M. TECH. ENERGY MANAGEMENT (REGULAR)

YEAR 2013-2015

Syllabus

School of Energy & Environmental Studies

Devi Ahilya Vishwavidyalaya,

Takshashila Campus, Khandwa Road,

Indore-452 017(M.P)

Ph: 0731-2460309, 2462366, Fax: 0731-2467378

Email: mtech_coordinator@yahoo.com

www. dauniv.ac.in

SCHOOL OF ENERGY AND ENVIRONMENTAL STUDIES
DAVV INDORE

M.TECH. (ENERGY MANAGEMENT) 2013-2015
TWO YEARS COURSE STRUCTURE

COURSE	COURSE TITLE	Credits	Hours	Semester
	Core Theory Course			
EN-701	Solar Energy: Fundamentals, Devices and Systems	3	48	II
EN-702	New and Renewable Energy Sources and Technologies	3	48	I
EN-703	Heat Transfer And Process Integration	3	48	I
EN-704	Engineering Thermodynamics : Quality & Quantity Aspects	1½	24	I
EN-705	Water and Waste Water: Pollution and Control Technologies	3	48	I
EN-706	Air and Noise Pollution: Effects and Control Technologies	3	48	I
EN-707	Energy Conservation (Thermal Systems)	3	48	II
EN-708	Energy Conservation (Electrical Systems)	3	48	III
EN-709	Energy Auditing Techniques	1½	24	II
EN-710	Environmental Auditing and Environmental Impact Assessment	1½	24	II
EN-711	Energy Modeling and Project Management	3	48	II
	Other Theory Courses			
EN-712	Efficient Lighting: Sources, Systems and Design Aspects	3	48	III
EN-713	Green Building Technologies and simulation	3	48	II
EN-714	Electrical Power Generation, Transmission and Distribution	3	48	II
EN-715	Global and Indian Energy Scenario	1½	24	I
EN-716	Instrumentation, Measurements and Controls	3	48	I
EN-717	Bio and Fossil Fuels Technology	3	48	III
EN-718	Energy Conservation Opportunities in Process of Designated Industries	3	48	III
EN-719	Solid Waste Management	3	48	III
	TOTAL CREDITS (THEORY)	**51**		
EN-801	Energy Conservation Laboratory	3	48	III
EN-802	Heat Transfer Laboratory	3	48	II
EN-803	Biomass/Biogas laboratory	3	48	I
EN-804	Solar Thermal and Photo - Voltaic Laboratory	3	48	II
	TOTAL CREDITS (LABORATORY)	**12**		
EN-805	Field Visits	6	-	II
EN-806	Seminar	3	-	I
EN-807	Digital Video Review	3	-	II
EN-808	Mini Project	12	-	III
EN-809	Major Project	26	-	IV
	TOTAL CREDITS (OTHERS)	**50**	-	
	GRAND TOTAL	**113**		

EN 701: Solar Energy: Fundamentals, Devices and systems

Credits: 3 (48Hours)

UNIT I

Earth & Sun Relationship

i. Earth & Sun Relation	:	Solar Angles, Day length, Angle of Incidence on Tilted Surface, Sun path Diagram, Shadow Determination.
ii Available Solar Radiation	:	Extraterrestrial Characteristics, Effect of Earth Atmosphere, Measurement and Estimation on Horizontal and Tilted Surface.
iii Solar Radiations Characteristics Coating.	:	Transparent and Opaque Materials, Selective

UNIT II.

Solar Collectors

i Flat Plate Collectors	:	Effective Energy Losses, Thermal Analysis, Heat Capacity Effect, Evacuated Tubular Collectors
ii Air Flat Plate Air Collectors	:	Types, Thermal Analysis.
iii Concentrating Collectors	:	Designing and types, Thermal Analysis, Single Axis and Two Axis Solar Tracking.
iv. Evacuated Tubular Collectors	:	Types, Thermal Analysis.
v. Solar Cookers	:	Types, Thermal Analysis, and Testing Methods

UNIT III.

Thermal Energy Storage

: Sensible Storage (Water, pebble bed and ground storage) Latent Heat Storage.

Thermal Energy Systems

i Solar Water Heating System	:	Components, Natural Flow, Forced Flow and Load Estimation Gravity Flow Systems, Mathematical Modeling.
ii. Solar Air Heating Systems	:	Space Heating, Solar Drying, Load Estimation.
iii. Solar desalination system	:	Design and type, Solar still, performance analysis.

UNIT IV.

Solar Refrigeration and Desiccant

i Cooling	:	Vapor Absorption Refrigeration cycle, Water ammonia and Lithium bromide – water absorption refrigeration systems, Solar Operated Refrigeration Systems, Solar Desiccant cooling (4-1/2).

UNIT **V.**

Solar Power Generator

i. Solar Thermal Power Generation	:	Basic Operating and applications, Parabolic trough Systems, Parboloidal Dish Systems, Heliostat system, Central Receiver Power Plants, Solar Furnace.
ii Solar Photovoltaic System	:	Basic Semiconductor Theory, Photovoltaic Principles, and Solar Cells: Characteristics, Types and Production Methods, Series parallel combination, Storage Batteries, Modules.
	:	Stand Alone, Grid Connected Hybrid System, DV Arrays, Energy Storage Devices, Power Conditioning, DC Bus Voltage, Power Distribution Devices and Guidelines.
iii Solar Pond	:	Working principles & System, Application

Recommended Books:

1. Duffle and Beckman, Solar Thermal Engineering Process, John Wiley & Sons, New York
2. J.S. Hsieh, Solar Energy, Prentice Hall Inc. New Jerssey
3. A.B. Meinel and M.B. Meinel, Applied Solar Energy, Addison – Wiley Pub. Co., Reading
4. P.J. Lunde, Solar Thermal Engineering, John Wiley & Sons, New York
5. N.C. Harris, C.E. Miller and I.E. Thomas, Solar Energy Systems Design, John Wiley & Sons, New York
6. H.P. Garg, Advanced in Solar Energy Technology, D. Reidel Publishing Co., Drdricht.
7. S.P. Sukhatme, Solar Energy, Tata McGrew Hill Company Ltd., New Delhi
8. M.A. Greaen "Solar Cells – Operating Principles, Technology, and System Applications", 1983 Prentice Hall, Inc. New Jersey.
9. Markvart, Solar Electricity, John Wiley
10. F. Kreith and J.F. Kreider, Principles of Solar Engineering Hemisphere Publishing Coro.
11. G.N. Tiwari and S. Suneja, Solar Thermal Engineering Systems, Narosa Publishing House.
12. Goden – Solar Energy
13. M P agrarwal - Solar Energy
14. W H Blass, F. Pfisterer – Advance in Solar Energy Technology
15. Mathur and Methaf - Solar Energy

EN 702: New and Renewable Energy Sources and Technologies

Credits: 3 (48 hours)

UNIT - I

Wind Energy:

Wind potential in India and world, basic principle of wind energy Conservation characteristics of wind power, Extractable wind power, Site selection, wind data analysis and predictions, Use of statistical tools, Different types of Wind Machines Electricity generating stand alone systems & grid connected systems, Performance Estimation of Wind turbines, Aerodynamic construction of rotor blades, wind Farms, wind mills & their applications, Cost economics, case studies.

