SRM VALLIAMMAI ENGINEERING COLLEGE

(An Autonomous Institution)

SRM Nagar, Kattankulathur – 603 203.

DEPARTMENT OF

ELECTRICAL AND ELECTRONICS ENGINEERING

QUESTION BANK

III SEMESTER

1916303 WIND ENERGY CONVERSION SYSTEMS

Regulation–2019

Academic Year 2022–23 ODD

Prepared by

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SUBJECT: 1916303 WIND ENERGY CONVERSION SYSTEMS

SEM / YEAR: III / II

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**	**Course Outcome**
1.	List out the components of WECS.	1	Remember	CO1
2.	How is the WECS classified?	3	Apply	CO1
3.	What is the power coefficient of wind turbine?	4	Analyze	CO1
4.	How is the coefficient of power calculated?	1	Remember	CO1
5.	List out the advantages of wind power.	2	Understand	CO1
6.	Plot the C_p curve of wind turbine.	5	Evaluate	CO1
7.	What are the two basic design of turbines?	2	Understand	CO1
8.	List the disadvantages of wind power generation.	2	Understand	CO1
9.	What are the types of wind mills?	1	Remember	CO1
10.	What is the application of Wind energy?	5	Evaluate	CO1
11.	What are factors considering while selecting wind power generation?	1	Remember	CO1
12.	List the important wind turbine generation installations in India.	4	Analyze	CO1
13.	List the types of generators used in wind power plant.	2	Understand	CO1
14.	Demonstrate the function of gear box in wind mills.	3	Apply	CO2
15.	What are the examples of wind energy?	4	Analyze	CO1
16.	How do wind turbine works?	1	Remember	CO1
17.	How efficient is wind energy?	6	Create	CO1
18.	What is momentum theory in wind power generation?	6	Create	CO1
19.	How is rotor power coefficient calculated?	1	Remember	CO1
20.	With an illustration describe the various forces acting on an air foil.	3	Apply	CO2
21.	What is aerodynamic braking system?	1	Remember	CO1
22.	Mention the four components of aerodynamics?	1	Remember	CO1
23.	List out the function of nacelle.	2	Understand	CO1
24.	What is the maximum efficiency of a wind turbine?	2	Understand	CO1

PART – B				
1.	Explain the different schemes for wind electric generation. (13)	1	Remember	CO1
2.	What is meant by Sabinin's theory? Explain in detail. (13)	5	Evaluate	CO1
3.	Derive Betz limit for the power co-efficient of wind turbine using simple momentum theory. (13)	6	Create	CO1
4.	Draw the basic block diagram and explain the components of wind energy conversion system in detail. (13)	3	Apply	CO1
5.	Explain in detail about the variable power wing energy conversion system. (13)	2	Understand	CO1
6.	With neat sketch explain about the Wind turbine functional control elements. (13)	1	Remember	CO1
7.	Briefly explain about the wind energy conversion schemes (13)	2	Understand	CO1
8.	Explain about the transformation of kinetic wind energy to rotational shaft energy. (13)	1	Remember	CO1
9.	Draw the block diagram shows the various component of wind turbine and explain function of each part. (13)	2	Understand	CO1
10.	Explain in detail about sabinin's theory of ideal wind turbine. Derive the sabinin's limit of power coefficient Cp. (13)	1	Remember	CO1
11.	Explain in detail about simple momentum theory? (13)	4	Analyze	CO1
12.	What are the environmental impacts of wind power? Explain each case in detail. (13)	4	Analyze	CO1
13.	Derive the Betz limit of power coefficient Cp of an ideal wind turbine. (13)	4	Analyze	CO2
14.	Derive the equation for power obtained from the wind from the first principles. (13)	3	Apply	CO2
15.	What are the various attributes to be taken care in the aerodynamically designed wind turbine? Explain in detail. (13)	1	Remember	CO1
16.	Briefly explain about the aerodynamics wind turbine. (13)	2	Understand	CO1
17.	(i)Describe the factors affecting the distribution of wind energy on the surface of the earth. (7) (ii)Account on the nature of the winds. (6)	1	Remember	CO1
PART – C				
1.	Discuss on sabinin's theory of ideal wind turbine. Derive the sabinin's limit of power coefficient Cp. (15)	5	Evaluate	CO1
2.	Derive and express the equation for power obtained from the wind from the first principles. (15)	6	Create	CO1
3.	Mention the various attributes to be taken care in the aerodynamically designed wind turbine? Explain in detail. (15)	6	Create	CO3
4.	Analyze the transformation of kinetic wind energy to rotational shaft energy. (15)	5	Evaluate	CO2
5.	Derive Betz limit for the power co-efficient of wind turbine using simple momentum theory. (15)	5	Evaluate	CO2

