

GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

**Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)
Semester-VI**

Course Title: ENERGY CONSERVATION & AUDIT
(Course Code: 4360903)

Diploma programmer in which this course is offered	Semester in which offered
Electrical Engineering	6 th Semester

1. RATIONALE

Electrical energy is the most common and widely used type of energy in the world. The subject of energy conservation is a concern for most energy users particularly industry. Energy conservation becomes even more important for the third world, developing countries, where the rising energy costs and the use of efficient energy apparatus are of significant concern to both the industry and the utility. The pressure of Technological development in all sectors on the energy sources has led to the growing the cost of energy around the world. Efficient and judicious use of the available energy sources would lead to the easing of such pressures. Thus it is necessary to save and conserve energy to the maximum possible extent. Also essential theoretical knowledge and practical skills about the concept of energy conservation is to be provided through different approaches of energy conservation in industries, project management and economic accepts. The process of energy audit will help to identify the various possible avenues in which savings of energy can be effectively adopted. This course makes the diploma holder well acquainted in the techniques of energy conservation in the fields of engineering. It also introduces him to the energy audit procedures.

2. COMPETENCY

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

- **Undertake energy conservation and energy audit.**

3. COURSE OUTCOMES (COs)

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.

- **Interpret** the need of energy conservation.
- **Implement** energy conservation techniques in electrical machines.
- **Evaluate** the techno economic feasibility for the energy conservation projects.
- **Demonstrate** energy conservation measures to improve efficiency of electrical power system.
- **Carry out** energy audit for an industry/organization.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	CA	ESE	CA	ESE	
3	0	2	4	30	70	25	25	150

Legends:

L – Lecture; T – Tutorial/Teacher Guided Theory Practice; P – Practical; C – Credit, CA – Continuous Assessment; ESE – End Semester Examination.

Note:

Out of 30 marks under the theory CA, 10 marks are for assessment of the micro-project to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be conducted during the semester for the assessing the attainment of the cognitive domain UOs required for the attainment of the COs.

5. SUGGESTED PRACTICAL EXERCISES:

Sr No	Practical Exercises (Major Outcomes in psychomotor domain)	Unit No.	Approx. Hrs. required
1	Identify star labelled electrical apparatus and compare the data for various star ratings.	I	2*
2	Prepare a technical report on energy conservation act 2001.	I	2
3	Estimate energy saving by improving power factor of an Induction Motor.	II	2*
4	Compare Conventional Transformer and Energy Efficient Transformers.	II	2*
5	Compare power consumption of different types of TL with choke and electronic ballast.	II	2*
6	Compare power consumption of different types of conventional tubelight, CFL and LED lamps by direct measurements.	II	2
7	Determine depreciation cost of a given energy conservation project/equipment.	III	2*
8	Find out the payback period and return on investment for a given energy conservation project/equipment.	III	2*
9	List the various energy conservation methods useful in power generation, transmission and distribution	IV	2
10	Collect electricity bill of an industrial consumer and suggest suitable tariff for energy conservation and its impact on energy bill	IV	2*
11	Collect electricity bill of a commercial consumer and suggest suitable tariff for conservation and reduction of its energy bill	IV	2*
12	Identify various measuring instruments used for energy audit.	V	2*
13	Use various measuring instruments for carrying out energy audit. (Any two)	V	2
14	Prepare a sample energy audit questionnaire	V	2*
15	Prepare a sample energy audit report	V	2*

A suggestive list of Practical Exercises is given in the above table. A judicious mix of minimum 10 or more practicals need to be performed, out of which, the practicals marked as '*' are compulsory, so that the student reaches the 'Precision Level' of 'Psychomotor Domain Taxonomy' as generally required by the industry.

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

Sr.No.	Equipment Name with Broad Specifications	Pra. No.
1	3 - ϕ induction motor	3
2	3 - ϕ or 1 - ϕ transformer	4
3	Ammeters MI Type: AC/DC 0-5-10Amp	3, 4
4	Voltmeter MI Type: AC/DC, 0-150/300V, 0-250/500V	3, 4
5	Wattmeter: Three phase double element 5/10Amp. 250/500V	3, 4
6	Wattmeter: Single phase, single element 2.5/5Amp, 200/400V	3, 4
7	Low power factor wattmeter : Single phase, 5/10Amp, 250/500V	3, 4
8	Three phase Power factor meters: AC, 415V, 50 Hz, 5-10 Amp	3, 4
9	Load bank: Resistive	3, 4
10	FTL, Electric choke. Electronic ballast	5
11	Clip on meter (amp, volts) digital	3, 4, 5
12	Multimeter	3, 4, 5
13	CFL & LED of different ratings	5, 6
14	Lux meter	12, 13

7. AFFECTIVE DOMAIN OUTCOMES

Students are able

- To create awareness regarding energy conservation in society.
- To select appropriate techniques to reduce energy wastage in household appliances.