UNIT - II

Small Scale Hydroelectric (Mini & Micro Hydel)

Classification of Small Hydro Power Stations, Components of a Hydroelectric Scheme, Civil Works Design Considerations for Mini and Micro Hydel Projects, Turbines and Generators for Small Scale Hydro Electric, Protection, Control and Management of Equipments, Advantages and Limitations of Small Scale Hydro-Electric, Hybrid Systems. Hydrolic Ram and its Applications

UNIT - III

Geothermal Energy

Potential Sites, Estimations of Geothermal Power, Nature of Geothermal Sites, Hot-Dry Rocks Resources, Magma Resources, Systems for Energy Generation, Applications of Geothermal Energy, Environmental Issues.

Ocean Energy

Basic Theory of OTEC, Potential and application of Technologies, Basic Theory of Wave Energy, Potential and Technologies, Basic Theory of Tidal Energy, Potential and Technologies.

UNIT - IV

Hybrid systems

Wind-PV systems, Wind-DG systems, Wind-Hydel systems, Gasifier DG- Wind systems) and Application areas, Hydrogen energy production, storage & application.

UNIT - V

Direct Energy Conversion

MHD Generators Basic, Principle of MHD, Open Cycle and Closed Cycle MHD Technologies, Applications Advantages & Disadvantages.

Fuel Cells

Basic Principle of working, potential, classification of Fuel Cells, Types of Fuels cells, Advantages & Disadvantages, Conversion efficiency of fuel cells, Types of Electrodes, Applications, Thermo – Electric Generators and Refrigeration

UNIT – VI

Hydrogen Energy

Production**,** Electrolysis, Thermo-chemical methods, Fossil fuel methods, Solar Energy Methods, Storage, Transportation, Applications.

Recommended Books

1. Twidell & AW. Wier, Renewable energy resources, English Language book, Society *I* E& FN Spon (1986).
2. Grey & O.K. Ganhus, Tidal power, Plenum Press, New York (1972).
3. Goswami. Alternative energy in agriculture, Vol. II CRC Press Inc. Florida, 1986.
4. E.R. Berman, Geothermal Energy;'Noyes DATA Corpor_tion, New Jersey, 1975.
5. D.A Stafford. & D.L. Hawkee & R Horton, CRC Press Inc., Florida.
6. N.K. Bansal., M. Kleeman & M. Mielee, Renewable conversion technology, Tata McGraw Hill, New Delhi.
7. S.S.L. Chang, energy Conversion, Prentice Hall Inc., 1963
8. V.D., Hunt, Wind power: A handbook on Wind energy Conversion systems. Van Nostrand Reinhold Company, 1981.
9. D.A. Stafford, D.A, Hawkees, D.L. & R. Hoston, Methane production from waste organic matter, CRC Press, Boca Raton, 1980
10. D.L. Wise, Fuel Gas Production trom biomass Vol. I-IV, CRC press, Boca Raton.
11. F. Kreith, Handbook of Solid waste Management, McMillan Inc.
12. K.L. Wang & N.C. Periera, Handbook of Environmental Engineering, VoL 2, solid waste processing & recovery. The Humane press, Cliton, New Jersey.
13. N.C. Cheremenisoff, P.N. Cheremenisoff & F. Ellurbrush, Biomass- Application, technology & production, Marcel Dekker, New York, 1980.
14. W. Salonas & Frostner D., Environmental Management of Solid waste- dredged material & tail minings. Springer_Yedag,New York, 1988.
15. G. Technobanogalous, H.Vigil. & T. Theilsein, Integrated Solid waste management collection, disposal & reuse, McGraw Hill, 1994.
16. Kreith Goswami – hand book of Energy Efficiency and Renewable Energy
17. Leon freris- Renewable energy
18. Da Rosa – Fundamental of renewable energy

EN-703: Heat Transfer and Process Integration

Credits: 3 (48 hours)

Unit I

Basic Heat Transfer Concept and Terminology:

Basic Concepts Terminology, Heat Transfer Coefficients, Thermal Resistance, Overall Heat Transfer Coefficient.

Conduction:

Conduction Equation, Steady State Conduction in simple geometries, Thermal; Contact Resistance ,Critical Thickness of Insulation, Multidimensional Steady State Heat Conduction (Shaper Factor), Types of Fins, Effectiveness and Efficiencies of Fins Area Weighted Fine Efficiency, Transient Heat Conduction ,Lumped Heat Capacity Analysis, Heiler's Charts for Semi-Infinite Medium, Slab Cylinder and Sphere, Periodic Heat Conductions.

Unit II

Convection:

Similarity Principle, Mass moments and Energy Balance equations, Evaluation of Dimensionless Parameters, Forced Flow Convection (Laminar, Turbulent &Mixed) Thermal and Velocity Boundary Layer Thickness Convective Heat Transfer Coefficient ,Drag Coefficient for Flat Plate, Inside tube , Cylinder, Sphere and banks of tubes, Free convection (Laminar, Turbulent &Mixed) on horizontal Verticals and Inclined Plates, Inclined Parallel Plates, Horizontal, Verticals, Cylinder and Sphere ,Two Phase Convection :Phase Condensation on vertical and Single Tube, Bank of Tube Boiling.

Unit III

Radiation:

Blackbody Radiation, View Factor Algebra, Enclosures with Black Surfaces and Grey Surfaces, Radiosity, Heat Exchangers and its Types, Effectiveness, LMTD and NTU Methods.

Unit IV

Pinch Technology and Process Integration

Principle of pinch Technology , Stream Network, Design of Energy Recovery System, Selection of Pinch Temperature Difference: Graphical and Tabular Methods, Stream Splitting , Process Retrofit Application, Installation of heat pump and engines, Grand Composite Curves.

Reference Books

1. M.N. Oziesik, Heat Transfer - A Basic Approach, McGrew Hill Book Co., New Delhi.
2. M.Becter, Heat Transfer: A Modem Approach
3. S.P. Shukatme, Heat Transfer, Orient Longman, New Delhi.
4. W.H. Giedt, Principles of Engineering Heat Transfer, D.Van Norstand Company Inc.(1961)
5. F. Kireth, Radiation Heat Transfer, International Text book Co., Semton, USA (1962).
6. Process Integration, Chapter of Energy Efficiency, By Eastop.
    - Bejan Adrian – Heat Transfer
    - Y. Bayazitoglu – Element of Heat Transfer
    - Karlekar – Heat Transfer
    - J.P. Holman – Heat Transfer
    - Robin Smith -- Chemical Process (Design and Integration)

EN – 704: Engineering Thermodynamics: Quantity and Quality Aspects

Credits: 1½ (24 Hours)

UNIT I

Properties of Pure Substances: Ideal gas, Equation of State and corresponding state correlations for PVT Systems, Fundamental Concepts and basic Principles

UNIT II

The First Law of Thermodynamics:
Fundamentals, Closed Systems, first Low Analysis of Control Volumes, Steady Flow Process, Steady Flow Engineering Devices, Reversible Work, Irreversibility energy, Exergy

Second Law Efficiency of Thermodynamics:
Fundamentals, Carnot Cycle, Availability Analysis of Closed Systems, Analysis of Steady Flow Systems, and Analysis of unsteady Flow Systems.

Sterling Engine: Principle, working and efficiency

UNIT III

Thermodynamics of Flow Process: Nozzle, Throttling of Gases and Vapors, Mixing of gases, Compressors.

