II B.Tech. I Semester Supplementary Examinations, May -2005
HYDRAULICS AND HYDRAULIC MACHINERY
(Electrical & Electronic Engineering)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. (a) Differentiate between simple manometers and differential manometers.
   (b) Determine the gauge and absolute pressures in N/m^2 at a point on the free surface and at 4 m below the free surface of water. Take atmospheric pressure as 76 cm of Hg.

2. (a) Briefly explain the classification of flows.
   (b) What type of acceleration is to be expected if
      i. Streamlines are parallel and equidistant
      ii. Streamlines are straight and converging
      iii. Streamlines are curved but equispaced
      iv. Streamlines are curved and converging

3. (a) Explain the different forms of energy in a fluid.
   (b) The cross-sectional area of a convergent pipe is so shaped that the velocity of flow along the centre line varies linearly from 1 m/s to 10 m/s in a distance of one metre. The pipe is inclined downward at an angle of 30^0 with horizontal. Determine the difference in pressure between the two points, assuming the specific weight of the liquid as $7.85kN/m^3$.

4. A pipe line of 600 mm diameter is 1.5 km long. To increase the discharge, another line of the same diameter is introduced parallel to the first in the second half of the length. If f = 0.04 and head at inlet is 300 mm calculate the increase in discharge. Neglect minor losses.

5. Give the complete classification of orifices with neat sketches and also explain the phenomenon of jet contraction in orifice flow?

6. A jet of water, cross-sectional area $20cm^2$,issues with a velocity of 25m/s and strikes a stationary plate held at 30^0 to the axis of jet.Find the force exerted by the jet on the plate,and work out the components of force in the direction normal to the jet.Also find how the discharge gets distributed after striking the plate.

7. A double jet Pelton wheel has specific speed of 14 and develops 1 MW. The head available from the reservoir to the nozzle is 400 m. Allowing 5% for friction loss in the pipe, calculate the speed, diameter of jets and mean diameter of the buckets. Take Cv = 0.98, speed ratio = 0.46 and overall efficiency = 82%.

8. (a) Explain the indicator diagram for a reciprocating pump. How the area of the pump is proportional to the workdone?

(b) A single acting reciprocating pump running at 30 rpm delivers 0.012 m^3 /s of water. The diameter of the piston is 25 cm and stroke length is 50 cm. Determine:

i. the theoretical discharge of the pump

ii. coefficient of discharge and

iii. slip and percentage slip for the pump.

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1. (a) How does vapour pressure affect fluid flow?
   (b) Find the torque required to rotate a shaft of diameter 50 mm at 1400 rpm concentrically with a sleeve 50.16 mm in diameter and 10 m long filled with oil. Kinematic viscosity of oil is $0.94 \times 10^{-4} m^2/s$. Specific gravity of oil is 0.85.

2. (a) Derive the continuity equation for one-dimensional flow.
   (b) Distinguish between stream line, path line and streak line.

3. (a) Define the Bernoulli's equation for rotational flow mentioning the assumptions.
   (b) A pipe bend tapers from a diameter of 500mm at inlet to a diameter of 250mm at outlet and the flow is turned through 750. The pressures at inlet and outlet are $3.5N/m^2$ and $2.5N/m^2$. If the pipe is conveying oil of specific gravity 0.85, calculate the magnitude and direction of the resultant force on the bend when the oil flow rate is $0.5m^3/s$. The bend is in a horizontal plane.

4. (a) Explain hydraulically smooth and rough turbulent flows
   (b) A smooth pipe of diameter 80mm and 800m long carries water at the rate of $0.5m^3/minute$. Calculate the loss of head, wall shear stress and centerline velocity. Assume kinematic viscosity of water as 0.015 stokes. Assume f = $0.0791/(\mathrm{Re})^{1/4}$

5. Give the complete classification of orifices with neat sketches and also explain the phenomenon of jet contraction in orifice flow?

6. A square plate weighing 115N and of uniform thickness and 30 cm edge is hung so that horizontal jet 2 cm diameter and having a velocity of 15 m/s impinges on the plate. The center line of the jet is 15 cm below the upper edge of the plate, and when the plate is vertical the jet strikes the plate normally and at its center. Find what force must be applied at the lower edge of the plate in order to keep plate vertical.If the plate is allowed to swing freely, find the inclination to vertical which the plate will assume under the action of jet.

7. A Kaplan turbine develops 15 MW power under a head of 30 m. The diameter of the boss is 0.35 times the diameter of the runner. Assuming a speed ratio of 2, a flow ratio of 0.65 and an overall efficiency of 88%, determine :
   (a) the diameter of the runner

(b) the speed of the turbine , and

(c) the specific speed

8. A 4 stage Centrifugal pump has impellers 380mm diameter and 19mm wide at outlet. The outlet vane angle is 458 and the vanes occupy 8 % of the outlet area. The manometric efficiency is 84 % and the overall efficiency is 72%. Determine the head generated by the pump when running at 900 RPM, and discharging 59 lts/sec. Also determine the power required to drive the pump.

