Name:

Enrolment No:

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

End Semester Examination, May 2019

Programme Name: M. Tech REE | **Semester : II**

Course Name : Wind Energy Technology | **Time : 03 hrs**

Course Code : EPEC 8008 | **Max. Marks : 100**

Nos. of page(s) : 3

Instructions: All questions are mandatory. Assume parameters wherever required and mention the same.

SECTION A

S. No.		Marks	CO
Q 1	State the major heat producers in the nacelle of large wind power plant	4	CO1
Q 2	Calculate the required diameter of a wind turbine to generate 10 kW at a wind speed of 7 m/s and a rotor speed of 100 rpm. Assume power coefficient as 0.4, mechanical system efficiency as 0.9 and electrical system efficiency as 0.95.	4	CO2
Q 3	Explain the stalling action of wind turbine blades using power verses wind speed characteristics.	4	CO3
Q 4	Draw the equivalent circuit of Induction machine coupled to a wind turbine.	4	CO4
Q 5	Explain in detail about the environmental impacts created by wind farms in the coastal region of India.	4	CO5

SECTION B

Q 6	An HAWT rotates at 100 rpm and the wind speed through the blade is 6.5 m/s. For a pitch angle of 4 degree at the inner edge (varying at 0.5 degree till out-edge), plot a graph showing the variation of the angle of incidence i with the radial distance along a blade.						10	CO2
Q 7	The wind data for a site in terms of percentage of time over a year for different speed groups is given below:						10	CO3
	Speed group (m/s)	$0<v\leq 3$	$3<v\leq 6$	$6<v\leq 9$	$9<v\leq 12$	$12<v\leq 16$	$16<v\leq 20$	
	Percentage of time	12.36	28.3	29.37	18.96	9.31	1.7	
	Calculate the annual average power if the wind passing normally through the swept area of a turbine of diameter 30m. Assume the air density as 1.225 kg/m^3.							
Q 8	A four-pole induction generator is rated at 300kVA and 480V. It has the following parameters R_S=0.015Ω R'_R=0.0132Ω X_S=X'_R=0.12Ω X_M=8Ω. How much power does it produce at a slip of -0.02? Also, find the torque, power factor and efficiency. (Ignore mechanical losses)						5+5	CO4
Q 9	The basic information about a wind farm is given below:						10	CO5

Wind farm capacity (MW)	50
Capital Investment (€)	70000000
Period of operation (years)	25
Decommissioning cost (€)	3000000
O & M costs (€/kWh)	0.0091
Capacity factor	0.25
Electricity selling price, tariff (€/kWh)	0.08
Annual discount rate (%)	8
Inflation rate (%)	3

Use the above information given and find the following

i. AEP
ii. O & M cost in euro for each year (€/year)
iii. Annual revenue from selling the electricity (€/year)
iv. Annual net income (€/year)
v. NPV of the wind farm

SECTION-C

Q 10	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 four number of sections. 2. Assume relevant values of C_L and C_D if attack angle exceeds the given range	**20**	**CO2**

