GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering
Level: UG
Branch: Mechanical Engineering
Subject Code: BE05019021
Subject Name: Energy Conservation and Management

w. e. f. Academic Year:	2024-25
Semester:	5
Category of the Course:	Professional Elective Course - 2

Prerequisite:	Nil
Rationale:	The course is prepared to provide detailed understanding of energy conservation and management to address rapidly increasing global energy demand, depletion of non-renewable resources and addressing the global warming issue. It also aims to provide understanding of 3Es (Energy, Economics and Environment) and their interaction, energy audit and financial management.

Course Outcomes:

Sr. No.	CO statement	Marks% weightage
CO-1	To utilize the evolution of Indian energy policy to examine their impact on national energy security and the growth of the Indian economy	10
CO-2	To apply concepts of financial management, energy monitoring and targeting	14
CO-3	To apply the knowledge of energy audit for the energy management and operation of energy audit instruments	14
CO-4	To analyze the energy saving area and improvement in efficiency of various thermal utilities and systems	48
CO-5	To evaluate the efficacy of national and international climate schemes	14

Teaching and Examination Scheme:

Teaching / Learning Scheme (in Hours per semester)					Total Credits	Assessment Pattern and Marks					Total Marks
						Theory		Tutorial / Practical			
L	T	P	PBL	Total no of hours per semester		ESE (E)	PA / CA (M)	PA/CA (I)	PBL (I)	ESE (V)	
45	00	30	15	90	03	70	30	20	30	50	200

**** Problem-Based Learning (PBL) aims to accommodate learning beyond syllabus as per clause 9.4 of NBA manual.***

Content:

Sr. No.	Content	Total Hrs
1	**Energy Scenario:** Classification of energy, Indian energy scenario, sectorial energy consumption (domestic, industrial and other sectors), energy needs of growing economy, energy intensity, long term energy scenario, energy pricing, energy security, energy conservation and its importance, energy strategy for the future	**05**

	Energy Conservation Act 2001 and related policies: Energy conservation Act 2001 and its features, notifications under the Act, Schemes of Bureau of Energy Efficiency (BEE) including designated consumers, state designated agencies, Electricity Act 2003, integrated energy policy, national action plan on climate change, ECBC code for building construction	
2	**Financial Management, Energy Monitoring and Targeting:** Investment-need, financial analysis techniques simple payback 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 Energy Service Companies (ESCOs) **Energy Monitoring and Targeting:** Elements of monitoring and targeting, data and information analysis, techniques, energy consumption, production, cumulative sum of differences (CUSUM), Energy Management Information Systems (EMIS)	**06**
3	**Energy Management and Audit:** Need and types of energy audit, energy management (audit) 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 and metering, IoT and smart metering, mandatory energy accounting for power distributors (DISCOMs)	**06**
4	**Energy Efficiency in Thermal Utilities and systems:** **Boilers:** Combustion in boilers, performances evaluation, analysis of losses, feed water treatment, blow down, energy conservation opportunities. boiler efficiency calculation, evaporation ratio, efficiency of coal, oil and gas fired boilers, soot blowing and soot deposit reduction, reasons for boiler tube failures, start up, shut down and preservation **Steam System:** Assessment of steam distribution losses, steam leakages, steam trapping, condensate and flash steam recovery system, identifying opportunities for energy savings, steam utilization, performance assessment of steam system, thermo-compressor, steam pipe insulation, condensate pumping, steam dryers **Furnaces:** Classification, general fuel economy measures in furnaces, excess air, heat distribution, temperature control, draft control, waste heat recovery, forging furnace heat balance, cupola, non-ferrous melting, induction furnace, performance evaluation of a furnace **Insulation and Refractories:** Insulation types and application, economic thickness of insulation, heat savings and application criteria, refractory types, selection and application of refractories, heat loss, cold insulation **Heat Exchangers:** Networking, pinch analysis, multiple effect evaporators, condensers, distillation column **Waste Heat Recovery:** Classification, advantages and applications, commercially viable waste heat recovery devices, saving potential **Cogeneration:** Definition, need, application, advantages, classification, saving potentials. heat balance, steam turbine efficiency, tri-generation, micro turbine **Heating, ventilation, air conditioning (HVAC) and Refrigeration System:** Factors affecting refrigeration and air conditioning system performance and savings opportunities, saving potential of vapor absorption refrigeration system, heat pumps and their applications, sections of ventilation system, and performance assessment of window and split room air conditioners and star labels	**22**
5	**Energy, environment and climate change:** United Nations Framework Convention on Climate Change (UNFCC), sustainable development, Kyoto Protocol, Conference of Parties (COP), Clean Development Mechanism (CDM), Bachat Lamp Yojna, Perform Achieve and	**06**

