

SRM VALLIAMMAI ENGINEERING COLLEGE

(Autonomous Institution)

SRM Nagar, Kattankulathur – 603 203

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

QUESTION BANK



VII SEMESTER

PEE605 WIND ENERGY CONVERSION SYSTEMS

Regulation – 2023

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Prepared by

Ms. Bency. P, Assistant Professor (Sr. G)



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SUBJECT & SUBJECT CODE: PEE605 WIND ENERGY CONVERSION SYSTEMS

SEM / YEAR: VII/ III

UNIT-I INTRODUCTION				
Components of WECS-WECS schemes-Power obtained from wind-simple momentum theory- Power coefficient-Sabinin's Theory-Aerodynamics of Wind turbine				
PART-A				
Q. No	Questions	BT Level	Competence	CO
1.	What are the schemes of WECS?	BTL1	Remembering	CO1
2.	Define Power Coefficient.	BTL2	Understanding	CO1
3.	Name the components of WECS.	BTL1	Remembering	CO1
4.	List out various WECS schemes.	BTL2	Understanding	CO1
5.	A wind turbine has a blade radius of 4m. Find the swept area.	BTL1	Remembering	CO1
6.	Calculate the power available in wind if: Air density = 1.225 kg/m ³ , Swept area = 20 m ² , Wind speed = 8 m/s	BTL2	Understanding	CO1
7.	A turbine blade rotates at 30 rad/s with radius 2 m. Wind speed is 10 m/s. Find TSR.	BTL1	Remembering	CO1
8.	If wind power available is 1000 W and turbine output power is 450 W, find power coefficient.	BTL2	Understanding	CO1
9.	A wind turbine extracts 59.3% of wind power. Name this limit.	BTL1	Remembering	CO1
10.	Determine the swept area of a wind turbine having blade radius of 6 m.	BTL2	Understanding	CO1
11.	Find the wind power available for the following data: Air density = 1.2 kg/m ³ , Rotor swept area = 25 m ² , Wind velocity = 10 m/s	BTL1	Remembering	CO1
12.	A turbine rotor rotates at 25 rad/s with blade radius of 3 m while wind speed is 15 m/s. Calculate the tip speed ratio.	BTL2	Understanding	CO1
13.	The output power of a wind turbine is 600 W when the available wind power is 1500 W. Determine the power coefficient.	BTL1	Remembering	CO1
14.	A wind turbine extracts 50% of the total wind power. State whether this value satisfies the Betz limit.	BTL2	Understanding	CO1
15.	A wind turbine rotor diameter is 8 m. Find: Radius, Swept area and Circumference of rotor blade path	BTL1	Remembering	CO1
16.	State Betz limit.	BTL2	Understanding	CO1
17.	Write the equation for power available in wind.	BTL1	Remembering	CO1
18.	Define tip speed ratio.	BTL2	Understanding	CO1
19.	What is meant by aerodynamic efficiency?	BTL1	Remembering	CO1
20.	What is simple momentum theory?	BTL2	Understanding	CO1
21.	State the assumptions made in momentum theory.	BTL1	Remembering	CO1

22.	Define axial induction factor.		BTL2	Understanding	CO1
23.	What is meant by wake rotation?		BTL1	Remembering	CO1
24.	Define rotor swept area.		BTL2	Understanding	CO1
25.	What are the factors affecting wind power generation?		BTL1	Remembering	CO1
PART-B					
1.	What are the components of WECS? Describe them.	(16)	BTL3	Applying	CO1
2.	What is known as Aerodynamics? With necessary diagram, explain the Aerodynamics of Wind Turbine.	(16)	BTL4	Analyzing	CO1
3.	With necessary illustration, explain simple momentum theory.	(16)	BTL3	Applying	CO1
4.	State and explain Sabinin's theory.	(16)	BTL4	Analyzing	CO1
5.	Obtain expression for power from the wind in the case of horizontal axis propeller-type wind mill.	(16)	BTL3	Applying	CO1
6.	Derive the expression for forces on the blades of propeller type wind turbine.	(16)	BTL4	Analyzing	CO1
7.	Describe the simple momentum theory.	(16)	BTL3	Applying	CO1
8.	A wind turbine operates with Air density = 1.225 kg/m^3 , Rotor radius = 5m, Wind speed = 12 m/s. Calculate Swept area, Power available in wind and Maximum power obtainable using Betz limit	(16)	BTL4	Analyzing	CO1
9.	A turbine produces 8 kW output power from available wind power of 15 kW. Find the Power coefficient and Efficiency of turbine.	(16)	BTL3	Applying	CO1
10.	A wind turbine blade radius is 3 m and rotational speed is 40 rad/s., Wind velocity is 12 m/s. Determine the tip speed ratio and Rotor swept area.	(16)	BTL4	Analyzing	CO1
11.	Air enters a wind turbine at 14 m/s and leaves at 8 m/s. Determine the average wind speed and axial induction factor.	(16)	BTL3	Applying	CO1
12.	A horizontal axis wind turbine operates in an area where the air density is 1.18 kg/m^3 . The turbine has a rotor radius of 6 m and is exposed to a wind speed of 10 m/s. Determine the swept area of the rotor, the total power available in the wind, and the maximum power that can be extracted based on Betz limit.	(16)	BTL4	Analyzing	CO1
13.	A wind energy conversion system delivers an output power of 10 kW while the total wind power available to the turbine is 18kW. Calculate the power coefficient of the turbine and determine its efficiency.	(16)	BTL3	Applying	CO1
14.	A wind turbine has blades of radius 4m and rotates at an angular speed of 35 rad/s. If the wind is blowing at a velocity of 14 m/s, determine the tip speed ratio of the turbine and calculate the rotor swept area.	(16)	BTL4	Analyzing	CO1
15.	In a wind turbine system, air enters the rotor at a velocity of 16 m/s and leaves the turbine at 9 m/s. Calculate the average wind velocity through the turbine and determine	(16)	BTL3	Applying	CO1

