

## SUSTAINABLE ENERGY SYSTEMS

**Paper Code: ETEN-413**

**Paper: Sustainable Energy Systems**

<b>L</b>	<b>T/P</b>	<b>C</b>
<b>3</b>	<b>1</b>	<b>4</b>

**INSTRUCTIONS TO PAPER SETTERS:**

**MAXIMUM MARKS: 75**

1. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. It should be of 25 marks.
2. Apart from Question No. 1, rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, student may be asked to attempt only 1 question from each unit. Each question should be of 12.5 marks

*Objective:*

1. To describe the fundamentals and main characteristics of renewable energy sources and their differences compared to fossil fuels.
2. To explain the technological basis for harnessing various types of renewable energy sources.

**UNIT – I**

Introduction to sustainable energy – Global sustainability, Role of Energy Conservation, Economics of Energy Generation and conservation System. Geothermal energy: Availability, Geothermal sources, system development and limitations Ocean thermal energy conversion (OTEC): Methods, OTEC system, energy from tides, Scope and economics, Introduction to integrated energy systems.

[T1, T2][No. of Hours: 11]

**UNIT – II**

Solar energy – Production and transfer of solar energy, Sun-Earth angles, Availability and limitations of solar energy, Measuring techniques and estimation of solar radiation, Photovoltaics and Solar pond, Solar thermal collectors, Flat plate collectors. Heat transfer processes, Short term and long term collector performance, Solar concentrators – Design, analysis and performance evaluation. Applications of Solar energy.

[T1, T2, R2][No. of Hours: 11]

**UNIT – III**

Wind energy: Introduction, Wind Characteristics, Principles of wind energy conversion, Site selection considerations. Types of Wind machines, Wind power plant design, Wind Farms, Operation, maintenance and economics. Energy storage, applications of Wind Energy, Environmental Aspects.

[T1, T2][No. of Hours: 11]

**UNIT – IV**

Energy from Biomass, Biomass conversion technologies, Biogas Generation, Classification of Biogas plants, Biomass as a source of energy, thermal gasification of Biomass. Energy Storage : Mechanical Technologies, Pumped Hydroelectric storage, Compressed Air Energy Storage, Fundamentals of Battery and Fuel cells, Rechargeable Batteries, Fuel Cells and Hydrogen.

[T1, T2,R3][No. of Hours: 12]

**Text Books:**

- [T1] Rai G.D., “Non-Conventional Energy Sources”, Khanna Publishers, New Delhi.  
[T2] Thorndike E.H., “Energy and Environment- a primer for Scientist and Engineers”, Wesley Publishing Company.

**Reference Books:**

- [R1] Mittal K.M., “Non-conventional Energy Systems-Principles, Progress and Prospects”, Wheeler Publications, New Delhi.  
[R2] Duffie J.A. and Beckman W.A., “Solar Energy thermal processes”, John Wiley, New York.  
[R3] Kreith F. and Kreider J.F., “Principles of Solar Engineering”, Tata McGraw Hill Education (P) Ltd.  
[R4] Ahmed, “Wind energy- Theory and Practice”, PHI Learning (P) Ltd., New Delhi.  
[R5] Kothari, “Renewable Energy Sources and Emerging Technologies”, PHI Learning (P) Ltd., New Delhi