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

Hydraulic Machines (HM)

P. Pages : 3 **NKT/KS/17/7285/7311**

Time : Three Hours * 0 5 1 5 * 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) Derive expression for mass rate of flow of compressible fluid through nozzle fitted to a tank. What is the condition for maximum rate of flow. **6**

b) A supersonic plane flies at 2000 km/hr at an altitude of 9 km above the sea level in standard atmosphere. If the pressure and density of air at this altitude are stated to be 30 kN/m^2 absolute and 0.45 kg/m^3, make calculation for pressure temperature and density at stagnation point on the nose of the plane. **7**
Take R = 287 J/kg-k & y = 1.4.

2. a) An airplane is flying through a still air having pressure of 78 kN/m^2 and temperature of - 8°C. If the temperature of air at the stagnation point on the nose of the plane is less than 15.2°C, find maximum speed of the plane. **6**
Take R = 287 J/kg-k & y = 1.4

b) Explain in details, the impact of jet ? Sate its general case for the force exerted by the jet on the plate. **7**

3. a) Show that the hydraulic efficiency of pelton wheel is maximum when peripheral wheel velocity is half the absolute velocity of jet at inlet. **6**

b) Three jet pelton turbine is required to generate 10000 kw under the net head of 400m. The blade angle at outlet is 15° and reduction in relative velocity while passing over the blade is 5%. If the overall efficiency of the wheel is 80%. C_v = 0.98 & speed ratio = 0.46 then find : **8**
i) Diameter of jet
ii) total flow in m^3/s
iii) force exerted by jet on the bucket.

4. a) What do you mean by term governing of a turbine ? Explain with neat sketch the working of oil pressure governor. **6**

b) A pelton wheel of 1.2 m mean bucket diameter works under the head of 650 m. The jet deflection is 165° & its relative velocity in reduced over the bucket by 15% due to friction go the water is to leave the bucket without any whirl, determine : **8**

i) rotational speed of wheel.
ii) ratio of bucket speed to jet velocity.
iii) Impulsive force & power developed by wheel.
iv) Efficiency of wheel

Assume $C_V = 0.97$

5. a) Differentiate between the inward and outward radial flow turbine. **4**

b) An inward flow reaction turbine has external and internal diameters as 1.0 m & 0.6 m respectively. The hydraulic efficiency of the turbine is 90%. Head on turbine 36 m. The velocity of flow at outlet is 2.5 m/s & the discharge at outlet is radial. If the vane angle at outlet is 15° & the width of the wheel is 100 mm at inlet and outlet, determine **9**

i) guide blade angle
ii) Speed of turbine
iii) Runner vane angle at inlet
iv) Power developed

6. a) What is cavitation ? How can it be avoided in reaction turbine. **5**

b) A propeller reaction turbine of runner diameter 4.5 m is running at 40 rpm. The guide blade angle at inlet is 145° & the runner blade angle at outlet is 25° to the direction of vane. The axial flow area of water through runner is 25 m^2. If the runner blade angle at inlet is radial, determine : **8**

i) Hydraulic efficiency
ii) Discharge through turbine
iii) Power developed by turbine
iv) Specific speed of turbine

7. a) What do you understand by the characteristic curves of a centrifugal pump ? Explain various important types of characteristic curves. **7**

b) A centrifugal pump rotating at 900 rpm delivers 50 litres/s against net head of 15 m. The vane angle at outlet is 30° and the flow velocity at outlet is 1.4 m/s go the manometric efficiency of the pump is 85%, find the diameter and width of impeller at outlet. **6**

8. a) What is multistaging in centrifugal pump ? Explain with neat sketch pumps in series and in parallel. **6**

b) A centrifugal pump discharges 0.15 m^3/s of water against head of 12.5 m, the speed of rotation of the impeller being 600 rpm. The diameter at the outer and inner periphery of the impeller are 50 cm and 25 cm and the vanes are bent back at an angle of 35° to the tangent at exit assuming that the area of flow is constant at 0.07 m^2 from inlet to outlet of impeller, **7**

Calculate

i) Manometric efficiency of pump
ii) Vane angle at inlet
iii) Loss of head at inlet to impeller when discharge is reduced by 40%, the speed of rotation being unchanged.

9. a) Explain the construction and working principle of single acting reciprocating pump with the help of neat sketches. **7**

b) A single acting reciprocating pump having bore of 20 cm and stroke of 30 cm runs at 50 rpm. The pump is raising water to a height of 20 m above the pump level at the rate of 0.0078 m^3/s. The efficiency of the pump is 75%. Determine : **6**

i) theoretical discharge
ii) Percentage slip
iii) Coefficient of discharge
iv) Theoretical power
v) Actual power required to run the pump.

10. a) Show from first principle that the work saved against friction in the delivery pipe of single acting reciprocating pump by fitting air vessel is 84.8% while for double acting reciprocating pump work saved is only 39.2%. **7**

b) Single acting reciprocating pump raises water to a height of 20 m through delivery pipe of 35 m long and 140 mm in diameter. The bore and stroke of Piston are 250 mm and 400 mm. Cavitation occurs at 2.5 m of water absolute find the speed at which pump can run without separation on delivery side if the pipe first rises vertically and then runs horizontally. Will there be any change in the maximum speed if the pipe first runs horizontally and then rises vertically. **6**

11. a) Explain the different types of hydraulic similarities that must exist between prototype and its model. **5**

b) Explain unit quantities. **3**

c) A laboratory tests were conducted on a 1/10 scale model of a francis turbine under a head of 4 m and indicated that it could develop 8 kw power when operating at 500 rpm. Determine the speed and power developed by a full size turbine when working under the head of 40 m. **6**

12. Write short notes on **any three** of following. **14**

i) Hydraulic Ram.

ii) Submersible pump.

iii) Air lift pump

iv) Specific speed.

v) Regenerative pump.

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