Code : 021510

B.Tech. 5th Semester Exam., 2013

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

(a) Fluid

(b) Guide vanes

(c) Draft tube

(d) Turbo means

(e) Hydraulic turbine

(f) Stay ring

(g) Mechanical efficiency

(h) Specific speed

(i) Centrifugal pump

(j) Manometric head

2. *(a)* Explain the classification of fluid machineries. 5

(b) Establish the ratio of forces exerted by a water jet when it is made to strike—

(i) a stationary flat plate held normal to it;

(ii) a flat plate moving in the direction of jet at one-third the velocity of jet;

(iii) a series of flat plates mounted on a wheel and moving at one-third the velocity of jet. 9

3. *(a)* Briefly explain the different types of turbine and write the advantages of each. 5

(b) A 40 m/s velocity jet of water strikes without shock a series of vanes moving at 10 m/s. The jet is inclined at an angle of 20° to the direction of motion of vanes. The relative velocity of jet at outlet is 0·9 times of the value at inlet and the absolute velocity of water at exit is to be normal to the motion of vanes. Determine *(i)* the vane angles at entrance and exit, *(ii)* the work done on vanes per second per N of water supplied by the jet and *(iii)* the hydraulic efficiency. 9

4. *(a)* Show that the efficiency of a Pelton wheel will be maximum when the velocity of the wheel is half the velocity of the jet of water at inlet. 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, *(iii)* the runner blade angle at inlet and through the turbine. Assume the discharge from the runner is radial. 9

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

(b) A Pelton wheel has to develop 13230 kW under a net head of 800 m while running at a speed of 600 r.p.m. If the coefficient of the jet $C_v = 0 \cdot 97$, speed ratio $\phi = 0 \cdot 46$ and the ratio of the jet diameter is $\frac{1}{16}$ of the wheel diameter,

calculate the number of jets required for the Pelton wheel. Also calculate *(i)* the diameter of jet, *(ii)* the diameter of pitch circle and *(iii)* the quantity of water supplied to the wheel. 10

6. *(a)* Differentiate between centrifugal and reciprocating pump. 4

(b) A centrifugal pump having an impeller 30 cm outside diameter rotates at 1050 r.p.m. The vanes are radial at exit and 7·5 cm wide. The velocity of radial flow through the impeller is 3 m/s. The velocities in the suction and delivery pipes are 2·5 m/s and 1·5 m/s respectively. Neglecting frictional losses, determine the height through which the pump lifts, and the horsepower of the pump. Assume radial entry. 10

7. *(a)* Explain the different efficiencies used in centrifugal pump. 6

(b) A centrifugal pump lifts water against a static head of 40 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 7·5 m. The impeller is 40 cm in diameter, 2·5 cm wide and runs at 1250 r.p.m. The blade angle at exit is 30°. If the manometric efficiency is 80° and mechanical efficiency 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 130 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 16000 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) the static pressure ratio;

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

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

   (d) the theoretical power required to drive compressor 14

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

   (a) Relief valve

   (b) Electrohydraulic governor

   (c) Priming of a pump

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