UNIT- II: WIND TURBINES

HAWT-VAWT-Power Developed-Thrust-Efficiency-Rotor Selection-Rotor design considerations Tip

speed ratio-No. of Blades-Blade profile-Power Regulation-yaw control- Pitch angle control- stall control-Schemes for maximum power extraction.				
PART – A				
Q.No	**Questions**	**BT Level**	**Competence**	**Course Outcome**
1.	Define thrust force, angle of attack.	1	Remember	CO3
2.	Define lift and drag force of an wind mill.	2	Understand	CO1
3.	What is lift and drag coefficient?	5	Evaluate	CO3
4.	List out the factors to be considered for rotor selection of WPP	1	Remember	CO4
5.	Define Tip Speed Ratio and blade solidity.	2	Understand	CO4
6.	Sketch Cp Vs λ curves for various types of wind turbines.	1	Remember	CO2
7.	What are the two types of brakes on a wind turbine?	1	Remember	CO3
8.	What is gearbox in wind turbine?	2	Understand	CO2
9.	Define stall control of wind turbine.	6	Create	CO2
10.	What is yaw control of wind turbine?	1	Remember	CO2
11.	What is pitch control of wind turbine?	1	Remember	CO3
12.	Define tip speed ratio, laminar flow, turbulent flow.	3	Apply	CO3
13.	Compare the performance of 3 blade and 4 blade WPP.	3	Apply	CO4
14.	Draw the different blade profile for the different TSR.	4	Analyze	CO1
15.	Write the factors affecting the performance rotor of a wind mill.	5	Evaluate	CO4
16.	Express the formula for thrust force.	3	Apply	CO1
17.	Write about pitch controlled WPP.	6	Create	CO4
18.	Analyze the factors involved in estimation of wind energy at a site?	4	Analyze	CO4
19.	Define the term gradient height.	2	Understand	CO3
20.	Define capacity factor.	4	Analyze	CO2
21.	Distinguish upwind and downwind machines.	1	Remember	CO2
22.	List out the disadvantages of darrieus rotor.	1	Remember	CO3
23.	Summarize the features of VAWT.	4	Analyze	CO4
24.	Write a note on the support structure provided for VAWT.	2	Understand	CO4
PART – B				
1.	Discuss in detail various considerations in the design procedure of wind turbine rotor. (13)	1	Remember	CO1
2.	Describe the various types of vertical axis wind turbines with suitable illustrations. (13)	1	Remember	CO3
3.	Explain various schemes of maximum power extraction applied for a WECS. (13)	1	Remember	CO3
4.	Explain the step by step procedure for designing the blade of a wind mill. (13)	1	Remember	CO2
5.	Explain the factors affecting the performance rotor of a wind mill with necessary graphs and curves. (13)	2	Understand	CO3
6.	Derive the formula for thrust force and TSR. (13)	4	Analyze	CO3

7.	Explain in detail about the lift force, drag force, different loads acting on the rotor blades with necessary diagrams and equations. (13)	2	Understand	CO3
8.	Explain in detail different pitching mechanisms of wind mill. (13)	2	Understand	CO3
9.	Explain in detail about active stall controlled WPP and passive stall controlled WPP. (13)	4	Analyze	CO3
10.	Explain the various features of pitch controlled WPP and stall controlled WPP. (13)	5	Evaluate	CO4
11.	Explain the various requirements of Power Electronic Converters for the WPP applications. (13)	4	Analyze	CO2
12.	How energy from the wind is extracted? Explain the process using suitable diagram. (13)	6	Create	CO2
13.	Discuss the various designs of rotors used for HAWT with its merits and demerits. (13)	3	Apply	CO3
14.	Discuss the advantage of vertical axis windmill over horizontal type. (13)	3	Apply	CO2
15.	Discuss on Maximum Power Extraction Schemes & Power Control in Wind Energy Conversion System. (13)	2	Understand	CO3
16.	Describe about Power control techniques in wind turbines. (13)	2	Understand	CO3
17.	(i)Write the factors affecting the performance rotor of wind mill. (6) (ii) Compare the performance of 3 blade and 4 blade WPP. (7)	1	Remember	CO2
	PART – C			
1.	Explain all methods of pitch control techniques of a wind mill. (15)	5	Evaluate	CO3
2.	Analyze the factors affecting the performance rotor of a wind mill with necessary graphs and curves. (15)	6	Create	CO3
3.	Discuss on various schemes of maximum power extraction applied for a WECS. (15)	5	Evaluate	CO2
4.	Demonstrate the step by step procedure for designing the blade of a wind mill. (15)	6	Create	CO2
5.	Compare stall controlled and pitch controlled WPP. (15)	6	Create	CO3

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 - Drive Train model- Generator model for Steady state and Transient stability analysis- Reference frame theory.

