

B.Tech 5th Semester Exam., 2017

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. Choose the correct answer of the following
(any seven) : $2 \times 7 = 14$

(a) A free water jet acts upon a water wheel that has semi-circular vanes fitted on its periphery. The theoretical maximum efficiency of this wheel system is

- (i) 50%
- (ii) 67%
- (iii) 75%
- (iv) 100%

(b) The unit speed N_u of a turbine having a rotational speed of N and head H is equal to

(i) $NH^{0.5}$

(ii) $N/H^{0.5}$

(iii) $H^{0.5}/N$

(iv) $(H/N)^{0.5}$

(c) Specific speed of a turbine is defined as the speed of a member of same homologous series of such a size that it

- (i) delivers unit discharge at unit head
- (ii) delivers unit discharge at unit power
- (iii) delivers unit power at unit discharge
- (iv) produces unit power under unit head

(d) What does Euler's equation of turbo machines relate to?

- (i) Discharge and head
- (ii) Discharge and velocities
- (iii) Head and power
- (iv) Head and velocities

- (e) In a Francis turbine, the runner blades are radial at the inlet and the discharge leaves the runner radially at the exit. For this turbine
- relative velocity is radial at the outlet.
 - absolute velocity is radial at the outlet
 - guide-vane angle is 90° at inlet
 - velocity of flow is constant
- (f) Without residual whirl in the flow at the entrance to a draft tube, the best cone angle is
- $< 10^\circ$
 - 12°
 - 18°
 - 24°
- (g) A Kaplan turbine is
- a high-head mixed-flow turbine
 - a low-head axial-flow turbine
 - an outward-flow reaction turbine
 - an inward-flow impulse turbine

- (h) A centrifugal pump is started with its delivery valve kept
- fully open
 - fully shut
 - partially open
 - 50% open
- (i) The indicator diagram of a reciprocating pump is a plot of
- work done *vs* stroke length
 - acceleration head *vs* stroke length
 - pressure head *vs* stroke length
 - crank speed *vs* power developed
- (j) A centrifugal jet pump is classified as
- positive displacement pump
 - rotary pump
 - hydrostatic pump
 - None of the above
2. (a) Explain the similarity laws for turbines. 5
- (b) A 10 cm diameter jet of water strikes a curved vane with a velocity of 25 m/s. The inlet angle of the vane is zero and the outlet angle is 150° measured with respect to the impinging jet direction. Determine the resultant force on the vane when the vane is stationary. 9

3. An inward-flow reaction turbine has an inlet guide vane angle of 30° and inward edges of the runner blade at 115° to the direction of rotation. The breadth of the runner at the inlet is a quarter of the inlet diameter and there is no whirl velocity at the outlet. The gross head is 20 m and the speed is 1000 r.p.m. The hydraulic and overall efficiencies may be assumed to be 88% and 85% respectively. Estimate the runner diameter at inlet and the power developed. 14

- (a) What are the different characteristics of Francis turbine? Discuss any one of them. 6
- (b) A Francis turbine develops 800 kW at an efficiency of 90% under a net head of 12 m. The draft tube used in this setup is a vertical cylindrical pipe of 2 m diameter. (a) What increase in power could be expected if a tapering vertical draft tube having an outlet diameter of 2.5 m replaces the existing cylindrical draft tube? (b) What would be the increase in the overall efficiency? Assume that the head, speed and discharge remain the same and there are no additional friction losses due to the new draft tube. 8

(Turn Over)

5. (a) Explain different component parts of a centrifugal pump. 6
- (b) A centrifugal pump delivers water at the rate of 40 litres/sec for a total head of 30 m. Find the output of the pump. If the overall efficiency of the set consisting of the pump and the electric motor is 75%, find the power required to drive the motor. 8
6. A centrifugal pump is required to discharge 600 litres/sec of water and develop a head of 15 m when the impeller rotates at 750 r.p.m. The manometric efficiency is 0.80. The loss of head in the pump due to fluid resistance can be assumed to be $0.027 V^2$ where, V = velocity with which the water leaves the impeller. Water enters the impeller without shock and whirl and the velocity of flow is 3.2 m/s. Determine the (a) impeller diameter, (b) blade angle at outlet and (c) outlet area. 14
7. (a) Define slip in a reciprocating pump. Explain the phenomenon of negative slip. 6

(b) A single-acting reciprocating pump has a plunger of diameter of 250 mm and stroke of 350 mm. If the speed of the pump is 60 r.p.m. and if it delivers 16.5 litres/sec of water against a suction head of 5 m and a delivery head of 20 m, find the theoretical discharge, coefficient of discharge, slip, the percentage slip of the pump and the power required to drive the pump. 8

8. A $1/5$ scale model of a prototype air compressor consuming 225 kW and running at a speed of 1000 r.p.m. delivers a flow rate of 9 kg/s through a pressure ratio of 5. At dynamically and kinematically similar conditions, what would the operating speed, mass flow rate and power consumption be for the full-scale prototype? 14

9. Write short notes on any *two* of the following : 14

(a) Draft tube

(b) Turbine

(c) Specific speed of pump

(d) Priming of a pump
