Techno India NJR Institute of Technology

Course File

Wind and Solar Energy System (7EE5-11)

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For Techno India NJR Institute of Technology
पंकज पोरवाल
Dr. Pankaj Kumar Porwal
(Principal)

Syllabus:

RAJASTHAN TECHNICAL UNIVERSITY, KOTA

Scheme & Syllabus

IV Year- VII & VIII Semester: B. Tech. (Electrical Engineering)

7EE5-11: WIND AND SOLAR ENERGY SYSTEM

Credit: 3 **Max. Marks: 150(IA:30, ETE:120)**

3L+0T+0P **End Term Exam: 3 Hours**

SN	CONTENTS	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	**Physics of Wind Power** History of wind power, Indian and Global statistics, Wind physics, Betz limit, Tip speed ratio, stall and pitch control, Wind speed statistics-probability distributions, Wind speed and power-cumulative distribution functions.	5
3	**Wind Generator Topologies** Review of modern wind turbine technologies, Fixed and Variable speed wind turbines, Induction Generators, Doubly-Fed Induction Generators and their characteristics, Permanent Magnet Synchronous Generators, Power electronics converters. Generator-Converter configurations, Converter Control.	11
4	**The Solar Resource** Introduction, solar radiation spectra, solar geometry, Earth Sun angles, observer Sun angles, solar day length, Estimation of solar energy availability.	4
5	**Solar Photovoltaic** Technologies-Amorphous, monocrystalline, polycrystalline; V-I characteristics of a PV cell, PV module, array, Power Electronic Converters for Solar Systems, Maximum Power Point Tracking (MPPT) algorithms. Converter Control.	8
6	**Network Integration Issues** Overview of grid code technical requirements. Fault ride-through for wind farms - real and reactive power regulation, voltage and frequency operating limits, solar PV and wind farm behavior during grid disturbances. Power quality issues. Power system interconnection experiences in the world. Hybrid and isolated operations of solar PV and wind systems.	8
7	**Solar Thermal Power Generation** Technologies, Parabolic trough, central receivers, parabolic dish, Fresnel, solar pond, elementary analysis.	4
	TOTAL	

Course Overview:

Rajasthan is one of the several states in India where a large number of wind and solar grid connected electric power installations, and competent technicians to maintain these vital renewable energy power plants is a dire need of the industry. In this 40-hour course students will learn the Physics of Wind Energy, Wind Generator Topologies, The Solar Resource, Solar Photovoltaic, Network Integration Issues and Solar Thermal Power Generation. It is to fulfill this need, that this course has been designed so that the electrical engineer would be able to maintain the installations thereby minimizing the downtime.

At the end of this course the student will be able to apply their knowledge for Solar photovoltaic system design and solving the integration issues faced by wind and solar energy system. This will helps students to get into renewable industry.

Course Outcome:

CO. NO.	Cognitive Level	Course Outcome
1	Synthesis	Student will be able to summarize and categorize the environmental aspects of non-conventional energy resources.
2	Synthesis	Student will be able to explain and relate the need of renewable energy resources, historical and latest developments.
3	Analysis	Students will be able to analyze the use of solar energy and the various components used in the energy production with respect to applications like-heating, cooling, desalination, power generation, drying, cooking etc.
4	Application	Students will be able to demonstrate the need of Wind Energy and the various components used in energy generation and show the classifications.

Prerequisites:

1. Renewable Energy Sources.
2. Fundamentals of Power System.
3. Students should be proficient in solving mathematical equations.

Course Outcome Mapping with Program Outcome:

Course Outcome	Program Outcomes (PO's)											
CO. NO.	Domain Specific (PSO)					Domain Independent (PO)						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	1	1	-	-	-	1	1	-	1
CO2	2	1	-	-	1	1	1	-	1	-	1	1
CO3	3	3	2	2	2	1	-	-	1	-	1	1
CO4	3	2	2	1	2	1	-	-	-	-	1	1
1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)												

Course Coverage Module Wise:

Lect. No.	Unit	Topic
1	**1**	**Introduction:** Objective, scope and outcome of the course.
2	**2**	**Physics of Wind Power**
3	2	History of wind power,
4	2	Indian and Global statistics, Wind physics, Betz
5	2	limit, Tip speed ratio, stall and pitch control, Wind speed statistics probability
6	2	distributions, Wind speed and power-cumulative distribution functions.
7	**3**	**Wind Generator Topologies**
8	3	Review of modern wind turbine technologies,
9	3	Fixed and Variable speed
10	3	wind turbines,
11	3	Induction Generators,
12	3	Doubly-Fed Induction Generators
13	3	and their characteristics,
14	3	Permanent Magnet Synchronous Generators,
15	3	Power electronics converters.
16	3	Generator-Converter configurations,
17	3	Converter Control.
18	**4**	**The Solar Resource**
19	4	Introduction, solar radiation spectra,
20	4	solar geometry, Earth Sun angles,
21	4	observer Sun angles, solar day length, Estimation of solar energy availability.