	the axial induction factor.				
16.	Explain the major components of a Wind Energy Conversion System (WECS) and describe the function of each component.	(16)	BTL4	Analyzing	CO1
17.	With the help of a suitable diagram, explain the simple momentum theory used in wind energy conversion systems.	(16)	BTL3	Applying	CO1
18.	State Sabinin's theory and explain its significance in wind turbine operation.	(16)	BTL4	Analyzing	CO1

UNIT-II WIND TURBINES

HAWT-VAWT-Power Developed-Thrust-Efficiency-Rotor Selection-Rotor design considerations- Tip Speed Ratio-No. Of Blades-Blade profile-yaw control, Pitch angle control- stall control-Schemes for maximum power extraction

PART-A

Q. No	Questions	BT Level	Competence	CO
1.	Write the equation of power developed in Wind Turbine.	BTL1	Remembering	CO1
2.	Name the schemes for maximum power extraction.	BTL2	Understanding	CO1
3.	Define thrust in HAWT.	BTL1	Remembering	CO1
4.	State the efficiency of VAWT.	BTL2	Understanding	CO1
5.	A HAWT blade rotates at 20 rad/s with radius 4 m and wind speed 10 m/s. Find TSR.	BTL1	Remembering	CO1
6.	A wind turbine develops 5 kN thrust force. Find the unit of thrust.	BTL2	Understanding	CO1
7.	A rotor has 3 blades each of area 2 m ² and swept area 40 m ² . Find solidity.	BTL1	Remembering	CO1
8.	A wind turbine rotates at 150 rpm. Convert it into rad/s.	BTL2	Understanding	CO1
9.	Wind speed increases from 5 m/s to 10 m/s. Find the increase in power ratio.	BTL1	Remembering	CO1
10.	A horizontal axis wind turbine rotates at 25 rad/s with a blade radius of 5 m. If the wind velocity is 12 m/s, calculate the Tip Speed Ratio (TSR).	BTL2	Understanding	CO1
11.	A wind turbine experiences a thrust force of 8 kN. Identify the SI unit used for thrust force.	BTL1	Remembering	CO1
12.	A wind turbine rotor consists of 4 blades, each having an area of 1.5 m ² . If the rotor swept area is 48 m ² , determine the solidity of the rotor.	BTL2	Understanding	CO1
13.	A wind turbine rotor runs at 180 rpm. Convert the rotational speed into rad/s.	BTL1	Remembering	CO1
14.	The wind velocity increases from 6 m/s to 12 m/s. Determine the ratio of increase in wind power.	BTL2	Understanding	CO1
15.	Define HAWT.	BTL1	Remembering	CO1
16.	Define VAWT.	BTL2	Understanding	CO1
17.	Compare HAWT and VAWT.	BTL1	Remembering	CO1
18.	Define thrust in HAWT.	BTL2	Understanding	CO1

