Code No: RR210106 **Set No.1**

II B.Tech. I Semester Regular Examinations, November -2005
FLUID MECHANICS
(Civil Engineering)

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

Answer any FIVE Questions
All Questions carry equal marks

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1. Three cylindrical tubes of internal radii 200 mm, 210 mm and 220 mm, wall thickness 5 mm and length 0.5 m are placed coaxially. The space between the inner and middle cylinders is filled with an oil of viscosity 8.34 poise and the space between the middle and outer cylinders is filled with an oil of viscosity 9.89 poise. What is the torque required to rotate the middle cylinder at 360 rpm. [16]

2. A 1.8 m diameter cylindrical tank is laid with its axis horizontal on a level ground. Each of its ends are closed by a hemispherical dome. The tank contains oil of relative density 0.9 under pressure. If a pressure guage on the top of the tank reads 22 kPa, calculate the resultant force on the spherical end. [16]

3. (a) Explain one, two and three dimensional flows.
   (b) If ϕ= 3xy, find x and y components of velocity at (1,3) and (3,3). Determine the discharge passing between streamlines passing through these points. [8+8]

4. (a) A 400 m long pipe has a slope of 1 in 100 and tapers from 1.2 m dia at high end to 0.6 m dia at the low end. The discharge is 100 lit/sec. If the pressure at high end is 100 kN/m^2, find the pressure at the low end. Neglect friction.
   (b) A 20 cm diameter pipe has a 90^0 bend (to the right) in the horizontal plane. When a discharge of 150 lit/sec of oil (S = 0.8) is sent in this pipe, the pressure at the beginning of the bend is found to be 0.5 m of oil. Estimate the resultant force exerted by the oil on the bend. [8+8]

5. (a) What is Magnus effect. Why it is known as Magnus effect.
   (b) Why is the streamlining of automobiles is of less practical importance than that of subsonic airplanes.
   (c) Find the drag force difference on a flat plate of size 1.5m x 1.5m when the plate is moving at a speed of 5m/sec normal to its plate first in water and second in air of density $1.24kg/m^3$. Coefficient of drag is given as 1.10. [5+5+6]

6. (a) Compute the kinetic energy and momentum correction factors for laminar flow between fixed parallel plates.
   (b) Oil flows through a pipe of 15cm diameter and 650m length with a velocity of 0.5 m/sec. If the kinematic viscosity of oil at the temperature is 18.7 stokes, find the loss of heat in friction. Assume the specific gravity of oil as 0.9. [8+8]

7. A pipe 0.15 m diameter taking off from a reservoir suddenly expands to 0.3 m at the end of 16 m and continues for another 15 m. If the head above the inlet of the

pipe is 4.88 m determine the actual velocity at the exit, taking into consideration all the losses. Take f= 0.04 for the complete pipe line. [16]

8. A vertical venturimeter of (d/D) ratio equal to 0.6 is fitted in a 0.1 m diameter pipe. The throat is 0.2 m above the inlet. The meter has a cd of 0.92. Find the pressure difference as recorded by two gages fitted at the inlet and throat and find the difference on a vertical differential mercury manometer (sp. Gravity of mercury = 13.6), when a liquid of specific gravity 0.8 flows through the meter at the rate of 0.05 m^3 per second. [16]

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1. A painter is painting a wall 3mX4m with a brush 0.1m wide and 0.0125m thick the thickness of one coat of paint is $7X10^{-3}$ m and the viscosity of the paint is 2 Pa-s. Calculate the total work required for painting one side of the wall. Assume the variation of velocity as liner. [16]

2. (a) Find the total pressure force and the depth of center of pressure on an inclined plane surface submerged in a liquid.
   (b) At a certain location in the flow field, pressure equals 50 m of water column. Obtain the equivalent pressure head in terms of
      i. Kerosene of specific gravity 0.8
      ii. carbon tetrachloride of specific gravity 1.5. [8+8]

