Ref. No. : Ex/ME/5/T/122/2024

BACHELOR OF ENGINEERING (MECHANICAL ENGINEERING) FIRST YEAR SECOND SEMESTER EXAMINATION 2024

Fluid Machinery I

Time: 3 hours

Full Marks: 100

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

Assume any data not given with suitable justification

1. a) 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. *12*

   b) Obtain an expression for the blade efficiency of a Francis turbine in terms of inlet blade angles. *8*

2. a) Using Buckingham's Pi theorem obtain the major non dimensional parameters used in hydraulic turbo machines. Hence deduce the expressions for specific speeds for centrifugal pumps and hydraulic turbines. *12*

   b) It is required to predict the performance of a large centrifugal pump from that of a model one-fourth the original size. The model absorbs 5kW when working under a head of 6m at a speed of 400 rpm. The prototype pump is required to operate under a head of 18 m. What will be its speed and power needed to run it? Also determine the ratio of discharge between the original

and model pumps. *8*

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

   b) A Pelton wheel of 1.2 m mean diameter works under a head of 650 m. The jet deflection by the bucket is 165^0 and the relative velocity is reduced by 15% due to friction. Determine the rotational speed, power developed and hydraulic efficiency of the wheel. Consider nozzle coefficient = 0.97 and jet diameter 10 cm. The water leaves the bucket without any tangential component of velocity. *10*

4. a) Explain why the use of a draft tube in a reaction turbine may increase the chances of cavitation. *8*

   b) A Francis turbine works under a head of 250 m. The machine discharges 15 m^3/s while rotating at 450 RPM. The inlet diameter of the rotor is 2 m and the blade width at inlet is 28 cm. Hydraulic and overall efficiencies are respectively 0.94 and 0.92. Determine the blade angles at inlet and the specific speed. *12*

5. a) When does cavitation take place in a centrifugal pump? Explain how cavitation can be prevented. *8*

   b) The impeller of a centrifugal pump is of 30 cm diameter and 5 cm width at the

periphery and has blade angle 60^0 at outlet. The pump delivers 17 m^3/min and the impeller rotates at 1000 rpm. Assuming the pump is designed to admit radially, calculate (i) velocity and direction of water as it leaves the impeller (ii) torque exerted by the impeller on water (iii) shaft power *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) A Kaplan turbine works under a net head of 23 m and when running at a speed of 150 rpm develops 23 MW. The blade tip and hub diameters are 4.75 m and 2 m respectively. If the hydraulic efficiency is 93 % and the overall efficiency 85%, calculate the inlet and outlet blade angles at the tip and the hub. *10*