19.	Define rotor efficiency.		BTL1	Remembering	CO1
20.	What is rotor selection?		BTL2	Understanding	CO1
21.	Define tip speed ratio.		BTL1	Remembering	CO1
22.	State the importance of blade profile.		BTL2	Understanding	CO1
23.	What are the factors affecting rotor design?		BTL1	Remembering	CO1
24.	Define yaw control.		BTL2	Understanding	CO1
25.	Define pitch angle control.		BTL1	Remembering	CO1
PART-B					
1.	Explain the factors to be considered for Rotor selection in Wind Turbines?	(16)	BTL3	Applying	CO1
2.	Describe the Stall Control method in wind energy systems.	(16)	BTL4	Analyzing	CO1
3.	Define Tip speed ratio. Describe how the Number of blades are selected in Wind Turbines.	(16)	BTL3	Applying	CO1
4.	Compare Yaw control and Pitch angle control in Wind Turbines.	(16)	BTL4	Analyzing	CO1
5.	Obtain the expression for maximum power in the case of HAWT.	(16)	BTL3	Applying	CO1
6.	Design various aspects of rotor for VAWT.	(16)	BTL4	Analyzing	CO1
7.	Design rotor of HAWT considering Tip speed ratio, number of blades, blade profile.	(16)	BTL3	Applying	CO1
8.	Describe the analysis of Yaw control, pitch angle control and stall control in the case of HAWT.	(16)	BTL4	Analyzing	CO1
9.	A Horizontal Axis Wind Turbine (HAWT) is installed at a coastal location where the wind velocity is 12 m/s. The turbine has a rotor radius of 8 m and operates under an air density of 1.225 kg/m ³ . If the turbine has a power coefficient of 0.4, determine the rotor swept area, the total power available in the wind, and the mechanical power extracted by the turbine.	(16)	BTL3	Applying	CO1
10.	The blade tip of a wind turbine moves at a speed of 84 m/s while the incoming wind approaches the turbine at a velocity of 14 m/s. The rotor radius of the turbine is 7 m. Using the given data, calculate the Tip Speed Ratio (TSR), the angular speed of the rotor in rad/s, and the corresponding rotor speed in rpm.	(16)	BTL4	Analyzing	CO1
11.	A Vertical Axis Wind Turbine (VAWT) having a rotor radius of 4 m and a height of 10 m operates at a site where the wind speed is 10 m/s. The air density is 1.225 kg/m ³ and the turbine efficiency is 38%. Determine the swept area of the turbine, the power available in the wind, and the electrical power output generated by the turbine.	(16)	BTL3	Applying	CO1
12.	A wind turbine rotor consists of five blades, each having an area of 2.8 m ² . The rotor diameter is 10 m. Calculate the rotor swept area, the total blade area, and the solidity of the rotor.	(16)	BTL4	Analyzing	CO1

13.	A wind turbine extracts energy from a wind stream where the air density is 1.225 kg/m^3 and the wind speed is 11 m/s . The rotor radius is 6 m and the turbine operates at 75% of the Betz limit. Determine the rotor swept area, the power available in the wind, the maximum theoretical power that can be extracted, and the actual power extracted by the turbine.	(16)	BTL3	Applying	CO1
14.	A Horizontal Axis Wind Turbine rotates at 180 rpm and has a rotor radius of 5 m . The wind approaching the turbine has a speed of 8 m/s . Determine the angular speed of the rotor in rad/s , the blade tip speed, and the Tip Speed Ratio (TSR) of the turbine.	(16)	BTL4	Analyzing	CO1
15.	A wind turbine with a rotor diameter of 14 m operates at a wind speed of 13 m/s . The air density is 1.225 kg/m^3 and the turbine has a power coefficient of 0.42 . Using the given information, calculate the rotor swept area, the power available in the wind, and the output power developed by the turbine.	(16)	BTL3	Applying	CO1
16.	A wind turbine rotor has four blades, each having an area of 3.5 m^2 . The rotor radius is 6 m . Determine the total blade area, the swept area of the rotor, and the solidity of the wind turbine.	(16)	BTL4	Analyzing	CO1
17.	Explain Tip Speed Ratio (TSR) and its importance in wind energy conversion systems. Also discuss the selection of the optimum number of blades in wind turbines.	(16)	BTL3	Applying	CO1
18.	Derive the expression for the maximum power extracted by a Horizontal Axis Wind Turbine (HAWT).	(16)	BTL4	Analyzing	CO1

UNIT-III FIXED SPEED SYSTEMS

Generating Systems- Constant speed constant frequency systems –Choice of Generators Deciding Factors- Synchronous Generator-Squirrel Cage Induction Generator.

Model of Wind Speed- Model wind turbine rotor – Generator model for Steady state and Transient stability analysis.

