# GUJARAT TECHNOLOGICAL UNIVERSITY

ENERGY ENGINEERING (39)
ENERGY CONVERSION SYSTEMS
**SUBJECT CODE**: 2713902
SEMESTER: I

**Type of course:** Energy Engineering

**Prerequisite:** Basic knowledge of Energy sources and Thermodynamics

**Rationale:** The course provides understanding of conventional energy conversion systems

**Teaching and Examination Scheme:**

| Teaching Scheme | | | Credits | Examination Marks | | | | | | Total Marks |
|---|---|---|---|---|---|---|---|---|---|---|
| L | T | P | C | Theory Marks | | Practical Marks | | | | |
| | | | | ESE (E) | PA (M) | PA (V) | | PA (I) | | |
| | | | | | | ESE | OEP | PA | RP | |
| 3 | 2# | 2 | 5 | 70 | 30 | 20 | 10 | 10 | 10 | 150 |

**Content:**

| Sr. No. | Topics | Teaching Hrs. | Module Weightage |
|---|---|---|---|
| **1** | **Fundamentals of Energy Conversion:**<br>• Introduction to Energy Forms,<br>• Energy, Heat, Work and Power<br>• Thermodynamics of Energy Conversion<br>• Energy Sources, Primary energy sources, Conversion of primary into secondary energy sources such as Electricity, Thermal or Steam | 2 | 5 |
| **2** | **Fuel Combustion and Gasification:**<br>• Fuel Composition and Heating Value<br>• Combustion stoichiometry and calculation<br>• Gaseous product combustion<br>• Coal gasification<br>• Gasification process and gasifiers | 5 | 10 |
| **3** | **Thermal Energy :**<br>• Steam and Gas power plant cycle, Rankine and Bryton cycles, Efficiency Enhancement through Reheat, Regenerative and Intercooling, Supercritical cycle<br>• Steam Generators and Boilers -Types, Performance evaluation of boilers, Boiler Water Treatment and blow down, Introduction to FBC Boilers, Mechanism and Operational Features of FBC, Retrofitting FBC system to conventional boilers,<br>• Steam turbines: Classification, impulse turbine, reaction turbine, compound turbine, performance evolution, energy losses in turbine and governing, turbine auxiliary system, Advances in thermal energy | 18 | 40 |
| **4** | **Nuclear Energy :** | 7 | 15 |

| | | | |
|---|---|---|---|
| | • Energy Conversion through fission and fusion,<br>• Nuclear reactor: PWR, BWR, GCR,HTGR, HWR, LMFBR<br>• Advances in nuclear energy | | |
| **5** | **Co-generation, Tri-generation & Waste Energy Recovery :**<br>• Co-generation & Tri-generation: Definition, need, application, advantages, classification, saving Potential,<br>• Waste Heat Recovery: Concept of conversion efficiency, energy waste, waste heat recovery classification, advantages and applications, commercially viable waste heat recovery devices. | 13 | 30 |

**Reference Books:**


1. Nikolai V. Khartchenko, Advance Energy Systems, Taylor and Francis Publishing
2. M.M.El-Wakil, Powerplant Technology, Tata McGraw Hill
3. Rajmohan Gupta, "Steam Turbine", Oxford & IBH Publishing Co. Pvt. Ltd.
4. P. K. Nag, "Power Plant Engineering", Tata McGraw Hill Publications.
5. R. Yadav, "Steam Turbine", Khanna Publishers.
6. Ganesan, "Gas Turbine", McGraw Hill
7. Dr. Meherwan P. Boyce, P.E., "Gas Turbine Engineering Handbook", 3rd edition
8. Arora and Domkundwar "Power Plant Engineering", Dhanpatrai and Sons
9. BEE Reference book: no.1/2/3/4
10. Practical Heat Recovery – Boyen J.L. John Wiley, New York, USA1976


**Course Outcome:**

After learning the course the students should be able to:

1. Define Energy, Heat, Work, power and other Energy related Terms
2. Explain energy conversion cycle
3. Calculate stiochiometric air required for combustion
4. Evaluate performance of energy conversion systems
5. Compare various energy conversion systems

**List of Experiments:**

The students will have to prepare laboratory manual based on the syllabus content. Following are the recommended experiments to be incorporated in the laboratory journals.

1. Characterization of Fuel
2. Determination of Calorific Value of fuels
3. Combustion product analysis
4. Determination of boiler efficiency
5. Evaluation of performance parameters of steam power cycle
6. Evaluation of performance parameters of gas power cycle
7. Study of nuclear power generation
8. Study of combined, cogeneration and tri-generation systems
9. Study of waste heat recovery systems

**Design based Problems (DP)/Open Ended Problem:**

1. For an actual steam based thermal power plant, (a) Performa Energy Analysis, (b) Prepare Energy flow diagram (c) find out cost/ unit power generation

2. For an actual gas based thermal power plant, (a) Performa Energy Analysis, (b) Prepare Energy flow diagram (c) find out cost/ unit power generation

3. Prepare a case study on economics of a Gas Turbine based co-generation systems
4. Prepare working model/chart/animation of different energy conversion systems

**Major Equipments:**

1) Bomb Calorimeter
2) Junker's Calorimeter
3) Flash & Fire Point Apparatus
4) Carbon Residue Apparatus
5) Automatic Proximate Analyzer
6) Pressure gauges, Thermometers, Liquid level gauges, Flow meters
7) Gas analyzers
8) Steam Turbine Power Plant system (Rankine Cycle Simulator)
9) Gas Turbine Power Plant System
10) Gasifier

**List of Open Source Software/learning website:**
www.nptel.iitm.ac.in/courses/**;** https://www.coursera.org/**;** https://www.edx.org/**; Power Plant Simulator Software**