	Trade scheme, Carbon Credit Trade Scheme, Prototype Carbon Fund	
	Total	**45**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
10	**10**	**60**	**10**	**10**	**00**

R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

The syllabus of Energy Conservation and Management directly contributes to:

SDG 7	Affordable and Clean Energy
SDG 9	Industry, Innovation, and Infrastructure
SDG 11	Sustainable Cities and Communities
SDG 12	Responsible Consumption and Production
SDG 13	Climate Action

Reference Books:

1. Energy Conservation Guidebook, Dale R Patrick et al., River Publishers
2. Handbook of Energy Audits, Albert Thumann, Fairmont Press
3. The Bureau of Energy Efficiency (BEE) Guidebooks for Certified Energy Managers and Auditors
4. Energy Management Handbook, W.C. Turner, Fairmont Press
5. Heating and Cooling of Buildings: Design for Efficiency, J. Kreider and A. Rabl, McGraw Hill

List of Experiments:

1. To study the various acts and policy for the energy conservation.
2. To study various financial analysis techniques, energy performance contracts and role of energy service companies.
3. To study the elements of energy monitoring and targeting, techniques, CUSUM and Energy Management Information Systems (EMIS).
4. To get familiarized with use of energy audit instruments and prepare the energy audit report.
5. To carry out performance evaluation and evaluate energy saving opportunities for boiler.
6. To carry out performance evaluation and evaluate energy saving opportunities for steam system.
7. To study the various of insulations and refractories, evaluate economic thickness of insulation and apprise the selection criteria for the insulation and refractories.
8. To carry out performance evaluation and evaluate energy saving opportunities for furnace.
9. To carry out performance evaluation and analyze energy saving opportunities for the window/split air-conditioners.
10. To apprise various national and international climate schemes.

Major Equipment: energy audit instruments

List of Open-Source Software/learning website:

1. https://nptel.ac.in/courses/112105221
2. https://onlinecourses.nptel.ac.in/noc25_ar10/preview
3. https://onlinecourses.nptel.ac.in/noc25_hs136/preview
4. https://onlinecourses.swayam2.ac.in/e-learning/preview/nou26_es05

List of Indian standards related to the course: Indian standards for energy conservation and management are primarily developed and enforced by the BEE often in collaboration with the BIS. These standards aim to improve energy efficiency, reduce energy intensity, and promote sustainable practices across industrial, commercial, and residential sectors. Faculty members are required to give introduction about various BEE and Indian standards related to the course during theory and/or practical sessions. Students may be asked to prepare a report on one or more related Indian standards under PBL. **Acts, standards and schemes which are included in the content above are not repeated here.**

1. ISO 50001:2018 (Energy Management System)
2. Energy Conservation Guidelines for Industries 2018 by BEE, Ministry of Power
3. Energy Conservation Rules 2025

List of suggested activities for Problem-based Learning (PBL):

Sr. No.	PBL category	Name of the activity	No. of hours	Evaluation Criteria
1.	Complex Problem-Solving targeting relevant SDGs / Mini Project	Mini Project	15h	Based on the novelty of project, technical understanding, report quality and presentation
2.	Case Study Analysis / Seminar	Seminar	15h	Based on the quality of report and presentation, technical understanding
3.	Micro project	Micro project	8h	Based on the novelty of project, technical understanding, quality of report and demonstration
4.	Industry/Research laboratory visit	Industry/Research laboratory visit	Visit = 5h, Report preparation = 5h Total = 10h	Based on report submitted. Report should contain observations and calculations based on industry/ lab data.
5.	Video Based Learning	Technical video-based learning related to the subject	Duration of video = 5h Report preparation = 5h Total = 10h	Report /presentation based on the video learning outcomes.
6.	Assignment / Technical Writing / Research Writing	Assignment writing. Numerical based assignment is preferable.	5 assignments of 4 h each Total = 20h	Based on the correctness of submitted assignment
7.	Group Discussion / Quiz /	Problem solving/Coding using C, C++, MATLAB,	5 small coding-based assignment of 2h each	Based on the coding solution submitted.

