

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY, WAKNAGHAT

TEST - 2 EXAMINATION - 2023

B.Tech. - VII Semester (CSE/IT/ECE/BT/BI)

COURSE CODE (CREDITS): 22BIWCE733

MAX. MARKS: 25

COURSE NAME: Perennial Power Structures

COURSE INSTRUCTORS: Saurabh Rawat

MAX. TIME: 1 Hour 30 Minutes

*Note: (a) All questions are compulsory.*

*(b) Marks are indicated against each question in square brackets.*

*(c) The candidate is allowed to make Suitable numeric assumptions wherever required for solving problems*

**Q1.** A horizontal shaft, propeller type wind-turbine is in area having following wind characteristics:

Speed of wind 10 m/s at 1 atm and 15°C. Given  $R =$  gas constant 287 J/kg.K 1 atm and Pressure 1 atm =  $1.01325 \times 10^5$  Pa. Calculate the following:

- Air density  $\rho$
- Total power density in wind stream,  $W/m^2$
- Maximum possible obtainable power density,  $W/m^2$
- Actual obtainable power density corresponding to an efficiency of 42%,  $W/m^2$
- Total power from a wind-turbine of 120 m dia. corresponding to the actual obtainable power density calculated in (4).
- Torque and axial thrust on the wind-turbine operating at 40 rpm and at maximum efficiency of 42%.  
(CO2, CO3) [1+1+2+2+1+3 = 10]

**Q2.** Derive and prove that the maximum efficiency of an ideal wind turbine is '16/27 times the wind power'.  
(CO3) [5]

**Q3.** Calculate the total thrust and aerodynamic power developed in a 3 – blade wind turbine at a wind velocity of 9 m/s. The machine specifications are as follows: Diameter of rotor = 9 m; Rotational speed = 100 rpm; Blade length = 4 m; TSR = 5.23; Chord Length = 0.45 m; Pitch angle = 5°; Distance from shaft to inner edge = 0.5 m; Airfoil section = NACA 23018  
(CO3) [6]

Attack angle (°)	CL	CD
$i_1$	0.95	0.0105
$i_2$	1.20	0.0143
$i_3$	0.75	0.0092
$i_4$	0.46	0.0078

**Q4.** Supporting with technical aspects, elaborate on the type of wind turbine you would install for harnessing wind energy in Rajasthan and in coastal area of Tamil Nadu.  
(CO2, CO3) [4]