3. (a) Define Stream function and velocity potential.
   (b) A fluid flow field is given by $V = x^2yi + y^2zj - (2xyz + yz^2)k$. Prove that it is a case of possible steady incompressible fluid flow. Calculate the velocity at the point (2,1,3). [8+8]

4. (a) Two pipes 0.5 m and 0.25 m in diameter are connected by a smooth transition bend making an angle of 75^0 between the two pipes. When a discharge of 0.4 m^3/s of water is flowing through this bend, the pressure on the upstream larger diameter pipe is 200 KPa. Calculate the force on the bend. Assume the bend to be horizontal.
   (b) In a smooth pipe of uniform diameter 25 cm, a pressure of 50 KPa was observed at section 1 which was at elevation 10.0 m. At another section 2 at an elevation of 12.0 m, the pressure was 20 KPa and the velocity was 1.25 m/s. Determine the direction of flow and the head loss between these two sections, the fluid in the pipe is water. [8+8]

5. (a) Differentiate between
      i. Stream line body and bluff body
      ii. Friction drag and pressure drag.
   (b) A kite 60cm x 60cm weighing 2.943 N assumes an angle of 10^o to the horizontal. If the pull on the string is 29.43N when the wind is flowing at a speed of 40 km/hr. Find the corresponding coefficient of drag and lift. Density of air is given as 1.25 kg/m^3. [8+8]

6. (a) What is Hagen poiseuilles equation. Derive the same for Laminar flow through pipes.

(b) What power is required per kilometer of a line to overcome the viscous resistance to the flow of glycerine through a horizontal pipe of diameter 10cm at the rate of 10 lit/sec. Take viscosity as 8 poise and kinematic viscosity as 6 stokes. [8+8]

7. The population of a city is $8X10^5$ and it is to be supplied with water from a reservoir 6.4 km away. Water is to be supplied at the rate of $0.14m^3$ per head per day and half the supply is to be delivered in 8 hours. The full supply level of the reservoir is R.L 180.00. and its lowest water level is R.L.105.00. The delivery end of the main is at R.L 22.50 and the head required there is 12m. Find the diameter of the pipe. Take f= 0.04. [16]

8. A venturimeter having inlet diameter 100 mm and throat diameter 25 mm is fitted in a vertical pipe, throat is 0.3 m below the inlet, for measuring the flow of petrol of specific gravity 0.78. Pressure gauges are fitted at inlet and throat. Taking loss of head between inlet and throat as 36 times the velocity head at inlet, find c_d of the meter and the discharge when the inlet gauge reads 274.68 KN/m^2. [16]

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1. Two discs of 20 cm diameter are placed 1 mm apart and the gap is filled with an oil of viscosity 0.8 poise. Determine the power required to rotate upper disc at 600 R.P.M., while holding the lower disc stationary. [16]

2. A rectangular plate 2 m length and 1 m height lies immersed vertically in a liquid of relative density 0.75 such that 2 m side is parallel to and at a depth of 0.7 m from the free liquid surface. If the plate has a circular hole of 0.5 m diameter drilled at its center, compute the total pressure exerted by the liquid on the plate and the depth of the center of pressure. [16]

3. (a) The velocity of a 3-D flow field is given by $V = (y^2+z^2)i + (x^2+z^2)j + (x^2+y^2)k$ Determine the acceleration components at a point (1,2,3)
   (b) Derive the continuity equation for a 3-D fluid flow. [8+8]

4. A pipeline is 15 cm in diameter and is at an elevation of 100 m at section A. At section B, it is at an elevation of 107.0 m and has a diameter of 30 cm. When a discharge of 50 lit/sec of water is passed through this pipe, the pressure at section A is observed to be 30 KPa. The energy loss in the pipe is 2 m. Calculate the pressure at B when the flow is
   (a) from A to B,
   (b) from B to A. [16]

