

Subject Code: 1ET2130402	Subject Title: Elective:IV- Power Electronics For Renewable Energy Systems
Pre-requisite Subject	Fundamental Knowledge of Power Electronics and Renewable Energy.

Course Objective: After learning the course, the students should be able to:

- The increasing demand of the energy, rapid depletion of the conventional energy sources, and the environmental concern, have accelerated the interest in the renewable energy sources. However, energy from most of these renewable energy sources is not in the form required and needs power electronics converters to process the power and to convert the voltage/current in the appropriate form.
- This course is aimed to provide detailed knowledge of these renewable energy sources, need of power electronic converters, various converter topologies for different renewable sources, issues in their operation, control and integration etc.

Teaching Scheme (Hours per week)				Evaluation Scheme (Marks)								
Lecture	Tutorial	Practical	Credit	Theory				Practical				Total
				University Assessment		Continuous Assessment		University Assessment		Continuous Assessment		
				Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
4	-	-	4	24	60	16	40	-	-	-	-	100

Subject Contents				
Sr. No	Topic	Total Hours	Weight (%)	
1	Energy Scenario: National and International current energy scenario; Share of renewable and non-renewable energy sources.	03	05%	
2	Photovoltaic Energy Conversion Systems: Introduction to solar cell, PV cell technology, I-V and P-V curves of PV cell/modules/array, Electrical modelling of PV cell, Sun tracking and Sun tracking System (Mechanical Tracking), Maximum Power Point Tracking (Electrical Tracking), MPPT techniques, I-V and P-V curves under non uniform conditions, PV inverter configurations, Distributed MPPT, Control of PV inverter/converter configurations, Grid connected Systems, Islanded systems, Recent development in converter configurations for PV.	10	25%	
3	Wind Energy Conversion Systems: Basics of wind energy, Components of wind turbine, Wind turbine aerodynamics, MPPT control, Modelling of wind energy system, Types of generators: induction (singly fed and doubly fed) and synchronous generators, Converters for wind energy conversion system, Fixed speed and variable speed wind energy conversion system, Control schemes for different wind energy conversion system configurations.	12	30%	
4	Operation and control of Distributed Energy Generators: Distributed Power Generation Systems, Single-Stage Photovoltaic Systems, Small/Medium-Sized Wind Turbine Systems, Overview of the Control Structure, Control of Power Converters for Grid-Interactive Distributed Power Generation Systems, Droop Control; Power Control in Micro grid, Control Design Parameters, Harmonic Compensation, Ancillary Feature, Voltage Support at Local Loads Level, Reactive Power Capability, Voltage Support at Electric Power System Area: Anti-islanding, Ride-through requirements.	06	15%	

5	Issues, Regulations and Standards for Grid Connection: Grid requirements for PV system and modern wind energy system: Issues like safety, harmonics, stability, synchronization, islanding, restoration and ride-through etc., Recent international standards adopted by various countries.	05	10%
6	Energy Storage system: Introduction, The Structure of Power Storage Devices, Pumped storage Hydroelectricity, Compressed Air Energy Storage System, Flywheels, Battery Storage, Battery charging circuits, Hydrogen Storage, Superconducting Magnet Energy Storage, Super-capacitors, Role of Energy Storage Devices for distributed generation, Fuel Cell: Principle, types and applications, Converters for fuel cell, Control of Fuel Cell Control System, Electric and Hybrid Vehicles, Power Electronics for EV and Hybrid vehicles, Vehicle to grid and vehicle to home system, Concept of Smart Grid, Communication, metering, issues etc.	07	15%

Course Outcome:

After learning the course, the students should be able to:

- Correlate the need of renewable energy for the benefit of the society.
- Demonstrate use of power converters for processing of renewable power.
- Select appropriate power electronic converter for particular renewable energy source.
- Design the control scheme for power converter for PV system.
- Design the control scheme for power converter for Wind Energy Conversion System.
- Explain the issues involved in the control and integration of renewable sources with the grid.
- Demonstrate the knowhow of various energy storage techniques.

List of Text Books:

1. Remus Teodorescu, Marco Liserre, Pedro Rodriguez, "Grid Converters for Photovoltaic and Wind Power Systems", Wiley IEEE Press, Jan 2011.
2. Bin Wu, Yongqiang Lang, Navid Zargari, Samir Kouro, "Power Conversion and Control of Wind Energy Systems", Wiley IEEE Press, July 2011.
3. Haitham Abu-Rub, Mariusz Malinowski, Kamal Al-Haddad, "Power Electronics for Renewable Energy Systems, Transportation and Industrial Applications", Wiley IEEE Press, June 2014.

List of Reference Books:

1. Chetan S. Solanki; "Solar Photovoltaics: Fundamentals, Technologies & applications", Prentice Hall of India, 2009.
2. Mukund R. Patel; "Wind & Solar Power System Design, analysis & Operation", Taylor & Francis, 2006.
3. Qing-Chang Zhong, Tomas Hornik; "Control of Power Inverters in Renewable Energy and SmartGrid Integration" Wiley IEEE Press, Jan 2013.
4. M. Hashem Nahrir, Caisheng Wang; "Modeling and Control of Fuel Cells: Distributed Generation Applications", Wiley IEEE Press, 2009.

List of Open Source Software/learning website:

1. MIT OPEN COURSEWARE by Massachusetts Institute of Technology - website: ocw.mit.edu
2. Courses available through NPTEL. - website : nptel.ac.in