Roll No: ----------

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

End Semester Examination – December 2017

Program/course: B.Tech ET + IPR **Semester – VII**
Subject: Wind Energy Technology **Max. Marks : 100**
Code : ETEG 401 **Duration : 3 Hrs**
No. of page/s: 3

Section A

All questions are mandatory: (Each question: 4 marks)

Q.no.	COs	Question
1.	CO1	Discuss the advantages and disadvantages of Wind Energy Conversion System.
2.	CO2	Draw the vector diagram of velocities and forces experienced on wind rotors.
3.	CO3	Draw and explain power versus speed characteristics.
4.	CO4	Draw the equivalent circuit of induction generator suitable for standalone WECS.
5.	CO5	Discuss the environmental impacts of wind farms.

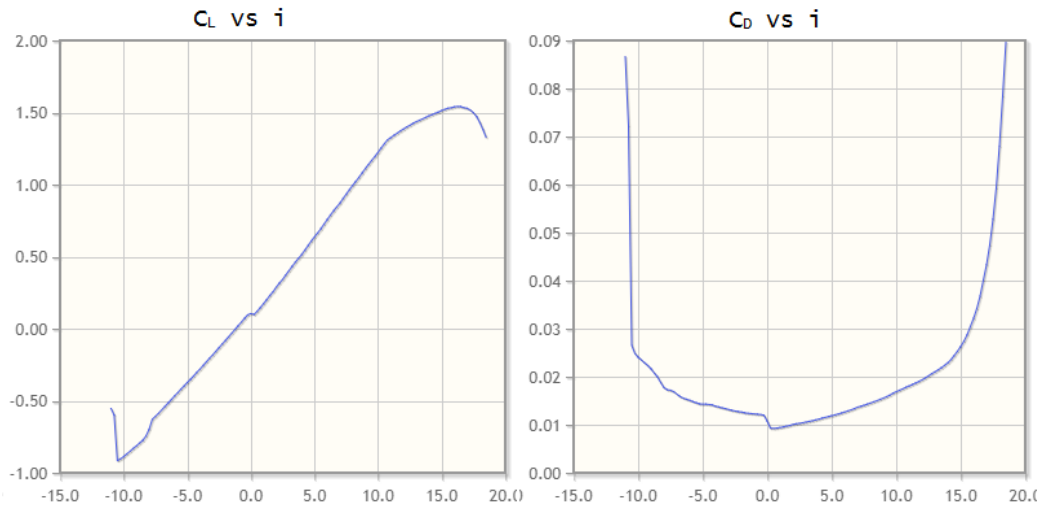
Section B

All questions are mandatory: (Each question: 10 marks)

Q.no.	COs	Question
6.	CO1	Explain the following configurations of vertical axis wind turbine with neat diagram a. Darrieus rotor b. Savonius rotor
7.	CO2	Derive the expression of power extracted from wind energy and prove that the value of $C_p = 16/27$.
8.	CO3	a. Explain in detail about various methods used for measuring wind speed. b. Explain briefly about the wind turbines used for pumping application.
9.	CO4	Derive the expression for shaft power output of an induction machine. If this induction machine is connected to a three-bladed wind turbine to satisfy the demand of an isolated system, comment on real and reactive power flow in the induction generator. Assume slip s = -0.036.

Section C

All questions are mandatory: (Each question: 20 marks)

Q.no.	COs	Question
10.	CO2	Calculate the total thrust and aerodynamic power developed in a three-blade wind turbine at a wind velocity of 9m/s. The machine specifications are as follows: Diameter = 9m Rotational speed = 100 rpm TSR = 5 Chord length = 0.45m, uniform throughout the blade Pitch angle = 5°, no twist Distance from axis to inner edge of the blade = 0.5m Aerofoil section = NACA 43012A (shown in figure) Note: 1. Divide the blade into three number of sections. 2. Assume relevant values of C_L and C_D if attack angle exceeds the given range  Figure NACA 43012A
11.	CO1	a. Explain the main factors, which govern the selection of site for a proposed wind farm. b. Explain with a neat sketch the construction and working of synchronous machine. **OR**
	CO4	Consider a wound rotor induction machine with the following parameters: $R_1 = 0.005\Omega\ R_2' = 0.004\Omega\ X_1 = 0.01\Omega\ X_2' = 0.008\Omega\ X_m = 0.46\Omega$

		The line to line voltage is 480 V. The machine is rated as generator with a nominal power of 2.0 MW at a slip of -0.036. Find the following a. The rated stator current. b. The rated rotor current. c. The actual power supplied. d. The input shaft power. When the rotor circuit is short-circuited

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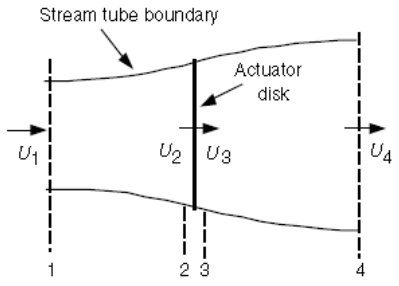
Section A

All questions are mandatory: (Each question: 4 marks)

Q.no.	COs	Question
1.	CO1	Explain the working principle of Darrieus rotor with neat diagram.
2.	CO2	Compare the Dutch wind turbine and Modern wind turbine.
3.	CO3	Explain the physical significance of tip speed ratio.
4.	CO4	Explain the principle of rotating magnetic field with a neat diagram.
5.	CO5	Discuss the scenario of wind energy in India.

