Name: Enrolment No:	UPES

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

End Semester Examination, December 2018

Programme Name: B. Tech ET+IPR | **Semester : VII**
Course Name : Wind Energy Technology | **Time : 03 hrs**
Course Code : ETEG 401 | **Max. Marks : 100**
Nos. of page(s) : 2
Instructions: All questions are mandatory.

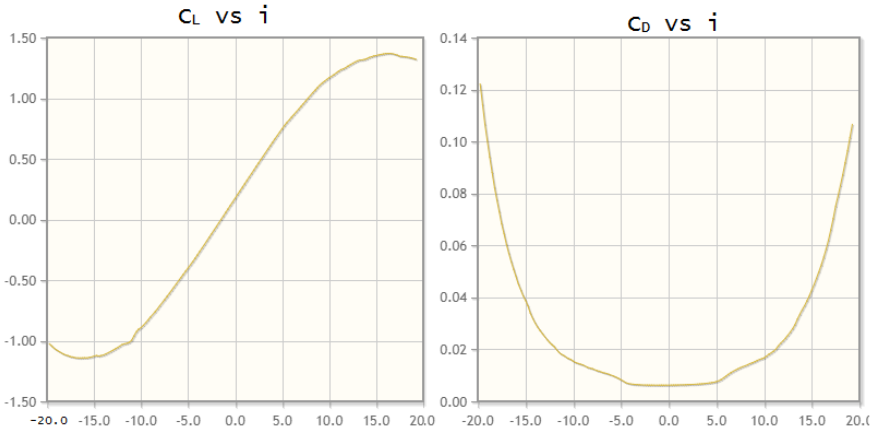
SECTION A

S. No.		Marks	CO
Q 1	Discuss different types of Wind Energy Conversion System with neat diagram	4	CO1
Q 2	Distinguish between the three major methods of aerodynamic control.	4	CO2
Q 3	A horizontal axis wind turbine has a diameter of 50m. When the wind speed unaffected by the turbine is 10 m/s, the turbine rotates at 60 rpm and produces 100kW of mechanical power. Find the tip speed ratio and the power coefficient.	4	CO3
Q 4	Explain which among the following electrical machines are suitable for WECS: a. PMDC b. Synchronous Machine c. Induction Machine d. DFIG	4	CO4
Q 5	Discuss the environmental impacts of on shore wind farms.	4	CO5

SECTION B

Q 6	Derive an expression for maximum power extracted from a wind turbine with the following assumptions: a. $\eta_{Generator} = 90\%$ b. $\eta_{Wind\ Turbine} = (1/2) ¿ \eta_{Generator}$	10	CO2
Q 7	a. Explain in detail about various methods used for measuring wind speed. b. Explain briefly about the wind turbines used for pumping application.	10	CO3
Q 8	a. Explain the difference between standalone and grid connected wind energy conversion system. b. Explain in detail about the following: i. Fixed speed wind turbine ii. Variable speed wind turbine	10	CO4
Q 9	a. Explain in detail about the various components, which affect the cost of electricity from wind farm. b. Explain the Wind energy scenario of India.	10	CO5

SECTION-C

Q 10	A windmill with a swept area of 1000m^3 operates with 56% efficiency under STP conditions. At the location of the windmill, there is no wind between 19:00 and 05:00. At 05:00, the wind starts up and its velocity increases linearly with time from zero to a value that causes the 24-h average velocity to be 20 m/s. At 19:00, the wind stops abruptly. Calculate the maximum energy the windmill can generate in one year.	**20**	**CO2**
Q 11	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	**20**	**CO3**

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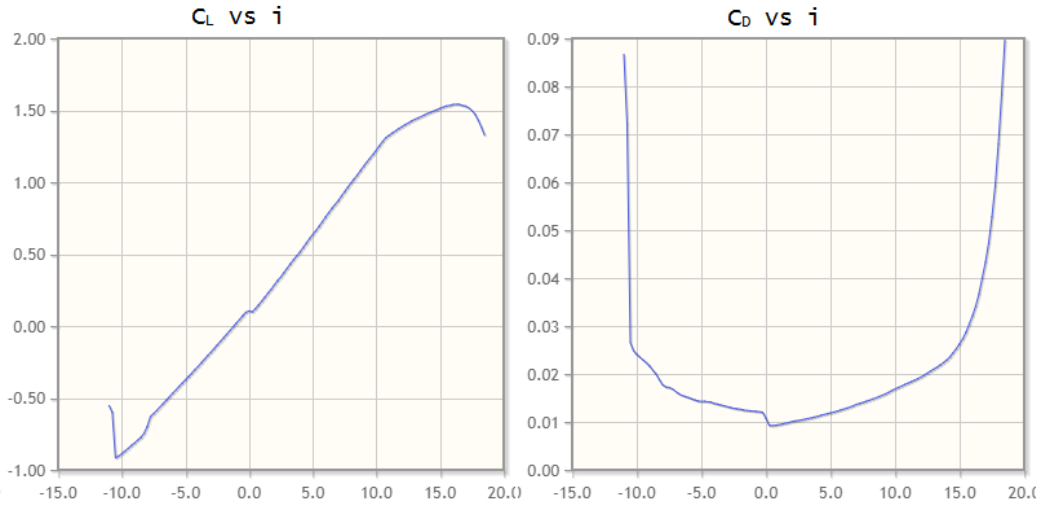
SECTION A

S. No.		Marks	CO
Q 1	Explain why the blade tip of a modern wind turbine can move at a speed about ten times faster than the wind speed.	4	CO1
Q 2	Explain the lift principle of a three bladed VAWT with neat sketches.	4	CO2
Q 3	A wind turbine has 3 blades with rotor diameter of 20 m, chord c = 0.75 m and rated speed of 60 rpm for rated power. At a wind speed of 15 m/s and ρ = 1.2 kg/m^3, calculate the power generated by the turbine when wind blows on the chord at an angle of 30°.	4	CO3
Q 4	Derive the equivalent circuit of an Induction generator connected to a wind turbine with rotor diameter 52m.	4	CO4
Q 5	Discuss the environmental impacts of off shore wind farms.	4	CO5

SECTION B

Q 6	Derive an expression for maximum power extracted from a wind turbine (works on thrust only) with the following assumptions: a. $\eta_{Generator} = 100\,\%$ b. $\eta_{Wind\ Turbine} = \eta_{Generator}$	10	CO2
Q 7	a. Explain the significance of power curve of a wind power plant. b. Explain the stalling action in wind turbines.	5+5	CO3
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. Calculate the following: a. Power produced at a slip of -0.02. b. the torque c. power factor d. Efficiency. (Ignore mechanical losses)	10	CO4
Q 9	a. Explain in detail about the various components of cost involved in Wind farm project timeline. b. Explain the impact of wind resource assessment on the economics of wind farms.	5+5	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 Rotational speed = 100 rpm TSR = 5 Chord length = 0.45m, uniform throughout the blade Pitch angle = 12°, 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	**20**	**CO2**

Q 11	The basic information about the Danish wind farm: Use the above information given and find the following a. AEP b. O & M cost in euro for each year (€/year) c. Annual revenue from selling the electricity (€/year) d. Annual net income (€/year) e. NPV of the wind farm f. LCoE for the wind farm (€/kWh)	**20**	**CO4**

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