2013

FLUID MACHINERY

Time Allotted : 3 Hours Full Marks : 70

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words

as far as practicable.

GROUP – A

(Multiple Choice Type Questions)

1. Choose the correct alternatives for the following :

10x1 = 10

i) By stock free entry it is meant

a) that the flow should enter the runner smoothly

b) that the relative velocity vector should have the

same direction as that of the tangent at the inlet

tip of the balde

c) that the absolute velocity vector should be

tangential to the inlet tip of the blade

d) that the velocity of flow should be natural.

ii) Turbines give best performance (*i.e.* work at peak

efficiency) when they are operated at full or designed

load. The performance of many turbines deteriorates

considerably at part loads. Which of the following

turbines is best suited for operations at part loads ?

a) Pelton turbine b) Francis turbibe

c) Kaplan turbine d) Propeller turbine.

iii) The net or effective head at the turbine is

a) the sum of gross head plus head loss in the

penstock

b) the sum of gross head plus head loss in the

penstock and the velocity head at the turbine exit

c) the difference between gross head minus head loss in penstock

d) the difference between gross head minus head loss in penstock and the velocity head at the turbine exit.

iv) The power obtainable from an impulse turbine is proportional to the number of nozzles used. A pelton turbine with six nozzles has a specific speed of 8·1. The specific speed per nozzle is

a) 1·35 b) 3·3

c) 2 d) 8·1.

v) The difference between the power obtained from the turbine shaft and the power supplied by water at its entry to the turbine is equal to

a) the hydraulic losses

b) mechanical losses

c) hydraulic and mechanical losses

d) mechanical and volumetric losses.

vi) The hydraulic efficiency of a turbine is defined as

a) the ratio of power utilized by runner to that supplied by the water at entry to the turbine

b) the ratio of power supplied by water at entry to the power utilized by runner

c) the ratio of power available at the turbine shaft to that supplied to it by the runner

d) the ratio of power supplied by the runner to the power available at the shaft.

vii) Cavitating conditions in turbines cause many undesirable effects. Select from the following the serious problems which arise from cavitation.

a) Damage to the runner blade surface

b) Damage to penstock

c) Damage to draft tube

d) Damage to spiral casing.

viii) Two centrifugal pumps can individually deliver liquid at the rate of Q_1 and Q_2 against heads H_1 and H_2 respeectively. If the liquid at the rate Q_1 plus Q_2 is to be delivered, how the pumps are to be connected ?

a) The pumps are to be connected in series such that the discharge from the pump is fed into other

b) The pump must be connected in parallel so that the dischasrge from each is fed into the main pipe

c) None of these.

ix) Which of the following statements partaining to centrifugal pump installation are correct ?

a) The discharge control valve is fitted in the suction pipe.

b) The suction pipe has larger diameter as compared to the discharge pipe

c) The suction pipe is provided with a foot-valve and a strainer

d) The delivery pipe is provided with a foot-valve and a strainer.

x) The manometric head is

a) the difference in elevation between the water surface in the high-level reservoir and the water level in the sump

b) the height to which water is lifted by the pump measured above the pump centre-line

c) the difference in the piezometric heads between the points on the livery and suction pipes as close

to the pump as possible

d) the head developed by the pump.

GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following. 3x5 = 15

2. What are the hydraulic functions of spiral casing, guide vanes and the draft tube ?

3. Why are centrifugal pumps less efficient as compared to turbines ?

4. Which type of turbine is best suited to conditions of changing loads on the turbine and why ?

5. Deduce the expression of theoretical head developed by a pump. What is meant by 'Priming' of a pump ?

6. What is pump cavitation ? What is meant by NPSH (Net Positive Suction Head) ?

GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following. 3x15 = 45

7. a) What are the main advantages of model testing ?

b) What is the significance of specific speed of turbomachines ? Show the dimensionless coefficients of a rotodynamic pump.

c) A quarter-scale turbine model is tested under a head of 10 m. The full-scale turbine is required to work under a head of 30 m and to run at 45 rad/s. At what speed must the model be run ? If the model develops 100 kW and uses water at 1 m 3/s at this speed, what power will be obtained from the full-scale turbine, its efficiency being same that of the model ? What is the specific speed of the full-scale turbine ? 2 + 4 + 9

8. A centrifugal pump lifts water against a static head of 40 m

of water. Suction and delivery pipes are both 150 mm in diameter. Head losses in the suction and delivery pipes are 2·5 m and 7 m of water respectively. The impeller is 400 mm in diameter, 25 mm wide and rotating at 1200 r.p.m. The impeller blade angle at exit is 30°. Assume radial entry at the impeller inlet, if the manometric efficiency is 85% and overall efficiency is 75%, determine the discharge and power required to drive the pump.

9. a) Show that the maximum efficiency condition of a pelton turbine is given by $u = v/2$, where u and v stands for bucket tip velocity and jet velocity before striking the bucket, respectively.

b) The mean bucket speed of a pelton turbine is 14 m/s. It is supplied with water at the rate of 0·8 m ^{3}/s under a head of 45 m. If the water jet is deflected by the buckets, through an angle of 165°, find the power and efficiency of the turbine. Assume coefficient of velocity as 0·985.   5 + 10

10. a) Discuss about the losses in a centrifugal compressor.

b) What is the basic difference between a fan & a compressor ?

c) Determine the pressure ratio developed and the specific work input to drive a centrifugal air compressor of an impeller diameter of 0·5 m and running at 7000 r.p.m. Assume zero whirl at the entry and $T_{01} = 290$ K. The slip factor and power input factor to be unity and the compression process is isentropic, for air $C_p = 1·005$ kJ/kg-K and $\gamma = 1·4$.

                                   3 + 2 + 10

11. a) Describe (with neat sketch) the functions of air vessels of reciprocating pump.

b) A single acting reciprocating pump having plunger diameter 20 cm and stroke length 30 cm is placed with its centre line 4 m above the the level of water in the suction tank. The suction pipe is 7·5 cm in diameter and 5 m long. If separation occurs when the absolute pressure head is 2·4 m of water, find the maximum sped of the pump to avoid separation at the beginning of the suction stroke. Assume normal barometric pressure as 10·4 m of water column and simple harmonic motion of the plunger.   5 + 10

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