GUJARAT TECHNOLOGICAL UNIVERSITY
Syllabus for Bachelor of Vocation (B.Voc.), 4th Semester
Branch: Solar & Renewable Energy
Subject Name: Introduction to Wind Energy Engineering
Subject Code: 1140701

Type of course: Core

Rationale: Address global energy and environmental challenges, develop a strong understanding of renewable energy technologies, analyze the economic and environmental aspects of renewable energy systems & emphasize energy conservation and efficiency in renewable energy applications**.**

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical		
L	T	P	C	ESE (E)	PA(M)	ESE (V)	PA (I)	
3	0	0	3	50	0	0	0	50

L- Lectures; T- Tutorial/Teacher Guided Student Activity; P- Practical; C- Credit; ESE- End Semester Examination; PA- Progressive Assessment

Content:

Sr. No.	Content	Total Hrs.	Module % Weightage
1	**Introduction to Wind Energy** Definition and significance of wind energy, Historical development of wind energy, Global trends and future prospects, Wind energy potential assessment methodologies, Socio-economic benefits and challenges of wind energy deployment	8	10
2	**Wind Resource Assessment** Basics of wind resource assessment, Instruments and methods for measuring wind speed and direction (anemometers, wind vanes, LiDAR), Data collection and analysis techniques (time series analysis, frequency distribution, Weibull distribution), Uncertainty analysis in wind resource assessment	10	20
3	**Wind Turbine Technology** Types of wind turbines (horizontal-axis: fixed and variable pitch, vertical-axis: Savonius, Darrieus), Aerodynamics of wind turbine blades, Mechanical components (yaw system, gearbox, brake system), Electrical components (generator types: synchronous, asynchronous, direct drive)	8	20
4	**Wind Energy Conversion Systems** Power extraction from wind: Betz limit and power coefficient, Control strategies for maximizing power output (pitch control, yaw control, stall control), Wind turbine load characteristics (aeroelastic effects, tower shadow, wake effects), Optimization techniques for wind turbine design and performance improvement	5	15
5	**Wind Farm Design and Layout** Wind farm siting considerations (wind resource assessment, environmental impact assessment), Layout optimization	6	15

	techniques (grid integration, wake effect mitigation), Micro-siting and optimization software tools (WindPRO, WAsP, OpenWind) Economic analysis and financing models for wind farm projects		
5	**Maintenance and Operation of Wind Turbines** Routine maintenance procedures (blade inspection, lubrication, gearbox inspection), Condition monitoring techniques (vibration analysis, oil analysis, thermography), Troubleshooting and fault detection (pitch system malfunction, generator failure), Safety considerations in wind turbine operation (working at height, electrical hazards)	5	20
	Total	**42**	**100**

Reference Books:

1. "Wind Energy: Fundamentals, Resource Analysis and Economics" Author: S. P. Sukhatme and J. K. Nayak, Publication: Universities Press
2. "Wind Energy Conversion Systems: Technology and Trends", Author: S. N. Bhadra, Publication: PHI Learning Pvt. Ltd.
3. "Introduction to Wind Energy", Author: Arvind S. Dhote, Publication: I.K. International Publishing House Pvt. Ltd.
4. "Wind Power Plants: Fundamentals, Design, Construction, and Operation", Authors: R. Gasch and J. Twele, Publication: Wiley-VCH, Edition: Translated edition (English) by G. P. Godenrath
5. "Wind Power in Power Systems", Author: Thomas Ackermann, Publication: Wiley-IEEE Press

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
15	15	10	5	5	-

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Createand above Levels (Revised Bloom's Taxonomy)

Course Outcomes:

Sr. No.	CO Statement	Marks % Weightage
CO-1	Understand the Principles and Significance of Wind Energy	20
CO-2	Analyze and Evaluate Wind Energy Systems	30
CO-3	Apply Wind Energy Concepts in Design and Operation	30
CO-4	Demonstrate Competence in Maintenance and Safety Practices	20

List of Open Source Software/learning website:

Students must refer to following sites to enhance their learning ability.

1. Open Energy Modelling Initiative (https://www.openmod-initiative.org/)
2. PVLIB-Python (https://pvlib-python.readthedocs.io/)
3. National Renewable Energy Laboratory (NREL) OpenEI (https://openei.org/)
4. National Programme on Technology Enhanced Learning: https://nptel.ac.in/courses/