Code : 021510

B.Tech 5th Semester Examination, 2016

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.

(iii) Question No. 1 is Compulsory.

1. Define the following terms (any seven): 2×7=14
   (a) Jet Impingement (b) Nozzle
   (c) Penstock (d) Propeller Turbine
   (e) Head Race (f) Unit Discharge
   (g) Scroll Casing (h) Runner
   (i) Mechanical Efficiency of a Pump
   (j) Guide Vane Angle

2. (a) A jet of water, 5 cm in diameter, issues with a velocity of 20 m/s and impinges on a series of vanes. The vanes are so arranged that each vane appears successively before that jet in the same position and always moves with velocity of 5 m/s. Find force on the plate, work done and the efficiency of system. 5

(b) A jet of water having a velocity of 45 m/s impinges without shock on a series of vanes moving at 15 m/s. The direction of motion of the vanes is inclined at 20° to that of the jet, the relative velocity at outlet is 0.9 of that at inlet, and the absolute velocity of the water at the exit is to be normal to the motion of vanes, find (i) vane angles at entrance and exit; (ii) work done on vanes per kg of water supplied by the jet; and (iii) hydraulic efficiency. 9

3. (a) What is the basis of selection of a turbine at a particular place? 5

(b) A turbine develops 3000 kW under a head of 300 m. The overall efficiency of the turbine is 83%. If speed ratio-0.46, C_v=0.98 and specific speed is 16.5, then find the (i) Type of turbine, (ii) Diameter of the turbine, and (iii) Diameter of the jet. 9

4. (a) Define the specific speed of a Turbine. Derive an expression for the specific speed. 7

(b) Prove that the work done per second per unit weight of water in a reaction turbine is given as: 7

$$\frac{1}{g}\left(V_{w_1}u_1 \pm V_{w_2}u_2\right)$$

Where, V_{w1} and V_{w2} = velocities of whirl at inlet and outlet.

5. (a) What is a Draft tube ? Explain with neat sketch. 4

(b) A Francis turbine working under a head of 30 m has a wheel diameter of 1.2 m at the entrance and 0.6 m at the exit. The vane angle at the entrance is 90° and guide blade angle is 15°. The water at the exit leaves the vanes without

any tangential velocity and the velocity of flow in the runner is constant, neglecting the effect of draft tube and losses in the guide and runner passages, determine the speed of wheel in r.p.m. and vane angle at the exit. State whether the speed calculated is synchronous or not. If not, what speed would you recommend to couple the turbine with an alternator of 50 cycles? 10

6. (a) What do you understand by characteristics curves of a pump? Explain with sketch. 6

(b) A centrifugal pump has the following dimensions: inlet radius = 80 mm, outlet radius = 160 mm, width of impeller at the inlet = 50 mm, $\beta_1 = 0.45$ radians, $\beta_2 = 0.25$ radians. Width of impeller at the outlet = 50mm. Assuming sockless entry and determine the discharge and the head developed by the pump when the impeller rotates at 90 radians/second. 8

7. (a) What are the causes of cavitation ? How will you prevent the cavitation in hydraulic Machines? 7

(b) Define Indicator diagram. How will you prove that area of indicator diagram is proportional to the work done by the reciprocating pump? 7

8. (a) How will you classify the reciprocating pump? 4

(b) The cylinder bore diameter of a single acting reciprocating

pump is 150 mm and its stroke is 300 mm. The pump runs at 50 rpm and lifts water through a height of 25 m. the delivery pipe is 22 m long and 100 mm in diameter. Find the theoretical discharge and the theoretical power required to run the pump. If the actual discharge is 4.2 litres/s, find the percentage slip. Also, determine the acceleration head at the beginning and middle of the delivery stroke. 10

9. (a) A single inlet-type centrifugal compressor handles 528 kg/min. of air. The ambient air condition are 1 bar and 20°C. The compressor runs at 20000 rpm with isentropic efficiency of 80%. The air is compressed in the compressor from 1 bar static pressure to 4 bar total pressure. The air enters the impeller eye with a velocity of 145 m/s with no prewhirl. Assuming that the ratio of whirl speed to tip speed is 9.0, calculate:

(i) Rise in total temperature during compression if the change in K.E. is negligible

(ii) The tip diameter of the impeller

(iii) Power required

(iv) Eye diameter if the hub diameter is 12 cm. 9

(b) What is a centrifugal compressor ? How does it differ from an axial flow compressor? 5