Form A: Paper-setting Blank Ref. No. **EX/PG/PE/T/129B/2017**

ME Power Engineering 1st yr. 2nd Semester Examination, 2017

Subject: Hydro Turbines

Time: Three hours Full marks: 100

Answer any Five Questions

No. of questions			Marks
1.	a)	A Pelton turbine based hydro power plant produces 13,000kW power under a head of 250m when running at 430rpm. Calculate the number of nozzles required, the size of the jets, diameter of the wheel, number of buckets and specific speed if the overall efficiency is 84%. Consider speed ratio, jet ratio and velocity ratio as 0.46, 6 and 0.98 respectively.	15+5
	b)	State the significance of $(NPSH)_{available}$ and $(NPSH)_{required}$.	
2.	a)	Design a Francis turbine runner using the following data: Head: 80m, Rotation speed: 750rpm, Power delivered: 375kW, Overall efficiency: 84%, Hydraulic efficiency: 93%, Ratio of inlet width to inlet diameter: 0.10, Flow coefficient: 0.15,. Also assume that 5% of the total flow area has been occupied by the blade thickness, radial flow at the exit and exit diameter is half of the inlet diameter of the runner.	16+4
	b)	What are the functions of a draft tube?	
3.	a)	Why the outlet of the draft tube of a reaction turbine is always immersed in tail water?	6+14
	b)	A vertical divergent draft tube 5.6m long is provided to a Francis turbine. The diameters of the draft tube at inlet and exit are 50cm and 70cm respectively. The velocity of water at the exit of the draft tube is 1.25m/s. If the loss of energy in the draft tube is 0.25 times the kinetic head at exit, calculate the efficiency of the draft tube.	
4.	a)	What do you mean by the intakes of a hydro power plant?	3+4+6+7
	b)	What are main components of an intake?	
	c)	How the losses in the intakes are minimized?	
	d)	What are losses to be considered while designing the intakes?	
5.	a)	What do you mean by the dead storage and live storage of a reservoir?	4+16
	b)	Given below are the monthly rainfall P and the corresponding runoff R values covering a period of 18 months for a catchment. Develop a	

correlation equation between R and P

Month	P	R	Month	P	R
1	5	0.5	10	30	8.0
2	35	10.0	11	10	2.3
3	40	13.8	12	8	1.6
4	30	8.2	13	2	0.0
5	15	3.1	14	22	6.5
6	10	3.2	15	30	9.4
7	5	0.1	16	25	7.6
8	31	12.0	17	8	1.5
9	36	16.0	18	6	0.5

6. a) With a neat diagram show the basic features of a small hydro power plant. 5+3+3+3+6
   b) Why anchor blocks are used for long penstocks?
   c) Based on what criteria penstocks are selected?
   d) What are the main components of a tubular turbine?
   e) Why surge tanks are essential for long penstocks?
   What is hydrograph? Show its different limbs with a neat sketch

7. a) Discuss the Thesissen polygon method to find the average rainfall for a given catchment area. 6+4+4+2+4
   b) What are the different loads considered while designing a dam?
   c) What do you mean by water budget equation?
   d) State the function of spillway.
   e) What do you understand by a mass curve of runoff? How can you determine the storage capacity of a reservoir with its help if a constant or a variable demand is know?

8. The data collected during performance testing of a Full Kaplan turbine based SHP (2x1.25MW) at different loads are tabulated below 20

Item/Load	100%	80%	60%	110%
Discharge (cumec)	22.31	16.816	12.37	23.141
Pressure at inlet (kg/cm^2)	0.43	0.49	0.527	0.42
Duration of test (minute)	30	15	15	10
Energy reading (Wh)	52.656	21.262	16.011	18.171
CTR	400A/1A			
VTR	3.3kV/110V			
TWL (right bank), m	2.858	3.065	3.177	3.050
TWL (left bank), m	2.362	2.577	2.699	2.563
Center line of Penstock (Bench mark): 426.50m above MSL				
Level of pressure transmitter diaphragm: 428.55m above MSL				
Elevation of ULS (left bank): 428.889m above MSL				
Elevation of ULS (Right bank): 429.411m above MSL				
Density of water: 997.0kg/m^3				

		Accleration due to gravity: 9.781m/s^2	
		Diamter of penstock where pressure transmitter is fitted: 3000mm	
9.	a)	Draw the efficiency curves verses percentage of load.	
	b)	What do you understand by dam toe type of hydro plants? What are the components and arrangements of such plants? Draw a neat sketch of such a plant.	3+3+3+12

For a run-of-river plant the discharge data available throughout the year related to the release from all outlets of a dam is given below. The performance testing of the SHP getting water from the dam at 100%, 80% and 60% of rated load gives efficiency of 79.3%, 76.6% and 71.7%. The SHP has two Francis Type machines each consumes 8.5cumnec water 100% load. Calculate the weighted efficiency of the plant.

Month	Discharge (cumec)
January	6.22
February	30.866
March	31.004
April	37.776
May	10.995
June	5.594
July	51.796
August	68.679
September	162.766
October	74.044
November	6.906
December	0