NIRMA UNIVERSITY

Institute:	**Institute of Technology**
Name of Programme:	**B. Tech. in Electrical Engineering**
Semester:	**V**
Course Code:	**3EE205DC24**
Course Title:	**Renewable Energy Sources**
Course Type:	**Core Course-I under Minor (Disciplinary)**
Year of Introduction:	**2024 – 25**

L	T	Practical component				C
		LPW	PW	W	S	
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Course Learning Outcomes (CLOs):

At the end of the course, the students will be able to –

1. apply the concepts of renewable energy sources for electricity generation **(BL3)**
2. infer the operational and control aspects of solar and wind energy system **(BL2)**
3. analyse issues and challenges of renewable energy sources in grid integration **(BL4)**
4. appraise the various technologies of hybrid power generation **(BL3)**

Contents: **Teaching Hours: 45**

Unit-I **Energy Sources** **04**

Conventional, non-conventional, renewable and non-renewable sources, statistics of resources and data on different sources in the world and in India, the significance of renewable sources and their exploitation, techno–commercial aspects of various renewable technologies, traditional energy systems, life cycle costing of various energy sources.

Unit-II **Solar Energy** **13**

Solar radiation, radiation measurement, insolation with and without atmospheric conditions, heat transfer concept: Radiation, conduction, convection, mass transport, solar thermal power plants: concentrating solar plants: parabolic trough system, solar tower system, parabolic dish system, applications: crop drying, distillation, solar chimney, water heating, rooftop solar system, etc.

Unit-III **Wind Energy** **13**

History, classification, components and operating characteristics of windmills, wind power generation, types of wind power generators, limitations of constant speed wind generators, variable speed wind energy generators, control of isolated and grid-connected wind energy generators, onshore and offshore wind farms, power system stability issues related to wind farms.

Unit-IV **Small Hydro Electric power plant** **03**

Introduction, operating principle and site selection of mini and micro hydropower plants, case study of pico hydel plant.

Unit-V **Biofuel Energy** **05**

Biomass characteristics and their availability, bioenergy extraction methods: anaerobic digestion, gasification, liquefication, biomethane, biohydrogen,

alcoholic fermentation, biodiesel, microbial fuel cell, biomass-based steam power plant, combined cycle power plant, cogeneration plant, case studies.

Unit-VI **Tidal Energy, Wave Energy, Geothermal Energy, Hybrid Systems** **07**

Tide generation, energy calculation in the tide, OTEC, estimation of power associated with waves, challenges with wave energy, wave energy collecting devices, geothermal resources, exploration of geothermal energy, geothermal systems, concepts of hybrid system: PV-wind system, PV-hydro system, Biomass-PV-Diesel system, PV-solar thermal-grid connected system.

Self-Study:
The self-study contents will be declared at the commencement of semester. Around 10% of the questions will be asked from self-study contents.

Laboratory Work:
This shall consist of at least 10 practical / simulations based on the above Contents.

Suggested Readings:

1. J. Twidell, T Weir, Renewable Energy Sources, Taylor and Francis
2. G. M. Masters, Renewable and Efficient Electric Power System, Wiley-IEEE
3. S. P. Sukhatme, Solar Energy - Principles of thermal collection and storage, Tata McGraw Hill, New Delhi
4. J. A. Duffie and W. A. Beckman, Solar Engineering of Thermal Processes, John Wiley, New York
5. S. N. Bhadra, D. Kastha, S. Banerjee, Wind Electrical Systems, Oxford publications
6. G. D. Rai, Non-conventional energy sources, Khanna Publishers.
7. B. H. Khan, Non-Conventional Energy Resources, Tata McGraw Hill.
8. G. S. Sawhney, Non-Conventional Energy Resources, PHI learning.
9. Joshua Earnest, Wind Power Technology, PHI learning.
10. Chetansingh Solanki, Solar Photo Voltaics: Fundamentals, Technologies and Applications, PHI learning.

Suggested List of Experiments (not restricted to the following): (Only for Information)

S. No.	Title of Experiments	Hrs.
1.	Demonstration of standalone PV system and wind energy conversion system with terminologies used for performance evaluation.	**4**
2.	Simulation of PV module and plot I-V and P-V characteristics of PV module.	**2**
3.	Analyse the effect of radiation, temperature and tilt angle on the I-V and P-V characteristics of PV module.	**2**
4.	Analyse the effect of series-parallel connection of PV module on I-V and P-V characteristics.	**2**
5.	To evaluate power flow of standalone PV system with AC/DC load with battery.	**4**
6.	To derive the efficiency of charge controller for standalone wind energy system	**2**
7.	To estimate the cut-in-speed and tip speed ratio (TSR) of wind turbine.	**2**
8.	Simulate the reachability of various types of dc to dc converter under varying load conditions	**2**
9.	Overview of tidal energy conversion system.	**2**
10.	Overview of wave energy conversion system.	**2**

L = Lecture, T = Tutorial, P = Practical, C = Credit