PART-A

Q. No	Questions	BT Level	Competence	CO
1.	What are known as deciding factors?	BTL1	Remembering	CO1
2.	A 4-pole synchronous generator runs at 1500 rpm . Calculate: - Frequency - Angular speed	BTL2	Understanding	CO1
3.	A synchronous generator produces electricity at 50 Hz while rotating at 1000 rpm . Determine the number of poles required.	BTL1	Remembering	CO1
4.	An induction generator has: - Synchronous speed = 1500 rpm - Rotor speed = 1545 rpm Find slip.	BTL2	Understanding	CO1
5.	A squirrel cage induction generator operates with a synchronous speed of 1500 rpm and a slip of -0.04 . Calculate the rotor speed.	BTL1	Remembering	CO1
6.	A synchronous generator has 6 poles and rotates at 1000 rpm .	BTL2	Understanding	CO1

	Determine the generated frequency.				
7.	An induction generator has a synchronous speed of 1500 rpm and a rotor speed of 1560 rpm. Calculate the percentage slip.		BTL1	Remembering	CO1
8.	A six-pole synchronous generator operates at a speed of 1000 rpm. Determine the generated frequency and the angular speed of the machine.		BTL2	Understanding	CO1
9.	An eight-pole synchronous generator runs at 750 rpm. Calculate the frequency of the generated voltage and the corresponding angular velocity.		BTL1	Remembering	CO1
10.	A synchronous generator rotates at 750 rpm and generates electrical power at a frequency of 50 Hz. Determine the number of poles of the machine.		BTL2	Understanding	CO1
11.	A synchronous generator operates at 600 rpm and produces an output frequency of 60 Hz. Calculate the required number of poles.		BTL1	Remembering	CO1
12.	An induction generator operates with a synchronous speed of 1800 rpm and a rotor speed of 1854 rpm. Determine the slip of the generator.		BTL2	Understanding	CO1
13.	A six-pole synchronous generator operates at a speed of 1000 rpm. Determine the generated frequency and the angular speed of the machine.		BTL1	Remembering	CO1
14.	List the design considerations required for developing a generator model suitable for steady-state analysis.		BTL2	Understanding	CO1
15.	What is meant by a wind speed model?		BTL1	Remembering	CO1
16.	What is a wind turbine rotor model?		BTL2	Understanding	CO1
17.	Define steady-state analysis.		BTL1	Remembering	CO1
18.	What is a drive train model?		BTL2	Understanding	CO1
19.	Why is generator modeling required in WECS?		BTL1	Remembering	CO1
20.	A wind turbine rotor rotates at 30 rpm. Convert the speed into rad/s.		BTL2	Understanding	CO1
21.	The average wind speed increases from 8 m/s to 10 m/s. Calculate the percentage increase in wind speed.		BTL1	Remembering	CO1
22.	A wind turbine has a rotor radius of 4 m. Determine the rotor swept area.		BTL2	Understanding	CO1
23.	A wind speed model consists of a mean wind speed of 12 m/s and a gust component of 3 m/s. Determine the resultant wind speed.		BTL1	Remembering	CO1
24.	A generator model operates at a terminal voltage of 400 V and a current of 10 A. Calculate the apparent power output.		BTL2	Understanding	CO1
25.	List the factors to be considered for the design of generator model for steady state analysis.		BTL1	Remembering	CO1
PART-B					
1.	Explain the choice of Generators for fixed speed systems and derive the model of synchronous Generator for Wind speed.	(16)	BTL3	Applying	CO1
2.	Explain the deciding factor in synchronous generator to	(16)	BTL4	Analyzing	CO1

	get constant speed constant frequency in wind energy system.				
3.	Explain squirrel cage induction generator model for fixed speed system.	(16)	BTL3	Applying	CO1
4.	A 6-pole synchronous generator operates at a speed of 1000 rpm and delivers an output power of 500 kW. Determine the generated frequency and angular speed of the generator. If the generator efficiency is 92%, calculate the mechanical input power required.	(16)	BTL4	Analyzing	CO1
5.	A squirrel cage induction generator has a synchronous speed of 1500 rpm and operates at a rotor speed of 1560 rpm. Determine the slip and percentage slip of the machine. If the generator develops an output power of 250 kW at an efficiency of 90%, calculate the mechanical input power.	(16)	BTL3	Applying	CO1
6.	A fixed-speed wind energy conversion system employs a 4-pole synchronous generator operating at 1500 rpm. Calculate the generated frequency and angular speed. If the generator supplies a load of 400 kW with an efficiency of 88%, determine the mechanical power supplied by the wind turbine.	(16)	BTL4	Analyzing	CO1
7.	A synchronous generator equipped with 10 poles is driven by a wind turbine at a speed of 600 rpm. The generator delivers 750 kW of electrical power with an efficiency of 94%. Determine the operating frequency, angular velocity, and the mechanical power supplied to the generator shaft.	(16)	BTL3	Applying	CO1
8.	A wind-driven squirrel cage induction generator rotates at 1872 rpm while its synchronous speed is 1800 rpm. Evaluate the slip and percentage slip of the generator. If the electrical output power is 300 kW and the machine efficiency is 93%, calculate the mechanical input power.	(16)	BTL4	Analyzing	CO1
9.	In a fixed-speed wind energy conversion system, an 8-pole synchronous generator is coupled to a turbine and operates at 750 rpm. The generator supplies 600 kW to the load at an efficiency of 90%. Calculate the generated frequency, angular speed, and the mechanical power developed by the wind turbine.	(16)	BTL3	Applying	CO1
10.	A wind turbine rotor has a radius of 8 m and operates at a wind speed of 12 m/s. Assuming the air density to be 1.225 kg/m ³ , calculate the rotor swept area and the power available in the wind. Explain how the wind speed model influences the power extracted from the turbine.	(16)	BTL4	Analyzing	CO1
11.	A wind turbine rotor rotates at 24 rpm and has a radius of 6 m. Determine the angular speed of the rotor and the blade tip speed. Discuss the significance of rotor	(16)	BTL3	Applying	CO1

