

**III B.Tech. I Semester Regular Examinations, November -2005**  
**HYDRAULIC MACHINERY AND SYSTEMS**  
**(Mechanical Engineering)**

Time: 3 hours

Max Marks: 80

Answer any FIVE Questions  
All Questions carry equal marks

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1. (a) Derive an expression for torque exerted by water on a wheel with radial curved vanes.  
(b) A jet of water having a velocity of 15 m/s strikes a curved vane moving with a velocity of 5 m/s in the same direction as that of the jet at inlet. The vane is so shaped that the jet is deflected through  $135^\circ$ . The diameter of jet is 10 cm. Assume the vane could be smooth. Find the force exerted by the jet on the vane in the direction of motion, power exerted on the vane and the efficiency of the vane. [8+8]
2. (a) Explain various types of water wheels?  
(b) Differentiate between radial flow and parallel flow turbine? [8+8]
3. (a) Write a short note on the factors influencing the performance of turbines?  
(b) Obtain an expression for the specific speed of a turbine? [8+8]
4. (a) What is an air vessel? Describe the function of air vessel in reciprocating pumps.  
(b) Find the saving in work done against friction in the delivery of a double acting reciprocating pump by fitting air vessels. [6+10]
5. (a) What are the mechanical losses in the working of a centrifugal pump?  
(b) The impeller of a centrifugal pump has outer diameter of 40 cm and inner diameter of 20 cm. The blade angle at outlet is  $30^\circ$ . The speed of the impeller is 1450 rpm. The velocity of flow at inlet and out let is same at 2.2 m/ sec. Find head developed if manometric efficiency is 75%, absolute velocity at out let and blade angle at inlet. [8+8]
6. (a) When will the dynamic similarity exist between model and prototype?  
(b) Two geometrically similar pumps are to run at the same speed of 1100 rpm. One of the pumps lifts  $0.1 \text{ m}^3/\text{sec}$  to a head of 16 m. Determine the head of the other pump to lift half of the discharge. [8+8]
7. (a) Describe with neat sketch the working of a hydraulic press.  
(b) A hydraulic press has diameter of ram 200 mm and of plunger 40 mm. It is provided with a lever for applying force to the plunger. If the ratio of leverage is 10, determine the weight lifted by the press, when the force applied to the level is 100 N. [8+8]

8. Explain different types of fluid control valves with neat sketches. [16]

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1. (a) Derive an expression for the force exerted on a flat vertical plate moving in the direction of jet.
- (b) A 15 m/s velocity jet of water 5 cm in diameter strikes perpendicularly a smooth flat plate. Determine the force exerted by the jet on the plate if the plate is at rest and if it moves in the direction of the jet with a velocity of 5 m/s. Also determine the work done in each case and the efficiency of the jet in the second case. [6+10]

2. Show that the hydraulic efficiency of a Pelton wheel is given by

$$\eta_h = (1 + \cos \phi) \frac{2u(V - u)}{V^2}$$

With the usual notations

V = Velocity of the jet

u = Velocity of the vane at the impact point

$\phi$  = outlet vane angle

[16]

3. (a) Write a short note on the factors influencing the performance of turbines?
- (b) Obtain an expression for the specific speed of a turbine? [8+8]
4. (a) Differentiate between
  - i. A single acting and double acting reciprocating pumps
  - ii. A single cylinder and double cylinder reciprocating pumps.
- (b) A double acting reciprocating pump running at 50r.p.m is discharging 900 litres of water per minute. The pump has a stroke of 400 mm. The diameter of piston is 250 mm. The delivery and suction heads are 25m and 4m respectively. Find the slip of the pump and power required to drive the pump. [8+8]
5. (a) Draw the outlet velocity triangle for back ward curved vane of a centrifugal pump.
- (b) Explain the working of a centrifugal pump with the help of a neat sketch[8+8]
6. A centrifugal pump runs at 800 rpm and delivers 5 m<sup>3</sup>/ sec against a head of 7 m. The impeller has an outer diameter of 25 cm and width of 5 cm at out let. If the vane angle at out let is 50°, determine the manometric efficiency . Find the specific speed. [16]

7. A hydraulic press has a plunger diameter 20 mm and the ram diameter 160 mm. The stroke of the plunger is 200 mm and the weight lifted by the press is 10 KN. The distance traveled by the weight is 600 mm in 10 minutes. Determine
- (a) Force applied to the plunger
  - (b) Power required to move the plunger
  - (c) Number of strokes of the plunger. [16]
8. Power is to be transmitted hydraulically to a distance of 8 km by means of a number of 10 cm pipes laid horizontally, for which the coefficient of friction may be taken as 0.03. The pressure at the accumulator is maintained constant at 66.5 Kg/cm<sup>2</sup>. Determine the number of pipes required to ensure an efficiency of at least 92 percent when the power delivered is 220 h.p. [16]

