

Branch Name:	Electrical Engineering
ProgramCode:	ET213
CourseName:	Modeling & Simulation of Renewable Energy Sources
CourseCode:	2ET2130205T
Pre-requisiteCourse:	Fundamental Knowledge of Electrical Machines & Renewable Sources

Course Objectives:

1. To understand the 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 then to analyze the machines.
2. To identify The major objective of the subject is to develop modelling concepts of various renewable energy sources.
3. To understand various impact of renewable energy on power system.

Teaching and Examination Scheme:

Credit	Teaching Scheme Hours per week				Evaluation Scheme (Marks)								
					Theory (Marks)				Practical (Marks)				Total (Marks)
	L	T	P	Total	SEE		CCA		SEE		CCA		
					Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
3	3	-	-	3	24	60	16	40	-	-	-	-	100

Course Contents:

Sr. No	Topic	Total Hours	Weightage (%)
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 PMSG, 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%

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, NickJenkins.
4. JanakaEkanayake, Phill Cartwright, Mike Hughes, Wiley, A John Wiley & Sons, Inc, Publication.

Reference Books:

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

Journal papers:

1. IEEE Power ElectronicsLetters
2. Electric power systemsresearch.
3. Int. Journal of electric power and energysystems
4. IEEE Power & EnergyMagazine
5. IEEE Journal ofPhotovoltaic.

Course Learning Outcomes (CLO): On completion of this course, the students will be able to:

CLO	Description	Bloom'sTaxonom yLevel
CLO1	Acquire the knowledge regarding modelling of renewable energy sources.	1Remembering
CLO2	Understand the various simulation studies.	2 Understanding
CLO3	Solve various real world power system grid integration issues of renewable energy sources in smart grid.	3 Applying 5Evaluate
CLO4	Know about permanent magnet synchronous motor and generator .	1Remembering
CLO5	Analyze and design of photovoltaic cell.	4Analyze 6 Creating
CLO6	Analyze and design of wind and solar hybrid power system.	4Analyze 6 Creating

Mapping of CLOs with POs & PSOs

Course Learning Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CLO1				L		H			M			M				L
CLO2				M			L				M		M			L
CLO3	H	L			H	M		L			L			H	L	
CLO4				L		H			M			M				L
CLO5			L		M			M		L		M		M	H	
CLO6			L		M			M		L		M		M	H	

H: High, M: Medium, L: Low