PART – A

Q.No	Questions	BT Level	Competence	Course Outcome
1.	What is fixed speed wind turbine?	1	Remember	CO3
2.	What controls the speed of a wind turbine?	5	Evaluate	CO3
3.	Which controller is used in wind turbine?	1	Remember	CO3

4.	Why is variable speed wind turbine generator WTG more efficient than fixed speed WTG?	2	Understand	CO3
5.	What are the assumptions used in steady state stability analysis of wind mill generator model?	2	Understand	CO3
6.	Define short circuit ratio of generator.	3	Apply	CO3
7.	What are the assumptions used in transient state stability analysis of wind mill generator model?	1	Remember	CO3
8.	What do you mean by constant speed constant frequency systems?	6	Create	CO3
9.	Draw the block diagram of WECS based on self excited induction generator.	1	Remember	CO3
10.	What are the advantages and disadvantages of fixed speed WECS?	4	Analyze	CO3
11.	Compare fixed speed WECS and variable speed WECS.	5	Evaluate	CO3
12.	Define wind modeling.	4	Analyze	CO3
13.	Compare SCIG and DFIG.	6	Create	CO3
14.	Compare conventional synchronous machine and PMSG.	3	Apply	CO3
15.	Define weibull and rayliegh distribution for wind speed modeling.	3	Apply	CO3
16.	Draw the speed torque characteristics of induction machine.	4	Analyze	CO4
17.	What is the drive train model of wind turbine?	1	Remember	CO3
18.	What is the formula of rotor speed?	1	Remember	CO3
19.	What is the difference between synchronous speed and rotor speed?	2	Understand	CO3
20.	What is squirrel cage induction generator?	2	Understand	CO3
21.	How is frequency controlled in a wind turbine?	1	Remember	CO3
22.	What is the frequency of wind turbine?	2	Understand	CO3
23.	Do windmills generate AC or DC?	4	Analyze	CO3
24.	Define rayliegh distribution for wind speed modeling.	1	Remember	CO3
PART – B				
1.	Derive the steady state model of induction generator and describe its steady state performance characteristics. (13)	1	Remember	CO3
2.	Explain with necessary equations the drive train model. (13)	1	Remember	CO3
3.	Describe model of wind speed and wind turbine rotor. (13)	1	Remember	CO3
4.	Explain the different factors to be considered for choosing the generator for wind mill applications. (13)	2	Understand	CO3
5.	Explain steady state stability analysis for generator model	1	Remember	CO3

	for wind mill application. (13)			
6.	Explain transient state stability analysis for generator model for wind mill application. (13)	3	Apply	CO3
7.	Explain different methods used for modeling of wind with necessary equations and tabulations of data. (13)	4	Analyze	CO3
8.	Derive the torque equation of induction machine and deduce step by step equivalent circuit of it. (13)	3	Apply	CO3
9.	Explain different types of drive train modeling of wind turbine with neat diagram and relationships of various parameters. (13)	2	Understand	CO3
10.	Draw the block diagram for the implementation of constant speed constant frequency based WECS and explain the function of each block in it. (13)	4	Analyze	CO3
11.	Explain different type of turbines used for constant speed WECS. (13)	2	Understand	CO3
12.	Discuss about Constant speed constant frequency systems in Fixed speed system. (13)	5	Evaluate	CO3
13.	Describe about the Modelling of wind turbine rotor. (13)	6	Create	CO3
14.	Briefly discuss on drive train model. (13)	4	Analyze	CO4
15.	Explain about Wind speed measurement using anemometer. (13)	1	Remember	CO3
16.	Compare fixed speed WECS and variable speed WECS. (13)	2	Understand	CO3
17.	Discuss about the Construction and working of Squirrel cage induction generator. (13)	1	Remember	CO3
	PART - C			
1.	Explain the complete operation of matrix converter used for wind mill applications. (15)	6	Create	CO3
2.	Analyze transient state stability analysis for generator model for wind mill application. (15)	5	Evaluate	CO3
3.	Sketch out the block diagram for the implementation of constant speed constant frequency based WECS and explain the function of each block in it. (15)	5	Evaluate	CO3
4.	Discuss about the steady state model of induction generator and describe its steady state performance characteristics. (15)	6	Create	CO3
5.	**Analyze the concept of Reference frame theory.**	5	Evaluate	CO3

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 modelling Variable speed variable frequency schemes.