Chemical Thermodynamics: Chemical Reactions, Chemical and Phase Equilibrium
Thermodynamics Analysis of Process

Reference Books

7. Yunus A. Cengel, Introduction to Thermodynamic and Heat Transfer, McGrew Hill Company, Inc. (1997).
8. Frank W. Schmidt. Robert E. Henderson and Carl H. Wolgemuth, Introduction to Thermal Sciences: Thermodynamics, Fluid Dynamics, Heat Transfer, John Wiley and Sons Inc. (1993).
9. William L. Haberman and Jems E.A. John. Engineering Thermodynamics with Heath Transfer (:znd edition), Allyn.;'imC:i:Bacon (1989).
10. Process Integration, Chapter of Energy Efficiency, By Eastop.
    - S.E Jorgensen – Eco Exergy as Sustainability

EN-705: Water and Waste Water: Pollution and Control Technologies

3: Credits (48 hours)

UNIT I

Fundamentals: Definition, Classification, Sources Water quality Standards.

Water Chemistry: Theory of Acid Base Equilibrium, Water Pollution And Control: Indicators, Hardness & Determination of DO BOD, COD of Water, and Water Pollution due to heavy metals and Organic Pollutants.

Water Treatment: Surface water: Water Purification Processes in Natural Systems (Physical, Chemical, Bio-Chemical Processes) And Its Application, Response Of Stream To Bio-Degradable Organic Wastes.

UNIT II

Water Treatment Methods: Principles and Design

Unit Operations – Aeration Systems

Sedimentation – types of settling and settling equations, design criteria and design of settling tanks.

Coagulation and Flocculation – types of coagulants, coagulant aids, coagulation theory, optimum dose of coagulant, jar test method, design criteria and numerical examples.

Filtration – theory, types, filter backwash, operational problems and trouble shooting.

UNIT III

Unit processes.

Water Softening- Principles and design- Ions causing hardness, various methods.

Waste Water Treatment : Principles and Design

Objectives of wastewater treatment, characteristics, flow variations, types of reactors and reactors analysis.

Mass Loading Factors, Impacts, Estimation And Their Unit Loading.

UNIT IV

'**Principle of Biological Treatment**; Microbial Growth Rates, Treatment Kinetics, Food/Micro Organism Ratio, Substrate Removal Efficiency.

Theoretical principles and design

Aerobic Suspended Growth Systems, Activated Sludge, Aerated Lagoon, Principles and design of stabilization ponds

Aerobic Attached Growth

Trickling Filters,

UNIT V

Anaerobic - UASBS, Sludge Digesters, Anaerobic Ponds. Different Types of Industrial Effluent Treatment Plants

Sludge Processing– separation - sludge thickeners, volume reduction, conditioning and digestion – aerobic and anaerobic.

Numerical problems

Case Studies

Recommended Books

1. Environmental Pollution and Its Control Jeffrey J. and P.A. Vesilind.
2. Chemistry for Environmental Engineering Clair N. Sawyer & McCarty, TATA McGraw Hill International Publication IIIrd Edition.1986
3. Environmental Engineering - Howard S.Peavy et.al, TATA McGraw Hill International Publication 1st Edition. 1986
4. Environmental Engineering – Ruth F. Weiner and Robin Matthews fourth edition.
5. Water & Waste Water Technology - Marle J. Hammer, Prentice Hall of India Ltd. New Delhi 2nd
6. Waste Water Treatment, Disposal & Reuse - Metcalf & Eddy, TATA McGraw Hill Publication New Delhi 3rd Edition.
7. Waste Water Treatment for Pollution Control – Soli J. Arceivala, TATA McGraw Hill Publication New Delhi 2nd Edition.
8. Energy Conservation in water and wastewater facilities.
9. Water Treatment Handbook, Vol. 1& 2
10. "Manual on water supply and Treatment ", CPHEEO, Ministry of Urban Development, GOI, New Delhi, 1999.
11. "Manual on Sewerage and Sewage Development", CPHEEO, Ministry of Urban Development, GOI, New Delhi, 1993.

EN-706: Air and Noise Pollution: Effects and Control Technologies

3: Credits (48 hours)

UNIT I

Noise Pollution and Control

The Decibel Scale, Sound Intensity Level. Classification of Noise, Noise Standards. Effects of Noise, Noise Control Methods, Acoustical Materials, Acoustical Enclosures, Silencers and Muffle Reverberation Control, Personal Hearing Protection Devices, Role of Vegetation in Noise Control.

UNIT II

Air Pollution & Control: Definition, Air Quality, Classification Of Air Pollutants, Air Pollution Episodes.

UNIT III

Air Pollution Monitoring

Collection of Gaseous Air Pollutants, Collection of Particulate Pollutants, Measurement of SO_x, NO_x, CO, Oxidants and Ozone.

UNIT IV

Meteorology & Dispersion of pollutants:

Wind Circulation, Lapse Rate, Stability Conditions, Maximum Mixing Depths.

Air pollution control technologies for particulates and gaseous contaminants.

Gravity settlers, Electrostatic precipitators, bag Filters Scrubbers Cyclone, control for moving sources

UNIT V

Global Concerns, Light Pollution and Thermal Pollution

Recommended Books

1. Understanding Environmental Pollution Marquita K.
2. Environmental Pollution And Its Control, COGENT International, 1st edition 1998 S.A. Abbasi
3. Environmental Noise Pollution And Its Control, Anmol Publication 1st edition 1992 Chhatwal G.R.et al
4. Environmental Pollution And Its Control Jeffrey J. and P.A. Vesilind
5. Air Pollution: M. N. Rao & HVN Rao, TATA McGraw Hill Publication, New Delhi, 12th edition, 1998
6. Chemistry for Environmental Engineering Clair N. Sawyer & McCarty, TATA McGraw Hill International Publication IIIrd Edition.1986
7. Environmental Engineering - Howard S.Peavy et.al, TATA McGraw Hill International Publication 1st Edition. 1986.
8. T K Ray, Air Pollution Control in Industries , Vol-1,2
9. J.N.B, Air Pollution and Plant Life.
10. Robert Jennings Heinson, Air Pollution.

EN- 707: Energy Conservation (Thermal Systems)

3: Credits (48 hours)

UNIT I

Fuel Analysis

Proximate Analysis, Ultimate Analysis, Calorific Value. Combustion: Theoretical Air Requirement, Efficiency Estimates, Combustion Control, Stability in Flames.

Furnaces

Classification, General Fuel Economy Measures in Furnaces, Excess Air and Heat Distribution Losses, Temperature Control, Draft Control, Case Studies.

UNIT II

Insulation and Refractory

Insulation Type and Application, Economic Thickness of Insulation, Heat Savings and Application Criteria, Refractory-Types, Selection and Application of Refractories, Case Studies.

UNIT III

Boilers:

Types, Analysis of Losses, Performance Evaluation, Feed Water Treatment, Blow Down, Energy Conservation Opportunities, Case Studies.

FBC Boilers:

Introduction, Mechanism of Fluidized Bed Combustion, AFBC, CFBC, PFBC Boilers, Condensing Boilers, Saving Potential, Case Studies.

UNIT IV

Steam System:

Properties of Steam, Assessment of Steam Distribution Losses, Steam Leakages, Steam Trapping, Condensate and Flash Steam Recovery System, Identifying Opportunities for Energy Saving, Case Studies.

Cogeneration

Need, Applications, Advantages, Topping Cycles, Bottoming Cycles, Combined Cycles, Steam Tracking Mode, Electricity Tracking Mode, Saving Potential, Case Studies.

UNIT V

Waste Heat Recovery:

Availability and Reversibility, First and Second Law Efficiencies, Classification, Advantages and Applications, Commercially Viable Heat Recovery Devices, Saving Potential, Case Studies.

