B.E. MECHANICAL ENGINEERING (PART TIME) FIRST YEAR SECOND SEMESTER – 2018

FLUID MACHINERY I

Time: 3 hrs Full Marks: 100

*Answer **five** questions*

All the parts of a question should be answered together.

1. a)With a neat sketch describe the major components of a Kaplan turbine installation. *8*

   b) Deduce the Reynolds Transport Equation. Obtain the expression for torque developed by a turbo machine from it. *12*

2. a) How does the role of turbine casing differ for a Pelton and a Francis turbine? *5*

   b) Why is a Pelton turbine unsuitable for low heads? *5*

   c) A Kaplan turbine develops 15000 kW power at a head of 30 m. The diameter of the boss is 0.35 times the diameter of the runner. Assume a speed ratio 2.0 and overall efficiency 90%. If the flow velocity is 15.77 m/s calculate the runner diameter, rotational speed and specific speed. *10*

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) Discuss why the degree of reaction of a Pelton turbine is zero *5*

c) A Pelton wheel 2.5 m diameter operates under the following conditions: Available head= 300m . Speed= 300 rpm. Blade friction coefficient= 0.98 Coefficient of velocity of jet=0.98. Blade angle =165^0. Diameter of jet= 20 cm Mechanical efficiency=0.95. Determine the power developed, hydraulic efficiency and specific speed. *10*

4. a) Draw neat velocity diagrams for slow, medium and fast Francis runners assuming no whirl at outlet. *5*

b) Explain why cavitation takes place in a centrifugal pump and discuss how it may be prevented. *7*

c) An inward flow reaction turbine has an inlet guide vane angle of 30^0 and inlet blade angle of 60^0. The breadth of the runner at inlet is a quarter of the diameter. The overall head is 15 m and the speed is 1000 rpm. The hydraulic and overall efficiencies are respectively 0.88 and 0.85. Determine the runner diameter at inlet and the power developed. *8*

5 a) Explain the terms manometric efficiency, mechanical and overall efficiency of a hydraulic turbine and establish a relation between them. *7*

b) A centrifugal pump is to discharge 100 liters/s at a speed of 1450 rpm against a

head of 15 m. The impeller has an outer diameter of 25 cm with a width at the outlet of 6 cm. The manometric efficiency is 0.8. Determine the blade angle at outlet. *8*

c) A centrifugal pump with critical cavitation factor 0.12 is to be installed at a location where barometric and vapour pressures are respectively 95 kPa and 3 kPa absolute. If the pump is to deliver 0.15 m^3/s of water against a head of 25 m calculate the maximum allowable elevation above sump water surface assuming frictional head loss in suction pipe to be 0.25 m of water. *5*

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. *10+4*

b) A turbine develops 8000 kW when running at 100 rpm. The head on the turbine is 30 m. If the head is reduced to 18 m , determine the speed and power developed by the turbine. *6*