GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

COURSE CURRICULUM
COURSE TITLE: ENERGY CONSERVATION & AUDIT
(COURSE CODE: 3350902)

Diploma Programme in which this course is offered	Semester in which offered
Electrical Engineering	5th Semester

1. RATIONALE

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 because energy conserved/saved is 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 by this course.

2. LIST OF COMPETENCY

The course content should be taught and implemented with the aim to develop different types of skills so that students are able to acquire following competency:

- **Plan and supervise for conservation of electrical energy**

3. COURSE OUTCOMES

The theory should be taught and practical should be carried out in such a manner that students are able to acquire different learning out comes in cognitive, psychomotor and affective domain to demonstrate following course outcomes.

i. Identify the demand supply gap of energy in Indian scenario.
ii. Carry out energy audit of an industry/Organization.
iii. Draw the energy flow diagram of an industry and identify the energy wasted or a waste stream.
iv. Select appropriate energy conservation method to reduce the wastage of energy
v. Evaluate the techno economic feasibility of the energy conservation technique adopted.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	ESE	PA	ESE	PA	
4	0	2	6	70	30	20	30	150

Legends: L-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** - Practical; **C** – Credit, **ESE** - End Semester Examination; **PA** - Progressive Assessment**.**

5. COURSE DETAILS

Unit	Major Learning Outcomes (out comes in cognitive)	Topics and Sub-topics
Unit – I Elements of Energy Conservation and Management	1a. Explain general energy problem in India 1b. Identify the scope for energy conservation 1c. Explain the Concept of energy conservation and its benefits	1.1 General energy problem, Sector wise Energy consumption, demand supply gap, Scope for energy conservation and its benefits 1.2 Energy conservation Principle – Maximum energy efficiency, Maximum cost effectiveness
	1d. Explain Energy conservation act 2001 and with its Mandatory provisions and features	1.3 Mandatory provisions of EC act 1.4 Features of EC act-Standards and labeling, designated consumers, Energy Conservation Building Codes (ECBC)
	1e. Explain the concept of energy management and its objectives 1f. Describe the initialization and organizing energy management program	1.5 Energy management concept and objectives 1.6 Initializing Planning, Leading, Controlling, Promoting, Monitoring and Reporting. energy management programmes
Unit– II Energy Conservation Approaches In Industries	2a. Identify energy conservation opportunities in various electrical systems in industries 2b. List the energy saving opportunities in electric motors 2c. Explain conservation of energy achieved by improving pf and harmonics	2.1 energy saving opportunities in electric motors 2a. Benefits of Power factor improvement and its techniques-Shunt capacitor, Synchronous Condenser etc., 2b. Effects of harmonics on – Motors, and remedies leading to energy conservation
	2d. Explain benefits of the listed methods and techniques aiding to conserve energy in lighting systems, heating and Cooling	2.3 Energy conservation by VSD 2.4 Methods and techniques of energy conservation in ventilation and air conditioners

Unit	Major Learning Outcomes (out comes in cognitive)	Topics and Sub-topics
	systems, Variable speed drive (VSD) ? 2e. State the energy conservation strategies in furnaces, ovens and boilers	- compressors pumps, fans and blowers - Area Sealing, Insulating the Heating / cooling fluid pipes , automatic door closing- Air curtain, Thermostat / Control 2.4 Energy conservation in electric furnaces, ovens and boilers
	2f. State the energy conservation strategies in electric lighting	2.5 lighting techniques – Natural , CFL, LED lighting sources and fittings
Unit– III Techno-economic Evaluation of Energy Conservation Option	3a. Describe circumstances that need capital investments for energy conservation in any plan 3b. Calculate the cost of energy conservation project 3c. Calculate the depreciation cost using sinking fund method 3d. Calculate the payback period for a given energy conservation equipment 3e. Evaluate a energy conservation project based on risk analysis	3.1 New equipment, technology, staffing, training 3.2 Calculation and costing of energy conservation project. 3.3 Depreciation cost, sinking fund method. 3.4 Cost evaluation by Return On Investment(ROI) and pay back method etc. 3.5 Risk analysis 3.6 Case study.
Unit– IV Energy Conservation in Power Generation, Transmission and Distribution:	4a. Identify scope of energy conservation in Generation 4b. Explain Demand side management and its significance in energy conservation Explain Energy conservation measures to optimize Transmission and distribution losses	4.1 Performance improvement of existing power plant: co-generation , small hydro ,DG Set 4.2 .Demand side management 4.3 Load response programmes 4.4 Types of tariff and restructuring of electric tariff Technical measures to optimize T and D losses
Unit– V Energy Audit	5a. Explain the concept of energy audit and its benefits 5b. Draw energy flow diagram to identify waste stream and energy wastage 5c. State the types of energy audits 5d. Describe the methodology for preliminary & detailed energy audit 5e. Describe energy audit report with a simple example 5f. Enlist the Measurements and	5.1 Energy audit and its benefits, 5.2 Energy flow diagram 5.3 Preliminary, Detailed energy audit. 5.4 Methodology of -preliminary energy audit and Detailed energy audit – Phase I, Pre audit, Phase II- Audit and Phase III- Post audit 5.5 Energy audit report. 5.6 Electrical Measuring Instruments - Power Analyser,

Unit	Major Learning Outcomes (out comes in cognitive)	Topics and Sub-topics
	measuring instruments used in energy audit 5g. Describe IE rules and regulations for energy audit Describe Electricity act 2003	Combustion analyzer, fuel efficiency monitor, thermometer-contact, infrared, pitot tube and manometer, water flowmeter, leak detector, tachometer and luxmeter 5.7 IE rules and regulations for energy audit Electricity act(Numerical)

6. SUGGESTED SPECIFICATION TABLE WITH HOURS and MARKS (THEORY)

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Elements of Energy Conservation And Management	08	02	03	03	08
II	Energy Conservation Approaches In Industries	16	06	08	04	18
III	Technoeconomic Evaluation of Energy Conservation Option	12	05	05	06	16
IV	Energy Conservation In Power Generation, Transmission And Distribution	10	04	06	04	14
V	Energy Audit	10	06	02	06	14
	Total	**56**	**23**	**24**	**23**	**70**

Legends: R = Remembrance; U = Understanding; A = Application 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.

