| Course Code | Course Name | L-T-P | Credits | Year of Introduction |
|---|---|---|---|---|
| BT362 | Sustainable Energy Processes | 3-0-0 | 3 | 2016 |

**Prerequisite: Nil**

**Course Objectives**

- To introduce the current and potential future energy systems, covering resources, extraction, conversion, and applications, with emphasis on meeting regional and global energy needs in a sustainable manner.

**Syllabus**

Classification of energy, extraction, conversion, and applications of solar energy, wind energy, ocean energy, biomass energy, fuel cells and hydro-dynamic systems, merits and demerits of various energy systems, energy storage.

**Expected outcome**

Students who successfully complete this course should be able to

i. Identify global and Indian energy sources.
ii. Explain capture, conversion and application of solar and wind energy.
iii. Explain conversion of biomass to energy.
iv. Explain the capture of energy from oceans.
v. Explain fuel cells and energy storage routes.

**Reference Books**


1. Bansal N K, Kleemann M, Michael Meliss, *Renewable Energy Sources & Conversion Technology*, Tata McGraw Hill publishing Company, New Delhi, 1990.
2. Boyle, Godfrey, *Renewable Energy*, 3/e, Oxford University Press, 2012.
3. S P Sukhatme, *Solar Energy - Principles of Thermal Collection and Storage*, 2/e, Tata McGraw- Hill Publishing company, New Delhi,1996.
4. Pramod Jain, *Wind Energy Engineering*, McGraw Hill, 2011.
5. Donald L Klass, *Biomass for Renewable Energy, Fuels and Chemicals*, Academic Press, 1998.


**Course Plan**

| Module | Contents | Hours | Sem. Exam Marks |
|---|---|---|---|
| I | **General classification of energy**. Conventional and non-conventional. Renewable and non-renewable. Global and Indian energy sources. Global and Indian energy consumption. Problems of fossil fuels. Environmental aspects of energy utilization. Energy and sustainable development. Energy planning. Renewable energy sources, potentials, achievements and applications. | 7 | 15% |
| II | **Solar energy**. Solar radiation. Solar thermal systems. Flat plate and concentrating collectors. Solar desalination. Solar pond. Solar cookers. Solar dryers. Solar thermal electric power plant. Solar photovoltaic conversion. Semiconductor and thin film technology. Solar cells. Solar photovoltaic power generation. Hybrid systems. Merits and limitations of solar energy. | 7 | 15% |
| **FIRST INTERNAL EXAM** | | | |

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|---|---|---|---|
| III | **Wind energy**. Availability of wind energy, Site characteristics, Wind turbine types-horizontal axis and vertical axis-design principles of wind turbine. Wind power plants, Wind energy storage. Safety and environmental aspects. Merits and limitations of wind energy. | 7 | 15% |
| IV | **Biomass energy**. Biomass resources, Biomass conversion technologies-direct combustion, pyrolysis, biomass gasification. Biogas production. Biomethanation as an aid to environment improvement. Bioethanol, biodiesel and biobutanol production. Hydrogen as fuel. Biohydrogen production. Storage of hydrogen. | 7 | 15% |
| **SECOND INTERNAL EXAM** | | | |
| V | **Energy from the oceans**. Ocean thermal electric conversion. Tidal energy conversion. Geothermal energy conversion. Hydro power-global and Indian scenario. Positive and negative attributes of hydropower. Electricity from hydropower. Small hydropower. | 7 | 20% |
| VI | **Fuel cells.** Alkaline fuel cells. Phosphoric acid fuel cell. Molten carbonate fuel cell. Solid oxide fuel cell, Solid polymer electrolyte fuel cell. Magneto-hydrodynamic systems. Electric vehicles. Energy storage routes like thermal, chemical, mechanical, electrical storage. Batteries. | 7 | 20% |
| **END SEMESTER EXAMINATION** | | | |

**QUESTION PAPER PATTERN:**

Maximum Marks: 100 Exam Duration: 3 hours

The question paper consists of Part A, Part B and Part C.

Part A consists of three questions of 15 marks each uniformly covering Modules I and II. The student has to answer two questions (15×2=30 marks).

Part B consists of three questions of 15 marks each uniformly covering Modules III and IV. The student has to answer two questions (15×2=30 marks).

Part C consists of three questions of 20 marks each uniformly covering Modules V and VI. The student has to answer two questions (20×2=40 marks).

For each question there can be a maximum of 4 subparts.