

GUJARAT TECHNOLOGICAL UNIVERSITY

ELECTRICAL ENGINEERING (09) ENERGY CONSERVATION AND AUDIT SUBJECT CODE: 2180910 B.E. 8th SEMESTER

Type of course: Engineering Science (Electrical)

Prerequisite: Fundamentals of Courses like Power Systems, Electrical Machines, Applied thermal and hydraulic engineering etc.

Rationale: The course provides basic understanding of energy audit and management. The consumption of energy is increasing day by day. One way to cope up with the increase in energy demand is to increase the production of energy which demands more investment and the other way is to conserve the energy as energy conserved/saved is twice the energy generated. Energy conservation means reduction in energy consumption but not compromising with the quality or quantity of energy production. Essential theoretical and practical knowledge about the concept of energy conservation, energy management, different approaches of energy conservation in industries, economic aspects of energy conservation project and energy audit and measuring instruments in commercial and industrial sector will be achieved through this course.

Teaching and Examination Scheme:

Teaching Scheme			Credits C	Examination Marks						Total Marks
L	T	P		Theory Marks			Practical Marks			
			ESE (E)	PA (M)	ALA	ESE (V)	OEP	PA (I)		
3	0	2	5	70	20	10	20	10	20	150

Content:

Sr. No.	Content	Total Hrs.	% Wtg.
1.	Energy Audit Methodology and recent trends. General Philosophy, need of Energy Audit and Management, EC Act, Definition and Objective of Energy Management, General Principles of Energy Management. Energy Management Skills, Energy Management Strategy. Economics of implementation of energy optimization projects, it's constraints, barriers and limitations, Financial Analysis: Simple Payback, IRR, NPV, Discounted Cashflow; Report-writing, preparations and presentations of energy audit reports, Post monitoring of energy conservation projects, MIS, Case-studies / Report studies of Energy Audits. Guidelines for writing energy audit report, data presentation in report, findings recommendations, impact of renewable energy on energy audit recommendations. Instruments for Audit and Monitoring Energy and Energy Savings, Types and Accuracy. Case studies of implemented energy cost optimization projects in electrical utilities as well as thermal utilities.	11	25-30%
2.	Electrical Distribution and Utilization: Electrical Systems, Transformers loss reductions, parallel operations, T & D losses, P.F. improvements, Demand Side management (DSM), Load Management, Harmonics & its improvements,	11	25-30%

	Energy efficient motors and Soft starters, Automatic power factor Controllers, Variable speed drivers, Electronic Lighting ballasts for Lighting, LED Lighting, Trends and Approaches. Study of 4 to 6 cases of Electrical Energy audit and management (Power factor improvement, Electric motors, Fans and blowers, Cooling Towers, Industrial/Commercial Lighting system, etc.)		
3.	Thermal Systems: Boilers- performance evaluation, Loss analysis, Water treatment and its impact on boiler losses, integration of different systems in boiler operation. Advances in boiler technologies, FBC and PFBC boilers, Heat recovery Boilers- it's limitations and constraints. Furnaces- Types and classifications, applications, economics and quality aspects, heat distributions, draft controls, waste heat recovering options, Furnaces refractory- types and sections. Thermic Fluid heaters, need and applications, Heat recovery and its limitations. Insulators- Hot and Cold applications, Economic thickness of insulation, Heat saving and application criteria. Steam Utilization Properties, steam distribution and losses, steam trapping, Condensate, Flash steam recovery.	10	20-25%
4.	System Audit of Mechanical Utilities: Pumps, types and application, unit's assessment, improvement option, parallel and series operating pump performance. Energy Saving in Pumps & Pumping Systems. Bloomers (Blowers) types & application, its performance assessment, series & parallel operation applications & advantages. Energy Saving in Blowers Compressors, types & applications, specific power consumption, compressed air system, & economic of system changes. Energy Saving in Compressors & Compressed Air Systems Cooling towers, its types and performance assessment & limitations, water loss in cooling tower. Energy Saving in Cooling Towers .Study of 4 to 6 cases of Energy Audit & Management in Industries (Boilers, Steam System, Furnaces, Insulation and Refractory, Refrigeration and Air conditioning, Cogeneration, Waste Heat recovery etc.)Study of Energy Audit reports for various Industries and Organizations	10	20-25%