7. SUGGESTED LIST OF EXERCISES/PRACTICALS

The tutorial/practical/exercises should be properly designed and implemented with an attempt to develop different types of cognitive and practical skills **(Outcomes in cognitive, psychomotor and affective domain)** so that students are able to acquire the competencies.

Note*: Here only outcomes in psychomotor domain are listed as practical/exercises. However, if these practical/exercises are completed appropriately, they would also lead to development of* ***Programme Outcomes/Course Outcomes in affective domain*** *as given in a common list at the beginning of curriculum document for this program. Faculty should refer to that common list and should ensure that students also acquire those Programme Outcomes/Course Outcomes related to affective domain*

Following is the list of experiments for guidance.

S. No.	Unit No.	Practical Exercises (Major Outcomes in psychomotor domain)	Hrs. required
1	I	List various energy management systems prevailing in a particular industry/Organization	2
2	I	Identify the energy management skills and strategies in the energy management system	2
3	I	Organize a energy management programme in a given industry	4
4	II	List the various energy conservation methods useful in a particular industry	2
5	II	Identify the critical areas where energy conservation is required	4
6	II	Select appropriate energy conservation method for the critical area identified	4
7	III	List the various energy conservation methods useful in power generation, transmission and distribution	2
8	IV	Find out the payback period for a given energy conservation equipment	4
9	IV	Determine depreciation cost of a given energy conservation project/equipment	4
10	V	Draw the energy flow diagram for a industry/shop floor division	4
11	V	Identify various measuring instruments used for energy audit	4
12	V	Use various measuring instruments for carrying out energy audit	4
13	V	Prepare a sample energy audit questionnaire	2
14	V	Prepare a energy audit report	2
15		Prepare a technical report on energy conservation act 2003	2
16		Prepare a technical report on ECBC	2
Total (perform any practical worth 28 hours from above depending upon the availability of resources so that most units are covered)			**48**

8. SUGGESTED LIST OF STUDENT ACTIVITIES

Following is the list of proposed student activities:

i. Assignments on solving simple numericals

ii. Prepare a report based on a survey of at least two nearby industries on energy conservation measures adopted by them using questionnaire

iii. Carry out a survey on internet and prepare a report on energy conservation act and ECBC

9. SPECIAL INSTRUCTIONAL STRATEGIES (if any)

Carry out detailed energy audit of your Institute or any other official building.

10. SUGGESTED LEARNING RESOURCES

A) List of Books

S. No.	Title of Book	Author	Publication
1.	Electric Energy Generation, Utilisation and Conservation	Sivaganaraju, S	Pearson, New Delhi, 2012
2.	Electrical Power	V. K. Mehta	Khanna and Khanna Publishers, New Dehli
3.	Electrical Power	S. L. Uppal	Khanna and Khanna Publishers, New Dehli
4.	Art and Science of utilization of Electrical Energy	H. Partab	Dhanapat Rai and Sons, New Dehli
5.	Prasanna Chandra	Project Management	Tata Mcgraw Hill, New Delhi
6.	Prasanna Chandra	Financial Management	Tata Mcgraw Hill, New Delh
7.	Wayne C. Turner	Energy Management Handbook	-
8.	Paul O Callaghan	Energy management	Mcgraw Hill, New Delhi
9.	www.bee-india.com	Fundamentals of electrical system	Bureau of Energy Efficiency

B) List of Major Equipment/ Instrument with Broad Specifications

Sl. No.	Measuring instruments
1.	Anemometer
2.	Lux Meter
3.	Power Analyzer
4.	Turbine Flow Meter
5.	Thermometer (Contact / Non-contact type)
6.	Tachometer (Contact / Non-contact type)
7.	Pressure Gauges
8.	Ammeter (AC / DC)
9.	Voltmeter (AC / DC) Mandatory
10.	Power Factor meter
11.	Tong Tester
12.	Earth Tester
13.	Energy meter
14.	Tri-vector meter
15.	Stroboscope

16. Multimeter
17. Pitot tube and manometer
18. Water Flow Meter
19. Leak Detector

C) List of Software/Learning Websites

i. www.bee. com
ii. www.nptel.iitm.ac.in

11. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Faculty Members from Polytechnics

- **Prof. S. V. Jagani**, Lecturer in Electrical Engineering, Govt. Polytechnic, Dahod
- **Prof. T. A. Patel,** Lecturer in Electrical Engineering, Govt. Polytechnic, Dahod
- **Prof. H C Chawda**, Lecturer in Electrical Engineering, R C Technical Institute, Ahmedabad

Coordinator and Faculty Members from NITTTR Bhopal

- **Dr (Mrs.) C. S. Rajeshwari,** Professor, Department of Electrical and Electronics Engineering,
- **Dr. Joshua Earnest,** Professor, Department of Electrical and Electronics Engineering,