8. UNDER PINNING THEORY:

Unit	Major Learning Outcomes	Topics and Sub-topics
Unit - I Elements of Energy Conservation	1a. Explain the concept of energy conservation and its benefits. 1b. Explain energy conservation act 2001 1c. Explain the concept of star labelling 1d. Explain Important Aspects of Energy Conservation	1.1 Indian energy scenario 1.2 Need of energy conservation 1.3 Energy conservation Principle 1.4 Benefits of energy conservation 1.5 Energy conservation act 2001 and its Purpose 1.5 Mandatory provision of the energy conservation act 2001. 1.6 Important features of energy conservation act 2001: <ul style="list-style-type: none"> • Standards and labelling (S&L) • Demand side management (DSM) • Energy conservation Building Code (ECBC) • Designated consumers • Bachat lamp Yojana (BLY) 1.7 Star labelling: need and benefits 1.8 Economic aspect and Environment aspect for energy conservation.
Unit - II Energy Efficient Technologies in Electrical Systems	2a. Identify energy conservation opportunities in various electrical systems in industries 2b. Explain the energy conservation strategies in induction motor 2c. Explain the energy conservation strategies in transformer 2d. Explain the energy conservation strategies in electric lighting	2.1 Energy efficient induction motor and its advantages 2.2 Benefits of power factor improvement 2.3 Power factor improvement techniques: static capacitor method, synchronous condenser method, phase advancer and related numericals 2.4 automatic power factor controllers 2.5 Maximum demand controllers 2.6 Energy conservation by variable speed drive 2.7 Need of Energy efficient transformer 2.8 Comparison between Conventional Transformer and Energy Efficient Transformers

		<p>2.9 Advantages of amorphous transformers</p> <p>2.10 Transformers loss reductions</p> <p>2.11 Energy efficient luminaires: CFL & LED</p> <p>2.12 Advantages of electronic ballast and electronic fan regulator</p> <p>2.13 Good lighting practice</p>
Unit - III Technoeconomic Evaluation of Energy Conservation Project	<p>3a. Calculate the cost of energy conservation project</p> <p>3b. Calculate the depreciation cost</p> <p>3c. Calculate the payback period and return on investment</p>	<p>3.1 Different cost of an energy conservation project</p> <p>3.2 Depreciation and methods to calculate it:</p> <ul style="list-style-type: none"> • straight line method • sinking fund method • diminishing value method • Related numericals <p>3.3 Modes of economic analysis:</p> <ul style="list-style-type: none"> • Payback period • Return on investment and • Related numericals
Unit - IV Energy Conservation in Power Generation, Transmission and Distribution	<p>4.a Identify scope of energy conservation in electrical power generation</p> <p>4.b Identify scope of energy conservation in electrical power transmission</p> <p>4.c Identify scope of energy conservation in electrical power distribution</p>	<p>4.1 Co-generation and its need</p> <p>4.2 Types of co-generation</p> <p>4.3 Advantages of co-generation</p> <p>4.4 Measures to reduce transmission line losses</p> <p>4.5 Energy conservation by demand side management</p> <p>4.6 Reconstruction of tariff (types of tariff are not included)</p>
Unit - V Energy Audit	<p>5.a Explain the concept of energy audit and its benefit</p> <p>5.b Describe the methodology for preliminary and detailed energy audit</p> <p>5.c Preparation of the Energy Audit Report</p> <p>5.d Demonstrate the function of instruments used in energy audit</p> <p>5.e List roles and responsibilities of energy auditor</p>	<p>5.1 Energy audit and its benefits</p> <p>5.2 Types of energy audit</p> <p>5.3 Methodology for conduction of energy audit</p> <p>5.4 Structure of the Energy Audit Report</p> <p>5.5 Energy Audit Instruments</p> <p>5.6 Roles and responsibilities of energy auditor</p>

9. SUGGESTED SPECIFICATION TABLE FOR QUESTIONPAPER DESIGN:

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Elements of Energy Conservation	6	3	4	3	10
II	Energy Efficient Technologies in Electrical Systems	12	3	8	7	18
III	Technoeconomic Evaluation of Energy Conservation Project	8	3	4	7	14
IV	Energy Conservation in Power Generation, Transmission and Distribution	8	6	4	4	14
V	Energy Audit	8	3	4	7	14
Total		42	18	24	28	70

Legends: R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)