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1. (a) The surface tension of water in contact with air at 20^0C is 0.073 N/m. The pressure inside a water droplet is $0.15kN/m^2$ greater than the outside pressure. Calculate the diameter of the water droplet. Derive the equation used.
   (b) Differentiate between absolute and gauge pressures. Calculate the pressure in N/m^2 due to a column of 0.4 m of
      i. water
      ii. oil of specific gravity 0.9 and
      iii. mercury.
      Assume specific weight of water as $9810N/m^3$.

2. (a) Briefly explain the classification of flows.
   (b) What type of acceleration is to be expected if
      i. Streamlines are parallel and equidistant
      ii. Streamlines are straight and converging
      iii. Streamlines are curved but equispaced
      iv. Streamlines are curved and converging

3. (a) Explain the different forms of energy in a fluid.
   (b) The cross-sectional area of a convergent pipe is so shaped that the velocity of flow along the centre line varies linearly from 1 m/s to 10 m/s in a distance of one metre. The pipe is inclined downward at an angle of 30^0 with horizontal. Determine the difference in pressure between the two points, assuming the specific weight of the liquid as $7.85kN/m^3$.

4. (a) What are the various minor losses. Derive Darcy Weisbach equation for turbulent flow.
   (b) A pipe line carrying water has surface protrusions of average height 0.1mm. If the shear stress developed is $8N/m^2$, determine whether the pipe surface acts as smooth, rough or in transition. For water assume $\rho = 1000kg/m^3$, kinematic viscosity $= 0.9 \times 10^{-2}$ stokes.

5. Give the complete classification of orifices with neat sketches and also explain the phenomenon of jet contraction in orifice flow?

6. A jet of water, cross-sectional area $20cm^2$,issues with a velocity of 25m/s and strikes a stationary plate held at 30^0 to the axis of jet.Find the force exerted by the jet on the plate,and work out the components of force in the direction normal to the jet.Also find how the discharge gets distributed after striking the plate.

7. (a) Explain different efficiencies of a hydraulic turbine

   (b) A Pelton wheel is having a mean bucket diameter of 0.8 m and is running at 1000 rpm. The net head on the pelton wheel is 400 m. If the side clearance angle is 15^0 and discharge through the nozzle is 0.15 m^3/s, find the hydraulic efficiency of the turbine.

8. (a) Explain the different heads and efficiencies for a centrifugal pump

   (b) A centrifugal pump is running at 1000 rpm. The out let vane angle of the impeller is $30^0$and the flow velocity at the outlet is 3 m/s. The pump is working against a total head of 30 m and the discharge through the pump is 0.3 /s. If the manometric efficiency of the pump is 75% determine

      i. diameter of impeller and

      ii. width of the impeller at exit.

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1. (a) Define mass density, weight density, specific volume and specific gravity.
   (b) A 30 cm diameter shaft revolves in a guide bearing of 60 cm long at 500 rpm. If the oil film bearing is 0.13 mm and viscosity of oil is $0.05 Ns/m^2$, find the power absorbed.

2. (a) Derive the continuity equation for one-dimensional flow.
   (b) Distinguish between stream line, path line and streak line.

3. (a) Define the Bernoulli's equation for rotational flow mentioning the assumptions.
   (b) A pipe bend tapers from a diameter of 500mm at inlet to a diameter of 250mm at outlet and the flow is turned through 750. The pressures at inlet and outlet are $3.5 N/m^2$ and $2.5 N/m^2$. If the pipe is conveying oil of specific gravity 0.85, calculate the magnitude and direction of the resultant force on the bend when the oil flow rate is $0.5 m^3/s$. The bend is in a horizontal plane.

4. Two reservoirs with a difference in water surface elevation of 10 m are connected by a pipeline ABC, which consists of two pipes AB and BC joined in series. Pipe AB is 10 cm in diameter, 20 m long and has a value of f = 0.02. Pipe BC is of 16 cm diameter, 25 m long and has a f = 0.018. The junctions with the reservoirs and between the pipes are abrupt.
   (a) calculate the discharge,
   (b) what difference in water elevations is necessary to have a discharge of 15 litres/sec. (include all minor losses).

5. Determine the diameter of the throat of a venturimeter to be introduced in a horizontal section of a 0.10m diameter main so that reading of the differential U-tube manometer is 0.60m of mercury when the discharge is 20 litres per second. Assume the coefficient of discharge of the meter as 0.95.

6. A horizontal jet of water 5cm diameter and velocity 40m/s is deflected through an angle of 135^0 by a stationary curved vane. Assume shock less and frictionless flow, determine the magnitude and direction of the resultant force on the vane.

7. Draw the general layout of a Hydro-Electric Power plant and explain the working.

8. A double acting reciprocating pump has a stroke of 25 cm and piston diameter of 12.5 cm. The center of the pump is 4m above the level of water in the sump and 30 m below the delivery water level. The lengths of suction and delivery pipes are 6 m

and 35 m respectively and their diameters are both 6 cm. If the pump is running at 30 rpm, estimate the pressure head developed on the piston in m of water at

(a) the beginning of the suction stroke,

(b) the middle of suction stroke, and

(c) the end of suction stroke.
If the mechanical efficiency is 80%, determine the power required to drive the pump. Take atmospheric pressure as 10.3 m of water and 4f = 0.04

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