

**IV Year II Semester**  
**17EE834**

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**RENEWABLE ENERGY SYSTEMS**  
**(Professional Elective-III)**

**Preamble:**

This course gives a flavour of renewable sources and systems to the students. This covers generation, design, efficiency and characteristics of various renewable energy sources including wind, hydro, biomass, fuel cells, tidal and geothermal systems.

**Learning objectives:**

1. To study the energy present scenario in worldwide and India.
2. To study wind energy and maximum power point techniques.
3. To study wind energy conversion systems, Betz coefficient, tip speed ratio.
4. To study basic principle and working of small hydro power systems.
5. To study tidal power generation and bio energy sources.
6. To study fuel cell and geothermal power generation.
7. To understand conversion technologies, processes, systems and devices and equip the student to take up projects in those areas.

**Unit – I**

**Fundamentals of Energy Systems:** Energy conservation principle – Energy scenario -world Energy Status– Energy scenario in India - Introduction to renewable energy resources-various forms of renewable energy - Ministry of New and Renewable Energy (MNRE)

**Unit – II**

**Wind Energy**

Sources of wind energy - Wind patterns – Types of turbines –Horizontal axis and vertical axis machines - Kinetic energy of wind – Betz coefficient – Tip–speed ratio – Efficiency –Power output of wind turbine – Selection of generator(synchronous, induction) – Maximum power point tracking – wind farms – Power generation for utility grids-Solar Wind Hybrid energy systems.

**Unit – III**

**Small Hydro Power Systems**

Basic working principle – Classification of hydro systems: Large, small, micro –measurement of head and flow – Energy equation – discharge curve and estimation of power potential -Types of turbines – Numerical problems.

**Unit – IV**

**Tidal power systems**

Tidal power – Basics – Kinetic energy equation – Turbines for tidal power – Numerical problems – Wave power – Basics – Kinetic energy equation – Wave power devices – Linear generators.

## **Unit – V**

### **Bio Energy Sources**

Fuel classification-Energy through various processes - Energy through fermentation - Gasification - various types of gasifiers -Pyrolysis - Fixed bed and fast Pyrolysis - Bio energy through digestion - Types of Digesters and sizing-Factors affecting the yield of products.

## **Unit – VI**

### **Fuel Cells and Geothermal Systems**

Fuel cell: Classification of fuel for fuel cells – Fuel cell voltage– Efficiency – V-I characteristics.

Geothermal: Classification – Dry rock and hot aquifer – Energy analysis – Geothermal based electric power generation.

### **Learning Outcomes:**

Student should be able to

1. Explain wind energy conversion systems, wind generators, power generation.
2. Explain the solar wind hybrid renewable energy systems
3. Explain basic principle and working of hydro, tidal, biomass, fuel cell and geothermal Systems
4. Explain the basic principles of energy conversion processes and devices used therein.
5. Identify suitable renewable source and technology for a given requirement.
6. Undertake field projects in these areas.

### **Text books:**

1. Energy Science: Principles, Technologies and Impacts, John Andrews and Nick Jelly, Oxford University Press.
2. Renewable Energy Resources, John Twidell and Tony Weir, Taylor and Francis -second edition, 2013.

### **Reference books:**

1. Rai,G.D., Solar Energy Utilization, Khanna Publishers, N. Delhi, 2010.
2. Renewable Energy- Edited by Godfrey Boyle-oxford University. Press, 3rd edition, 2013.
3. Handbook of renewable technology Ahmed and Zobaa, Ramesh C Bansal, World scientific, Singapore.
4. Renewable Energy Technologies / Ramesh & Kumar /Narosa.
5. Renewable energy technologies – A practical guide for beginners – Chetong Singh Solanki, PHI.
6. Non-conventional energy source –B.H.khan- TMH-2nd edition.