EEPE3005 RENEWABLE ENERGY SOURCES (3-0-0)

Course Learning Objectives: This course will enable to understand the students the working, characteristics, and types of renewable energy sources.

- To make the students analyze the energy conversion mechanisms of the renewable energy sources and hybrid systems.
- To enable students to integrate and implement renewable energy systems in power grids.
- To make students optimize the technical, economic, and environmental performance of renewable energy technologies.

Module I (10 Hours)

Introduction: Types of energy sources (Conventional and non-conventional) and its Impacts, Worldwide potentials of these sources, Energy consumption patterns, Distributed generation. Renewable Sources: Renewable energy sources and features, Solar Energy: Solar thermal Systems, Types of collectors, Collection systems, efficiency calculations, applications. Solar photovoltaic system-Operating principle, Characteristics of PV systems, Equivalent circuit, Cell, Module, Array, Series and parallel connections, Cell mismatching, Maximum power point tracking, Standalone and grid interactive systems, Peak power operation, Applications of solar PV, Modeling of PV cell.

Module II (8 Hours)

Wind Energy: Wind energy, Wind energy conversion, Types of wind converters, System components, Aerodynamic operation of wind turbines, Maximum power extracted from wind, Wind speed and power characteristics, Choice of generators, turbine rating, electrical load matching, Variable speed operation, single and double output systems, DFIG concepts, Reactive power compensation, Control systems, System design features, Stand alone and grid connected operation.

Module III (6 Hours)

Small Hydro Systems: Layout of a Micro-Hydro scheme, Water turbines: Classification and characteristics, Present status.

Bio-Mass: Principles of biomass conversion, Combustion and fermentation, Anaerobic digestion, Classification of Biogas plants, Present status

Tidal power: Tidal phenomena, Tidal power development and tide mills, Ocean tidal energy conversion schemes, Present status

Module IV (7 Hours)

Energy storage Technologies: Energy storage, Need of energy storage, Specifications, Types of storage. Battery management. Fuel Cell energy storage systems. Ultra Capacitors.

Hybrid Systems: Need for hybrid systems, Range and type of hybrid systems, Hybrid Micro hydel-PV, PV-Wind systems, Electric and hybrid electric vehicles.

Course Outcomes (CO): On completion of this course, students are able to:

CO1. Discuss the concepts of conventional and non-conventional energy sources along withtheir environmentimpacts, and the importance of solar power systems

CO2. Evaluate the operation and control of wind energy conversion systems, turbine designs, DFIG operation, and reactive power compensation.

CO3. Describe the principles and technologies of small hydro, biomass, and tidal energy systemsand assess their current status and applications.

CO4. Assess different energy storage systems and hybrid renewable configurations, including battery management, fuel cells, and hybrid electric vehicles.

Text Book(s):

1. B.H.Khan, “Non-Conventional Energy Resources”, Tata McGrawHill, 2009.

2. S. N. Bhadra, D. Kastha, S. Banerjee, “Wind Electrical Systems”,Oxford University Press, 2005.
3. Renewable energy sources and emerging technologies -D.P. Kothari, K.C. Singal, and R. Ranjan, PHI Learning Pvt. Ltd.

Reference Book(s):

1. Modern Electric Vehicle Technology by C.C. Chan and K.T. Chau.
2. O. I. Elgerd, Electric Energy Systems Theory. New York, NY, USA: McGraw-Hill Education, 1995.
3. B. M. Weedy, B. J. Cory, N. Jenkins, J. Ekanayake, and G. Strbac, Electric Power Systems, 5th ed. Hoboken, NJ, USA: Wiley, 2012.
4. R. D. Bergen and V. Vittal, Power System Analysis. Upper Saddle River, NJ, USA: Pearson Education Inc., 1999.