

|                              |                                                   |
|------------------------------|---------------------------------------------------|
| <b>Branch Name:</b>          | Electrical Engineering                            |
| <b>Program Code:</b>         | ET109                                             |
| <b>Course Name:</b>          | Energy Conservation and Audit (Open Elective-III) |
| <b>Course Code:</b>          | 2ET1090881T                                       |
| <b>Pre-requisite Course:</b> | --                                                |

### Course Objectives:

1. The objective of the course is to understand the basic components of different energy sources and access national or international energy scenarios.
2. Analyze, calculate and improve the energy efficiency and performance of electrical and industrial utilities.
3. Apply to incorporate diverse options and evaluate the business, policy environment in relation to energy conservation and energy.

**Teaching and Examination Scheme:**

| Credit | Teaching Scheme<br>Hours per week |   |   |       | Evaluation Scheme (Marks) |      |      |      |                   |      |      |      | Total<br>(Marks ) |
|--------|-----------------------------------|---|---|-------|---------------------------|------|------|------|-------------------|------|------|------|-------------------|
|        |                                   |   |   |       | Theory (Marks)            |      |      |      | Practical (Marks) |      |      |      |                   |
|        | L                                 | T | P | Total | SEE                       |      | CCA  |      | SEE               |      | CCA  |      |                   |
|        |                                   |   |   |       | Min.                      | Max. | Min. | Max. | Min.              | Max. | Min. | Max. |                   |
| 3      | 3                                 | - | - | 3     | 24                        | 60   | 16   | 40   | -                 | -    | -    | -    | 100               |

**Course Contents:**

| Sr. No. | Topic                                                                                                                                                                                                                                                                                                                                                                                                                                              | Total Hours | Weightage (%) |
|---------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|---------------|
| 1       | <b>Energy Scenario:</b><br>Commercial and non-commercial energy, Primary energy resources, Commercial energy production, Final energy consumption, Energy needs of growing economy, Long term energy scenario, Energy pricing, Energy sector reforms, Energy and environment, Air pollution, Climate change, Energy security, Energy conservation and its importance, Energy strategy for the future, Energy conservation act 2001.                | 05          | 10            |
| 2       | <b>Basics of Energy &amp; its Various Forms:</b><br>Electricity basics, DC and AC currents, Electricity tariff, Load management and maximum demand control, Power factor, Thermal basics, Fuels, Thermal energy content of fuels, Temperature and pressure, Heat capacity, Sensible and latent heat, Evaporation, Condensation, Steam, Moist air, Humidity and heat transfer, Units and conversion.                                                | 05          | 10            |
| 3       | <b>Energy Management and Audit:</b><br>Definition, Energy audit, Need, Types of energy audit, Energy management approach, understanding energy costs, Benchmarking, Energy performance, matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution, Energy audit instruments. Energy audit methodology and standards as per the Bureau of Energy Efficiency (BEE). | 06          | 10            |
| 4       | <b>Energy Action Planning:</b><br>Key elements, Force field analysis, Energy policy purpose, Perspective contents, Formulation, Ratification, Organizing, Location of energy management, Top management support, Managerial function, Roles and responsibilities of energy manager, Accountability, Motivation of employees, Information system designing barriers, Strategies, Marketing and communicating, Training & planning.                  | 04          | 10            |

|           |                                                                                                                                                                                                                                                                                                                                                                      |    |    |
|-----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|----|
| <b>5</b>  | <b>Financial Management:</b><br>Investment, Need, Appraisal and criteria, Financial analysis techniques, Simple payback period, Return on investment, Net present value, Internal rate of return, Cash flow, Risk and sensitivity analysis, Financing options, Energy performance contracts and role of ESCOs.                                                       | 05 | 10 |
| <b>6</b>  | <b>Global Environmental Concerns:</b><br>United Nations Framework Convention on Climate Change (UNFCCC), Kyoto protocol, Conference of Parties (COP), Clean Development Mechanism (CDM), Prototype Carbon Fund (PCF), Sustainable development.                                                                                                                       | 03 | 08 |
| <b>7</b>  | <b>Electrical System:</b><br>Electricity billing, Electrical load management & maximum demand control, Power factor improvement & its benefits, Selection & location of capacitors, Performance assessment of p.f capacitors, Distribution and transformer losses.                                                                                                   | 04 | 08 |
| <b>8</b>  | <b>Electric Motors:</b><br>Types, Losses in induction motors, Motor efficiency, Factors affecting motor performance, Rewinding and motor replacement issues, Energy saving opportunities with energy efficient motors.                                                                                                                                               | 03 | 08 |
| <b>9</b>  | <b>Lighting System:</b><br>Light source, Choice of lighting, Luminance requirements, Terminologies used in lighting systems, Recommended illuminance standards, Methodology of energy efficiency audit in lighting systems, Good practices, Energy conservation avenues.                                                                                             | 03 | 08 |
| <b>10</b> | <b>DG Set System:</b><br>Basics of internal combustion engines, Factors affecting selection & performance, Waste heat recovery to enhance cost effectiveness of DG sets, Energy performance assessment, Energy conservation avenues and troubleshooting.                                                                                                             | 03 | 08 |
| <b>11</b> | <b>Energy Efficient Technologies in Electrical System:</b><br>Maximum demand controllers, Automatic power factor controllers, Energy efficient motors, Soft starters with energy saver, Variable speed drives, Energy efficient transformers, Electronic ballast, Occupancy sensors, Energy efficient lighting controls, Energy saving potential of each technology. | 04 | 10 |

