# B.E. MECHANICAL ENGINEERING (PART TIME) FIRST YEAR SECOND SEMESTER – 2019

## FLUID MACHINERY I

Time: 3 hrs Full Marks: 100

*Answer **five** questions*

*Assume any missing data with suitable justification.*

*All the parts of a question should be answered together.*

1. a)With a neat sketch describe the major components of a Pelton turbine installation. *10*

   b) Write the Reynolds Transport equation. (*No deductions required*). Explain the significance of each term and obtain the Euler's turbine equation from it stating the relevant assumptions made. *10*

2. a) Define degree of reaction for a turbine and obtain an expression of it in terms of blade angles for a slow Francis turbine. *10*

   b) A Kaplan turbine develops 8850 kW power at a head of 5.5 m. The diameter of the boss is 0.35 times the diameter of the runner. Assume a speed ratio 2.1 and overall efficiency 85%. If the flow velocity is 6.96 m/s calculate the runner diameter and the rotational speed. *10*

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3.a) Show that using a draft tube causes the pressure at the exit of a reaction turbine to fall below atmospheric pressure. *5*

b) Why are spiral casings of varying area used in reaction turbines? *5*

c) A Pelton wheel is required to develop 6 MW when working under a head of 300 m. It rotates with a speed of 550 rpm. Assuming jet ratio as 10 and overall efficiencyas 85% calculate the diameter of the wheel and volume of water flow. Assume nozzle velocity coefficient = 0.98 and speed ratio 0.46. *10*

4. a) Explain the nature of head vs discharge and power vs discharge curves of centrifugal pumps for different types of vanes. *7*

b) What are *Thoma's cavitation factor* and *critical cavitation factor*? How are they used in predicting or preventing cavitation in centrifugal pumps ? *5*

c) When a laboratory test was carried out on a pump, it was found that, for a total head of 36 m cavitation began when the sum of the static pressure and velocity head at inlet was reduced to 3.5 m. The atmospheric pressure was 750 mm of Hg and the vapour pressure of water was 1.8 kPa. If the pump was to operate at a location where atmospheric pressure was reduced to 620 mm of Hg and the temperature is so reduced that the vapour pressure is 830 Pa. Assuming the cavitation parameter and pipe friction losses remain unchanged , determine by how much the height of the pump is to be reduced. *8*

5 a) "The efficiency of a reaction turbine is generally more than that of a centrifugal pump." Justify the statement. *5*

b) Why are Pelton turbines unsuitable for low heads? *5*

c) Show that pressure rise in the impeller of a centrifugal pump is given by $(V_{f1}^2 + u_2^2 - V_{f2}^2 \operatorname{cosec}^2 \beta_2) / 2g$, where the symbols have their usual meanings. Neglect all losses and consider backward curved vanes. *10*

6 a) Using Buckingham's Pi-theorem determine the major non-dimensional parameters which are used in turbomachine analysis. Hence obtain the expressions for specific speeds of a turbine and pump. *12*

b) A hydraulic turbine is to develop 845 kW when running at 100 rpm under a net head of 10 m. In order to predict its performance a 1:10 scale model is tested under a head of 6 m. What would be the speed, power output and discharge of the model if it runs under the conditions similar to the prototype. *8*