PART – A

Q.No	Questions	BT Level	Competence	Course Outcome
1.	What are the features of variable speed WECS?	2	Understand	CO1
2.	Compare fixed speed WECS and variable speed WECS	4	Analyze	CO1

3.	What is the need for variable speed WECS?	2	Understand	CO1
4.	What are the pros and cons of variable speed WECS?	1	Remember	CO1
5.	List the various advantages of PMSG over DFIG?	3	Apply	CO1
6.	List out features of DFIG used for WECS.	1	Remember	CO1
7.	Derive the simplified model of PMSG in d-q reference frame.	1	Remember	CO1
8.	List out the features of PMSG used for WECS.	1	Remember	CO1
9.	Compare DFIG and PMSG.	2	Understand	CO1
10.	Draw the wind power versus wind speed characteristics curve.	5	Evaluate	CO1
11.	Draw the block diagram of variable speed constant frequency WECS.	4	Analyze	CO1
12.	Write down the formula for capacity factor.	6	Create	CO1
13.	Which generator is used in variable speed wind energy conversion system?	3	Apply	CO2
14.	Which type of wind mill has high efficiency?	3	Apply	CO2
15.	What controls the speed of a wind turbine?	4	Analyze	CO2
16.	What is the need for variable speed WECS?	1	Remember	CO3
17.	Distinguish between variable speed constant frequency systems and variable speed variable frequency systems.	6	Create	CO5
18.	Sketch out the wind speed characteristics curve.	2	Understand	CO2
19.	What is the advantage of variable speed wind turbine?	1	Remember	CO3
20.	What is a DFIG generator?	5	Evaluate	CO1
21.	What are the disadvantages of doubly-fed induction generator?	1	Remember	CO3
22.	What is Betz criterion?	1	Remember	CO3
23.	Draw the CP curve.	4	Analyze	CO1
24.	Mention the working principle of VFD.	2	Understand	CO1
PART – B				
1.	Explain the mathematical modeling of DFIG with necessary equations. (13)	1	Remember	CO1
2.	Derive the torque equation of induction machine and deduce step by step equivalent circuit of it. Prove P2:Pm:Prot.cu.loss = 1:(1-s):s (13)	1	Remember	CO1

3.	With neat illustrations, explain the power-wind speed characteristics. (13)	1	Remember	CO1
4.	Discuss different modes of operation of DFIG with necessary power flow diagrams. (13)	2	Understand	CO1
5.	Deduce the equivalent circuit of induction machine. (13)	2	Understand	CO3
6.	Explain the equivalent circuit of PMSG with all of its parameters. (13)	2	Understand	CO3
7.	Draw the block diagram of variable speed variable frequency systems and explain the function of each block in it. (13)	1	Remember	CO5
8.	Compare Fixed speed system and variable speed system. (13)	3	Apply	CO3
9.	Explain the mathematical modeling of PMSG with necessary equations. (13)	4	Analyze	CO3
10.	Derive the torque equation of induction machine. (13)	4	Analyze	CO5
11.	Describe the features of variable speed WECS and explain how itis advantageous than the fixed speed WECS. (13)	6	Create	CO5
12.	Compare fixed speed WECS and variable speed WECS. (13)	3	Apply	CO2
13.	List out the types of towers used for wind mill with diagram. List out pros and cons of each type. (13)	4	Analyze	CO1
14.	Draw and explain the power- wind speed characteristics curve. Explain each term. (13)	5	Evaluate	CO3
15.	With block diagram explain WECS with fixed-speed with squirrel-cage induction generator (SCIG) and variable-speed with doubly fed induction generator (DFIG). (13)	4	Analyze	CO5
16.	Compare DFIG and PMSG. (13)	3	Apply	CO2
17.	Briefly explain the power flow control techniques in wind energy systems. (13)	1	Remember	CO5
PART – C				
1.	Explain all types of towers used for wind mill with diagram. List out pros and cons of each type. (15)	5	Evaluate	CO2
2.	Derive the torque equation of induction machine and deduce step by step equivalent circuit of it. Prove P2: Pm:Prot.cu.loss = 1:(1-s):s. (15)	5	Evaluate	CO1
3.	Explain the mathematical modeling of PMSG with necessary equations. (15)	6	Create	CO1
4.	Describe the features of variable speed WECS and explain how itis advantageous than the fixed speed WECS. (15)	6	Create	CO5
5.	Explain the mathematical modeling of DFIG with necessary equations. (15)	5	Evaluate	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**	**Course Outcome**
1.	What are the interconnection requirements for wind power plants?	1	Remember	CO5
2.	Name any two issues of grid connection.	1	Remember	CO5
3.	What is LVRT?	2	Understand	CO5
4.	How are wind power systems classified?	5	Evaluate	CO5
5.	What are the major problems related to grid interconnection?	5	Evaluate	CO5
6.	What are the advantages of grid connected systems?	2	Understand	CO5
7.	What is voltage dip and voltage swell?	2	Understand	CO5
8.	Define voltage sag.	6	Create	CO5
9.	Define sub synchronous resonance SSR in power grid.	6	Create	CO5
10.	What is matrix converter?	3	Apply	CO5
11.	How are wind turbines connected to the grid?	1	Remember	CO5
12.	What is the ramp rate of a wind turbine?	4	Analyze	CO5
13.	What is low voltage ride through?	3	Apply	CO5
14.	Define the ramp rate limit of wind power output.	2	Understand	CO5
15.	What are the two main types of grid connectivity in a wind?	1	Remember	CO5
16.	Define pitch angle.	1	Remember	CO5
17.	List the horizontal wind power collectors.	4	Analyze	CO5
18.	What is the difference between stand alone and grid connected wind generators?	3	Apply	CO5
19.	Which type of wind mill has high efficiency?	4	Analyze	CO5
20.	Define cut out speed.	1	Remember	CO5
21.	List the advantages of odd no of blades than even no of blades in wind mills.	4	Analyze	CO5
22.	Define angle of attack in the design of wind mill blades.	1	Remember	CO5
23.	What are the two main types of grid connectivity in a wind?	1	Remember	CO5
24.	What are the grid-connected issues in wind turbines?	1	Remember	CO5