Section B

All questions are mandatory: (Each question: 10 marks)

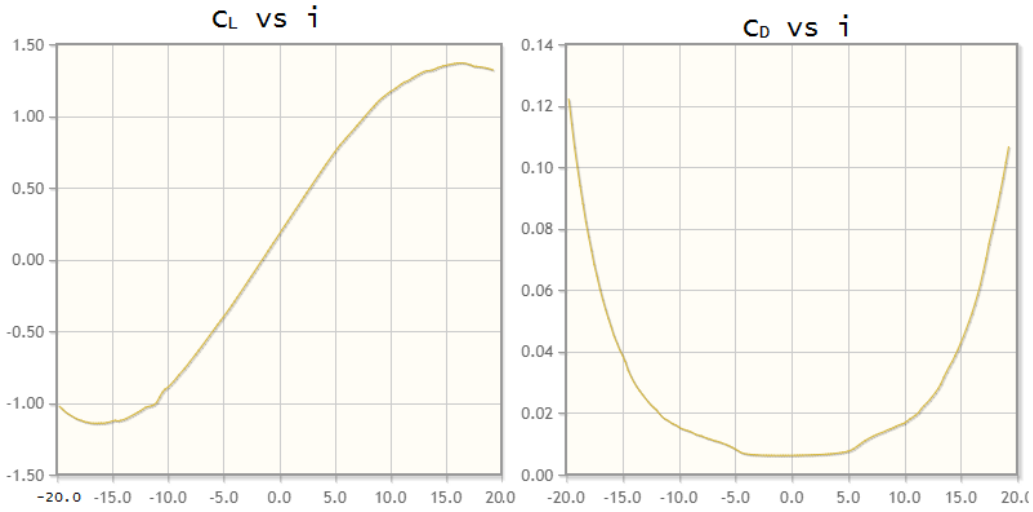
Q.no.	COs	Question
6.	CO1	Classify different types of wind turbines and explain all in detail with a neat diagram.
7.	CO2	From the figure shown below, the fraction of power extracted from the wind is given by the power coefficient$C_p = 4a(1 - a^2)$. Find the value of axial interference factor when maximum value of C_p is 16/27. 

8.	CO3	a. Explain different types of control mechanism applied in wind energy conversion system. b. The following data relate to a propeller turbine: Wind speed = 20 m/s. Air density = 1.205 kg/m^3 Turbine diameter = 12 m and operating speed of the turbine = 45 rpm at maximum efficiency. Calculate: i. Total power density in the wind stream. ii. Maximum obtained power density. iii. Power density at 35% efficiency. iv. Total power generated.
9.	CO4	Explain why induction generator is preferred compared to synchronous generator for wind turbine applications.

Section C

All questions are mandatory: (Each question: 20 marks)

Q.no.	**COs**	**Question**
10.	CO2	Calculate the total thrust and aerodynamic power developed in a three-blade wind turbine at a wind velocity of 9m/s. The machine specifications are as follows Diameter = 9m Rotational speed = 100 rpm TSR = 5 Chord length = 0.45m, uniform throughout the blade Pitch angle = 5°, no twist Distance from axis to inner edge of the blade = 0.5m Aerofoil section = NACA 63-215 (shown in figure) Note: 1. Divide the blade into three number of sections. 2. Assume relevant values of C_L and C_D if attack angle exceeds the given range

		 Figure NACA 63-215
11.	CO3	a. Explain principle of operation of standalone and grid connected wind energy conversion system with a neat diagram. b. Explain the importance of wind resource assessment for wind farm design. **OR**
	CO4	Consider a wound rotor induction machine with the following parameters: $R_1 = 0.004\Omega\ R_2' = 0.003\Omega\ X_1 = 0.01\Omega\ X_2' = 0.006\Omega\ X_m = 0.68\Omega$ The line to line voltage is 400 V. The machine is rated as generator with a nominal power of 2.0 MW at a slip of -0.035. Find the following c. The rated stator current. d. The rated rotor current. e. The actual power supplied. f. The input shaft power. When the rotor circuit is short-circuited with a resistance R=0.1 ohms.