BACHELOR OF ENGINEERING (MECHANICAL ENGINEERING) 1st Year 2nd Semester Examination 2023

Fluid Machinery I

Time: 3 hours **Full Marks: 100**

*Answer any **five (5)** questions*

Assume any missing data with suitable justification.

1. a) Deduce the Reynolds Transport equation. Explain the significance of each term and obtain the Euler's turbine equation from it stating the relevant assumptions made. *20*

2. a)Using Buckingham's Pi- theorem obtain the major non-dimensional parameters which are used in turbo machine analysis. Hence determine the expressions for dimensional and dimensionless specific speeds. *12*

   b) Test runs on a centrifugal pump indicate that when driven at 2000 rpm, it discharges 10 m^3/min against a head of 100m. At this capacity the input is 300 kW. If a geometrically similar pump twice the size runs at 1500 rpm, find its discharge, head and power for the same efficiency. *8*

3. a) What do you mean by *degree of reaction* of a hydraulic turbine? Obtain an expression of it for a slow Francis runner in terms of fixed and moving blade angles at inlet. *12*

b) A Pelton wheel is required to develop 6MW when working under a head of 300 m. It rotates with a speed of 550 rpm. Assume jet ratio =10 and overall efficiency 85%. Calculate the wheel diameter and discharge through the wheel. Assume nozzle coefficient and speed ratio to be 0.98 and 0.46 respectively. *8*

4. a) Explain with the help of appropriate diagrams the mechanism by which a Francis turbine generates power. Show that use of a draft tube increases the chances of cavitation. *10*

b) 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. *10*

5. a) When does cavitation take place in a centrifugal pump? Explain how cavitation can be prevented by determining the Thoma's cavitation factor. *8*

b) A centrifugal pump having 35 cm outlet diameter and 18 cm inlet diameter is to deliver water against a net head of 25 m at the design speed of 1200rpm. The width of the impeller wheel at outlet is 6 cm and the flow velocity remains constant. The impeller blades are bent back at 30^0 to the tangent at outlet. Assuming a manometric efficiency of 90%, determine the width of the impeller at inlet and the discharge from the pump. *12*

6. a) Obtain an expression for the hydraulic efficiency of a Pelton wheel and hence explain under what conditions this efficiency is a maximum. *10*

b) For a Kaplan turbine with runner diameter 4 m, the discharge is 60 m^3/s and the hydraulic and mechanical efficiencies are 0.9 and 0.94 respectively. The boss diameter is 0.3 times the runner diameter and the speed ratio is 2. Calculate the net available head on the turbine, the power developed and the specific speed. *10*