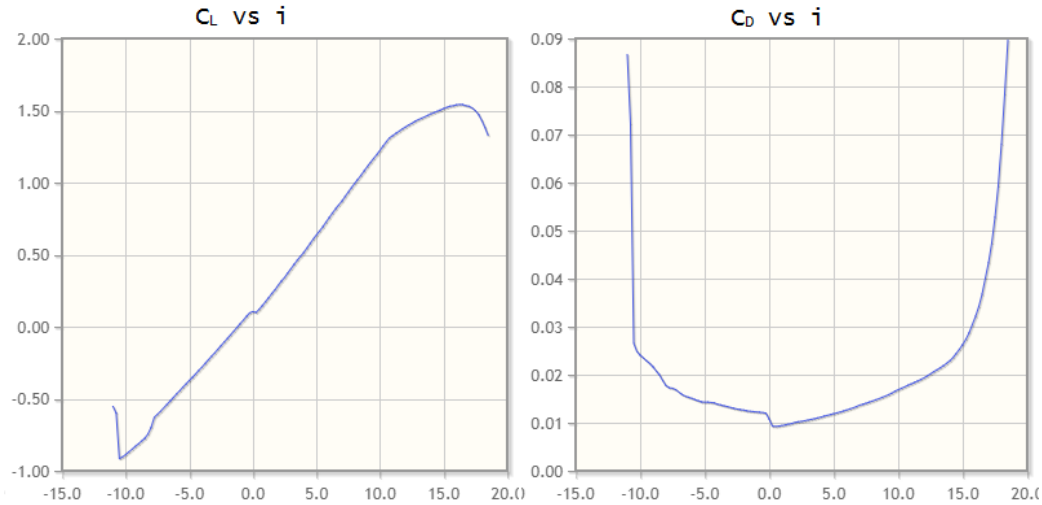

Figure NACA 43012A

Q 11

Design solar-wind hybrid standalone system with storage device to satisfy the load (shown below)

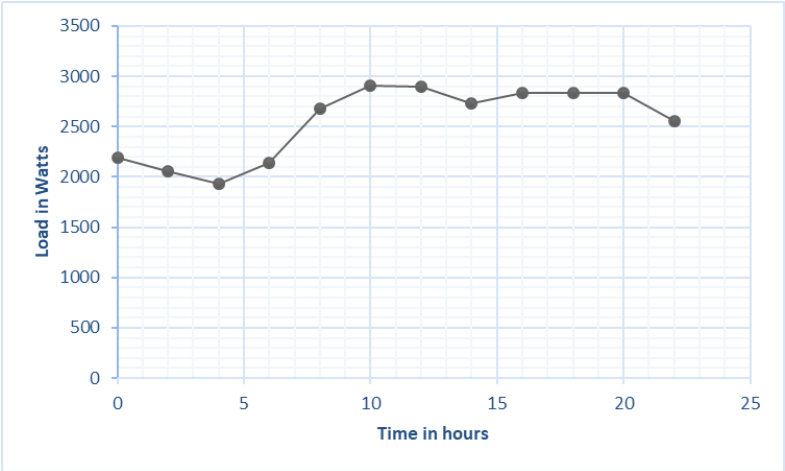

Figure Daily Load curve

Consider the wind and solar data given below:

Solar data (W/m^2)	0	0	0	199	712	1114	1295	1207	874	385	0	0
Wind speed (m/s)	5.01	5.03	4.94	4.98	5.44	5.37	5.12	4.98	5.01	5.09	5.18	5.20
Time (measured instant)	0	2	4	6	8	10	12	14	16	18	20	22

Assume the parameters wherever required.

