GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Engineering

Level: Diploma

Branch: Renewable Energy

Course / Subject Code: DI03064011

Course / Subject Name: Wind Energy Technology

w. e. f. Academic Year:	2024-25
Semester:	3rd
Category of the Course:	PCC

Prerequisite:	**Inheritance of basic concepts of wind Power plant and their application**
Rationale:	In recent few decades, consumption of distinct fossil fuels has increased beyond its benchmark limit on account of massive industrialization, commercialization, residential, transportation and many more, which has resulted in deterioration of environment at very rapid rate. Hence it has been mandatory to switch from utilization of conventional source of energy to non-conventional source of energy to fulfill demand of energy as well as preserving the environment in all respect. There are available various forms of renewable sources in abundant amount for producing neat and clean energy. One of them is wind energy which is most significant clean energy source with various advancement. Hence Wind power plant has been choice for generating clean and green electricity. This syllabus will enable to understand fundamentals, laws, distinct terms, maintain components – turbine and generators and controlling strategies.

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes	RBT Level
01	Understand fundamental of wind energy conversion.	U
02	Apply laws and principle to convert kinetic energy of wind into electrical energy.	A
03	Maintain distinct components of wind power plant.	A
04	Maintain distinct Turbines and Generators of wind power plant.	A
05	Apply different control strategies to wind power plant.	A

**Revised Bloom's Taxonomy (RBT)*

GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Engineering

Level: Diploma

Branch: Renewable Energy

Course / Subject Code: DI03064011

Course / Subject Name: Wind Energy Technology

Teaching and Examination Scheme:

Teaching Scheme (in Hours)			Total Credits L+T+ (PR/2)	Assessment Pattern and Marks				Total Marks
				Theory		Tutorial / Practical		
L	T	PR	C	ESE (E)	PA(M)	PA(I)	ESE (V)	
3	0	2	4	70	30	20	30	150

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	**Basic Introduction of Wind Energy** Contents: (1) Introduction, Historic Background and Merits and Demerits (2) Nature & Origin of Wind, Variation of wind speed with height (3) Properties of Air & Wind and Wind Characteristics (4) Criteria for on shore & off shore site selection of wind plant (5) Estimation of Wind energy at site (6) Wind Energy Conversion System and Application (7) Environmental aspects (8) Comparison with other Energy renewable sources (9) Wind energy scenario and programs in India	8	18 %
2.	**Laws & Terminologies associated with Wind energy** Contents: (1) Application of fluid flow and aerodynamics principle for wind energy extraction, Betz Law, Co-efficient of power, Wind energy pattern factor and. (2) Terminologies: Blade Element, Chord, Wind Velocity, Incident Wind Velocity, Teethering, Blade element linear velocity, Leading edge, Trailing edge, Relative Wind Velocity, Angular speed, angle of incidence, pitch angle, Lift & Drag force, tangential force and solidity. Swept and Intercept area, Tip	14	31 %

	Speed, Tip speed ratio and Blade pitch angle. (3) Wind power density, Power in wind stream, Power of Wind turbine, Wind velocity duration curve and Mean Wind velocity (4) PV Characteristics, Power Vs Wind Speed Characteristics, Power co-efficient Vs Tip speed ratio, Wind power Duration Characteristics and Energy pattern factor (5) Plant load Factor, Capacity utilization factor, Plant availability factor and Speed drive schemes (6) Wind turbines efficiency (7) Characteristics of various types of rotors (8) Economic consideration		
3.	**Construction and working of various components of Wind plants** Contents: (1) Foundation, Tower, Nacelle, Hub, Blades (2) Rotor, Gear box (3) Synchronous Generator, Exciter, Transformer (4) Control system: Variable resistors, Reactive power Compensating capacitor (5) Power Convertors: Rectifier Unit (RU), Line Convertor Unit (LCU), Distribution Cabinet (DiCa) containing all Circuit Breaker, Internal Supply Unit (ISU), Synchronous Machine Exciter Module and Input – Output board (6) Anemometer (7) Yaw system (8) Transformers used in Wind Plant (9) Power cables used in Wind Mills	08	18 %
4.	**Construction and working of wind Turbine & Generator** Contents: (1) Various Terms: Wind mill, Wind Turbine, Wind Turbine Generator Unit, Wind Farm, Cut-in-speed, Mean wind speed, Rated wind speed, Cut-out wind velocity, Mean line and Camber. (2) Classification of Wind mills/Machines/Turbine (3) Based on type of rotor: Propeller type, Multiblade type,	10	22 %

	Savonius type and Darrieus type. (4) Based on the orientation of the axis of Rotor: Horizontal Axis Wind Turbine Generator (HAWT) and Vertical Axis Wind Turbine (VAWT). (5) Performance of Wind mill (Co-efficient of performance). (6) Comparison between Horizontal axis and Vertical axis Wind machines/Turbine. (7) Hybrid Wind Energy system and its merit and demerits (8) Problems in operating large wind power generators		
5.	**Controlling Techniques** Contents: (1) Gear boxes control for both small and large Wind Plant. (2) Mechanical Control Technique: Yaw control, Tilt control, Pitch control, Stall control etc. (3) Electrical Control: Power Electronics Based Control, various control panels (4) Application of batteries in Wind power plant (5) Sensors	05	11 %
	Total	**45**	**100**

