Code : 021510

B.Tech. 5th Semester Exam., 2013

FLUID MACHINERY

Time : 3 hours   akubihar.com   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)

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. akubihar.com   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. akubihar.com   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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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

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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 $3 \cdot 3(H)^{0.5}$. The radial velocity of flow at inlet is $1 \cdot 1(H)^{0.5}$. 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

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 $149 \cdot 26$ kW. It is working under a head of $7 \cdot 62$ 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 $7 \cdot 0$ m. The impeller is 40 cm in diameter and $2 \cdot 5$ cm wide and

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; akubihar.com

(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

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

(a) Draft tube

(b) Turbine

(c) Specific speed akubihar.com

(d) Centrifugal pump

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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

P.T.O.

(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

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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. akubihar.com 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. akubihar.com 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. akubihar.com 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: akubihar.com

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

   (ii) The tip diameter of the impeller akubihar.com

   (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