**Text Books:**

1. Guide books for National Certification Examination for Energy Manager / Energy Auditors Book-1, General Aspects (available online).
2. Guide books for National Certification Examination for Energy Manager / Energy Auditors Book-3, Electrical Utilities (available online).
3. Encyclopedia of Energy, McGraw Hill Publication.
4. Handbook of Energy Engineering- Albert Thumann, The Fairmont Press Inc. Delhi, 2013.

**Reference Books:**

1. Energy management Handbook- Wayne C. Turner, John Wiley and sons.
2. Energy Efficiency Manual for GERIAP, UNEP- Cleaner Production, Bangkok prepared by National Productivity Council.
3. Financial management- Prasanna Chandra, Tata Mc-Graw Hill, 8<sup>th</sup> edition-2011.
4. Projects: Planning, Analysis, Selection, Implementation and Review- S. Choudhury, Tata McGraw Hill, 10<sup>th</sup> Edition, 2023.

**ICT/MOOCs Reference:**

1. <https://nptel.ac.in/courses/108/106/108106022/>
2. [https://nptel.ac.in/content/storage2/nptel\\_data3/html/mhrd/ict/text/112105221/lec51.pdf](https://nptel.ac.in/content/storage2/nptel_data3/html/mhrd/ict/text/112105221/lec51.pdf)
3. <https://beeindia.gov.in/content/energy-auditors>

**Course Learning Outcomes (CLO): On completion of this course, the students will be able to:**

| CLO  | Description                                                                                                                              | Bloom's Taxonomy Level |
|------|------------------------------------------------------------------------------------------------------------------------------------------|------------------------|
| CLO1 | Understand the basic components of different energy sources and access national or international energy scenarios.                       | 2 Understanding        |
| CLO2 | Know the economics of energy conservation opportunities in electrical and industrial utilities and needs of energy audit and management. | 1 Remembering          |
| CLO3 | Analyze, calculate and improve the energy efficiency and performance of electrical and industrial utilities.                             | 4 Analyzing            |
| CLO4 | Apply to incorporate diverse options and evaluate the business, policy environment in relation to energy conservation and energy.        | 3 Applying             |
| CLO5 | Evaluate the techno economic feasibility of the energy conservation technique adopted.                                                   | 5 Evaluating           |

**Mapping of CLOs with POs & PSOs:**

| Course Learning Outcomes | Program Outcomes (POs) |      |      |      |      |      |      |      |      |       |       |      | Program Specific Outcomes(PSOs) |       |       |       |
|--------------------------|------------------------|------|------|------|------|------|------|------|------|-------|-------|------|---------------------------------|-------|-------|-------|
|                          | PO 1                   | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO12 | PS O1                           | PS O2 | PS O3 | PSO 4 |
| CLO1                     | H                      | L    | L    | L    | L    | H    | H    | H    | L    |       |       | H    | M                               | M     | H     | L     |
| CLO2                     | H                      | H    | M    | H    | H    | H    | H    | L    | L    | M     | L     | L    | H                               | H     | L     |       |
| CLO3                     | H                      | H    | M    | H    | M    | H    | M    |      | H    | M     | H     |      | H                               | H     | L     | L     |
| CLO4                     | H                      | L    | L    | L    | L    | H    | L    |      | L    |       | L     |      | L                               | M     | L     |       |
| CLO5                     | H                      | M    | L    | L    | L    | M    | L    |      | L    |       | L     | L    | L                               | M     | L     | M     |

H: High, M: Medium, L: Low