HVAC and Refrigeration System, Vapor compression Refrigeration Cycle, Refrigerants, Factors Affecting Refrigeration and Air Conditioning System Performance and Savings Opportunities.

Vapor Absorption Refrigeration System: Working Principle, Types and Comparison with Vapor Compression System, Saving Potential, Distribution systems for conditioned air

Cooling Towers

Types and Performance Evaluation, Efficient System Operation, Flow Control Strategies and Energy Saving Opportunities, Case Studies.

Recommended Books

1. G. L. Witte, Phillips S.Scbmidt and Daid R. Brown, Industrial Energy Management and Utilization, Hemisphere Publishing Corporation, Washington.
2. Carig,B. Saith, Energy Management Principles, Applications, Bnefit and Saving, Per n Press, New York.
3. F. W. Pyne, P *gm* Energy Conservation Manual, Fairmont Proem, INC.P.O. Box 14227 Atlanta,GA 30224
4. D. Patrick and S.W. Fardo, Energy U-sent and Conservation, Prentice Hall, INC Engleweek Cliffs (NJ) 7632.

5. Davida , Fuels Of Opportuniy , Characteristics And Uses In Combustion Systems, Edition-2004 Publisher- ELSEVIER LTD. UK
6. O.P. Gupta , Element Of Fuel Furnaces And Refractories, Edition-Second
7. Gunnar , Anderlind , A Theoretical Analysis Of Thermal Insulation
8. E.R. Berman , Geothermal Energy.
8. Threlked , Thermal Environmental Energy.

EN- 708: Energy Conservation (Electrical Systems)

3: Credits (48 hours)

UNIT I

Electrical Systems and bill analysis: ECO (Energy Conservation Opportunities)

Basis of Energy and its various forms: Electrical Basis-DC & AC, currents active power, reactive power and apparent power, star, delta connection.

Bill/Bill Analysis: ECO (Energy Conservation Opportunities)

Electricity billing, electrical load management, maximum demand control.

Power Factor:

Power factor, improvement and its benefit, selection and location of capacitors, performance assessment of PF capacitors.

Lighting Systems:

Light source, Choice of Lighting, Luminance requirements, Energy conservation avenues.

UNIT II

Electric Motors: ECO

Introduction, Types, Motor characteristic, Motor Efficiency, losses in induction motors, , factor affecting motor performance, Motor Load Survey: Methodology, Rewinding motor and replacement issues, Energy Saving Opportunities in Motors, Motor Selection, Energy Efficient Motors, , Speed Control of AC Induction Motors ,Soft starter with energy savers, Variable Speed Drives(VFD).

Transformers and Electric Distribution:

Types of transformers, Transformer losses, Energy efficient transformers, Factor affecting the performance of transformers and Energy Conservation Opportunities, Cables, Switch Gears, Distribution Losses, and energy conservation opportunities in-house electrical distribution system.

UNIT III

Compressed Air Systems: ECO

Introduction, Types of air compressors, compressor efficiency, efficient compressor operation, compressed air systems components, capacity assessment, and leakage test, factors affecting the performance and Efficiency, energy savings opportunities.

UNIT IV

HVAC and Refrigeration System: ECO

Vapor compression refrigeration cycle, Refrigerants, Coefficient of performance, Capacity, Factors affecting Refrigeration and Air conditioning system performance and savings opportunities. Vapor absorption refrigeration system: Working principle, Types and comparison with vapor compression system, saving potential

UNIT V

Fans & Blowers: Types, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities

Pumps and Pumping System: ECO

Types, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities. Agricultural pumps

Diesel Generating System:

Factors affecting selection, Energy performance assessment of diesel conservation avenues

Cooling Tower:

Types and performance evaluation, efficient system operation, Flow control strategies and energy saving opportunities, Assessment of cooling towers

Case studies

Recommended Books

1. Efficient Electrical Use by C.B. Smith.
2. Savings Electricity in Utility Systems of Industrial Plants by B.G. Desai, B.S. Vaidya D.P. Patel and R. Parman.
3. Manual of variable speed drines by CII
4. Efficient use of electricity in industries by B.G. Desai, B.S. Vaidya, M.P. Parmarad R. Parman.
5. Pump Application Desk Book by P.N. Garagy.
6. Electrical Power Distribution in Industrial Plants by M.D. Parmar.
7. Electronic Energy Utilization and Conservation by S.C. Tripaths.
8. Energy Conservation in electrical systems, a reading material prepared by D. Buddhi.
9. Smalensky , Electrical Machines , Vol-3, MIR Publishers MOSCOW
10. Igor J. Karassik , Pump Hand Book , Third Edition 2001 , Mcgrawn-Hill
11. B.R. Gupta, Generation Of Electrical Energy Edition 2005, Eurasia Publishing House (PVT.) LTD. Ram Nagar
12. Karassik , Pump Hand Book
13. Energy Conservation in Water and wastewater facilities

EN –709: Energy Auditing Techniques

Credit: 1½ (24 Hours)

UNIT I

Energy Audit

Definition, Need and Objectives.

Types of Energy Audit

Internal Audit, External Audit, Walk through Energy Audit, Preliminary Energy Audit, Detailed Energy Audit, Investment Grade Energy Audit, Industrial Energy Audit, Utility (Services) Energy Audit, Commercial Energy Audit, Residential Energy Audit.

UNIT II

Energy Audit Strategies

Monitoring and Control, Questioning the Need, Minimizing the Need of End Use, Minimizing the Losses, Operating the Equipment at Optimum Efficiency, Operating the Most Efficient Equipments from Set of Equipments, Minimizing the Idle Redundant Running, Proper Maintenance of the Equipment, Substitution with Efficient Equipment, Substitution with more Efficient Equipment, Substitution with more Efficient Process, Energy Storage, Fuel Substitutions, Quality Control and Recycling.

Basic Components of Energy Audit

Preparing for Audit Visit, Instrumentation, Data Collection Techno-economic Analysis, Safety Considerations.

UNIT III

Energy Audit Instruments

Combustion Analysis, Temperature Management, Pressure Measurement, Flow Measurement, Humidity Measurement, Energy and Power Measurement, Light Level Measurement, Infrared Equipment, Tachometer & Stroboscope, P.F. Meter, Ultrasonic flow meter, and Steam & Air Leak Detector.

UNIT IV

Important Survey Items

Buildings, Lightings, HVAC, Furnaces & Ovens, Boilers and Steam Lines, Air Compressor and Compressed Air Distribution Lines, Chillers and Chilled Water Distribution Lines, Process Water Generation and Distribution Lines, Electrical Distributions Transformers and Lines, Pumps, Fans and Blowers, Cooling Towers, Electrical Motors, Waste Heat Sources, Material Transport, Peak Load Equipments.

UNIT IV

Methodologies of Conducting Energy Audit

Preliminary Questionnaire, Review of Previous Records, Introductory Meeting, Walk through Tour, Flow Chart Construction for Detail Energy Audit, Identification of Required Audit Instruments, Finalization of Audit Schedule with the Company, Getting Detailed Data.

