Course Code EPE-801	Credit Hours (Th-Pr) 3-0	**Clean Energy Generation, Integration and Storage (Core)**	Contact Hrs/Week (Th-Pr) 3-0	Total Contact Hrs (Th-Pr) 45-0

Course Outline:

1. This course is designed for electrical engineers to provide a primer on the generation, grid integration and storage of renewable energy system. It covers a wide span starting from fundamental principles of renewable energy generation and the mathematical modeling for computer simulation. Then it provides technical insight into energy conversion systems essential for the reliable integration with the load. Then it provides a sufficient introduction to the various forms of energy storage that are electrical, chemical and mechanical storage. Although the primary focus of this course is on the two most naturally occurring renewable energy sources – solar and wind, however this course also provides basic introduction to Solar Thermal, Fuel Cells, Biomass, Geothermal, Microhydro, Tidal and Wave Energy Systems. The course concludes by discussing issues in the grid integration of large scale renewable energy systems as well as the enabling technologies for grid integration which are essential for reliability and power quality.

Eligibility Criteria:

2. B.E (Electrical Engineering)

Recommended Books:

S. No.	Title	Author(s)	Assigned Code	Remarks
a.	Renewable and Efficient Electric Power Systems	Gilbert Masters	GM	Text Book
b.	Wind & Solar Power Systems	Mukund R. Patel	MP	Reference
c.	Renewable Energy Integration: Challenges and Solutions	Jahangir Hussain	JR	Reference
d.	Energy Storage for Smart Grids: Planning and Operation for	Pengwei Du	PD	Reference

	Renewable and Variable Energy Resources			
e.	Large Scale Wind Power Grid Integration: Technological and Regulatory Issues	Ningbo Wang	NB	Reference

Course Objectives:

3. The core objective of this course is to familiarize the students with different means of harnessing clean energy, how this energy can be integrated with the existing grid and what challenges it poses to the security of the grid and how these challenges can be overcome with storage devices

Learning outcome:

4. On successful completion of the module the student will have:
   a. Sound understanding of energy production method from different renewable energy sources
   b. Appropriate knowledge of integration issues of renewable energy sources with the power grid
   c. Abilities to cope with the intermittency issues of renewables by deploying different energy storage devices.

5. **Topics Covered**

No	Topics	Contact Hours
a.	**Need of Renewable Energy System** Conversion Efficiency and Environmental Cost of Conventional Energy Systems	3
b.	**Solar Energy Conversion** Mathematical & Simulation Modeling Characteristic Curves & Dark I-V testing Bypass & Blocking Diodes for Partial Shading Sizing a PV array for certain load	6

c.	**Efficiency Maximization of PV Energy Conversion Systems** Principle & Significance Sun Tracking Partial Shading and Local Maxima Critical Analysis of the existing MPPT techniques	6
d.	**Wind Energy Conversion** Mathematical & Simulation Modeling Conversion Efficiency and Betz Limits Effects of Turbine Design on Efficiency Generator types	4
e.	**Efficiency Maximization of Wind Energy Conversion Systems** Pitch and Yaw Control Maximum Power Point Tracking Generator Loss Minimization	5
f.	**Alternate Renewable Energy Sources** Solar Thermal Fuel Cells Biomass Geothermal Tidal, Wave and Micro-hydro	6
g.	**Energy Storage** Electrical: Super Capacitors Chemical: Batteries Mechanical: Flywheel Others: Pumped storage, Compressed Gases and Thermal storage, Electric Vehicle	9
h.	**Grid Integration** Issues in Large Scale Renewable Energy Systems Enabling Technologies for Grid Integration	6