	modeling in the steady-state analysis of wind energy conversion systems.				
12.	A generator model operates at a terminal voltage of 415 V and supplies a current of 120 A at unity power factor. Calculate the apparent power output of the generator. Explain the role of generator models in steady-state and transient stability analysis of wind energy conversion systems.	(16)	BTL4	Analyzing	CO1
13.	A horizontal axis wind turbine has a rotor radius of 10 m and operates in a location where the average wind speed is 14 m/s. Assume the air density to be 1.225 kg/m ³ . Determine the rotor swept area and the total power available in the wind stream. Discuss the importance of wind speed modeling in the performance analysis of wind energy conversion systems.	(16)	BTL3	Applying	CO1
14.	The rotor of a wind turbine rotates at 30 rpm and has a blade radius of 7 m. Calculate the angular velocity of the rotor and the blade tip speed. Explain the role of rotor modeling in evaluating the steady-state performance of a wind energy conversion system.	(16)	BTL4	Analyzing	CO1
15.	A wind turbine generator delivers power at a terminal voltage of 440 V and supplies a current of 150 A at unity power factor. Calculate the apparent power output of the generator. Describe the significance of generator models in steady-state and transient stability studies of wind energy conversion systems.	(16)	BTL3	Applying	CO1
16.	Derive the drive train model for steady state analysis and compare it with the transient stability analysis.	(16)	BTL4	Analyzing	CO1
17.	With example design fixed speed induction generator model for transient stability analysis.	(16)	BTL3	Applying	CO1
18.	With example describe model of wind speed and wind turbine rotor.	(16)	BTL4	Analyzing	CO1

UNIT-IV VARIABLE SPEED SYSTEMS

Need of variable speed systems-Power-wind speed characteristics-Variable speed constant frequency systems synchronous generator- DFIG- PMSG –Variable speed generators modeling – Variable speed variable frequency schemes

PART-A

Q. No	Questions	BT Level	Competence	CO
1.	State any two needs for variable speed systems.	BTL1	Remembering	CO1
2.	Define PMSG.	BTL2	Understanding	CO1
3.	Draw wind speed characteristics.	BTL1	Remembering	CO1
4.	Draw block diagram of DFIG variable speed motor.	BTL2	Understanding	CO1
5.	A Doubly Fed Induction Generator (DFIG) rotor rotates at a speed of 1550 rpm while the synchronous speed is 1500 rpm. Determine the slip of the machine.	BTL1	Remembering	CO1