Post Audit Analysis

Process Flow Diagram, Material and Energy Balance, Energy Use and Cost Profile of each Fuel Used, Energy Balance Diagram for each Energy Type Used, Identification and Techno-economic Analysis of Energy Conservation Measures, Classification of Energy Conservation Measures, Outlines of Energy Audit Report Format

Energy Audit Subsidy Scheme of PCRA, IDBI and IREDA.
Useful Forms for Data Collections.
Useful Charts for Quick Estimations.
Checklists for each Devices and Distribution Lines.
Thumb Rules and Specific Energy Indices for Devices and Processes

Case Studies

Recommended Books

1. Instructions to Energy Auditors, Vol. - I & Vol. - II –
   National Technical Information Services U. S. Deptt. Of Commerce Springfield, VA 22161.
2. Energy Auditing, The Fairmont Press Inc. Published by Atlanta, Georgia
3. Albert Thumann, P.E., C.E.M. , Plant engineers & Managers Guide To Energy Conservation 8^{th} edition-2002, Published By The Fairmont Press , Inc 700 Indian Trail Liburn, GA30047
4. BEE VolumeI –Second Edition 2005
5. G.G. Ranjan: Optimizing Energy Efficiencies in Industry ,Edition-2003 McGraw Hill

EN –710: Environmental Auditing Techniques and Environmental Impact Assessment

1½ Credit (24 Hours)

UNIT I

Elements of Environmental Impact Assessment: Introduction

Principles, Origin and development of EIA Environmental Impact Analysis, Essential components of EIA, Project Screening , Baseline study , Impact Identification, Impact prediction, Evaluation and Mitigation. Methodology matrix method, Network, Overlay, Problems of EIA in developing countries, Future of EIA

UNIT II

The Interlinking

Positive and Negative Impacts, Primary and Secondary Impacts, Impacts on Physical, Chemical, Biotic and Social Environment, Environmental Impact Statement and Environmental Management Plan for Selected Industries.

Case Studies

Concepts of the Environmental Audit

UNIT III

Definition, Benefits, Objectives.

Legislation

Rules and Regulation, Gazette, Notification on Environmental Statement, Latest Amendments.

Need for Environmental Audit
Guidelines for Environmental Audit

UNIT IV

Methodology

i. Pre-audit activities; Preliminary Information, Audit Team.
ii. Activities at the site; Material Balance Waste Flow, Monitoring, Field Observations, Draft Report.
iii. Post-Audit Activities; Synthesis of Data Evaluation of Waste Treatment Facilities, Final report, Action plans, Follow up actions.

Material and Energy Flow Assessment, Preparation of Audit Report

- Water Consumption
- Guidelines to Environmental Safe Layouts to Minimize Losses & Waste.

- Control Mechanism
    - Waste water reduction
    - Air emission reduction
- Preparation of Audit Report
- Form V Case Studies

Recommended Books

1. Environmental Impact Assessment, Clark D. Brain, Biesel Donald
2. EIA for Developing Countries, Biswas Asit. K.
3. EIA Guidelines 1994, Notification of Govt. of India Impact Assessment Methodologies & Procedures.
4. Environmental Impact Assessment W. Canter(IInd Edition)
5. Auditing for Environmental Quality Leadership Willing, T-Johan
6. Environmental Audit Mhastear A. K.
7. Hugh Barton and Neol Brudes, A Guide to local Environmental Auditing, Earthscan Publications Ltd. (1995).

EN – 711: Energy Modeling & Project Management.

3 Credits (48 Hours)

Unit I

Introduction:

Role of modeling and project management in energy project

Unit II

Energy Markets:

Monopoly, oligopoly and competitive markets, behavior of markets with price change of energy, balance payment problems.

Basic Pricing:

Basic Pricing Principles, Growing Demands and Dynamic effects, Short Run versus Long Run Marginal Cost Pricing, Peak load and seasonal pricing, Pricing of Nonrenewable energy resources. Subsidized Prices and life line rates,

Unit III

Energy Planning:

Planning and Role of Demand Management, Integrated National Energy Plan, Supply and Demand analysis. Energy Balance, Perfect competitive economy, economic second best considerations, life line rates for poor consumers, Decentralized Energy Planning, Energy Modeling, Date Analysis & Demand management, LP models, Case studies, Force Field Analysis, Energy Policy Purpose, Perspective, Contents, Formulations and Ratification.

Unit IV

General Management:

Organizing, Location of Energy Management, Top Management Support, Managerial Functions, Roles and Responsibilities of Energy Manager, Accountability, Motivating – Motivation of Employees.

Project Management:

Definition and scope of project, Technical Design, Financing, Contracting, Implementation and Performance Monitoring. Implementation Plan for top management, Planning Budget, Procurement procedures, Construction, Measurement and Verification. Investment needs Appraisal and Criteria, Financial Methods of Projects evaluations, Case Studies.

Financial Management:

Investment-need, Appraisal and criteria, Financial analysis techniques-Simple pay back period, Return on investment, Net present value, Internal rate of return, Cash flows, Risk and sensitivity analysis; Financing options, Energy performance contracts and role of ESCOs. and Case Studies. Concept and purpose of projects management, functions of project manager, project feasibility analysis, project appraisal criteria, monitoring and control of a project,

Unit V

Network Analysis:

PERT and CPM network

Recommended Books:

1. D. Deo, S. Modak and P. R. Shukla, Decentralized Energy Planning Oxford and IBH Publishing Co. Pvt. Ltd.,
2. B. Bukhootaeo et al. Energy, Planning and Policy
3. J.K. Parikh,Modeling Approach to long term de and Energy Implications.
4. Markdias, Forecasting Methodologies.
5. Koontz,O.Donnel and We@ich,Managewnt Kogakuj3ha.Tokyo.
6. R.D. Agrawal, Organization and Management, Tata McGrew Hill, New Delhi.
7. Newman and Warren, The Process of Management, Concepts, Behavior and Practice, Prentice Hall of India, Mm Delhi.
8. J.A.F.Stoner and R- E. Ferrman, Management, Prentice Hall of India, New Delhi.
9. R. Srinivamm and S.A. Chunavala, nt Principles and Practices, Himalaya Publishing House, Delhi.
10. Prasana Chandra, Project Management, Appraisal and Implementation, Tata McGrew Hill Publishing Company.
11. M. Mohain, Project Planning and Control, Vikas Publishing House, New Delhi.
12. Akalank's Descriptive Law on Pollution and environment. Both editions Akalank Pub.
13. Leonard Ortolano, Environmental Regulation and Impact Assessment, John Wiley & Sons Inc.(1997)
14. TERI Energy Data Year Books.
15. Energy Management Hand Book, Chapter 2, Milton A. Williams
16. Energy Conservation in Industries, Center of Plant Engineering Services, Hyderabad. P
17. Productivity Vol.31 Jan-March,1991 No.4,Energy Policy Perspectives in India, Stephen Paulus.
18. Manual on Industrial Energy Audit, Energy Management Centre
19. Financial Management, Tata Mc-Graw Hill – Prasanna Chandra.
20. Principles of Project Management, NPC publication
21. Project Management, Tata McGraw Hill – S.Choudhury
22. Projects: Planning, Analysis, Selection, Implementation and Review, Tata McGraw Hill – S.Choudhury
23. Encyclopedia of Energy – McGraw Hill Publication
24. Handbook of Energy Engineering , The Fairmont Press Inc – Albert Thumann
25. Energy Handbook, Von Nostrand Reinhold Company - Robert L. Loftness
26. Cleaner Production – Energy Efficiency Manual for GERIAP, UNEP, Bangkok prepared by National Productivity Council

EN – 712: Efficient Lighting: Sources, Systems And Design Aspects

3 Credits (48 Hours)

Unit I

Lighting

Terms, Definitions Illuminance, Luminance Intensity Luminous Flux, Luminance Existence, Luminous efficacy, Luminous efficiency, Photometric Calculation: Point by Point Method.

Unit II

Eye

Accommodation, Adaptance, Binocular Vision, Resolving Power, Scotopic, Mesopic and Phetopic vision.

