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

Hydraulics Machines Paper - III

P. Pages : 3 **KNT/KW/16/7285/7311**

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. Assume suitable data whenever necessary.
9. Illustrate your answers whenever necessary with the help of neat sketches.
10. Use of non programmable calculator is permitted.

1. a) What is sonic velocity? prove that velocity of sound wave in a compressible fluid is given by : $C = \sqrt{\frac{dp}{d\rho}}$ where, P is fluid pressure in pipe and ρ is the density of the fluid. **7**

b) A 120 mm dia. pipe reduces to 60 mm dia. through a sudden contraction. It carries air at 25° C under isothermal condition. The absolute pressures in the two pipes before and after the contraction are 480 kN/m^2 and 384 kN/m^2 respectively. **6**

Determine.

i) Densities at the two sections.

ii) Velocities at the two sections.

iii) Mass flow rate.

Take R = 287 J/kg.k

2. a) At some section in the convergent- divergent nozzle, in which air is flowing, pressure, velocity, temperature and cross-sectional area are 200 kN/m^2, 170 m/s, 200° C and 1000 mm^2 respectively. If the flow conditions are isentropic, determine. **9**

i) Stagnation temperature and stagnation pressure.

ii) Sonic velocity and Mach number at this section.

iii) Velocity, Mach number and flow area at outlet section where pressure is 110 kN/m^2.

iv) Pressure, temperature, velocity and flow area at throat of the nozzle.

Take for air : R = 287 J/kgK.

C_P = 1.0 kJ/kgk, and r = 1.4.

b) Discuss in detail, "Normal shock wave" with neat sketch. **4**

3. a) Explain the elements of hydroelectric power plant with neat sketch. **6**

b) A Pelton wheel is receiving water from a penstock with gross head of 510 m. one-third of gross head is lost is friction in the penstock. The rate of flow through the nozzle fitted at the end of the penstock is 2.2 m^3/s. The angle of deflection of the jet is 165°. Determine. **8**

i) The power given by water to the runner and.

ii) Hydraulic efficiency of the pelton wheel.

Take. $C_V = 1.0$ and speed ratio = 0.45.

4. a) A Pelton wheel is designed for following specification: Power $= 9560\text{kW}$, Head $= 350\text{m}$, Speed $= 750\,\text{rpm}$, **9**
Overall efficiency $= 85\%$
jet diameter is not to exceed $1/6^{th}$ of the wheel diameter.
Determine the following.
i) Wheel diameter.
ii) Diameter of Jet.
iii) No. of Jets required.
Take : $C_V = 0.985$, Speed ratio $= 0.45$.

b) Explain with neat sketches performance characteristic curves for Pelton turbine. **5**

5. a) Explain the governing of a reaction turbine with a neat sketch. **6**

b) In an inward flow reaction turbine the head on the turbine is 32 m. The external and internal diameters are 1.44 m and 0.72 m respectively. The velocity of flow through the runner is constant and equal to 3 m/s. The guide blade angle is 10º and the runner vanes are rigid at inlet. If the discharge at outlet is radial, determine. **8**
i) The speed of the turbine.
ii) The vane angle at outlet of the runner, and.
iii) Hydraulic efficiency.

6. a) What are the functions of Draft Tube? Explain different types of draft tubes with suitable sketches. **6**

b) The hub diameters of Kaplan turbine working under a head of 12 m, is 0.35 times the diameter of runner. The turbine is running at 100 rpm. If the vane angle of the extreme edge of the runner at outlet is 15º and flow ratio is 0.6, find. **8**
i) Diameter at runner.
ii) Diameter of boss
iii) Discharge through runner.
The velocity of whirl at outlet is given as zero.

7. a) With a neat Sketch explain different components of a centrifugal pump. **6**

b) A Centrifugal pump is running at 1000 rpm. The outlet vane angle of the impeller is 45º and velocity of flow at outlet is 2.5 m/s. The discharge through the pump is 200 litres/s when the pump is working against a total head of 20 m. If the manometric efficiency of pump is 80%, determine. **7**
i) Outside diameter of impeller.
ii) Width of impeller at outlet.

8. a) What is multi-staging in centrifugal pumps? Explain with neat sketches pumps in series and in parallel. **6**

b) A centrifugal pump has discharge of 1565 liters/sec against a mean lift of 6.1 m. When it rotates at 200 rpm. The impeller diameter is 1.22 m and the area at outer periphery is 6450 cm^2. If the vanes are set back at an angle of 26º at the outlet, determine. **7**
i) Hydraulic efficiency.
ii) Power required to drive the pump.
iii) Minimum Speed to start pumping if the ratio of external to internal diameter is 2.

9. a) Explain the Indicator diagram of reciprocating pump with neat sketch. **6**

b) A single acting reciprocating pump having a bore of 150 mm and a stroke of 300 mm is raising water to a height of 20 m above the sump level. It has actual discharge of 0.0052 m^3/s and efficiency 70%. If the speed of the pump is 60 rpm, determine. **7**

i) Theoretical discharge.
ii) Theoretical power.
iii) Actual power.
iv) Percentage slip.

10. a) Explain Air vessels with neat sketch. **6**

b) A 'Three throw' pump has cylinders of 250 mm 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 tobe 1m in sanction pipe and 19 m in Delivery pipe. Velocity of water in delivery pipe is 1 m/s, overall efficiency is 85% and the slip is 3%. **7**
Determine.
i) Speed of the pump, and.
ii) Power required to run pump.

11. a) Explain any three dimensionless numbers with mathematical formula and their significance. **5**

b) Two geometrically Similar Pumps are running at the same speed of 1000 rpm. one pump has an impeller diameter of 0.30 m and lifts water at the rate of 20 litres/sec against a head of 15 m. Determine the head and impeller diameter of the other pump to deliver half the discharge. **8**

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

i) Air lift pump. **13**
ii) Specific speed for turbine and pump.
iii) Submersible pump.
iv) Cavitation in Reciprocating pump.

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