6.	The speed of a variable-speed wind turbine increases from 1000 rpm to 1400 rpm. Calculate the percentage increase in turbine speed.	BTL2	Understanding	CO1
7.	A Permanent Magnet Synchronous Generator (PMSG) produces an output voltage at a frequency of 50 Hz. Determine the corresponding angular frequency.	BTL1	Remembering	CO1
8.	A power electronic converter operates with an efficiency of 95% and receives an input power of 10 kW. Calculate the output power delivered by the converter.	BTL2	Understanding	CO1
9.	The output power of a wind turbine increases from 8 kW to 12 kW. Determine the percentage increase in power output.	BTL1	Remembering	CO1
10.	A Doubly Fed Induction Generator (DFIG) rotor operates at a speed of 1240 rpm while the synchronous speed is 1200 rpm. Determine the slip of the machine.	BTL2	Understanding	CO1
11.	The rotational speed of a variable-speed wind turbine increases from 900 rpm to 1350 rpm. Calculate the percentage increase in turbine speed.	BTL1	Remembering	CO1
12.	A Permanent Magnet Synchronous Generator (PMSG) generates electrical power at a frequency of 60 Hz. Determine the corresponding angular frequency.	BTL2	Understanding	CO1
13.	A power electronic converter operates with an efficiency of 92% and receives an input power of 15 kW. Calculate the output power delivered by the converter.	BTL1	Remembering	CO1
14.	The output power of a wind turbine increases from 10 kW to 16 kW. Determine the percentage increase in power output.	BTL2	Understanding	CO1
15.	State the concept of a Variable Speed Wind Energy Conversion System.	BTL1	Remembering	CO1
16.	Outline the requirement for variable speed operation in wind energy conversion systems.	BTL2	Understanding	CO1
17.	Identify the role of a Doubly Fed Induction Generator (DFIG) in wind energy conversion systems.	BTL1	Remembering	CO1
18.	Compare Variable Speed Constant Frequency systems with Variable Speed Variable Frequency systems.	BTL2	Understanding	CO1
19.	Outline the benefits associated with variable speed wind energy conversion systems.	BTL1	Remembering	CO1
20.	Specify the characteristics of a Permanent Magnet Synchronous Generator (PMSG).	BTL2	Understanding	CO1
21.	Illustrate the function of a Grid Side Converter in a variable speed wind energy system.	BTL1	Remembering	CO1
22.	Mention the function of a Rotor Side Converter in a DFIG-based wind energy system.	BTL2	Understanding	CO1
23.	Interpret the concept of decoupled control in wind turbine applications.	BTL1	Remembering	CO1
24.	Recall the purpose of Maximum Power Point Tracking (MPPT) in wind turbines.	BTL2	Understanding	CO1
25.	Relate power–wind speed characteristics to the performance of	BTL1	Remembering	CO1

	wind turbines.				
PART-B					
1.	Derive the power-wind speed characteristics of variable speed systems.	(16)	BTL3	Applying	CO1
2.	Write short notes on DFIG in variable speed systems.	(16)	BTL4	Analyzing	CO1
3.	Derive the modeling for variable speed generators.	(16)	BTL3	Applying	CO1
4.	Explain Variable speed and variable frequency schemes with necessary diagrams.	(16)	BTL4	Analyzing	CO1
5.	Explain the decoupled control of DFIG wind turbine with rotor side and grid side controller modelling.	(16)	BTL3	Applying	CO1
6.	Describe PMSG wind turbine model with schematic diagram and relevant equations.	(16)	BTL4	Analyzing	CO1
7.	A Doubly Fed Induction Generator (DFIG) operates with a rotor speed of 1540 rpm while the synchronous speed is 1500 rpm. Determine the slip and identify the mode of operation. If the machine delivers 500 kW with an efficiency of 92%, calculate the mechanical input power.	(16)	BTL3	Applying	CO1
8.	A Permanent Magnet Synchronous Generator (PMSG) based wind energy conversion system receives a mechanical input of 30 kW. If the generator efficiency is 90%, determine the electrical output power. Also calculate the power loss in the generator.	(16)	BTL4	Analyzing	CO1
9.	A power electronic converter delivers an output power of 25 kW at an efficiency of 95%. Determine the input power supplied to the converter and the power loss occurring in the converter.	(16)	BTL3	Applying	CO1
10.	A wind turbine operates at a wind speed of 10 m/s with a rotor radius of 6 m. The rotor rotates at an angular speed of 20 rad/s. Determine the tip speed ratio and comment on the turbine operating condition.	(16)	BTL4	Analyzing	CO1
11.	A variable-speed wind turbine increases its rotational speed from 900 rpm to 1350 rpm. Calculate the percentage increase in speed. If the turbine output power increases from 15 kW to 24 kW, determine the percentage increase in power output.	(16)	BTL3	Applying	CO1
12.	A variable-speed wind turbine operates with a rotor radius of 5 m and rotates at 18 rad/s under a wind speed of 8 m/s. Determine the tip speed ratio. If the turbine extracts 35 kW from the wind and the generator efficiency is 90%, calculate the electrical power delivered to the load.	(16)	BTL4	Analyzing	CO1
13.	A Doubly Fed Induction Generator (DFIG) operates at a rotor speed of 1240 rpm while its synchronous speed is 1200 rpm. Calculate the slip and specify the operating condition of the machine. If the generator supplies 600 kW at an efficiency of 94%, determine the mechanical	(16)	BTL3	Applying	CO1

