

## Course Plan

<b>School</b>	Engineering
<b>Department</b>	Energy
<b>Course Code</b>	EN570
<b>Course Name</b>	Energy Management and Auditing
<b>Session</b>	Spring 2024
<b>Credit</b>	4
<b>Lecture</b>	3
<b>Tutorial</b>	1
<b>Instructor</b>	Sadhan Mahapatra

### Abstract

This course deals with the understanding on energy management, and conservation and energy auditing. It deals with energy conversion processes in various utilities, energy cost optimization etc. It also deals the various features of Energy Conservation Act and the duties of Energy Manager and Energy Auditors. Apart from these, this course deals with electrical and thermal energy management in industry and residential sectors. This is a broad course aimed to expose the students on various aspects of energy auditing and conservation techniques.

### Objectives

- (a) To understand the energy management, conservation processes, principles of energy auditing, energy flow diagram, economics of energy conservation opportunities.
- (b) To understand the energy management information systems, various key features of Energy Conservation Act and ECBC.
- (c) To understand the scope for energy conservation in electrical and thermal energy utilities.

### Course Outcomes

- CO1: Discuss the principles of energy management, conservation and auditing in thermal and electrical utilities
- CO2: Assess scope of energy conservation in electrical and thermal utilities
- CO3: Analysis of economics of energy conservation opportunities in electrical and thermal utilities and reporting of energy audit

### Prerequisites of the course

Student must have understanding on various energy conversion processes in various utilities.

### Lecture Plan

Tentative Lecture/ Tutorial	Topic (s)
1	Energy units conversion, understanding on energy demand and supply energy cost, energy conservation and its importance
2	Electricity tariff, load management and maximum demand control
3	Thermal energy contents of fuel, heat capacity, Stoichiometric air-fuel ratio, flue gas analysis
4	Concept of energy management, need for energy management.

5	Energy auditing, basic components of an energy audit, types of energy audit,
6	Industrial, commercial and residential energy audit planning, measuring instruments, report preparation
7	Energy performance index, system efficiencies, input energy requirements optimization
8	Understanding energy used pattern and fuel & energy substitution, concepts of energy conservation and efficiency
9-10	Sankey diagrams, energy and material balances for different processes, methods for preparing process flow chart, procedure to carry out the material and energy balance in different processes
11	Energy conservation act and its features, duties and responsibilities of energy managers and auditor
12	Financial analysis techniques: simple payback period, return on investment, net present value, internal rate of return, cash flows and sensitivity analysis Case studies
13-14	Problem solving to calculate NPV, IRR
15-16	Project definition and scope, technical design and financing, project planning techniques; CPM and PERT, case studies
17	Energy Service Companies (ESCO), energy performance contracts and role of ESCOs
18-19	Energy action planning, force field analysis, energy policy purpose, perspective, contents, formulation, roles and responsibilities of energy manager, accountability
20	Energy monitoring and targeting various elements of monitoring & targeting
21	Data and information analysis; techniques, cumulative sum of differences (CUSUM)
22	Energy conservation in household, transportation, agricultural, service and industrial sectors
23	Energy management information systems, Smart grid, SCADA systems
24	Electric power systems, maximum demand management, load management, energy efficient technologies in electrical power systems
25-26	Role of power factor and its improvement,
27	Electrical energy management: supply and demand side management
28-29	Electric motors, energy efficient motors, factors affecting energy efficiency of a motor, Soft starters, Variable speed drives
30-32	Basic terms of lighting systems; lamp and luminaries types, recommended illumination level, methodology of lighting systems energy efficiency study, case study
33-35	Energy conservation opportunities in HVAC and refrigeration systems, compressed air systems, fans and blowers, pumping systems and cooling towers
36	DG Set systems, Operational parameters, Performance assessment of DG Systems, Energy conservation opportunities
37-38	Stoichiometric air fuel ratio, theoretical and excess air, combustion in boilers performances evaluation, analysis of losses, energy conservation opportunities
39	Energy conservation in buildings, building heating and cooling load management, Energy Conservation Building Code (ECBC)

40	Heat load calculation of a building.
41	Solar passive buildings, climate responsive buildings, Green buildings concept
42	Performance analysis of furnaces, energy conservation opportunities
43-44	Cogeneration and waste heat recovery, performance parameters, case studies
45	Thermal insulation, economic thickness of insulations
46-47	Types and properties of refractory, industrial use of refractory, heat losses from furnace walls
48	Energy performance assessment of heat exchangers

## Pedagogy

Teaching-learning methods to be used

- Lecture and Discussion
- Case studies
- Assignment and Presentations
- Problem Solving

## Evaluation Plan

Course Outcomes	C01		C02		C03		
Weightage (%)	35		30		35		
Marks	52.5		45.0		52.5		
Course Outcomes	Weightage of Marks	Test I (25)	Mid Term Test (40)	Test II (25)	Semester End (60)	Total (150)	
C01	35	20	15		17.5	52.5	
C02	30	5	15	5	20	45	
C03	35		10	20	22.5	52.5	
Total	100	25	40	25	60	150	
Assessment Criteria			Marks distribution				
Bloom Taxonomy	Level	Marks Weightage (%)	Marks	Test I (25)	Mid Term Test (40)	Test II (25)	Semester End (60)
Knowledge	Easy	10	15	5	5		5
Understanding	Easy	10	15	5	5		5
Application	Average	30	45	15	15		15
Analysis	Above average	30	45		10	15	20
Synthesis	Difficult	12	18			10	8
Evaluation	Difficult	8	12		5		7
TOTAL		100	150	25	40	25	60

### **Text Books**

- [1] Doty S. and Turner W. C. (2012); *Energy Management Handbook*, Eighth Edition, Fairmont Press
- [2] Kreith F. and West R. E. (1996); *Handbook of Energy Efficiency*, First Edition, CRC Press

### **Suggested Readings**

- [1] Thumann A. and Mehta D. P. (2008); *Handbook of Energy Engineering*, Sixth Edition, Fairmont Press
- [2] Capehart B. L. Turner W. C. and Kennedy W. J. (2011); *Guide to Energy Management*, Seventh Edition, Fairmont Press
- [3] Kao C. (1999); *Energy Management in Illumination System*, First Edition, CRC Press
- [4] Bureau of Energy Efficiency (BEE) (2012); *Study material for Energy Managers and Auditors Examination: Paper I to IV*
- [5] Thumann A. Niehus T. and Younger W. J. (2012); *Handbook of Energy Audits*, Ninth Edition, CRC Press