Course number : ENR114
Course title : Energy Auditing, Energy Efficiency & Energy Conservation
No. of credits : 6
No. of lectures-tutorial-practicals : 65-19-00
Faculty Name : Prof. RL Sawhney

Course outline

A growing worldwide concern for conservation of energy has reawakened interest in ecologically sustainability, processes and sources of energy. Different types of industries are consisted of various energy intensive processes. Hence, Energy efficiency and energy conservation in industries are as important as finding new energy sources. This course is designed to aware the students concerning various energy intensive process in different industries and to find out the energy conservation opportunities. Various methods of energy management and energy auditing on the site are also incorporated. Therefore, the course has the capability to prepare the students for energy auditing and managing the energy demand.

Evaluation procedure

- Assignments : 20%
- Two Minor Exams : 20% each
- Major Exam : 40%

Details of course contents and allotted time

	Topics	**Allotted time (hrs)**		
		L	**T**	**P**
1	***Energy Management*** Scope of energy management, necessary steps in energy management programme, general principles of energy management, qualities of energy manager, functions of energy manager, language of energy manager.	3	0	0
2	***Energy Audit*** Energy surveying and auditing, objectives, uses of energy, energy conservation schemes, energy index, cost index, pie charts, Sankey diagrams, load profiles (histograms), types of energy audits- preliminary energy audit – detailed energy audit, questionnaire, energy audit instruments, Energy audit report writing.	3	0	0
3	***Energy Conservation*** Indian energy conservation act-2001, second law of thermodynamics, rules for efficient energy conservation of energy and materials, technologies for energy conservation (reducing demand using alternative supplies, load factor, balancing and energy storage), supply side options, demand side options, maximum demand controller, transmission and distribution side options.	3	0	0
4	***Energy Efficient Motors*** Constructional details, factors affecting efficiency, losses distribution, soft starters, variable speed drives.	3	2	0

5	***Power Factor*** Causes and disadvantages of low power factor, methods to improve power factor, automatic power factor controllers.	2	0	0
6	***Energy efficient lighting*** Terminology, cosine law of luminance, types of lamps, characteristics, design of illumination systems, good lighting practice, lighting control, steps for lighting energy conservation.	4	2	0
7	***Boilers*** Fuels and combustion, type of boilers, performance evaluation, factors affecting boiler performance, data collection format for boiler performance assessment, case studies.	6	2	0
8	***Steam distribution system*** Steam pipe sizing, proper selection of steam traps, optimum insulation, steam utilization, steam balance – energy saving opportunities.	5	2	0
9	***Furnaces*** Types and classification of furnaces, performance evaluation of a typical furnace, general fuel economy measures in furnaces, case studies.	3	2	0
10	***Heat Recovery Systems*** Sources of waste heat, guidelines to identify waste heat, grading of waste heat, feasibility study of waste heat recovery, gas to gas heat recovery, rotary generators, heat pipes, gas to liquid heat recovery, waste heat boilers.	4	2	0
11	***Cogeneration*** Definition and need, basics of thermodynamic cycles, classification of cogeneration systems, steam turbine, gas turbine, typical heat to power ratio in various industries, operating strategies for cogeneration plant, typical cogeneration performance parameters, relative merits of cogeneration systems.	4	2	0
12	***Compressed air network*** Types of compressors, compressor selection, monitoring performance, specific power consumption, FAD test, capacity control and power consumption, compressed air distribution system, moisture separation.	3	0	0
13	***HVAC(Heating Ventilation and Air conditioning)*** Vapour compression system, vapour absorption system, measurements / field testing, performance evaluation, heat pump, energy efficiency ratios, energy conservation opportunities, case studies.	4	2	0
14	***Cooling towers*** Classification of cooling towers, selection and usage of cooling towers, factors affecting cooling tower performance, performance evaluation of cooling tower at site, energy saving opportunities in cooling tower.	2	0	0

15	***Pumps*** Classification of pumps, centrifugal pump, system characteristics, pump operating point, factors affecting pump performance, pump efficiency, effect of over-sizing the pump, effect of speed variation/impeller diameter change, energy performance and evaluation of pumping system at sites, flow control strategies, meeting the fixed flow reduction, meeting the variable flow reduction.	4	1	0
16	***Fans and blowers*** Types of fans and blowers, fan performance evaluation and efficient system operation, fan performance curves, fan selection, variable loads, flow control methods, energy saving opportunities.	2	0	0
17	***Energy conservation opportunities in DG based captive power generation***	2	0	0
18	***Energy conservation options in buildings***	5	0	0
19	***Financial Analysis*** Fixed and variable costs, interest charges, simple payback period, return on investment, net present value, internal rate of return, discounted cash flow methods, factors affecting analysis.	3	2	0
	Total	65	19	0

Text Books:

- LC Witte, PS Schmidt and DR Brown: **Industrial Energy Management and Utilization** (Hemisphere Publishing Corporation, Washington, 1998).
- W Trinks, MH Mawhinney, RA Shannon, RJ Reed, JR Garvey: **Industrial Furnaces**, Sixth Edition, (John Wiley & Sons, 2003)

Reference Books:

- JL Threlkeld: **Thermal Environmental Engineering**, Second Edition (Prentice Hall,1970)
- YP Abbi and Shashank Jain: **Handbook on Energy Audit and Environment Management**, (TERI Press, 2006)
- WC Turner: **Energy Management Handbook**, Seventh Edition, (Fairmont Press Inc., 2007)
- George Polimeros: **Energy Cogeneration Handbook**, (Industrial Press, Inc., New York, 1981)

Websites:

- National Productivity Council (http://www.npcindia.org/)
- EA/EM Guide Books (http://www.bee-india.nic.in/index.php?module=tri&id=4)

Reviewers:

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