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks (in %)					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
-	**19 %**	**81 %**	**-**	**-**	**-**

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)

References/Suggested Learning Resources:
(a) Books:

1.	**Title of Book**	**Publication**	**Author**
2.	Non-conventional Energy	Mc Grow Hill Education	B. H. Khan

	Resources	India	ISBN - 978-93-5260-188-2
3.	Non-conventional Energy Resources and utilization	S. Chand & Company Pvt. Ltd.	R. K. Rajput ISBN - 81-219-3971-2
4.	Wind power in power System	John Wiley & Sons Ltd	Thomas Ackerman ISBN - 0-470-85508-8
5.	Wind power technology	Earnest, Joshua	PHI learning, New Delhi, 2015 ISBN - 978-8120351271
6.	Wind Turbines	Hau, Erich	Springer – Verlag, Berlin Heidelberg, Germany, 2013, ISBN – 978- 3- 642-27150-2

(b) Open-source software and website:

1. http://qblade.org
2. http:// www.nrel.gov/

Suggested Course Practical List:

Sr. No.	Practical Outcome/Title of experiment	CO 1	CO2	CO3	CO4	CO5
1	Identify specified parts and components of wind plant.	√				
2	Differentiate distinct types of large wind power plant.	√				
3	Verify aerodynamic performance of large wind power plant.		√			
4	Verify the performance of temperature and vibration sensors used in wind power plant.		√			
5	Measure velocity of wind using anemometer.		√			
6	Verify the performance of contact less RPM sensors used in wind power plant.		√			

7	Differentiate distinct types of small wind power plant.			√		
8	Identify parts inside the nacelle of large wind power plant.			√		
9	Identify all components of electrical Switchyard.			√		
10	Identify the parts which require routine maintenance, oiling and greasing of both large and small Wind power plant.			√		
11	Verify generator performance of small wind turbine.				√	
12	Identify parts of direct drive small wind turbine.				√	
13	Identify parts of geared small wind turbine.				√	
14	Verify the performance of SCIG.				√	
15	Verify the performance of DFIG.				√	
16	Verify the performance of PMSG.				√	
17	Interpret the wiring of small wind turbine electric and electronic control panel.					√
18	Simulate fault in small wind turbine trainer.					√

List of Laboratory/Learning Resources Required:

Sr. No.	Equipment Name with Broad Specifications
01	Video programs of construction and working of small and large wind power plants.
02	New or used nacelle of small Wind turbine.
03	New or used nacelle of small Wind turbine gear box.

04	New or used nacelle of small Wind turbine electronics control panel.
05	Distinct ratings of thyristors used in Wind turbines.
06	New or used nacelle of small Wind turbine power electronics control panel.
07	3 Cup type Wind anemometer
08	Ultrasonic anemometer
09	Wind vane
10	Vibration sensors used in wind power plant
11	Temperature sensors of gear box, electric generators and ambient temperature used in WPP.
12	RPM sensors of rotor and electric generators used in wind power plant
13	Hydraulic and electric pitch sensor and actuators used in wind power plant.
14	3kW to 5kW direct drive small wind turbine with permanent magnet electric generator.
15	5 kW to 10 kW small wind turbine with gear box and Induction generator.
16	5 kW to 10 kW small wind turbine with electric - electronic control panel.
17	Small wind turbine trainer
18	Wind turbine emulator

Suggested Project List:

1. Basic Wind Turbine model
2. Case study of any large wind power plant
3. Study of gear box in small and large wind power plant
4. Study of electric generators used in large wind power plant
5. Study of towers in small and large power plant
6. Study of electric switch yard used in large wind power plant
7. Comparative study of small wind turbines
8. Comaparative study of small wind turbines
9. Wind speed measurement with anemometer for different locations
10. Develop model of grid connected wind turbine system

11. Develop model of off - grid connected wind turbine system
12. Wind powered water pump

Suggested Activities for Students:

Beyond classroom and laboratory learning, the following co-curricular activities are recommended to enhance the achievement levels of various outcomes in this course. Students are encouraged to undertake these activities either individually or in groups and prepare comprehensive reports of approximately five pages for each activity. Additionally, students should gather and document physical evidences for their portfolios, which could be beneficial during placement interviews:

a) Project Model / Seminar Presentations: Demonstrate project models or deliver seminars on various topics covered in the course content.

b) Numerical Problem Solving through assignment:

Assignments and numerical problems should be distributed unit-wise, and students should seek progressive assessment from the concerned course facilitators throughout the term. At the end of the term, the entire body of work should be submitted to the respective course facilitators for evaluation.

These activities will not only reinforce the theoretical understanding but also provide practical exposure and critical thinking opportunities essential for professional growth.

****