

COURSE CODE: 1152EE137	COURSE TITLE: <b>WIND ENERGY CONVERSION SYSTEMS</b>	L	T	P	C
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**COURSE CATEGORY:**

Program Elective

**PREAMBLE :**

Wind energy is the fast-growing renewable source for electricity generation. This course presents a broad overview of wind energy technology.

**PREREQUISITE COURSES:**

Basic Electrical Engineering

**RELATED COURSES:**

Renewable Energy sources, Electrical Machine Design

**COURSE EDUCATIONAL OBJECTIVES :**

- To learn about Power extraction from wind energy
- To distinguish the components and design of wind tower
- To understand working principle of induction generator, synchronous generator

**COURSE OUTCOMES :**

Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Fundamentals of wind energy conversion	K2
CO2	Types of wind turbines and aerodynamics	K2
CO3	Components of wind turbine and its construction	K2
CO4	Explain the principle of operation of Types of generator	K2
CO5	Wind turbine control and monitoring system	K2

**CORRELATION OF COs AND POs**

COS	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	L				L				L	M		
CO2	L								L	M		
CO3	H		H					M	L	M		
CO4	L							M	M	M		
CO5	L		M		M			H	M	M		

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<b>COURSE CONTENT:</b>		
<b>UNIT I</b>	<b>WIND ENERGY FUNDAMENTALS AND MEASUREMENTS</b>	<b>9</b>
Wind energy basics - Wind speed and scales - Terrain-Roughness-Wind mechanics - Power content – Class of wind turbine- Atmospheric boundary layers-Turbulence. Instrumentation for wind measurements - Wind data analysis - tabulation. Wind resource estimation - Betz's limit-Turbulence analysis.		
<b>UNIT II</b>	<b>WIND TURBINE AERODYNAMICS AND TYPES</b>	<b>9</b>
Airfoil terminology - Blade element theory - Blade design - Rotor performance and dynamics- Balancing technique (Rotor & Blade)-Types of loads - Source of loads-Vertical axis type -Horizontal axis - Constant speed Constant frequency - Variable speed variable frequency - Up wind-Down wind - Stall control-Pitch control - Gear coupled generator type - Direct generator drive/PMG/Rotor excited sync generator.		
<b>UNIT III</b>	<b>GEAR COUPLED GENERATOR WIND TURBINE COMPONENTS AND THEIR CONSTRUCTION</b>	<b>9</b>
Electronics sensors /Encode /Resolvers - Wind measurement: anemometer & wind vane - Grid synchronisation system - Soft starter - Switchgear [ACB/VCB]-Transformer - Cables and assembly - Compensation panel - Programmable logic control – UPS - Yaw & pitch system: AC drives - Safety chain circuits - Generator rotor resistor controller(Flexi slip) - Differential protection relay for generator - Battery/Super capacitor charger & Batteries/Super capacitor for pitch system-Transient Suppressor/Lightning arrestors - Oscillation & Vibration sensing.		
<b>UNIT IV</b>	<b>DIRECT ROTOR COUPLED GENERATOR (MULTIPOLE)[VARIABLE SPEED –VARIABLE FREQUENCY</b>	<b>9</b>
Excited rotor synchron. Generator/PMG generator - Control rectifier-Capacitor banks - Step up/Boost converter (DC-DC Step Up) - Grid tied inverter - Power management - Grid monitoring unit (Voltage and current) - Transformer - Safety chain circuits.		
<b>UNIT V</b>	<b>MODERN WIND TURBINE CONTROL &amp; MONITORING SYSTEM</b>	<b>9</b>
Details of pitch system & Control algorithms-Protections used & Safety consideration in wind turbine-Wind turbine monitoring with error codes - SCADA & Databases: remote monitoring and generation reports - Operation & Maintenance for product lifecycle - Balancing technique (Rotor & Blade) - FACTS control & LVRT & New trends for new grid codes.		
<b>TOTAL: 45 PERIODS</b>		
<b>TEXT BOOKS:</b>		
<ol style="list-style-type: none"> <li>1. Renewable Energy Engineering and Technology – A Knowledge Compendium, ed.VVN Kishore, TERI Press, 2008.</li> <li>2. Martin OL Hansen: Aerodynamics of Wind Turbines, 2nd ed. Earthscan, London</li> <li>3. Anna Mani: Wind Energy Data for India, Allied Publishers, 1990.</li> <li>4. C-Wet: Wind Energy Resources Survey in India Vol. VII</li> </ol>		

5. S.Rangrajan: Wind Energy Resources Survey in India V, Allied Publishers, Mumbai 1998.
6. Sathyajith Mathew: Wind Energy: fundamentals, resource analysis and economics
7. Prepared by WISE: Wind Power in India, 5000MW BY 2015
8. B.H.Khan: Non Conventional Energy Sources, Tata McGraw-Hill Education, 2006.

**REFERENCE BOOKS:**

1. Johnson, G.L., Wind Energy Systems, Prentice Hall, 1985. Martin OL Hansen: Aerodynamics of Wind Turbines, 2nd ed. Earthscan, London
2. Paul Gipe: "Wind energy Basics: A guide to small and micro wind" ,Chelsea Green Publishing, 2008.
3. L. L. Freris, Wind Energy Conversion systems, Prentice Hall, UK, 1990.
4. Godfrey Boyle., Renewable Energy: Power for a Sustainable Future, Second Edition, Oxford University Press, 2004.