	Simulation	Python, SCILAB, modeling and Analysis software or any other software	Total = 10h	
8.	Video Based Learning	Self-learning online course	Minimum duration of the course should be 10h	Examination based assessment at the end of course. Based on the certificate produced.
9.	Complex Problem-Solving targeting relevant SDGs / Mini Project	Identification and solution of Complex problem	Maximum 2 problems. Study of the problem and solution finding, Total = 10h	Based on the depth of the solution submitted.
10.	Video Based Learning	Videos on Industrial safety/Disaster Management aspects based on subject	Duration of video = 5h Report preparation = 5h Total = 10h	Based on quiz/report submitted
11.	Research Paper Review / Analysis	Technical paper reading and summarization of research papers based on relevant subject	5 research papers = 20h	Summarize research paper and evaluation critical parameters
12.	Poster / Chart / PowerPoint presentation	Poster/chart/power point preparation on technical topics	Duration = 6h	Based on poster/chart preparation and presentation skills
13.	Industry/Research laboratory visit	Industrial exposure for 2-3 days to observe and provide tentative solutions on society/environment/health/sustainability/any other issue	Duration = 15h for industrial exposure Problem identification and tentative solution = 10h Total = 20h	Based on evaluation of critical problems and solutions
14.	Group Discussion / Quiz / Simulation	Group Discussion on emerging/trending technical topics based on subject	Duration = 1h – 3h per topic	Based on performance in group discussion, technical depth, knowledge etc.
15.	Case Study Analysis / Seminar	Real world case studies-based learning	Duration of data collection/study = 5h Report preparation = 5h Total = 10h	Based on in-depth study, technical depth, data collected, fact finding, etc.
16.	Group Discussion / Quiz / Simulation	Application/Software development	Duration = 10h	Depending on the complexity of the Application/Software
17.	Assignment / Technical Writing / Research Writing	Research paper publication	Duration = 10h	Based on submission of proof of publication
18.	Micro project	Upgradation/Reverse engineering studies of existing equipment of the laboratory	Duration 10h	Based on the performance of the equipment
19.	Industry/Research laboratory visit	Expert lecture/session	Duration 3h For attending the lecture/session– 2h and for	Based on the proof of attendance and report submitted

			report writing 1h	
20.	Video Based Learning	Annotated Video Explanation of Concept/Problem	10h (Preparation + Recording + Submission)	Based on accuracy of explanation, clarity, and presentation style.
21.	Assignment / Technical Writing / Research Writing	Patent Search and Innovation Gap Identification	10h (Search + Report)	Based on number of relevant patents analyzed and identification of innovation scope.
22.	Assignment / Technical Writing / Research Writing	Preparation of a report on Indian Standard(s)	10h (study of Indian Standard(s) + report	Based on report quality and understanding of the relevant Indian Standard(s).

Note:

1. In alignment with Outcome-Based Education (OBE) and NBA accreditation requirements, the subject Heat Transfer **compulsorily incorporates Micro Project – 5 Marks as PBL activities.**
   These activities are incorporated as integral Project-Based Learning (PBL) components. These activities are designed to foster experiential learning, encourage innovation, and strengthen problem-solving skills by engaging students in practical applications of power converter design, simulation, and analysis. The inclusion of PBL ensures that learners develop higher-order cognitive abilities mapped to Bloom's taxonomy, while simultaneously enhancing teamwork, communication, and research competencies essential for professional engineering practice.
2. The hours allocated to specific activities should be proportionate to the total no. of PBL hours and marks.
3. All the suggested activity should be related to the subject.
4. The number of hours is suggestive. Faculty can sub-divide the number of hours based on the activity. However, total number of hours is fixed.
5. Rubrics for the evaluation will be prepared by the faculty members.
6. Subject teacher can add the relevant activities other than those listed above, with the consent of head of the department and DQAC.

****