

III Year B.Tech. EEE – II Semester

23A02604c	<p align="center">RENEWABLE AND DISTRIBUTED ENERGY TECHNOLOGIES</p> <p align="center">(Professional Elective-III)</p>	L	T	P	C
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Course Objectives:

- To This course explores each of the principal renewable energy sources in turn. Each technology is examined in terms of the relevant physical principles; the main technologies involved; environmental impact; the size of the potential renewable resource; and the future prospects of green energy.
- This Distributed Generation course is intended to provide knowledge of the benefits of renewable energy generation, availability of distributed generation technology, electricity generation technologies, issues related to grid interconnection, and methods of analyzing the technical and economic feasibility.

Course Outcomes: At the end of the course, the student will be able to

- CO1:** Comprehend the renewable energy scenario, anticipate future energy demand and to understand the abstraction concept of electrical energy from Solar Energy. -**L3**
- CO2:** Understand the abstraction concept of electrical energy from wind, bio-mass and Tidal energy sources. -**L2**
- CO3:** Understand electrical energy storage along with working of Green Energy.-**L2**
- CO4:** Exemplify rudimentary idea of Distributed Generation.-**L3**
- CO5:** Comprehend the technical impact, control, and economic aspects of Distributed Generation. -**L4**

UNIT I

Energy Scenario and Solar Energy:

Introduction: Fundamentals of renewable energy sources, Types of energy, Renewable and Non- renewable energy, SWOT analysis, Global warming and climate change, World energy transformation by 2050, Prospects of renewable energy in the world, Renewable energy availability in India.

Solar Energy Fundamentals: Solar Spectrum, propagation of solar radiation from the sun to earth; solar radiation geometry: sun-earth geometry, extra-terrestrial and terrestrial radiation.

Solar Thermal: Solar Collectors, Solar parabolic trough, Solar tower, Solar cooker, Solar water heater, Solar dryer, Solar Pond.

Solar Electric Power Generation: A Generic PV Cell, PV Materials, Equivalent Circuits for PV Cells, Modules and Arrays; I-V Curve under Standard Testing Conditions; Impact of Temperature and Insolation on I-V curves; Shading Impacts on I-V curves; Maximum Power Point Trackers (MPPT).

UNIT II

Wind and Other Energy Systems:

Wind Energy: Air, Wind, Global and Local Wind, availability of wind energy in India, wind velocity and power from wind; major problems associated with wind power, Classification of wind energy conversion system (WECS)- Horizontal axis- single, double and multiblade system. Vertical axis- Savonius and darrieus types.

Biomass Energy: Introduction; Photosynthesis Process; Biofuels; Biomass Resources; Biomass conversion technologies-fixed dome; Urban waste to energy conversion; Biomass gasification (Downdraft).

Tidal Power: fundamental characteristics of tidal power, harnessing tidal energy, advantages, and limitations.

UNIT III

Energy Storage and Green Energy:

Energy Storage: Stationary Battery Storage – Basics of Lead-Acid batteries, Battery Storage Capacity, Coulomb efficiency instead of energy efficiency, Battery Sizing. Different Battery storage technologies and comparison of their performance. Introduction to Super capacitors.

Green Energy: Historical Development, Basic Operation of a Fuel Cell, Fuel Cell Thermodynamics, Entropy and the theoretical efficiency of Fuel Cells, Gibbs Free Energy and Fuel Cell efficiency, Electrical output of an Ideal Cell, Electrical Characteristics of Real Fuel Cells, Types of Fuel Cells, H₂: Operating principles, Zero energy Concepts. Benefits of hydrogen energy, hydrogen production technologies (electrolysis method only), hydrogen energy storage, applications of hydrogen energy, problem associated with hydrogen energy.

UNIT IV

Introduction to DG and its Grid Integration:

Introduction: Need for Distributed generation, renewable sources in distributed generation, current scenario in Distributed Generation, Planning of DGs – Siting and sizing of DGs – optimal placement of DG sources in distribution systems.

Grid integration of DGs: Different types of interfaces - Inverter based DGs and rotating machine-based interfaces - Aggregation of multiple DG units. Energy storage elements: Batteries, ultracapacitors, flywheels.

UNIT V

Technical Impact, Economic and Control aspects of DG:

Technical impacts of DGs: Transmission systems, Distribution systems, De-regulation – Impact of DGs upon protective relaying – Impact of DGs upon transient and dynamic stability of existing distribution systems

Economic and control aspects of DGs: Market facts, issues, and challenges - Limitations of DGs. Voltage control techniques, Reactive power control, Harmonics, Power quality issues. Reliability of DG based systems – Steady-state and Dynamic analysis.

Text Book:

1. Muhammad Kamran, Muhammad Rayyan Fazal, "*Renewable Energy Conversion Systems*", First Edition, Elsevier Academic Press, 2021.
2. G. D. Rai, *Non-Conventional Sources of Energy*, Khanna Publisher, 2004

Reference Books:

1. G N Tiwari, *Solar Energy: Fundamentals, Design, Modeling and Applications*, Narosa, 2002.
2. Mukund R Patel, *Wind and Solar Power Systems: Design, Analysis, and Operation*, 2nd Edition, Taylor & Francis, 2006.
3. H. Lee Willis, Walter G. Scott, "*Distributed Power Generation – Planning and Evaluation*", Marcel Decker Press, 2000.
4. Gilbert M. Masters, "*Renewable and Efficient Electric Power Systems*", 2nd Edn., IEEE Press, Wiley, 2013.
5. N. Jenkins, J.B. Ekanayake and G. Strbac, "*Distributed Generation*", 1st Edn, The Institution of Engineering and Technology, London, 2010.

Online Learning Resources:

1. <https://archive.nptel.ac.in/courses/121/106/121106014/#>
2. https://onlinecourses.nptel.ac.in/noc22_ch27/preview
3. <https://www.nptelvideos.com/lecture.php?id=8517>