Characteristic

Correlated Color Temperature Glare, Brightness, Contrast, Color Rendering, Photometric Analysis.

Unit III

Lamps

GLS, Halogen, Housecent Lamps, Low Pressure Sodium Lamps High Pressure Sodium Lamps, High Pressure Mercury Lamps, Metal Halide Lamp, LED's

Luminaries, Control Gears, Energy Efficient Sources Lighting Requirement

Unit IV

Day lighting

Solar Illuminance, Overcast and Clear Sky Illuminance, Lumen Method, Daylight Factor Method, Energy Saving by Day lighting, Interior Lighting, Commercial Lighting, Industrial Lighting, Exterior Lighting, Lighting and Air Conditioning, Lighting and Energy Conservation Standard.

Recommended Books

1. Illumination Engineering: From Edison's Lamp to the Laser by J.F. Murdocre.
2. Energy Sawing Lighting Systems by P.C. Sorcar.
3. Daylight: Design & Analysis by C.L.Robbine
4. Daylighting in Architecture, A European Reference Book, Published by James & James.
5. Lampa and Liabtins Edited by M.A. Cayleas and A.M. Paraden.
6. IES Lighting Handbooks, Published by Illuminating Engineering Society of North America
7. IRS Lighting Ready Reference Edited by J.E. Kaufran and J.F.Chria tereen
8. IES Lighting Hand Book Edited by J.B,.Kaufman and J.F,.Christersen

EN - 713: Green Building Technologies

3 Credits (48 Hours)

Unit I

Green Building Design Strategies and Building Codes:

Energy use in Buildings, Factors effecting Energy use, Energy Conservation options. External Factors – Climate, Building Orientation, Shading, types of shading devices.

Unit II

Thermal Comfort:

Criteria and various Parameters, Psychometric Chart, Thermal Indices. Indoor air quality; Requirements in residential, Commercial, Hospital Buildings.

Unit III

Passive heating concepts: Direct gain, indirect gain, isolated gains and suspense

Passive cooling concepts: Evaporative Cooling, Evaporative Air and Water Coolers, Radiative Cooling, Application of Wind, Water and Earth for Cooling ,use of isolation, Shading, Paints and cavity walls for cooling;

Passive heating and cooling concepts: Roof pond/sky therm, roof radiation trap, vary-therm wall, earth sheltered or earth based structures and earth air tunnels; selective ventilation, components- windows and thermal storage

Unit IV

Heat Transmission in Buildings:

Surface Coefficient, Air cavity, Internal and External Surface, Overall Thermal Transmittance Walls and Windows, and Packed Roof-thatched Heat Transfer due to ventilation/ infiltration, Building loss coefficient Internal Heat gains, Solar Temperature, Steady State Method (for Trombe Wall, Water wall and Solarium), Degree Day method

Unit V

Modeling of Building: Correlation methods - solar load ratio, load collector ratio, thermal time constant method, Analytical methods - thermal circuit analysis, admittance procedure of metrics. The periodic solutions - thermal modeling of AC / Non AC buildings, software application.

ASHRAE Methods and standards for estimates of Heating and cooling and Ventilation, Requirements of Different use Buildings, Air Quality control Equipments,

Typical Designs of Selected Buildings in various Climatic Zones, Thumb Rules for Design of Building systems.

Evaluation methods: LEED methodology, BEE star rating, GERRHA Methodology

Case Studies

Recommended Books

1. M.S.Sodha, N.K. Banaal, P.K.Bansal, A.Rumaar and M.A.S. Malik, Solar Passive: Building Science and Design, Pergamon Preen (1986).
2. Jamee; L. Threlked, Thermal Environment Engineering, Prentice Hall, INC-, Raglevood Cliffs, New Jersey (1970)
3. T.A. Markus and R.N. Morris, Building, Climate and Energy Spottwoode Ballantype Ltd-, London U.K. (1980)
4. Solar Thermal Energy Storage, H. P. Garg et.al, D. Reidel Publishing Company (1985)
5. Mathematical Modeling of Melting and Freezing Process, V Alexiades & A.D. Solomon, Hemisphere Publishing Corporation, Washington (1993)
6. Energy storage technologies, a reading material prepared by Dr. D. Buddhi, School Of Energy And Environmental Studies, DAVV, Indore.

EN - 714: Electric Power Generation Transmission and Distribution
Credits 3 (48 Hours)

Unit I

Generation:

Various Method of Electrical Generation, Thermal Power Plants, Hydroelectric Power Plants, Hydro Turbines, Gas Turbines, Intergraded Gasification- Combustion Power Cycle Plant, Nuclear power plant.

Unit II

Transmission

Basic Concept, Power in Single Phase, AC Circuits, Complex Power, Power Triangle, Phasor Diagram Power in Balanced Three-Phase Circuit.

Types of Conductors, Skin Effect, Corona Losses, Basics of Transmission & Distribution System, Layout of Substation and Component of Substation.

Impedance of Transmission Lines, Capacitance of Transmission Lines, Representation of Power Systems. Bundle Conductors.

Performance of Short, Medium and Long Transmission Lines, Transmission Line Losses, Underground Cables, Voltage Regulation, Power grid.

Unit III

Distribution

Radial and Ring Type Distribution Systems, Kelvin's Economic Law, Distribution Network. Distributions and Feeder, Voltage Regulation Distribution Losses.

Depreciation and Tariffs, Economics of Generation, Power Factor Improvement.

Recommended Books

1. I.J. Nagrath and D.P. Kothari, Modern Power System Analysis Tata McGraw Hill, New Delhi (1983)
2. T. Gonen, Electric Power Distribution System Engineering, McGraw Hill Book Co. (1988)
3. Soni, Gupta, and Bhatnagar, A course in Electrical Power,Danpat Rai and Sons. .
   Wadhwa, C.L. Generation, Distribution and Utilization of Electrical Energy, Coiley Eastern Ltd. (1989).
4. William D. Stevenaon, Elements of Power System Analysis, Mc Graw Hill, London (1982)
5. Basic Electrical Engineering by J. B. Gupta, 3rd Edition (2006)
6. Nuclear Energy By Raymond L. Murray 6th Edition (2008)

EN-715: Global and Indian Energy Scenario

Credits 1½ (24 Hours)

Unit I

Introduction:

Role of energy in Socio-economic development: Energy & Socio-economic aspects.

Global Scenario of Energy:

Use and their availability and overall energy demand. Energy Consumption in various sectors and its changing pattern, exponential increase in energy consumption and projected future demands.

Unit II

Energy Resources:

Coal, Oil, Natural Gas, Nuclear Power and Hydroelectricity, Solar and Other Renewable etc. World Reserves of fossil fuels and their possibility of substitution by other fuels

Unit III

Energy Security:

Energy for security and Energy needs and demands of developing countries Security of Energy,

Future Energy Options:

Sustainable Development, Energy Consumption and its impact on environmental climatic change.

Unit IV

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

Unit V

Energy Needs of Growing Economy:

Sector-wise need of energy for economic growth

Energy and Environment:

Energy Consumption and its impact on Environment, Role of Renewable Energy sources in Sustainable development.