20 **CO4**

Name: Enrolment No:	UPES

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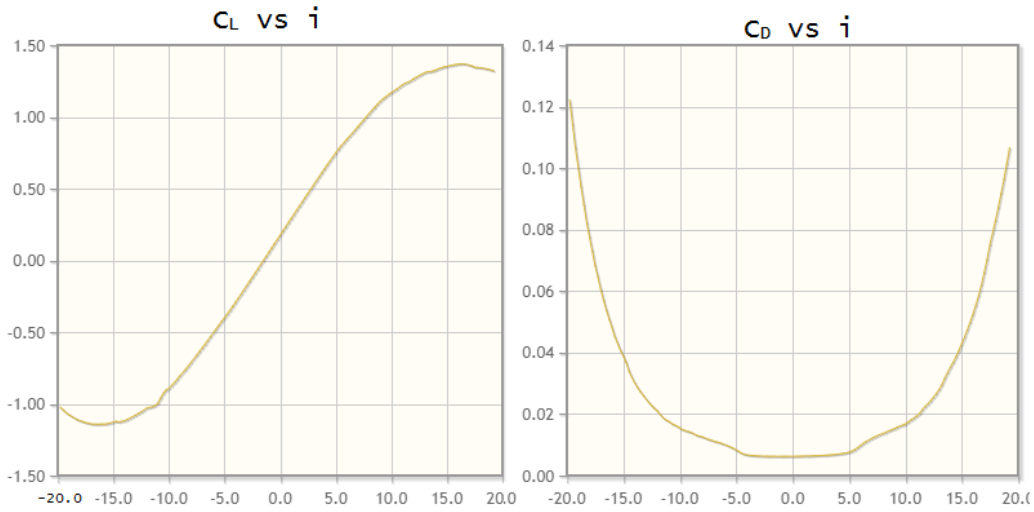
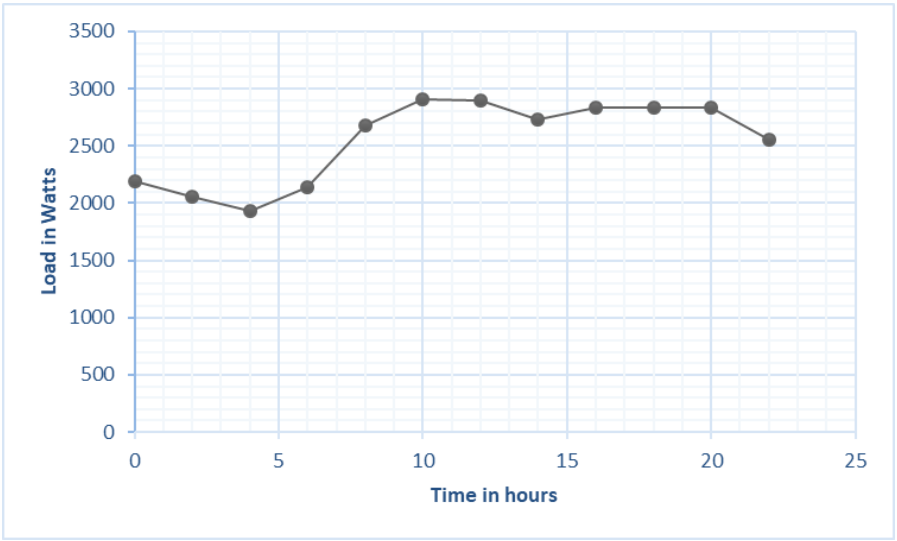
SECTION A

S. No.		Marks	CO
Q 1	Describe the role of SCADA system in a WPP	4	CO1
Q 2	An HAWT has a diameter of 10m. When the undisturbed wind speed of 10 m/s makes the turbine to rotate at 320 rpm and produces 10 kW of mechanical power; calculate the following: a. TSR b. C_p	4	CO2
Q 3	Distinguish between the three major methods of aerodynamic control.	4	CO3
Q 4	Discuss various applications of Wind Energy Conversion System.	4	CO4
Q 5	Explain the term Levelized cost of electricity (LCOE).	4	CO5
	SECTION B		
Q 6	Compare the WT performance between Momentum theory and Blade Element theory.	10	CO2
Q 7	The annual average wind velocity at a height of 10m over a flat terrain is 6 m/s. The boundary layer exponent is 0.13. Find the annual average power density (W/m^2) in the wind at a height of 50m. Assume the Rayleigh distribution as an approximation to the wind velocity-duration distribution over the terrain and 1.225 kg/m^3 as the density of air.	10	CO3
Q 8	a. Discuss the necessary conditions/constraints to be considered while designing a wind-diesel hybrid system for any given site. b. Explain the off-shore wind energy scenario of India.	5+5	CO4
Q 9	a. Explain the impact of wind resource assessment on the economics of wind farms b. Explain in detail about the various components of cost involved in Wind farm project timeline.	10	CO5
	SECTION-C		
Q 10	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	20	CO2

	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 four number of sections. 2. Assume relevant values of C_L and C_D if attack angle exceeds the given range  Figure NACA 63-215		
Q 11	Design solar-wind hybrid grid-tied system to satisfy the load (shown below)  Figure Daily Load curve	**20**	**CO4**

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