	PART – B			
1.	Explain Low Voltage Ride Through control strategy of grid connected variable speed wind turbine generator system. (13)	1	Remember	CO5
2.	Explain the various grid interconnection requirements of WECS. (13)	2	Understand	CO5
3.	Sketch the low-voltage ride through characteristics of grid connected WECS and discuss it. (13)	2	Understand	CO5
4.	Discuss briefly the role of WECS used as ancillary services for frequency and voltage control of the grid. (13)	1	Remember	CO5
5.	Explain the choice of generators for fixed speed systems and derive the model of synchronous generator for wind speed. (13)	2	Understand	CO5
6.	Derive the power wind speed characteristics of variable speed systems. (13)	4	Analyze	CO5
7.	Write the short notes on DFIG in variable speed systems. (13)	3	Apply	CO5
8.	Derive the modeling for variable speed generators. Also explain variable speed and variable frequency schemes with necessary diagrams. (13)	4	Analyze	CO5
9.	What is meant by standalone WECS system? Explain about the issues of grid connection. (13)	6	Create	CO5
10.	Explain in detail about (i) machine side controllers and (ii) grid side controllers. (13)	4	Analyze	CO5
11.	Explain wind energy storage systems and hybrid systems. (13)	5	Evaluate	CO5
12.	Discuss few points on Grid connected wind power system. (13)	3	Apply	CO5
13.	Briefly discuss on Wind power grid interconnection. (13)	1	Remember	CO5
14.	Describe about the Real and reactive power regulation in wind farms. (13)	1	Remember	CO5
15.	Explain LVRT control strategy of grid connected variable speed wind turbine generator system. (13)	2	Understand	CO5
16.	List out the components required for grid connected system. (13)	1	Remember	CO5
17.	Discuss in detail on the supply of ancillary services for frequency and voltage control. (13)	2	Understand	CO5
	PART – C			
1.	Explain in detail about machine side controllers and grid side controllers. (15)	6	Create	CO5
2.	Explain about the Grid connection and integration of wind power. (15)	6	Create	CO5
3.	Discuss about the modeling for variable speed generators. Also explain variable speed and variable frequency schemes with necessary diagrams. (15)	5	Evaluate	CO5
4.	Discuss on Enhanced Dynamic behavior of Grid Connected Wind Farms in Load Participation and Frequency Regulation.	5	Evaluate	CO5

		(15)			
5.	Analyze Grid connected wind power system.	(15)	6	Create	CO5

COURSE OUTCOMES:

- Acquire knowledge on the basic concepts of Wind energy conversion system.
- Understand the mathematical modeling and control of the Wind turbine.
- Develop more understanding on the design of fixed speed system.
- Study about the need of Variable speed system and its modeling.
- Able to learn about Grid integration issues and current practices of wind interconnection with power system.