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1. (a) Obtain an expression for the force on the inclined plate moving in the direction of the jet . Also get the expression for the work done per second by the jet on the plate.  
(b) A jet of water moving at 12 m/s impinges on a concave shaped vane to deflect the jet through  $120^\circ$  when stationary. If the vane is moving at 5m/s, find the angle of jet so that there is no shock at inlet. Also compute the absolute velocity of jet at exit both in magnitude and direction and the work done per second per N of water. Assume that the vane is smooth. [6+10]
2. A Pelton turbine works under a head of 450 m and rotating at 12 rev/sec. Calculate the power produced and the hydraulic efficiency when the discharge through the machine is  $0.3 \text{ m}^3/\text{s}$  and the jet is deflected by  $170^\circ$ . Take  $C_v = 0.97$  and the blade velocity coefficient  $K = 0.90$ . [16]
3. (a) One Pelton wheel develops 15MW power under a head of 360m at 450 rpm. What is its specific speed? What would be its normal speed and output under a head of 145m .  
(b) Explain what do you understand by unit speed, unit power and unit discharge of turbine. [10+6]
4. A double acting reciprocating pump raises water to a height of 20m through a delivery pipe 35 m long and 140 mm in diameter. The bore and stroke of piston are 250mm and 400 mm respectively. Cavitation occurs at 2.5m of water absolute. Find the speed at which pump can run without separation on delivery side if the pipe rises first vertically and then runs horizontally. Will there be any change in the maximum speed if the pipe first runs horizontally and then rises vertically?  
[16]
5. (a) What are the types of centrifugal pumps? Explain with the help of neat sketches where necessary.  
(b) Draw the out let velocity triangle for radial vane of a centrifugal pump. What is preventing? Why is it needed in a centrifugal pump ? [8+8]
6. (a) When will the dynamic similarity exist between model and prototype?  
(b) Two geometrically similar pumps are to run at the same speed of 1100 rpm. One of the pumps lifts  $0.1 \text{ m}^3/\text{sec}$  to a head of 16 m. Determine the head of the other pump to lift half of the discharge. [8+8]

7. A hydraulic press has a plunger diameter 20 mm and the ram diameter 160 mm. The stroke of the plunger is 200 mm and the weight lifted by the press is 10 KN. The distance traveled by the weight is 600 mm in 10 minutes. Determine
- (a) Force applied to the plunger
  - (b) Power required to move the plunger
  - (c) Number of strokes of the plunger. [16]
8. (a) What are hydraulic systems? Describe briefly a hydrostatic and hydro-kinetic system and cite examples.
- (b) Describe the principle of working of a vane pump with a neat sketch. [8+8]

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1. (a) Obtain an expression for the force exerted by a jet of water on a fixed vertical plate in the direction of the jet.  
(b) A jet of water of diameter 7.5 cm moving with a velocity of 25 m/s strikes a fixed plate in such a way that the angle between the jet and plate is  $60^\circ$ . Find the force exerted by the jet on the plate in the direction normal to the plate and in the direction of the jet. [6+10]
2. (a) What do you mean by inward and outward flow turbines?  
(b) Differentiate between impulse and reaction turbines. Give examples. [8+8]
3. (a) One Pelton wheel develops 15MW power under a head of 360m at 450 rpm. What is its specific speed? What would be its normal speed and output under a head of 145m .  
(b) Explain what do you understand by unit speed, unit power and unit discharge of turbine. [10+6]
4. (a) Derive an expression for the discharge of water when air vessel fitted to the delivery pipe of a double action reciprocating pump  
(b) A single acting reciprocating pump running at 60 r.p.m has a plunger diameter of 250 mm and a stroke of 500 mm. The delivery pipe is 100mm diameter and 50m long. If the motion of the pump is simple harmonic, find the power required to overcome friction of delivery pipe when a large air vessel is fitted at the center line of the pump. Assume  $f=0.01$ . [8+8]
5. (a) What are the types of centrifugal pumps? Explain with the help of neat sketches where necessary.  
(b) Draw the out let velocity triangle for radial vane of a centrifugal pump. What is preventing? Why is it needed in a centrifugal pump ? [8+8]
6. (a) When will the dynamic similarity exist between model and prototype?  
(b) Two geometrically similar pumps are to run at the same speed of 1100 rpm. One of the pumps lifts  $0.1 \text{ m}^3/\text{sec}$  to a head of 16 m. Determine the head of the other pump to lift half of the discharge. [8+8]
7. (a) What do you understand by Hydraulic Accumulator? Derive an expression for the capacity of an accumulator.

- (b) An accumulator transmits 50 KW power through a 150 mm pipe line 250 m long. The loss of head due to friction is 2.5 percent. The diameter of the ram is 750mm. The coefficient of friction is 0.03. Determine the load on the ram.

[8+8]

8. Explain different types of fluid control valves with neat sketches.

[16]

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