direct electrolysis of water, direct thermal decomposition of water, biological and biochemical methods of hydrogen production..
- Storage of Hydrogen : Gaseous, Cryogenic and Metal hydride
- Utilisation of Hydrogen: Fuel cell – principle of working, construction and applications.

Unit-04 : *Hydel and Integrated Energy Systems (C-1, L-10)*

- Mini and Microhydel power (MHP) generation: Classification of hydel plants, Concept of micro hydle, merits, MHP plants: Components, design and layout, Turbines, efficiency etc., Status in .
- Integrated Energy systems & their cost benefit analysis.

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 (Mc-Graw Hill)
4. Solar cell- Marteen A. Green
5. Solar Hydrogen Energy Systems -T. Ohta (Ed.) (Pergamon Press)-1979
6. Hydrogen Technology for Energy – D.A.Maths (Noyes Data Corp.) –1976
7. Handbook : Batteries and Fuel cell – linden (Mc.Graw Hill)- 1984
8. Batteries- Vol-I and II –Collins
9. Wind energy Conversion Systems – Freris L.L. (Prentice Hall-1990)

10. Wind Turbine Technology: Fundamental concepts of wind turbine technology

- Spera D.A. (ASME Press,NY, 1994)

1. Wind Energy Systems – G.L. Johnson (Prentice Hall, 1985)
2. Wind Energy Explained – J.F.Manwell, J.G. McGowan and A.L. Rogers (John Wiely & Sons Ltd.- 2002)

EN-123: ENVIRONMENTAL IMPACT OF ENERGY SYSTEMS:

Unit-01: *Environmental Impacts (C-1,L-10)*

- Environmental degradation due to energy production and utilization, Primary and secondary pollution, air, thermal and water pollution, depletion of ozone layer, global warming, biological damage due to environmental degradation.
- Methods of Environmental Impact Assessment.

Unit-02 : *Pollution : Thermal plants (C-1, L-10)*

- Pollution due to thermal power station and its control and systems.

Unit-03 : *Pollution : Nuclear & Hydro Plants* (C-1, L-10)

- Pollution due to nuclear power generation, radioactive waste and its disposal
- Effect of Hydro electric power stations on ecology and environment.

Unit-04 : *Industrial waste (C-1, 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 : *Global Environmental Concern (C-1, L-10)*

- United Nations Framework Convention on Climate Change (UNFCC),
- Protocol, Conference of Parties (COP)
- Clean Development Mechanism (CDM), Prototype Carbon Funds.
- Carbon Credits and its trading, Benefits to developing countries, Building a CDM project.

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,(Mc-Graw Hill)

EN-124: ENERGY AUDIT & MANAGEMENT -I

Unit-01: *General Aspects (C-1, L-10)*

- General Philosophy and need of Energy Audit and Management
- Definition, General principles and types of energy audit, Energy management

approach-understanding energy costs, bench marking, energy performance, matching energy use to requirement, maximizing system efficiencies, optimizing the input energy requirements, fuel and energy substitution. Energy audit instruments.

Unit-02*: Procedures and Techniques* (*C-2, L-20)*

- 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., Non-economic factors, Conservation opportunities , estimating cost of implementation.
- The plant energy study report: Importance , contents, effective organization , report writing and presentation.

Unit-03: *Energy Policy Planning and Implementation (C-1, L-10)*

- Key elements, force field analysis, Energy policy purpose, perspective, contents, formulation, ratification, Organising- location of energy management, top management support, managerial functions, role and responsibilities of energy manager, accountability. Motivating –motivation of employees, Information system designing barriers, strategies, Marketing and communicating training and planning.
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Unit-04 : *Energy Balance & MIS (C-1, L-10)*

- First law efficiency and Second law efficiency, Facility as an Energy system, methods for preparing process flow, materials and energy balance diagram, identifying losses, improvements.
- Energy balance sheet and management information system (MIS)
- Energy modeling and optimization.

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 (Wieley Eastern)
5. Industrial Energy Conservation : D.A. Reay (Pergammon 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 hall-1993)
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-125: LABORATORY WORK (Second Semester)

PART-A : Thermal

1. Study of solar collector - efficiency Vs/ ΔT/I
2. Study of hot water system.
3. Determination of heat loss coefficients in flat plate collector.
4. Study of solar hot air collector/ solar dryer
5. Study of solar still
6. Study of vacuum tube collectors.
7. Performance evaluation of box type and concentrating type solar cooker.
8. Study of heat pipe

PART-B- Electrical & Other

9. Power Vs. load characteristics of SPV system.
10. Variation of power output with intensity of solar radiation and load.
11. Determination of efficiency of SPV water pump.
12. Determination of efficiency of DC/AC inverter.
13. Variation of diesel replacement with load in gasifiers.
14. Study of bio-gas plant.
15. Study of storage battery - charging, discharging characteristics and mentainance.
16. Wind power and annual energy estimation from wind data.
17. Pay back analysis, Financial work sheet of a renewable energy project.
18. Energy Audit of three of the following installations :

a. Workshop
b. Building lighting and ventilation
c. Air-conditioning systems.
d. Ice-factory
e. Small chemical plant
f. Foundry
g. Annealing furnaces
h. Printing press.

