Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

ME – SEMESTER II (NEW) – • EXAMINATION – SUMMER 2016

Subject Code: 2723911 **Date: 24/05/2016**

Subject Name: Wind and Small Hydro Energy System

Time:10:30 am to 01:00 pm **Total Marks: 70**

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

Q.1 **(a)** The Waibull parameter at a wind farm are c = 7 m/s and k=2.0. Plot Waibull distribution graph and derive wind speed at maximum probability function. **04**

(b) Design HAWT blade without wake rotation using BEM theory and estimate power produced by wind turbine. DUV400 airfoil is used for the blade, whose lift and drag characteristics has shown in Table-1. Take design wind speed as 10 m/s. **10**

Where, Design tip speed ratio = 3,
Rotor diameter = 20 m
number of blades = 3
total no of blade elements = 10

Alpha (deg)	CL	CD
0.1	0.0500	0.0122
2	0.3000	0.0116
4.1	0.5400	0.0144
6.2	0.7900	0.0146
8.1	0.9000	0.0162
10.2	0.9300	0.0274
11.3	0.9200	0.0303
12.1	0.9500	0.0369
13.2	0.9900	0.0509
14.2	1.0100	0.0648
15.3	1.0200	0.0776
16.3	1.0000	0.0917
17.1	0.9400	0.0994
18.1	0.8500	0.2306
19.1	0.7000	0.3142
20.1	0.6600	0.3186
30	0.7010	0.4758
40	0.7219	0.6686
50	0.6864	0.8708
60	0.5860	1.0560
70	0.4264	1.1996
80	0.2235	1.2818
90	0.0000	1.2900

Table 1

Q.2 **(a)** Explain one dimension momentum theory and derive Betz limit. **07**

	(b)	Write short note on Atmospheric Boundary Layer and turbulence.	**07**
		OR	
	(b)	Explain wind generation and Ecological indicators**.**	**07**
Q.3	**(a)**	Explain airfoil terminology for symmetrical and unsymmetrical airfoil with aid of neat sketch.	**07**
	(b)	Why pitch angle and cord length is kept different throughout the length of HAWT rotor blade? Explain with graphical aid.	**07**
		OR	
Q.3	**(a)**	List and explain types of loads for HAWT in brief.	**07**
	(b)	List and explain source of loads for HAWT in brief.	**07**
Q.4	**(a)**	Discuss Environmental concerns of wind turbine.	**07**
	(b)	Classify types of wind turbine. Differentiate between upwind and downwind HAWT.	**07**
		OR	
Q.4	**(a)**	Explain methods to evaluate rotor performance.	**07**
	(b)	Write difference between drag type and lift type Vertical Axis Wind Turbines with aid of neat sketch.	**07**
Q.5	**(a)**	State importance of Hydro graph and FDC.	**07**
	(b)	Explain site selection of small hydro turbines.	**07**
		OR	
Q.5	**(a)**	Classify hydro turbine. Write turbine selection criteria for hydro power plant.	**07**
	(b)	Discuss speed and voltage regulation of small hydro turbines.	**07**

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