

RENEWABLE AND DISTRIBUTED ENERGY TECHNOLOGIES

Course Code	23EE4601C	Year	III	Semester	II
Course Category	Professional Elective-II	Branch	EEE	Course Type	Theory
Credits	3	L-T-P	3-0-0	Prerequisites	PS - I
Continuous Internal Evaluation:	30	Semester End Evaluation:	70	Total Marks:	100

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	Understand the concepts of wind, solar, hydro, hybrid, and other renewable energy sources (L2).
CO2	Apply wind energy principles to analyze system components, energy conversion, and control strategies in distributed generation (L3).
CO3	Utilize solar PV concepts to design and optimize system performance using MPPT strategies (L3).
CO4	Analyze small hydro and hybrid renewable systems with focus on control, storage, and integration techniques (L4).
CO5	Ability to apply the various energy generation techniques and to measure the basic parameters and submit a report

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (3: High, 2: Medium, 1: Low)														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2	3		1									1	3	2
CO3	3		1									1	3	2
CO4		3	1									1	3	2
CO5									3	3				

SYLLABUS		
Unit No.	Contents	Mapped CO
I	Introduction and Wind energy systems Brief idea on renewable and distributed sources - their usefulness and advantages. Wind Energy Systems: Estimates of wind energy potential- wind maps- Aerodynamic and mechanical aspects of wind machine design - Conversion to electrical energy - Aspects of location of wind farm.	CO1 CO2 CO5
II	Wind power and energy Wind speed and energy - Speed and power relations - Power extraction from wind - Tip speed ratio (TSR) - TSR characteristics- Functional structure of wind energy conversion systems - Pitch and speed control - Power vs speed characteristics - Fixed speed and variable speed wind turbine control - Power optimization - Electrical generators - Self-	CO1 CO2 CO5

	Excited and Doubly-Fed Induction Generators operation and control.	
III	Solar PV Systems Present and new technological developments in photovoltaic - estimation of solar irradiance - components of solar energy systems - solar thermal system- applications- Modelling of PV cell - current-voltage and power-voltage characteristics - Effects of temperature and irradiance - Solar array simulator - Sun tracking - Peak power operations - PV system - MPPT techniques: Perturb and observe method, hill climbing and incremental conductance methods-Effects of partial shading on the characteristic curves and associated MPPT techniques - Solar park design outline-Solar Pond-Types of PV systems	CO1 CO3 CO5
IV	Small Hydro and other sources Hydel: Small-Mini-Medium -Plant layouts Waterpower estimates -use of hydrographs -hydraulic turbine - characteristics and part load performance - design of wheels - draft tubes and penstocks. Other sources: Tidal - geothermal - gas-based generations.	CO1 CO4 CO5
V	Hybrid Renewable systems Requirements of hybrid/combined use of different renewable and distributed sources -Need of energy storage- Control of frequency and voltage of distributed generation in Stand-alone and Grid-connected mode - use of energy storage and power electronics interfaces for the connection to grid and loads - Design and optimization of size of renewable sources and their storages.	CO1 CO4 CO5

Learning Resources	
Text Books:	
1. Math J. Bollen - Fainan Hassan 'Integration of Distributed Generation in the Power System' - IEEE Press - 2011. 2. G.D.Rai 'Non-Conventional Energy Sources' KHANNA PUBLISHERS	
Reference Books:	
1. Studies' Craig Anderson and Rudolf I. Howard 'Wind and Hydropower Integration: Concepts - Considerations and Case - Nova Publisher - 2012. 2. Amanda E. Niemi and Cory M. Fincher 'Hydropower from Small and Low-Head Hydro Technologies' - Nova Publisher - 2011. 3. D. YogiGoswami - Frank Kreith and Jan F. Kreider 'Principles of Solar Engineering' - Taylor & Francis 2000. 4. Math J. Bollen - Fainan Hassan 'Integration of Distributed Generation in the Power System' - IEEE Press - 2011. 5. S. Heier and R. Waddington 'Grid Integration of Wind Energy Conversion Systems' - Wiley - 2006. 6. Loi Lei Lai and Tze Fun Chan 'Distributed Generation: Induction and Permanent Magnet Generators' - Wiley-IEEE Press - 2007. 7. G.N. Tiwari 'Solar Energy Technology' - Nova Science Publishers - 2005.	
Learning Resources:	
1. https://archive.nptel.ac.in/courses/103/103/103103206 2. https://archive.nptel.ac.in/courses/103/107/103107157	