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks (%)					
R Level	U Level	A Level	N Level	E Level	C Level
10	40	30	10	10	-

Reference Books:

1. Energy Audit and Management, Volume-I, IECC Press
2. Energy Efficiency in Electrical Systems, Volume-II, IECC Press
3. Energy Management: W.R.Murphy, G.Mckay, Butterworths Scientific
4. Energy Management Principles, C.B.Smith, Pergamon Press
5. Industrial Energy Conservation, D.A. Reay, Pergammon Press
6. Energy Management Handbook, W.C. Turner, John Wiley and Sons, A Wiley Interscience
7. Industrial Energy Management and Utilization, L.C. Witte, P.S. Schmidt, D.R. Brown, Hemisphere Publication, Washington, 1988
8. Hand Book of Energy Audits, Albert Thumann, P.E., C.E.M. William J. Younger, C.E.M., CRC Press

Course Outcome: After learning the course the students should be able to,

1. Identify and assess the energy conservation/saving opportunities in different electric system
2. Identify and assess energy conservation opportunities in thermal system
3. Demonstrate skills required for energy audit and management.
4. Prepare energy flow diagrams and energy audit report
5. Suggest cost-effective measures towards improving energy efficient and energy conservation.

Suggested list of experiments:

1. Computing efficiency of DC motor/Induction Motor/Transformer
2. Calculating the efficiency of boiler / blowers / compressors etc.
3. Draw the energy flow diagram for an industry/shop floor division.
4. Study of various energy efficient equipment like LED lighting devices, Energy Efficient motors, Electronics ballast etc.
5. Soft starting of an induction motor
6. Study of Variable frequency drive based IM speed control for energy conservation.
7. Industry visit with an aim of
 - (i) Studying various energy management systems prevailing in a particular industry/Organization
 - (ii) Identifying the various energy conservation methods useful in a particular industry
8. Studying the various energy conservation methods useful in power generation, transmission and distribution
9. Study of APFC panel or Estimating the requirement of capacitance for power factor improvement.
10. Evaluating the energy conservation opportunity through various methods like simple payback period IRR and NPV.
11. Determine depreciation cost of a given energy conservation project/equipment
12. Study of various measuring instruments used for energy audit : Lux meter, Power analyzer, flue gas analyzer
13. Identifying the energy conservation opportunities in a lab, department or institute.
14. Prepare a sample energy audit questionnaire
15. Prepare a sample energy audit report
16. Prepare a technical report on energy conservation act 2003

SUGGESTED LIST OF STUDENT ACTIVITIES:

Following is the list of proposed student activities: Assignments on solving simple numerical, Prepare a report based on a survey of at least two nearby industries on energy conservation measures adopted by them using questionnaire, Carry out a survey on internet and prepare a report on energy conservation act an ECBC. Carry out detailed energy audit of your Institute or any other official building.

Major Equipments:

Anemometer, Lux Meter, Power Analyzer, Thermometer (Contact / Non-contact type), Tachometer (Contact / Non-contact type), Pressure Gauges, Multimeter, Ammeter (AC / DC), Voltmeter (AC / DC) Mandatory, Power Factor meter, Tong Tester, Earth Tester, Energy meter, Tri-vector meter, Stroboscope,

List of Open Source Software/learning website:

<https://beeindia.gov.in/>

<http://nptel.ac.in/>

https://lbre.stanford.edu/sem/energy_conservation

ACTIVE LEARNING ASSIGNMENTS: Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus gets covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should be submitted to GTU.