5. (a) Differentiate between
      i. Stream line body and bluff body
      ii. Friction drag and pressure drag.
   (b) A kite 60cm x 60cm weighing 2.943 N assumes an angle of 10^o to the horizontal. If the pull on the string is 29.43N when the wind is flowing at a speed of 40 km/hr. Find the corresponding coefficient of drag and lift. Density of air is given as 1.25 kg/m^3. [8+8]

6. (a) Compute the kinetic energy and momentum correction factors for laminar flow between fixed parallel plates.
   (b) Oil flows through a pipe of 15cm diameter and 650m length with a velocity of 0.5 m/sec. If the kinematic viscosity of oil at the temperature is 18.7 stokes, find the loss of heat in friction. Assume the specific gravity of oil as 0.9. [8+8]

7. If two pipes of diameter D and d and equal length L are arranged in parallel the loss of head for a flow of Q is h. If the same pipes are arranged in series the loss of head for the same flow Q is H. If d= 0.5D find the percentage of total flow through each pipe when placed in parallel and the ratio (H/h). Neglect minor losses and assume‘ f ’ to be constant. [16]

8. (a) What is an orifice?
   (b) What is coefficient of velocity, coefficient of contraction and coefficient of discharge?
   (c) What are the formulae for calculating the actual discharge if a rectangular orifice is used and if a circular orifice is used? [4+6+6]

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1. A plate having an area of $0.6m^2$ is sliding down the inclined plane at 30^0 to the horizontal with a velocity of 0.36 ms^{-1}. There is a cushion of fluid 1.8 mm thick between the plane and the plate. Find the viscosity of the fluid if the weight of the plate is 280N. [16]

2. (a) A tank contains 0.6 m of mercury, 2.5 m of liquid with unknown density, 2 m of water and 0.75 m of oil of relative density 0.9 with one layer over the other as they are immiscible. What is the specific weight of the unknown fluid if the absolute pressure measured at the bottom of the tank is 266.5 kPa and the atmospheric pressure is 101330 N/m^2.

   (b) Water stands to a height of 60 cm in each limb of the U tube with an internal diameter of 10 mm. What are the new heights of the water colums in the left and right limbs after $40cm^3$ of oil of density 0.8 g/cc is poured into the right limb. [8+8]

3. (a) Explain one, two and three dimensional flows.

   (b) If ϕ= 3xy, find x and y components of velocity at (1,3) and (3,3). Determine the discharge passing between streamlines passing through these points. [8+8]

4. A 30 cm diameter pipe is bifurcated into two nozzles at a y-junction. The nozzles discharge to atmosphere and have a velocity of 10 m/s each. Diameters of first and second nozzles are 7.5 cm and 10 cm respectively. The junction is in a horizontal plane and the angle of interception of two nozzles at the junction is 60^0 Neglecting the friction, determine the magnitude and direction of the resultant force on the y-junction. [16]

5. (a) Differentiate between

      i. Stream line body and bluff body

      ii. Friction drag and pressure drag.

   (b) A kite 60cm x 60cm weighing 2.943 N assumes an angle of 10^o to the horizontal. If the pull on the string is 29.43N when the wind is flowing at a speed of 40 km/hr. Find the corresponding coefficient of drag and lift. Density of air is given as 1.25 kg/m^3. [8+8]

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7. The population of a city is $8X10^5$ and it is to be supplied with water from a reservoir 6.4 km away. Water is to be supplied at the rate of $0.14m^3$ per head per day and half the supply is to be delivered in 8 hours. The full supply level of the reservoir is R.L 180.00. and its lowest water level is R.L.105.00. The delivery end of the main is at R.L 22.50 and the head required there is 12m. Find the diameter of the pipe. Take f= 0.04. [16]

8. (a) What will be the ratio of the area of the supply pipe to the area of the nozzle for maximum transmission of power through nozzle.

(b) A nozzle is fitted at the end of a pipe of length 300 m and of diameter 10 cm . For the maximum transmission of power through the nozzle, find the diameter of nozzle. Take f= 0.009. [8+8]

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