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

Hydraulic Machines

P. Pages : 4 **NRT/KS/19/3370/3396**

Time : Three Hours * 0 6 5 4 * 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. Illustrate your answers whenever necessary with the help of neat sketches.
11. Use of non programmable calculator is permitted.

1. a) Obtain expression for velocity of sound wave in a compressible fluid in term of the change of pressure and change of density. Also reduce it for adiabatic process. **7**

b) A gas with a velocity of 350 m/s is flowing through a horizontal pipe at a section where pressure is 8 N/cm^2 (abs) and temperature is 30º. The pipe changes in diameter and at this section, the pressure is 12 N/cm^2 (abs). Find the velocity of the gas at this section using **7**
i) Adiabatic process
ii) Isothermal process

OR

2. a) Explain the effect of area variation in compressible flow. Also discuss shapes of nozzle and diffuser for subsonic and supersonic flow. **7**

b) Find the Mach number when an aeroplane is flying at 900 km/hr through still air having a pressure of 8 N/cm^2 and temperature -15ºC. Take r = 1.4 and R = 287 J/kg k. Calculate the pressure, temperature and density of air at the stagnation point on nose of the plane. **7**

3. a) Explain construction and working of Pelton turbine with the help of neat sketch. **6**

b) A Pelton wheel is receiving water from a penstock with a gross head of 510 m. One third gross head is lost in friction in the penstock. The rate of flow through the nozzle at the end of the penstock is 2.2 m^3/s. The angle of deflection of the jet is 165º. Determine : **7**
i) The power given by water to the runner head and
ii) Hydraulic efficiency of the Pelton wheel.
Take coefficient of velocity = 0.98 and Speed ratio = 0.45.

OR

4. a) Derive the expression for hydraulic efficiency in Pelton turbine and show that for the maximum efficiency, blade velocity is half of jet velocity. **6**

b) A Pelton wheel is to be designed for following specification - **7**
Shaft Power = 10,000 kw
Head = 350 m
Speed = 800 rpm
Overall efficiency = 85%
Jet diameter = $1/6^{th}$ of wheel diameter
Determine the following :
i) The wheel diameter
ii) Diameter of jet
iii) The number of jet required.
Take $C_V = 0.985$, $k_u = 0.45$

5. a) Explain the principle of reaction turbine. Give role of draft tube and casing in the reaction turbine. **6**

b) The following data pertain to a Francis turbine : **7**
Net head = 80 m, Speed = 700 rpm, Shaft Power = 350 m, Overall efficiency = 86%, Hydraulic efficiency = 93%, Flow ratio = 0.22. Breadth ratio = $\frac{B_1}{D_1} = 0.1$ Outer diameter of runner = 2 x Inner diameter of runner. Velocity of flow = constant outlet discharge radial. The thickness of vanes occupy 6% of circumferential area of runner. Determine :
i) Diameter of runner at inlet and outlet
ii) Width of wheel at inlet
iii) Guide blade angle, and
iv) Runner vane angle at inlet and outlet.

6. a) What is meant by governing of turbine ? Explain the governing mechanism of Francis turbine with help of neat sketch. **6**

b) A propeller reaction turbine of runner diameter 4.5 m is running at 48 rpm. The guide blade angle at inlet is 145º and the runner blade angle at outlet is 25º to the direction of vane. The axial flow area of water through the runner is 30 m^2. If the runner blade angle at inlet is radial. Determine : **7**
i) Hydraulic efficiency
ii) Discharge through the turbine
iii) Power developed by the runner

7. a) Explain role of impeller in centrifugal pump. Give its classification and practical uses of different impeller. **6**

b) A centrifugal pump working in a dock pump 1500 litre per second against a mean lift of 6.1 m when impeller 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 developed to drive the pump and
iii) Minimum speed to start pumping if the ratio of external to internal diameter is 2.

OR

8. a) Write a short notes on : **6**

i) Multistaging of centrifugal pump.

ii) Net positive suction head.

iii) Priming of centrifugal pump.

b) The impeller of a centrifugal pump has an external diameter of 450 mm and internal diameter of 200 mm and its runs at 1440 rpm. Assuming a constant radial flow through the impeller at 2.5 m/s and that the vanes at the exit are set back at an angle of 25º. Determine : **7**

i) Inlet vane angle

ii) The angle of absolute velocity of water at exit makes with the tangent and

iii) The workdone per N of water.

9. a) Draw and explain indicator diagram of reciprocating pump by considering effect of piston acceleration and friction in the pipe. **6**

b) A single acting reciprocating pump has a diameter of 100 mm and stroke length 200 mm. The length and diameter of the suction pipes are 6.5 m and 50 m respectively. If the suction lift of the pump is 3.2 m and separation occurs when pressure in the pump falls below 2.5 m of water absolute and the manometer reads 763mm of Hg, find the maximum speed at which pump can run without cavitation in suction pipe. **7**

OR

10. a) What is necessity of air vessel in the reciprocating pump ? Explain with the help of sketch and also give its advantage. **6**

b) A single acting reciprocating pump, running at 50 rpm delivers 0.00736 m^3/s of water. The diameter of the piston is 200 mm and strokes length of 300 mm. The suction and delivery heads are 3.5 m and 11.5 m respectively. Determine : **7**

i) Theoretical discharge

ii) Coefficient of discharge

iii) Percentage slip of the pump, and

iv) Power required to drive the pump

11. a) Which type of similarities exist between model and prototype ? Also explain importance of dimensional number in model testing. **5**

b) A pump is discharging 0.025 m^3/s of water against a total head of 18 m. The diameter of the impellers is 0.4 m and it is rotating at 1400 rpm. Calculate the head, discharge and ratio of power of a geometrically similar pump of diameter 0.25 m when it is running at 2800 rpm. **6**

c) Define specific speed and give its significance in model testing. **3**

12. Write a short notes on **any three.** **14**

i) Hydraulic ram

ii) Air lift pump

iii) Submersible pump

iv) Hand pump

****