22	**5**	**Solar Photovoltaic**
23	5	Technologies-Amorphous,
24	5	monocrystalline, polycrystalline;
25	5	V-I characteristics
26	5	of a PV cell, PV module, array,
27	5	Power Electronic Converters for Solar Systems,
28	5	Maximum Power Point Tracking (MPPT) algorithms.
29	5	Converter Control.
30	**6**	**Network Integration Issues**
31	6	Overview of grid code technical requirements.
32	6	Fault ride-through for
33	6	wind farms - real and reactive power regulation, voltage and frequency operating limits,
34	6	solar PV and wind farm behavior during grid disturbances.
35	6	Power quality issues.
36	6	Power system interconnection experiences
37	6	in the world. Hybrid and isolated operations of solar PV and wind systems.
38	**7**	**Solar Thermal Power Generation**
39	7	Technologies, Parabolic trough,
40	7	central receivers, parabolic dish, Fresnel, solar pond, elementary analysis.

Text/Reference Books:

1 T. Ackermann, “Wind Power in Power Systems”, John Wiley and Sons Ltd., 2005.

2 G. M. Masters, “Renewable and Efficient Electric Power Systems”, John Wiley and Sons, 2004.

3 S. P. Sukhatme, “Solar Energy: Principles of Thermal Collection and Storage”, McGraw Hill, 1984.

4 H. Siegfried and R. Waddington, “Grid integration of wind energy conversion systems” John Wiley and Sons Ltd., 2006.

5 G. N. Tiwari and M. K. Ghosal, “Renewable Energy Applications”, Narosa Publications, 2004.

6 J. A. Duffie and W. A. Beckman, “Solar Engineering of Thermal Processes”, John Wiley & Sons, 1991.

Teaching and Learning resources:

NPTEL Course Link	https://nptel.ac.in/courses/108/108/108108078/x https://nptel.ac.in/courses/108/105/108105058/
Quiz	https://quizizz.com/admin/quiz/5f6d59d97eb592001c534eec/wind-energy https://quizizz.com/admin/quiz/5e1fe9ce162bce001bf38e9e/wind-energy https://quizizz.com/admin/quiz/5cacb850674f0b001bab3b51/solar-energy
Notes	https://library.uniteddiversity.coop/Energy/Wind/Wind_and_Solar_Power_Systems.pdf

Assessment Methodology:

1. Assignments one from each unit.
2. Midterm subjective paper where they have to solve the given problem. (Twice during the semester)
3. Final paper at the end of the semester subjective.

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Previous Year Question Paper:

7E1732

Roll No. _____ Total No. of Pages: 2

7E1732

B. Tech. VII - Sem. (Main) Exam., Feb.- March - 2021
PEC Electrical Engineering
7EE5 – 11 Wind and Solar Energy Systems

Time: 2 Hours **[To be converted as per scheme]**

Max. Marks: 82

Min. Marks: 29

Instructions to Candidates:

Attempt all ten questions from Part A, four questions out of seven questions from Part B and two questions out of five from Part C.

Schematic diagrams must be shown wherever necessary. Any data you feel missing may suitably be assumed and stated clearly. Units of quantities used /calculated must be stated clearly.

Use of following supporting material is permitted during examination. (Mentioned in form No. 205)

1. NIL 2. NIL

PART – A

(Answer should be given up to 25 words only) **[10×2=20]**

All questions are compulsory

Q.1 Explain the relation between power generated by a wind turbine and wind velocity.

Q.2 Explain the term 'stall'.

Q.3 Explain the reason for deploying induction generators in a wind turbine.

Q.4 What is a Sun angle?

Q.5 Explain application of MPPT.

Q.6 What is a wind farm?

Q.7 Explain some application of solar thermal power generation.

Q.8 Explain a major difference between monocrystalline & polycrystalline.

Q.9 Explain uses of PV solar module.

Q.10 What is the maximum efficiency of a wind turbine?

PART – B

(Analytical/Problem solving questions) **[4×8=32]**

Attempt any four questions

Q.1 Explain the history of wind power and Indian & Global statistics.

Q.2 Explain the generator converter configurations in a wind turbine.

Q.3 Explain working of Doubly fed induction generators in wind generator topologies.

Q.4 Explain estimation of solar energy availability.

Q.5 Explain Betz law and derive its mathematical model.

Q.6 Explain 'Gird Code' and explain its technical requirements.

Q.7 Explain concept of 'Solar Pond' and its application.

PART – C

(Descriptive/Analytical/Problem Solving/Design Questions) **[2×15=30]**

Attempt any two questions

Q.1 Explain fixed and variable speed wind turbines.

Q.2 Design a power electronic base converters to obtain supply for an Indian active distribution network.

Q.3 With reference to solar resources, explain the following –

(a) Earth Sun angle

(b) Solar Day length

(c) Solar Geometry

Q.4 Explain Hybrid and Isolated operations of Solar PV and wind systems.

Q.5 Write short note on any two –

(a) Parabolic trough

(b) Fresnel

(c) Central Receivers

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