	power input required.				
14.	A Permanent Magnet Synchronous Generator (PMSG) in a wind energy conversion system receives a mechanical power input of 40 kW. Assuming the generator efficiency is 92%, compute the electrical power output and evaluate the power loss occurring within the generator.	(16)	BTL4	Analyzing	CO1
15.	A power converter used in a variable-speed wind energy system delivers an output of 30 kW and operates with an efficiency of 96%. Determine the input power supplied to the converter and estimate the associated power loss.	(16)	BTL3	Applying	CO1
16.	A wind turbine functions under a wind velocity of 12 m/s and has a rotor radius of 5 m. If the rotor rotates at an angular speed of 24 rad/s, calculate the tip speed ratio and infer the operating characteristics of the turbine.	(16)	BTL4	Analyzing	CO1
17.	The rotational speed of a variable-speed wind turbine increases from 1000 rpm to 1500 rpm. Determine the percentage increase in rotor speed. If the turbine output power rises from 18 kW to 30 kW, calculate the corresponding percentage increase in power generation.	(16)	BTL3	Applying	CO1
18.	A variable-speed wind turbine equipped with a rotor of radius 6 m rotates at 16 rad/s in a wind stream of 9 m/s. Determine the tip speed ratio. If the turbine extracts 45 kW of mechanical power from the wind and the generator efficiency is 88%, calculate the electrical power supplied to the load.	(16)	BTL4	Analyzing	CO1

UNIT-V GRID CONNECTED SYSTEMS

Wind interconnection requirements, low-voltage ride through (LVRT), ramp rate limitations, and supply of ancillary services for frequency and voltage control, current practices, and industry trends wind interconnection impact on steady-state and dynamic performance of the power system including modeling issue

PART-A

Q. No	Questions	BT Level	Competence	CO
1.	What is meant by WECS system?	BTL1	Remembering	CO1
2.	Name any two issues of Grid connection.	BTL2	Understanding	CO1
3.	Define LVRT capability of wind turbine.	BTL1	Remembering	CO1
4.	What are the modeling issues in industry wind interconnection system?	BTL2	Understanding	CO1
5.	A wind farm injects 5 MW into grid. Convert into kW.	BTL1	Remembering	CO1
6.	Grid voltage drops from 440 V to 360 V. Find percentage voltage drop.	BTL2	Understanding	CO1
7.	A wind turbine supplies 50 Hz frequency. Find angular frequency.	BTL1	Remembering	CO1
8.	A wind system delivers 0.8 power factor lagging. Define reactive power condition.	BTL2	Understanding	CO1
9.	A wind turbine remains connected during 20% voltage sag.	BTL1	Remembering	CO1

	Name this capability.				
10.	A wind power station exports 8 MW of electrical power to the utility network. Express the power in kilowatts (kW).	BTL2	Understanding	CO1	
11.	During a disturbance, the grid voltage decreases from 460 V to 345 V. Determine the percentage voltage reduction.	BTL1	Remembering	CO1	
12.	A grid-connected wind turbine operates at a frequency of 60 Hz. Calculate the corresponding angular frequency.	BTL2	Understanding	CO1	
13.	A wind energy conversion system operates at a lagging power factor of 0.85. Indicate the nature of the reactive power associated with the system.	BTL1	Remembering	CO1	
14.	A wind turbine continues to operate without disconnecting from the grid during a 25% voltage dip. Identify this operational capability.	BTL2	Understanding	CO1	
15.	State the purpose of voltage control in a power system.	BTL1	Remembering	CO1	
16.	Classify the common power quality issues encountered in grid-connected wind energy systems.	BTL2	Understanding	CO1	
17.	List the requirements for connecting a wind energy system to the utility grid.	BTL1	Remembering	CO1	
18.	Relate the occurrence of flicker to the operation of wind energy conversion systems.	BTL2	Understanding	CO1	
19.	Identify the meaning of reactive power compensation.	BTL1	Remembering	CO1	
20.	Differentiate between voltage sag and voltage swell.	BTL2	Understanding	CO1	
21.	Mention the significance of fault ride-through capability in wind energy systems.	BTL1	Remembering	CO1	
22.	Interpret the impact of islanding on power system operation.	BTL2	Understanding	CO1	
23.	Specify the term used to describe distortion caused by harmonic components in a power system.	BTL1	Remembering	CO1	
24.	Outline the role of reactive power compensation in maintaining grid performance.	BTL2	Understanding	CO1	
25.	Define grid code.	BTL1	Remembering	CO1	
PART-B					
1.	What is meant by Standalone WECS system? Explain about the issues of Grid connection.	(16)	BTL3	Applying	CO1
2.	Explain in detail about Machine side controllers and Grid side controllers.	(16)	BTL4	Analyzing	CO1
3.	Design Grid connected wind system based on wind interconnection grid code requirements.	(16)	BTL3	Applying	CO1
4.	With example describe industry trends wind interconnection on steady state performance of the power system.	(16)	BTL4	Analyzing	CO1
5.	A wind farm consisting of ten wind turbines, each rated at 1.5 MW, is connected to the utility grid. Determine the total installed capacity of the wind farm. Present the essential requirements that must be satisfied for successful grid interconnection of wind energy conversion systems.	(16)	BTL3	Applying	CO1

