BACHELOR OF MECHANICAL ENGINEERING (PART TIME) 1st Year 2nd Semester Examination 2017

Fluid Machinery I

Time: 3 hrs Full Marks: 100

Answer Q 1 and any four from rest

Answers of all the parts of a question should be given together.

Assume any data not given with suitable justification.

1. a) Discuss the conditions for which the Euler's Turbine Head equation is applicable. *5*

   b) Why is a Pelton turbine not suitable for low heads? *4*

   c) What do you mean by specific speed of a turbine? What is its significance in the analysis of fluid machinery? *5*

   d) How are slow, medium and fast runners of a Francis turbine specified? *6*

2. a) With a neat sketch show the major components of a Kaplan turbine installation and briefly explain the function of each part. *10*

   b) Two inward flow reaction turbine runners have the same diameter 0.75 m and work under the same head with a velocity of flow 6 m/s. One runner operates at 450 rpm and has an inlet blade angle of 60^0. Determine the speed at which the other turbine should run if its inlet blade angle is 105^0. Assume that both the turbines have same efficiency and radial discharge at outlet. *10*

3. a) Derive the condition for which a Pelton turbine operates with maximum

efficiency. *10*

b) A reaction turbine works at 450 RPM under a head of 120 meters. Its diameter at inlet is 120 cm and the flow area is 0.4 m^2. The angles made by absolute and relative velocities at inlet are 20^0 and 60^0 respectively with the tangential velocity. Determine i) the volume flow rate ii) the hydraulic efficiency and iii) hydraulic power developed. *10*

4. a) A Kaplan turbine develops 2250 kW under a net head of 5.5 m and with overall efficiency 87%. The draft tube has a diameter of 2.8 m at its inlet and has an efficiency of 78%. In order to avoid cavitation, the pressure head at entry to the draft tube must not drop more than 4.5 m below atmosphere. Calculate the maximum height at which the runner may be set above the tail race level. *8*

b) Using Buckingham's Pi theorem obtain the major non dimensional parameters used in fluid machinery analysis. *8*

c) Explain why efficiency of pumps are usually lower than that of turbines? *4*

5. a) Deduce the Reynolds Transport equation. Explain the significance of each term. *10*

b) A Pelton wheel is required to develop 4000 kW at 400 rpm operating under an available head of 350 m. There are two identical jets and the bucket deflection angle is 165^0. Overall efficiency is 85%,nozzle velocity coefficient 0.97 and the speed ratio is 0.46. Blade friction coefficient is 86%.Calculate i) Wheel diameter ii) cross sectional area of each jet and iii) hydraulic efficiency. *10*

6. a) Explain with detailed analysis the function of a draft tube and sketch some typical draft tubes. *8*

   b) The impeller of a centrifugal pump has diameter of 16 cm, width 1.6 cm and vanes bent at 60^0 to the tangent at outlet. The flow velocity is constant and the pressure increase through the impeller is 70% of the total head generated by the pump. If the pump has to deliver water against a total head of 25 m with manometric efficiency 80%, determine the operating speed in rpm and the discharge. Neglect losses in the impeller. *12*