Code : 021510

B.Tech 5th Semester Exam., 2014

FLUID MACHINERY

Time : 3 hours *Full Marks* : 70

Instructions :

(i) The marks are indicated in the right-hand margin.

*(ii) There are **NINE** questions in this paper.*

*(iii) Attempt **FIVE** questions in all.*

*(iv) Question No. **1** is compulsory.*

(v) Assume any suitable data, if required.

1. Write on the following in short, preferably *one* or *two* sentences each (any *seven*) : 14

   Suction head

   Delivery head

   Static head

   Priming

   Multistage pump

   Stay ring

   Mechanical efficiency

   Fluid

   Power required to drive pump

   Monometric efficiency

2. *(a)* Explain the function of Francis turbine. 5

   (b) A Francis turbine works under a head of 260 m and develops 21900 MHP at a speed of 600 r.p.m. The volume flow rate through the machine is 7000 l/s. If the outside wheel diameter is 1·5 m and the axial wheel width at the inlet is 135 mm, find the overall efficiency of the turbine, its hydraulic efficiency, (η_h), and the inlet angles of the guide blades and the rotor blades. Assume a volumetric efficiency of 0·98 and the velocity at the draft tube exit to be 17·7 m/s. The whirl velocity component at the wheel exit is zero. 9

3. *(a)* Differentiate between inward-flow and outward-flow reaction turbines. 5

   (b) The total resistance offered to the motion of a jet-propelled boat is 500 kg. The boat is moving with a velocity of 6 m/s and draws water amid ship. The water is discharged through two jets provided at the back of the ship. The diameter of each jet is 150 mm. Determine the efficiency of jet propulsion. 9

4. *(a)* Obtain an expression for unit speed, unit discharge and unit power for a turbine. 5

(b) An inward-flow reaction turbine having an overall efficiency of 80% is required to deliver 136 kW. The head (H) is 16 m and the peripheral velocity is $3 \cdot 3(H)^{0 \cdot 5}$ The radial velocity of flow at inlet is $1 \cdot 1(H)^{0 \cdot 5}$. The runner rotates at 120 r.p.m. The hydraulic losses in the turbine are 15% of the available energy. Determine *(i)* the diameter of the runner, *(ii)* the guide vane angle, and *(iii)* the runner blade angle at inlet and through the turbine. Assume the discharge from the runner is radial. 9

5. *(a)* Explain the purposes of providing *(i)* scroll casing, *(ii)* stay vanes, and *(iii)* guide vanes for a reaction turbine. 4

(b) Dimensions of a centrifugal pump impeller are given below :

Parameter	*Inlet section*	*Outlet section*
Radius, r (mm)	200	600
Blade width, b (mm)	60	40
Blade angle, β (deg)	50	70

The pump handles water and is driven at 850 r.p.m. Calculate the theoretical head and mechanical power input if the flow rate is $0 \cdot 5$ m^3/second. 10

  (Turn Over)

6. *(a)* What is cavitation? Why and how can it be avoided? Where does it occur? Also explain net positive suction head (NPSH). Explain, in detail, in the context of a pump. 5

(b) A Francis turbine with an overall efficiency of 75% is required to produce 149·26 kW. It is working under a head of 7·62 m. The peripheral velocity is $0 \cdot 26\sqrt{2gh}$ and the radial velocity of flow at inlet is $0 \cdot 96\sqrt{2gh}$. The wheel runs at 150 r.p.m. and the hydraulic losses in the turbine are 22% of the available energy. Assuming radial discharge, determine the guide blade angle, the wheel vane angle at inlet, diameter of the wheel at inlet, and width of the wheel at inlet. 9

7. *(a)* Derive an expression for the starting speed of the centrifugal pump. 6

(b) A centrifugal pump lifts water against a static head of 35 m of which 4 m is suction. The suction and delivery pipes are both 15 cm in diameter. The head loss in the suction pipe is 2 m and in the delivery pipe is 7·0 m. The impeller is 40 cm in diameter and 2·5 cm wide and

  (Continued)

runs at 1150 r.p.m. The blade angle at exit is 30°. If the manometric efficiency is 80° and mechanical efficiency is 70° determine the power required to drive the pump and discharge. 8

8. A centrifugal compressor is desired to have a total pressure ratio of 4. The inlet eye of the compressor impeller is 30 cm in diameter. The axial velocity at inlet is 120 m/s and the mass flow is 10 kg/s. The velocity in the delivery duct is 115 m/s. The tip speed of the impeller is 450 m/s and runs at 15000 r.p.m. with total head isentropic efficiency of 78% and pressure coefficient 0·72. The ambient conditions are 1·013 bar and 15 °C. Calculate—

(a) static pressure ratio;

(b) static pressure and temperature at outlet of the compressor;

(c) work of the compressor per kg of air;

(d) theoretical power required to drive the compressor. 14

9. Write short notes on any *two* of the following : 7×2=14

(a) Draft tube

(b) Turbine

(c) Specific speed

(d) Centrifugal pump

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