B.E. (Mechanical Engineering / Power Engineering) Fourth Semester (C.B.S.)

Hydraulics Machines Paper - III

P. Pages : 3

TKN/KS/16/7373/7399

Time : Three Hours

Max. Marks : 80

Notes :
1. All questions carry marks as indicated.
2. Solve Question 1 OR Questions No. 2.
3. Solve Question 3 OR Questions No. 4.
4. Solve Question 5 OR Questions No. 6.
5. Solve Question 7 OR Questions No. 8.
6. Solve Question 9 OR Questions No. 10.
7. Solve Question 11 OR Questions No. 12.
8. Due credit will be given to neatness and adequate dimensions.
9. Assume suitable data whenever necessary.
10. Use of non programmable calculator is permitted.

1. a) Derive an expression for area velocity relationship for a compressible fluid in the form $\frac{dA}{A} = \frac{dV}{V}\left[M^2 - 1\right]$. **6**

b) Determine the speed and Mach number of a supersonic aircraft flying at an attitude of 1000 m where the temperature is 280 K. Sound of the aircraft is heard 2.15 seconds after the passage of air craft over the head of an observer. **7**
Take Y = 1.41 and R = 287 J/kg K.

OR

2. a) What do you mean by compressibility correction factor? Find an expression for compressibility factor. **6**

b) Air flows through a convergent – divergent nozzle. At some section in the nozzle pressure = 2 bar, velocity = 170 m/s. and temp = 200°C and cross sectional area = 1000 mm^2. **7**
Assuming isentropic flow conditions determine :
a) Stagnation temperature and pressure.
b) Sonic velocity and Mach number at this section.
c) Velocity, Mach number and flow area at outlet section where pressure is 1.1 bar.
d) Pressure, temperature, velocity and flow area at throat of the nozzle
Take R = 287 J/kgK
Cp = 1000 J/kg K and
Y = 1.4

3. a) Draw a neat sketch and explain the characteristic features of pelton wheel bucket. What are the limitations in keeping the deflection angle of the jet less than 180°? **6**

b) A Pelton wheel is required to develop 6 MW under a head of 300 m. If rotates with a speed of 550 rpm. Assuming Jet ratio as 10 and over all efficiency as 85%. **7**
Determine :
i) Diameter of wheel
ii) Quantity of water required.
iii) Number of jets.
Take : Cv = 0.98 and Ku = 0.46.

OR

4. a) Draw a general layout of a hydroelectric power plant using impulse turbine and explain briefly its construction and working. 6

b) A single jet Pelton wheel runs at 300 rpm under a head of 510 m. The jet diameter is 200 mm, its deflection inside the bucket is 165° and its relative velocity is reduced by 15% due to friction. Determine 7
i) Water power
ii) Resultant force on the bucket
iii) Overall efficiency.
Take Co – efficient of velocity = 0.98 and speed ratio = 0.46

5. a) What is cavitation? How can it be avoided in reaction turbines. 7

b) The following data pertains to an inward flow reaction turbine. 7
Net head = 86.4 m. Speed = 650 rpm
Output power = 397 KW
Hydraulic efficiency = 95%
Overall efficiency = 85%
Flow ratio = 0.17 Breadth Ratio = 0.1
Ratio of inner diameter to outer diameter = 0.5
Flow velocity constant and
Discharge radial.
Neglecting blockage by blades.
Find dimensions and blade angles of the turbine.

OR

6. a) What is governing and how it is accomplished in Reaction turbines? 7

b) A Kaplan turbine develops 22000 KW at an average head of 35m. Assuming a speed ratio of 2, flow ratio of 0.6 diameter of boss equal to 0.35 times the diameter of the runner and overall efficiency of 88 percent. Calculate the diameter, speed and specific speed of the turbine. 7

7. a) Show that the pressure rise of a centrifugal pump when frictional and other losses are neglected is given by $\frac{1}{2g}\left[V_{f_1}^2 + u_2^2 - V_{f_2}^2 \operatorname{cosec}^2\phi\right]$ 7

where V_{f_1}, V_{f_2} = velocities of flow at inlet and outlet respectively.

u_2 = tangential velocity at outlet

ϕ = vane angle at outlet

b) A centrifugal pump is required to discharge 0.118 m^3 of water per second against a head of 25m. When rotating at 1500 rpm. The manometric efficiency is 75%. The impeller diameter is 250 mm and its width at outlet is 50 mm. Determine the vane angle at the outer periphery of the impeller. 7

OR

8. a) What do you mean by "NPSH" Net positive suction heads? What is its importance. 7

b) A three stage centrifugal pump has impellers 450 mm in diameters and 20 mm wide at outlet. The vanes are curved back at the outlet at 450 and reduce the circumferential area by 10%. The manometric efficiency is 90% and the overall efficiency is 80%. The pump is running at 1000 rpm. and delivering 0.05 m^3/s. 7

Determine :

i) Head generated by the pump and

ii) Shaft power required to run the pump.

9. a) Define indicator diagram. Prove that work done by the reciprocating pump is proportional to the area of indicator diagram. 6

b) A three throw has cylinder of 250mm diameter and stroke of 500 mm each. The pump is required to deliver 0.1 m^3/s at a head of 100 m. Friction losses are estimated to be 1m in suction pipe and 19 m in delivery pipe. Velocity of water in delivery pipe is 1 m/s, overall efficiency is 85% and slip is 2%. 7

Determine :

i) Speed of the pump and

ii) Power required to drive the pump.

OR

10. a) What is negative slip in reciprocating pump? Explain with neat sketches the function of air vessels in reciprocating pump. 6

b) The bore and stroke of a reciprocating pump are 250 mm and 500 mm respectively. The pump delivers water through 150 mm delivery pipe to a tank which is 27 m horizontally from it. If separation occures at 25 kN/m^2 absolute, find the safe speed at which pump should run when 7

i) The delivery pipe is horizontal from the pump and then vertical upto the tank, and

ii) The delivery pipe is vertical from the pump and then horizontal upto the tank. The atmospheric pressure is 10.3 m of water.

11. a) What are the various methods of dimensional analysis to obtain a functional relationship between various parameters affecting a physical phenomenon. 6

b) A model turbine constructed to a scale of 1 : 10 when tested under a head of 8 m and 400 rpm. Gave an efficiency of 77 percent. Determine the rpm of the prototype and the ratio of powers developed by the model and prototype. If the prototype works under a head of 400 m? 7

OR

12. Write short notes on **any three.** 13

i) Air Lift Pump. ii) Hydraulic Ram

iii) Submersible Pump. iv) Regenerative Pump.

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