

Subject Code:1ET2130205	Elective-2 : Modelling & Simulation of Renewable Energy Sources
Pre-requisite Subject	Fundamental Knowledge of Electrical Machines & Renewable Sources

Course Objective:

- Modelling & Simulation of electrical machines is a subject where a student will learn the generalized theory of machines, reference frame theories and various types of transformation which will help them to analyze the machines.
- The major objective of the subject is to develop modelling concepts of various renewable energy sources.
- To make the students familiar with the impact of renewable energy on power system.

Teaching Scheme (Hours per week)				Evaluation Scheme (Marks)				
Lecture	Tutorial	Practical	Credit	University Assessment	Continuous Assessment	University Assessment	Continuous Assessment	Total
3	-	2	5	60	40	30	20	150

Subject Contents				
Sr. No	Topic	Total Hours	Weight (%)	
1	Fundamentals of Electric Machinery: Introduction, magnetically coupled circuits, electromechanical energy conversion, machine winding and air gap mmf, winding inductances and voltage equations. The basic two pole machine, transformer with movable secondary, transformer and speed voltages in the armature, analysis of electrical machines.	8	15%	
2.	Reference Frame Theory & Transformation in Electric machines: Equations Of Transformation: Changes Of Variable, Commonly Used Reference Frame, Transformation From Three Phase To Two Phase, Transformation From Rotating Axis To Stationary Axis, Physical Concept Of Park's Transformation, Transformed Impedance Matrix, Electrical torque.	8	20%	
3.	Permanent Magnet Synchronous Machine based wind Energy Conversion system. Surface permanent magnet (square and sinusoidal back emf type) and interior permanent magnet machines, Different type Permanent Magnet and their characteristics, construction, operating principle and true synchronous characteristics, dynamic modeling of PMSM, Operation of PMSG, control scheme of PMSG, MPPT Techniques, Applications.	10	25%	
4.	Modelling & Electrical characteristics of photovoltaic cell. Introduction, a generic photovoltaic cell, the simplest equivalent circuit for a photovoltaic cell, example of I-V curve for a photovoltaic cell, from cells to modules to arrays: from cells to a module, from modules to arrays, the PV I-V curve under standard test conditions, impacts of temperature and insolation on I-V curves, shading impacts of I-V curves, crystalline silicon technologies: single crystal czochralski silicon, ribbon silicon technology, cast multi crystalline silicon, crystalline silicon modules, thin film photovoltaic. Modelling of photovoltaic cell. Series- Parallel connection of PV cell.	10	25%	
5.	Hybrid Renewable Energy Systems: Wind and solar hybrid stand-alone power systems, control of hybrid power systems with and without grid connection, hybrid and distributed generation-solar PV, wind, DG and their combinations.	4	15%	

Course Outcome:

- At the end of the course, the students will acquire the knowledge regarding modelling of renewable energy sources and will be able to carry out various simulation studies.
- They will be capable to solve various real world power system grid integration issues of renewable energy sources in smart grid.

List of Text Books:

1. Analysis of electric machinery and drive systems, Second edition, Wiley interscience- Paul C.Krause, Oleg Wasynnczuk, and S.D. Sudhoff
2. Dynamic simulation of electric machinery, Prentice Hall PTR, 1997- C.M.Ong
3. Wind Energy Generation Modelling and Control, Olimpo Anaya-Lara, Nick Jenkins,
4. Janaka Ekanayake, Phill Cartwright, Mike Hughes, Wiley, A John Wiley & Sons, Inc, Publication.

List of Reference Books:

1. Variable Speed Generators, Ion Boldea, CRC press, Taylor & Francis Group.
2. Renewable and Efficient Electric Power Systems, Gilbert. M. Masters, Wiley- Interscience, A John Wiley & Sons, Inc, Publication.

Journal papers:

1. IEEE Power Electronics Letters
2. Electric power systems research.
3. Int. Journal of electric power and energy systems
4. IEEE Power & Energy Magazine
5. IEEE Journal of Photovoltaic.