Energy Policy Issues

Reforms in Energy

Recommended Books and relevant Literature site

1. TERI Energy Data Year Books.
2. Cleaner Production – Energy Efficiency Manual for GERIAP, UNEP, Bangkok prepared by National Productivity Council
3. Statistics have been drawn from BP Statistical Review of World Energy, June 2003, International Energy Outlook, March 2002, Energy Information administration, Office of integrated analysis and forecasting, US department of energy, Washington
4. Planning commission statistics
5. The Energy and Resources Institute (TERI)
6. www.bp.com/centres/energy
7. www.eia.doe.gov
8. www.epa.org
9. Bureau of Energy Efficiency- Volume 1

EN- 716: Instrumentation, Measurements and Controls
Credits 3 (48 Hours)

UNIT - I

Measurement & Instrumentation, classification, static and dynamic characteristics of instruments, sensors and transducer, classification and selection of transducers.

Displacement transducer, Strain gage, LVDT, piezoelectric transducers, pressure measurement: manometers; diaphragm, below elements. Introduction to vacuum gases, Bendron tube, Introduction of capacitive and Inductive transducer.

UNIT - II

Temperature measurement: Thermocouples, RTCs, Thermistors, Radiation and optical pyrometer, flow measurement: pitot tubes, turbo magnetic and electromagnetic flow meters, ultrasonic, velocity flow meter.

Anemometers, level measurement: Floats, displayer, hydrostatic and thermal electrical methods, Humidity and moisture measurement.

UNIT - III

Registers, Memories, microprocessor 8085: Block diagram, Pin out Diagram, Fetching and Executing Instructions, B.C. D Arithmetic 16 bit data operations.

UNIT - IV

Control systems: Feedback and non-feedback systems, feedback characteristics of control system. Block diagram, flow graph, Mason gain formula, regenerative feedback. Introduction to PID control, Hydraulic v/s Pneumatic Systems, Stability analysis of control systems, Rentu Hermit's criteria on Root loci, relative stability.

Case Studies

Recommended Books

1. W. D. Cooper and A.D. Helfrick, Electronic Instrumentation and Measurement Techniques, Prentice Hall of India, New Delhi (1989).
2. Krishna kant, Micro – Processors Data Acquisition.
3. D. Patranabis, Principles of Industrial Instrumentation, Tata McGrew-Hill publishing Company Ltd., New Delhi (1990).
4. I.J. Nagrath and M. Gopal, Control Systems Engineering, Wiley Eastern Ltd., New Delhi (1990).
5. S. Malvino, Digital Computer Electronics, Tata McGraw Hill, New Delhi.
6. Doeblin – Measurement System McGrew Hill Book Co., (1981).
7. T. R. Padmanabhan, Industrial Instrumentation: Principles and Design, Springer.
8. J.P. Homan, Experimental Methods for Engineering, 6th edition McGrew Hill Inc.
9. Instrumentation methods by Chatwal Anand, 3rd edition, Meerut publication house, Meerut
10. Instrumentation, Measurement and Control – D S Kumar

EN- 717: Bio and Fossil Fuels Technology

Credits 3 (48 hours)

Unit I

Biomass & Biomass management

Biomass availability, Characteristics of Biomass or organic wastes, Energy Plantation.
Waste Biomass /Organic utilization Technology options. Potential, Process and technologies, characteristics of Briquettes and their use

Unit II

Biochemical Process

Aerobic and Anaerobic Bioconversion process, Biogas production process, Effect of Feed and operational parameters, Types of digesters and their suitability, Applications. Design criterion of some Bio-methanation Plants, optimum sizing of landfill digesters & Gas storage systems.

Unit III

Thermo chemical Process

Biomass Gasification Process, Types of Gasifiers and their working, Feed and operational parameters on output Gas production, properties of output gases (mainly producer gas), Design of criterion, design of a Gasifier.
Biomass Pyrolysis: Process of slow and fast Pyrolysis for solid and liquid fuel Production, Technologies, Applications.

Unit IV

Bio-oils and Composting

Characteristics of Bio-diesel, Materials and Methods, and its applications, Alcoholic Fermentation Process, Technologies and its applications.

Composting

Process Material and operational, Parameters, characteristics of manure, applications. Vermi-composting: Process, Types of Species, Materials and Methods, Characteristics of Manure, Applications.

Unit V

Solid Fuels:

Clean coal technology, Underground combustion and gasification of coal, Carbon Capture and storage

Liquid Fuels: D G set for generation of Electricity

Gaseous Fuels:

Natural gases, methane from coal mines, manufactured gases, producer gas, water gas, biogas, refinery gas, LPG; Cleaning and purification of gaseous fuels.

Case Studies

References:

1. Biomass – Thermo-chemical Characteristics Edited by PVR Iyer; T R Rao; P D Grover and N P Singh, Published by Biomass gasifier Action Research Centre, Dept of Chemical Engineering , IIT Delhi

2. Kaup and Goss (1984) "Small Scale Gas Producer Engine System" Published by Friedr, Vieweg & Sohn Braunschweig/ Wiesbaden.

3. ABETS, IISc, Bangalore (2003) "Biomass to Energy – The science and technology of the IISc Bio-energy systems" Published by Science & Technology of the Indian Institute of Science, Bangalore

4. Reed, T. B. and Das, A. (1988) "Hand book of biomass down draft gasifier engine systems". Published by Solar Energy Research Institute, U.S. Dept. of Energy

5. K M Mital ,Biogas System - Principles & Applications Published by new Age international (p) Ltd, New delhi

6. Klaus von Mitzlaff, "Engines for biogas- theory, modification & economic operation" Published by friedr. Vieweg & Sohn Braunschweig/ Wiesbaden

7. Orion Polinsky "A Bio-fuels Handbook" Published by Oasis Publishing 2002.

8. S.P. Sharma & Chander Mohan, Fuels & Combustion, Tata McGraw Hill Publishing Co.Ltd. 1984

9. J. D. Gilchrist, Fuels, Furnaces & Refractories, Pergamom Press,

10. Blokh A.G, Heat Transmission in Steam Boiler furnaces, Hemisphere Publishing Corpn, 1988

11. Gupta O.P, Elements of Fuels, Furnaces & Refractories, 3rd edition, Khanna Publishers, 1996.

12. Samir Sarkar, Fuels & Combustion, 2nd Edition, Orient Longman, 1990

13. Bhatt, Vora, Stoichiometry, 2nd Edition, Tata McGraw Hill, 1984

EN –718: Energy Conservation opportunities In Process Of Designated Industries

Credits 3 (48 hours)

Industrial/Commercial Buildings

Buildings Envelope and Load reduction techniques, Utilities.

Case Studies: Green building, Energy efficient building etc

Energy Saving Measures In Energy Intensive Process Industry

Pulp and Paper, Sugar, Textile, Fertilizer and Textile and their Case Studies.
Chemical, Petroleum Refineries, Petrochemical Processes, Chlor-Alkali and their Case Studies.

Aluminum, Iron and Steel, Cement and their Case Studies.

Railways, Ports, Transport Sector, Power Stations and their Case Studies.

Recommended Books

1. Efficient Electrical Use by C.B. Smith.
2. Savings Electricity in Utility Systems of Industrial Plants by B.G. Desai, B.S. Vaidya D.P. Patel and R. Parman.
3. Manual of variable speed drines by CII
4. Efficient use of electricity in industries by B.G. Desai, B.S. Vaidya, M.P. Parmarad R. Parman.
5. Pump Application Desk Book by P.N. Garagy.
6. Electrical Power Distribution in Industrial Plants by M.D. Parmar.
7. Electronic Energy Utilization and Conservation by S.C. Tripaths.
8. Energy Conservation in electrical systems, a reading material prepared by D. Buddhi
9. G. L. Witte, Phillips S.Scbmidt and Daid R. Brown, Industrial Energy Management and Utilization, Hemisphere Publishing Corporation, Washington.
10. Carig,B. Saith, Energy Management Principles, Applications, Benefit and Saving, Per n Press, New York.
11. F. W. Pyne, P *gm* Energy Conservation Manual, Fairmont Proem, INC.P.O. Box 14227 Atlanta,GA 30224
12. D. Patrick and S.W. Fardo, Energy U-sent and Conservation, Prentice Hall, INC Engleweek Cliffs (NJ) 7632.
13. N.L Lens, Waste gas Treatment for Resource Recovery.
14. S.N. Ghosh and Yadav, Energy conservation and environment control and cement industries.