SEMESTER-III

EN-211: ENERGY AUDIT & MANAGEMENT-II

Unit-01 *: Economic Analysis and Financial Management (C-1,L-10)*

- Objectives, Investment need, 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), 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 , Energy performance contract and role of ESCO's.

Unit-02 : *Project Management (C-1, L-10)*

- 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-03 : *Energy Monitoring, Targeting Review and Evaluation(C-1, L-10)*

- 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-04 : *Energy Audit /Management –Case Studies (C-2, L-20*)

- Energy analysis techniques for energy optimisation
- Study of 4 to 6 cases of Thermal Energy audit and management (Boilers, Steam System, Furnaces, Insulation and Refractories, Refrigeration and Air conditioning, Co-generation, 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 Organisations.

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 (Wieley Eastern)
5. Industrial Energy Conservation : D.A. Reay (Pergammon 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 hall-1993)
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-212: ENERGY CONSERVATION –I

Unit-01: *General Aspects (C-1, L-10)*

- Introduction to energy conservation, approach and modern techniques, benefits and trends.
- Energy conservation technologies (Thermal Energy) – Conservation in energy intensive industries
- Economic evaluation of energy conservation technologies.
- Energy conservation in Thermal Utilities : Boilers, steam systems, Furnaces, Refractories etc.

Unit-02: *Waste Heat Recovery (C-1, L-10)*

- Sources of waste heat and its potential applications, waste heat survey and measurements,
- Heat recovery equipment and systems
- Incinerators
- Regenerators and Recuperates
- Waste Heat boilers.

Unit-03*: Energy Storage (C-1, L-10)*

- Need and importance of Energy storage in conventional and Non-conventional energy systems
- Various forms of energy storage: Thermal, Chemical, Mechanical, Electrical and Nuclear Energy storage.
- Energy storage Devices and systems
- Thermal insulation

Unit-04: *Energy conservation in buildings (C-1, L-10)*

- *Introduction, Definition and concepts,*
- *Heat loss and Heat gain and its evaluation*
- *Methods of improving thermal quality*
- *Optimum performance*
- *Thermal comforts in building,*
- Electrical energy conservation
- *Opportunities, techniques for energy conservation in buildings.*

Unit-05*: Case study : Thermal Energy conservation (C-1,L-10)*

- 4-6 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 (Wieley Eastern)
5. Industrial Energy Conservation : D.A. Reay (Pergammon 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 hall-1993)
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-213: ENERGY CONSERVATION-II

Unit-01*: General Aspects (C-1, L-10)*

- Energy conservation in Electrical systems and Utilities
- Economic aspect of energy conservation in electrical systems
- Energy conservation in Electrical Utilities : Motors, pumps, fans and blowers,
- Air conditioning and refrigeration systems, DG sets, etc.

Unit-02: *Illumination (C-1, L-10)*

- Introduction, illumination requirements, system elements, Day lighting
- Lighting system controls, System maintenance, Operating schedules
- Psychology of change over, Tips for conservation
- Products for energy conservation – Lighting.

Unit-03**:** *Electrical* Systems (C-1, L-10)

- Various techniques for energy conservation in electrical utilities.-
- Power factor improvement, Improvement in Transformer losses, T& D Losses etc.
- Conservation through load management, demand side management (DSM)
- Devices for energy conservation – Electrical: Energy efficient motors, Automatic cutoff timers, Demand monitors etc. Automatic power factor controllers, soft starters with energy savers, variable speed drives, electronic ballast, energy efficient transformers etc

Unit-04**:** *Case Studies : Electrical Energy Conservation (C-2, L-20)*

- 4-6 Case studies of Commercial/Industrial/Residential Electrical energy conservation systems and their economic 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 (Wieley Eastern)

5. Industrial Energy Conservation : D.A. Reay (Pergammon 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 hall-1993)

10.Handbook on Energy efficiency – .

11.ASHRAEE- Energy Use (4 Volumes),

12.CIBSI –guide –Users Manual (UK.)

13.CRC Handbook on Energy Efficiency – CRC Press

EN-214: PRACTICAL / INDUSTRIAL TRAINING (C-10, 24 Hours per week)

Students shall have to submit a report based on his training at the end of the semester and present the work which he has carried out.

SEMESTER-IV

EN-221 : Project (C-25, 36 Hours per week)

Students shall have to submit a report based on his project work at the end of the semester and present the work which he has carried out for evaluation.