6.	A wind turbine delivers 200 kW of active power at a lagging power factor of 0.8. Determine the apparent power supplied by the turbine. Bring out the role of reactive power compensation in improving voltage profile and power factor in grid-connected wind energy systems.	(16)	BTL4	Analyzing	CO1
7.	During a grid disturbance, the system voltage decreases from 440 V to 300 V for a short duration. Calculate the percentage voltage sag experienced by the system. Highlight the significance of fault ride-through capability and its contribution to grid stability.	(16)	BTL3	Applying	CO1
8.	A converter-fed wind energy system produces harmonic voltages of 12 V, 8 V and 5 V, while the fundamental voltage is 230 V. Determine the Total Harmonic Distortion (THD). Relate harmonic distortion to power quality issues in grid-connected wind energy systems.	(16)	BTL4	Analyzing	CO1
9.	The terminal voltage of a wind turbine varies periodically between 400 V and 420 V due to wind speed fluctuations. Calculate the percentage voltage variation with respect to the nominal voltage of 415 V. Relate these fluctuations to the phenomenon of flicker and its impact on consumers.	(16)	BTL3	Applying	CO1
10.	A distribution feeder normally operates at 415 V. During a fault, the voltage falls to 320 V, and during load rejection, it rises to 470 V. Determine the percentage voltage sag and percentage voltage swell. Differentiate between these two conditions and state their effects on electrical equipment.	(16)	BTL4	Analyzing	CO1
11.	A distributed wind generation system supplies a local load of 250 kW. Following a grid disconnection, the load demand remains 220 kW. Calculate the excess power available in the isolated system. Interpret the concept of islanding and discuss the necessity of islanding detection and protection schemes.	(16)	BTL3	Applying	CO1
12.	A wind power plant consists of 12 wind turbines, each having a rated capacity of 2 MW. Determine the total installed capacity of the wind farm. Indicate the key technical requirements that must be fulfilled for integrating a wind energy conversion system with the utility grid.	(16)	BTL4	Analyzing	CO1
13.	A grid-connected wind turbine supplies 240 kW of active power while operating at a lagging power factor of 0.75. Calculate the apparent power delivered by the turbine. Outline the importance of reactive power compensation in enhancing voltage profile and overall system performance.	(16)	BTL3	Applying	CO1
14.	During a network disturbance, the terminal voltage of a wind energy conversion system drops from 480 V to 320	(16)	BTL4	Analyzing	CO1

	V. Determine the percentage voltage dip experienced by the system. Bring out the significance of fault ride-through capability in maintaining continuous operation of wind turbines during grid faults.				
15.	A converter-interfaced wind turbine produces harmonic voltages of 10 V, 7 V and 4 V, while the fundamental voltage is 240 V. Calculate the Total Harmonic Distortion (THD). Classify the effects of harmonics on power quality and electrical equipment.	(16)	BTL3	Applying	CO1
16.	The output voltage of a wind turbine varies between 390 V and 430 V due to fluctuations in wind speed. Considering a nominal voltage of 415 V, determine the percentage voltage variation. Relate this variation to the phenomenon of flicker and its impact on consumers.	(16)	BTL4	Analyzing	CO1
17.	A distribution system normally operates at 440 V. During a fault condition, the voltage falls to 340 V, and during a sudden load removal, it rises to 500 V. Calculate the percentage voltage sag and percentage voltage swell. Distinguish between these two voltage disturbances and indicate their influence on connected loads.	(16)	BTL3	Applying	CO1
18.	A distributed wind generation unit supplies 300 kW of power to a local network. Following the loss of grid connection, the local load demand is measured as 260 kW. Determine the surplus power available within the isolated network. Interpret the concept of islanding and justify the need for anti-islanding protection schemes in wind energy systems.	(16)	BTL4	Analyzing	CO1

Course Outcome:

To understand the various types of energy storage Technologies.

To analyze thermal storage system.

To analyze different battery storage technologies.

To analyze the thermodynamics of Fuel Cell.

To study the various applications of energy storage systems.