EN -719: Solid Waste Management

Credit 3 (48 hours)

Unit I
Waste Management

Different Option, Integrated Waste Management Strategies, Collection, Transportation And Environmental Impact.

Unit II
Generation and Disposal Methods

Resources, Disposal and Recovery, Material and Products in Solid Waste.

Unit III
Characterization of Different Types Of Solid Waste

Municipal Solid Waste, Agro – Waste, Others

Unit IV
Hazardous Waste

Characterization, Collection, Transportation, Treatment, Storage and Disposal.

Unit V
Control Technologies

Issues, Techniques and Economics, Sources Reduction, Recycling, Non-incineration Technology, Incineration, Landfill, Refused Derived Fuels

Case Studies

Recommended Books

1. "Handbook of solid management" Frank Kerith, McGraw Hill, Inc. USA (1994).
2. Handbook of Environmental Engineering Vol. 2, Lawrence K. Wang and Worman C. Pereira, THE HUMAN Press, Clifton, New Jersey, (1990)
3. Hazardous Waste Management – Charles A. Wentz
4. T V Ramchandra- Management of Municipal Waste

EN – 801: Energy Conservation Laboratory

Credits 3 (48 Hours)

1. Determine the Ultimate analysis of the given sample.
2. Determine the proximate analysis of the given sample.
3. Determine the calorific value for the given sample.
4. Determine the percentage of excess air required for given fuel.
5. Determination of Stack Gas Composition by flue gas analyzer:
    a) Percentage of CO_2 or O_2 in flue gas.
    b) Percentage of CO in flue gas
    c) Temperature of flue gas.
6. Determine the water parameter:
    a) Total dissolved solids (TDS) b) pH
7. Determine the radiation & convection loss of the given surface.
8. Determine the heat loss due to the opening in boiler or furnace.
9. Determine the motor loading by following method:
    a) Input Power Method
    b) Line Current Method
    c) Slip Method
10. Determine the Efficiency of the motor by field test method.
11. Determine the Efficiency of the given fan.
12. Determine the Efficiency of the given Blower.
13. Calculate the actual free Air Delivery (FAD) & Percentage of Leakages of a given air compressor system.
14. Determine the Pump Efficiency of the given pump.
15. Calculate the Coefficient of performance (COP), EER, SPC for given Air condition unit:
    a) Window AC (Conventional)
    b) Split AC (Conventional)
    c) Split AC (Energy Efficient AC)
16. Determine the Installed Load Efficacy Ratio (ILER) for given areas.
17. Determine the efficacy of the given Incandescent v/s compact florescent lamp.
18. Determine the energy consumption of the different electrical appliance for 8, 12 and 24 hour.

EN – 802: Heat Transfer Laboratory

Credits 3 (48 Hours)

1. To determine the heat transfer coefficient in natural convection.
2. To measure the heat transfer coefficient in forced convection.
3. To determine temperature distribution, heat transfer and fin efficiency of a pin fin in natural and forced convection.
4. To determine and compare LMTD, Overall Heat transfer coefficient, efficiency and effectiveness of a heat exchanger in parallel flow and counter flow mode. (Water to water)
5. To determine and compare LMTD, Overall Heat transfer coefficient, efficiency and effectiveness of a heat exchanger in parallel flow and counter flow mode. (Water to air)
6. To determine and compare LMTD, Overall Heat transfer coefficient, efficiency and effectiveness of a heat exchanger in parallel flow and counter flow mode. (Shall and Tube)
7. To determine heat transfer coefficient for drop and film wise condensation.
8. To study the pool boiling phenomenon and to determine critical heat flux.
9. To determine the performance heat pipe.
10. To study and calibrate the thermocouples.
11. To determine Stefan Boltzmann constant of radiant heat transfer.
12. To measure the emissivity of the test surface in comparison to black surface.
13. Effectiveness of a heat exchanger with storage
14. To determine thermal conductivity of a metallic rod.
15. To determine thermal conductivity of an insulating power.
16. To determine thermal conductivity and temperature distribution across the width of the composite wall.

EN – 803: Biomass/Biogas Laboratory

Credits 3 (48 Hours)

1. Determination of proximate analysis (Moisture content, ash, Volatile matter & fixed carbon) for a Given Biomass Sample.
2. Determination of Total solids & volatile Solids for a given organic Biomass Sample.
3. Determination of elemental analysis (chemical method) for a Given Biomass Sample.
4. Determination of C/N Ratio for a given organic Biomass Sample.
5. Determination of Chemical Oxygen Demand for a Given Slurry or Liquid Sample.
6. Determination of Dissolved Oxygen & Biochemical in a Liquid Slurry Waste Sample.
7. Determination of Fats/oil Content in a given oil seed Biomass Sample.
8. Determination of Carbohydrates in a given organic Biomass Sample.
9. Determination of Calorific Value of a solid and liquid Biomass Sample.
10. To study the Effect of Different Loading Rates, Total Volatile Solids and Hydraulic Retention time on Generation of Biogas in Batch Type Digesters.
11. To study the Completion Yield of Methane Generation from Different Feed Stock in Batch Type Digesters.
12. To study the Demonstration & Working of Gas Chromotograph and its use for Analysis of Different Environmental Parameters.
13. Determination of Lignin, Cellulose, Hemicellulose in a Given Biomass a Sample.
14. Determination of Potassium, Sodium and Phosphorous in a Given Waste Slurry Sample.
15. Determination of Crude Protein in a Given Biomass Sample.
16. Study of Gasifier and its performance evaluation.
17. Characterization of liquid biomass and its comparison with diesel
18. Preparation of bio-diesel and determination of it physical properties
19. Performance study of CI engine with different fuel
20. Preparation of alcohol and its Performance study with SI engine

EN - 804: Solar Thermal and Photovoltaic Laboratory

Credits 3 (48 Hours)

1. Determination of Thermal Efficiency of Flat Plate Collector.
2. To Determine the Heat Loon Factor and Heat Removal Factor of a Flat Plate Solar Collector.
3. Study of Thermal Performance of a Built In Storage Solar Water Collector.
4. Determination of Tim Constant of a Flat Plate Solar Collector.
5. Thermal Testing of a Box Type Solar Cooker Determination of First and Second Figure of Merit.
6. Performance Evaluation of a Single Basin Solar Still.
7. Concentrated Solar Cooker: Determination of F_0 and FU_l.
8. Study of Thermal Performance of an Air Heater.
9. Drying Performance of a Solar Dryer.
10. Performance evaluation of wind generators.

PHOTOVOLTAIC

1. Power Load Characteristic of a Photovoltaic Cell.
2. Power Output Vs Exposed Area.
3. Power Output Vs Azimuthal and Tilt Angle
4. Spectral Response of a PV Cell.
5. PV System Performance
6. To Study the Effect of Solar Irradiance on Module Output.
7. To Study the Effect of Temperature on Module Output.