Note: This specification table provides general guidelines to assist students for their learning and to teachers to teach and question paper designers/setters to formulate test items/questions to assess the attainment of the COs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may slightly vary from above table

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related co-curricular activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct any two of the following activities in group and prepare reports of each activity:

- Carry out internet survey to collect information related Energy conservation projects.
- Collect the catalogues of star labeled equipments (min.2)
- Write report on performance of motor after rewinding.
- Collect videos to demonstrate working of Energy Conservation Equipments (any 2)
- Prepare PPT presentation on energy efficient motors.
- Prepare PPT presentation on energy efficient transformers.
- Collect information about energy efficient luminaries.
- Collect videos to demonstrate working of Energy Audit instruments.
- Visit a facility adopting cogeneration system and prepare a presentation.
- Assignments on solving simple numericals
- Prepare a report based on a survey of at least two nearby industries on energy conservation measures adopted by them using questionnaire.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the faculty can use to accelerate the attainment of the various outcomes of this course:

- Massive open online courses (MOOCs) may be used to teach various topics/sub topics.
- About 15-20% of the topics/sub-topics which is relatively simpler or descriptive in nature is to be given to the students for self-directed learning and assess the development of the COs through classroom presentations.

12. SUGGESTED PROJECT LIST (MICRO PROJECT)

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. However, in the fifth and sixth semesters, microproject should preferably be assigned individually undertaken to build up the skill and confidence in every student to become problem solver so that she/he contributes to the projects of the industry. In special situations where groups have to be formed for micro-projects, the number of students in the group should not exceed three.

Suggestive list of micro-projects is as under. Similar micro-projects could be added by the concerned faculty:

- a. Energy efficient lamps:**
Prepare comparative charts with ratings, cost and manufacturer details.
- b. Energy efficient home appliances:**
Interpret star labelling, its needs and benefits.
- c. Energy conservation campaign:**
Prepare charts/slogans to create energy conservation awareness among people.
- d. Energy efficient electrical machines:**
Prepare technical presentation on details of energy efficient transformers/motors.
- e. Energy conservation policies:**
Prepare report on energy conservation policies of Government of Gujarat.
- f. Energy Audit:**
Prepare charts based on various measuring instruments for carrying out energy audit
- g. Energy Manager and Energy Auditor:**
Identify roles and responsibilities of energy manager as well as energy auditor.

13. SUGGESTED LEARNING RESOURCES

Sr. No.	Title of Book	Author	Publication
1	Energy Technology	O.P. Gupta	Khanna Publishing House, New Delhi
2	Energy management	Dr. Sanjeev Singh	S K Kataria & Sons, New Delhi,
3	Financial Management	Prasanna Chandra	Tata Mcgraw Hill, New Delhi
4	Project Management T	Prasanna Chandra	Tata Mcgraw Hill, New Delhi
5	Energy Management and Conservation	Sharma, K. V., Venkateshaiah	I K International Publishing House Pvt. Ltd
6	Electric Energy Generation, Utilisation and Conservation	S. Sivaganaraju	Pearson, New Delhi, 2012
7	Electrical Power	V. K. Mehta	Khanna and Khanna Publishers, New Dehli

14. SOFTWARE/LEARNING WEBSITES

1. <https://beeindia.gov.in/>
2. <http://indianpowersector.com/>
3. www.mnes.nic.in
4. <https://powermin.nic.in/>
5. <https://www.anert.gov.in/>
6. www.nptel.iitm.ac.in
7. www.energymanagertraining.com
8. www.greenbusiness.com
9. www.worldenergy.org

15. PO-COMPETENCY-CO MAPPING:

Semester VI	Electrical Engineering: Energy Conservation & Audit (Course Code: 4360903)						
	POs						
Competency & Course Outcomes	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7
<u>Competency</u>	Undertake energy conservation and energy audit.						
Interpret the need of energy conservation	1	2	-	2	3	-	2
Implement energy conservation techniques in electrical machines	3	3	1	3	2	3	3
Evaluate the techno economic feasibility for the energy conservation projects.	3	-	-	-	2	-	1
Demonstrate energy conservation measures to improve efficiency of electrical power system	3	2	-	-	3	2	3
Carry out energy audit for an industry/ organization.	3	2	2	3	3	3	2

Legend: '3' for high, '2' for medium, '1' for low and '-' for no correlation of each CO with PO.

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons

Sr. No.	Name and Designation	Institute	Contact No.	Email
1.	Mr. ASHVIN M MAHESHWARI	Government Polytechnic, Dahod	9427533123	ampcity25@gmail.com
2.	TEJAL H PATEL	Dr. S & S Ghandhy college, Surat	8141971675	pateltejal.239@gmail.com