GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3160917
Semester – VI
Subject Name: Wind And Solar Energy

Type of course: Professional Elective Course

Prerequisite: Fundamental knowledge of electrical machines and power electronics

Rationale: This subject is offered to emphasize the role of renewable energy technologies (especially wind and solar energy) and their potentials. The course aims to introduce the basic concepts of wind and solar energy and the preliminary analysis to estimate the energy generation from the wind and solar systems. Various components involved in the wind and solar system are covered and the control approaches to improve the performance of the systems are also included. In addition to the various applications of solar and wind energy generation systems, the course also covers the issues related to the integration of these systems in the existing network. Thus, the course is intended to provide the foundation for the solar PV and thermal as well as wind energy generation systems.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	0	3	70	30	0	0	100

Content:

Sr. No.	Content	Total Hrs
1	**Module 1: Physics of Wind Power** History of wind power, Indian and Global statistics, Wind physics, Betz limit, Tip speed ratio, stall and pitch control, Wind speed statistics-probability distributions, Wind speed and power-cumulative distribution functions.	4
2	**Module 2: Wind generator topologies** Review of modern wind turbine technologies, Fixed and Variable speed wind turbines, Induction Generators, Doubly-Fed Induction Generators and their characteristics, Permanent Magnet Synchronous Generators, Power electronics converter, Generator-Converter configurations, Converter Control.	11
3	**Module 3: The Solar Resource** Introduction, solar radiation spectra, solar geometry, Earth Sun angles, observer Sun angles, solar day length, Estimation of solar energy availability.	3
4	**Module 4: Solar photovoltaic** Solar Cell fundamentals, Technologies-Amorphous, monocrystalline, polycrystalline; V-I characteristics of a PV cell, PV module, array; Power Electronic Converters for Solar	11

	Systems, Maximum Power Point Tracking (MPPT) algorithms, Converter Control, Solar PV applications, Grid-Connected System and Standalone system, Solar Water Pumps, Solar street lights, Battery sizing	
5	**Module 5: Network Integration Issues** Overview of grid code technical requirements, Fault ride-through for wind farms - real and reactive power regulation, voltage and frequency operating limits, solar PV and wind farm behavior during grid disturbances, Power quality issues, Power system interconnection experiences in the world. Hybrid and isolated operations of solar PV and wind systems	**8**
6	**Module 6: Solar thermal Systems** Solar Collectors, Solar water heater, Solar Passive Heating and Cooling Systems, Solar Cookers, Solar Refrigeration and Air Conditioning, Solar thermal power generation technologies, Parabolic trough, central receivers, parabolic dish, Fresnel, solar pond, elementary analysis.	**5**

Suggested Specification table with Marks (Theory): (For BE only)

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
15	**30**	**25**	**15**	**10**	**5**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. T. Ackermann, "Wind Power in Power Systems", John Wiley and Sons Ltd., 2005.
2. G. M. Masters, "Renewable and Efficient Electric Power Systems", John Wiley and Sons, 2004.
3. S. P. Sukhatme and J.K. Nayak, "Solar Energy: Principles of Thermal Collection and Storage", McGraw Hill, 3rd ed., 2008.
4. H. Siegfried and R. Waddington, "Grid integration of wind energy conversion systems" John Wiley and Sons Ltd., 2006.
5. G. N. Tiwari and M. K. Ghosal, "Renewable Energy Applications", Narosa Publications, 2004.
6. J. A. Duffie and W. A. Beckman, "Solar Engineering of Thermal Processes", John Wiley & Sons, 1991.
7. B.H. Khan, "Non-Conventional Energy Resources", McGraw Hill 2nd Edition 2017.
8. G.D. Rai, "Non-Conventional Sources of Energy", Khanna Publishers, 4th Edition, 2009

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Course Outcomes:

At the end of this course, students will have the ability to

Sr. No.	CO statement	Marks % weightage
CO-1	Demonstrate the importance of renewable energy source and various applications of solar and wind systems	**20**
CO-2	Do the preliminary analysis related to wind energy systems	**15**
CO-3	Do the preliminary analysis and design of solar PV and solar thermal systems	**30**
CO-4	Identify the power electronic converters for solar PV and wind energy systems	**20**
CO-5	Describe the issues related to the renewable energy in the electrical utility network	**15**

List of Experiments: Not Applicable

Major Equipment: Not Applicable

List of Open Source Software/learning website:

https://nptel.ac.in

http://web.mit.edu/renewable-iap09

https://www.digimat.in/index.html