NIRMA UNIVERSITY

Institute:	**Institute of Technology, School of Engineering**
Name of Programme:	**B.Tech. (Electrical Engineering)**
Semester:	**VII**
Course Code:	4EE303ME25
Course Title:	**Power Electronics in Renewable Energy Conversion**
Course Type:	**Department Elective-IV**
Year of Introduction:	**2025 – 26**

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Course Learning Outcomes (CLOs):

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

1. realize solar PV system with different MPPT schemes (BL5)
2. effectively design and conceptualize efficient PV system (BL5)
3. choose wind turbine technology and its impact on grid (BL3)
4. select converter and appropriate control strategy for off grid and on grid PV/wind system (BL4)

Unit	Contents	Teaching hours (Total 45)
Unit-I	**Photovoltaic Systems and MPPT** Model of PV cell, datasheet study, interconnection of non-identical PV modules in series and parallel, concept of Maximum Power Point Tracking (MPPT), conventional MPPT techniques, artificial intelligence based MPPT techniques, optimization based MPPT techniques, hybrid MPPT techniques	05
Unit-II	**Design of Off-grid Photovoltaic System** Sizing of PV system without battery, battery introduction and various battery parameters, battery selection, load calculation, days of autonomy and recharge, PV system design with battery, PV array design and selection, input impedance model of power converters, direct PV and battery connection, charge controller, battery charger design	05
Unit-III	**Interdisciplinary Applications of PV System** Peltier refrigeration, solar based Peltier refrigeration system, PV based pumped hydroelectric energy storage system, PV powered water pumping system	05
Unit-IV	**Grid Connected PV System** PV inverter structures derived from H-bridge topologies: basic full bridge inverter, HERIC H5 and H6 inverters, inverter structures derived from NPC topology, H-bridge based boosting PV inverter with high frequency transformer, three phase PV inverters, control	15

	structures of inverter, overview of International regulations: IEEE 1547, IEC 61727, IEC 61000 EMC, EN50160, response to abnormal grid conditions like voltage and frequency deviations, power quality requirements, anti islanding and various passive and active anti islanding techniques, concept of phase locked loop (PLL), various basic and advanced PLL techniques	
Unit-V	**Grid Connected Wind Turbine System** Different types of Wind Turbine System (WTS) power configurations, grid power converter topologies: single cell (VSC or CSC), multicell (interleaved or cascaded), WTS rotor side control and grid side control, active and reactive power control of WTS under normal operating conditions and grid disturbances, frequency and voltage deviation under normal operation, active power control: power curtailment, frequency control, reactive power control in normal operation, WTS behavior under grid disturbances, Converter modeling, voltage oriented control, direct power control, overview of various grid codes of different countries	10
Unit-VI	**Grid Filter Design** Filter topologies (L, LC, LCL), design considerations, resonance issues and damping solutions, non linear behavior of filter, performance evaluation of different types of filters	05

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 syllabus.

Suggested Reading:

1. Remus Teodorescu, Marco Liserre, Pedro Rodriguez, *Grid Converters for Photovoltaic and Wind Power Systems*, Wiley IEEE Press.
2. Haitham Abu-Rub, Mariusz Malinowski, Kamal Al-Haddad, *Power Electronics for Renewable Energy Systems, Transportation and Industrial Applications*, John Wiley & Sons, Ltd
3. Gilbert M. Masters, *Renewable and Efficient Electric Power Systems*, Wiley IEEE Press
4. J. A. Duffie and W. A. Beckman, *Solar Engineering of Thermal Processes*, John Wiley, NY
5. Joshua Earnest, *Wind Power Technology*, PHI learning.
6. S. N. Bhadra, D. Kastha, S. Banerjee, *Wind Electrical Systems*, Oxford publications.
7. Chetansingh Solanki, *Solar Photovoltaics: Fundamentals, Technologies and Applications*, Prentice Hall India Learning
8. Mukund R. Patel, *Wind and Solar Power Systems*, CRC Press, Florida
9. Muhammad H. Rashid, *Power Electronics: Circuits, Devices and Applications*, Pearson Education, New Delhi
10. Ned Mohan, Tore M. Undeland and William P. Robbins, *Power Electronics: Converters, Applications and Design*, John Wiley & Sons, Inc., New York
11. Research Papers in reputed journals, Product Literatures, Datasheets

Suggested List of Experiments:

Sr. No.	Name of Experiments/Exercises	**Hours**
1.	Simulation of off-grid PV system using conventional MPPT technique	02
2.	Simulation of off-grid PV system using optimization based MPPT technique	02
3.	Simulation of off-grid PV system using hybrid MPPT technique	02
4.	Simulation of three phase grid connected PV system	02
5.	Simulation of PMSG based wind turbine system	02
6.	Simulation of DFIG based wind turbine system	02
7.	Simulation of SRF-PLL based grid connected system	02
8.	Simulation of different types of PLL schemes.	02
9.	Demonstration of off-grid PV system using MPPT technique	02
10.	Demonstration of grid connected PV system	02
11.	Demonstration of wind turbine system	02
12.	Design of grid side filters for solar and wind systems	02