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

II B.Tech. I Semester Supplementary Examinations, May -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. 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.

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.

3. (a) What is a potential flow?
   (b) Write down the continuity equation for a unidimensional unsteady state incompressible flow.
   (c) The stream function for fluid flow is given by $\Psi = m \tan^{-1}(y/x)$. Sketch the streamlines and equipotential lines.

4. (a) A 30^0 reducer bend tapers from 600 mm diameter at inlet to 300 mm diameter at outlet. The pressure at inlet is 1.5 bar and the flow rate of oil (S = 0.9) through the bend is 500 lit/s. Assuming friction losses to be 20% of the Kinetic energy head at the inlet, Compute the magnitude and direction of the resultant force exerted by the fluid on the bend.
   (b) List out the applications of impulse-momentum principle.

5. (a) Define Laminar boundary layer, turbulent boundary layer, laminar sub-layer and boundary layer thickness.
   (b) A thin plate is moving in still atmospheric air at a velocity of 4m/sec. The length of the plate is 0.5m and width 0.4m. Calculate the thickness of boundary layer at the end of the plate and drag force on one side of the plate. Take density of air as 1.25 kg/m^3 and kinematic viscosity is 0.15 stokes.

6. (a) Describe Reynold's experiment with a neat sketch. What are the outcomes of Reynolds experiment.
   (b) A crude oil of viscosity 0.97 poise and relative density 0.9 is flowing through a horizontal circular pipe of diameter 10cm and of length 10m. Calculate the difference of pressure at the two ends of the pipe, if 100 kg of the oil is collected in a tank in 30 seconds.

7. Two reservoirs are connected by a pipe 2250 m long and 0.225m in diameter, the difference in water levels being 7.5 m. Find the flow through the pipe if f= 0.03. Also find the percentage increase in the discharge if for the last 600m a second pipe of the same diameter is laid along side the first.

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.

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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.

2. (a) A mercury U-tube monometer consists of two pipes A and B carrying fluids of relative densities 0.70 and 0.8 respectively. Pipe A is 0.15 m above pipe B. The manometer records a deflection of 8 cm with mercury level in the limb connected to pipe B being higher. The difference in elevation between the axis of pipe B and the mercury level in the limb connected to it is 0.18 m. Find the pressure difference between points A and B.

   (b) The absolute pressure at a point in a fluid is 85.2 kPa. What are the corresponding gauge and vacuum pressure in N/m^2 if the barometer reads 762 mm mercury. Express your answers in bars also.

3. (a) What is a potential flow?

   (b) Write down the continuity equation for a unidimensional unsteady state incompressible flow.

   (c) The stream function for fluid flow is given by Ψ= m $\tan^{-1}$(y/x). Sketch the streamlines and equipotential lines.

4. Gasoline which has a vapour pressure of 5.5 x 10^4 Pa (abs) and density $\rho = 680$ kg/m^3 flows through a constriction in a pipe where diameter is reduced from 20 cm to 10 cm. The pressure in the 20 cm pipe just upstream of the constriction is 50 KPa. If the atmospheric pressure is 75 cm of mercury, calculate the maximum discharge that can be passed through this constriction without cavitation occurring.

5. (a) Explain the different methods of preventing the separation of boundary layer.

   (b) A smooth flat plate 2.4m long and 90cm wide moves lengthwise at 6m/sec through still atmospheric air of density 1.25 kg/m^3 and kinematic viscosity 1.49 x $10^{-5} m^2$/sec. Assuming the boundary layer to be entirely laminar, calculate boundary layer thickness at the trailing edge of the plate, the shear stress half way along and the power required to move the plate.

6. (a) Describe Reynold's experiment with a neat sketch. What are the outcomes of Reynolds experiment.

(b) A crude oil of viscosity 0.97 poise and relative density 0.9 is flowing through a horizontal circular pipe of diameter 10cm and of length 10m. Calculate the difference of pressure at the two ends of the pipe, if 100 kg of the oil is collected in a tank in 30 seconds.

7. What is Reynolds number? Explain the variation of friction factor with Reynold's number for turbulent flow in smooth and rough pipes along with corresponding formulae.

8. A rectangular channel 6 m wide carries 2.8 m^3 per second at a depth of 0.9 m. What height of a broad crested rectangular weir must be installed to double the depth? Take coefficient of weir = 0.86.

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1. (a) A liquid with a volume of $0.2m^3$ at 300 kPa is subjected to a pressure of 3000kPa and its volume is found to decrease by 0.2%. Calculate the bulk modulus of elasticity of the liquid.
   (b) If the surface tension of water in contact with air is 0.075 N/m, what correction need be applied toward capillary rise in the monometer reading in tube of 3mm diameter.

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.

3. In a circular pipe the velocity varies as $\mathrm{v} = \mathrm{v}_m \left(1 - \frac{r^2}{R^2}\right)$ where v is the velocity at a radial distance r from the axis of the pipe and V_m is the maximum flow at the axis. Find the ratio of average velocity in the pipe to maximum velocity.

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

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.

6. (a) Derive an expression for the difference of pressure head for a given length of the two parallel plates which are fixed and through which viscous fluid is flowing.

(b) Calculate the pressure gradient along the flow, the average velocity and the discharge for an oil of viscosity 0.02 NS/m^2 flowing between two stationary plates 1m wide maintained 1cm apart. The velocity midway between the plates is 2.5 m/sec.

7. A pipe line of 0.6 m 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. Neglecting minor losses, find the increase in discharge if f= 0.04. The head at inlet is 30 m.

8. (a) Show that a capolletti weir can be treated as equivalent to suppressed rectangular weir.

   (b) Water flows through a rectangular channel 1m wide and 0.5 m deep and then over a sharp crested Cipolletti weir of crest length 0.6 m. If the water level in the channel is 0.225 m above the weir crest find the discharge over the weir, if velocity of approach is neglected and find the discharge if it is considered. Take $c_d = 0.6$.

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Code No: RR210106 **Set No.4**

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1. (a) Differentiate between "cohesion" and " adhesion"
   (b) Determine the absolute pressure and the gauge pressure that would exist within
      i. a spherical droplet of water 5mm in diameter.
      ii. a jet of water 5mm in diameter. Surface tension of water at the prevalent temperature is 0.0736 N/m and the barometer reading stands at 750 mm of mercy. Take sp. Gravity of mercury as 13.55.

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.

3. (a) Calculate the velocity component v, if u = $A(x^2 + y^2)$ so that the equation of continuity is satisfied.
   (b) For the following flow, determine the components of rotation about the various axes. $u = xy^3z, v = -y^2z^2, w = yz^2 - \frac{y^3z^2}{2}$
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4. (a) A pipe 12.5 cm in diameter is connected to a nozzle of 2.5 cm diameter by a flanged joint. If the nozzle discharges with a velocity of 43.2 m/s, find the magnitude and direction of force in the flanged connections.
   (b) Water is pumped at the rate of 200 l/s through a 30 cm pipe upto a hill top. If the pump maintains a pressure of 150 kN/m^2 at the hill top at an elevation of 45 m, What is the pressure at the foot hills at zero elevation. Neglecting losses, What is the power required to pump the water?

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.

6. (a) Describe Reynold's experiment with a neat sketch. What are the outcomes of Reynolds experiment.

(b) A crude oil of viscosity 0.97 poise and relative density 0.9 is flowing through a horizontal circular pipe of diameter 10cm and of length 10m. Calculate the difference of pressure at the two ends of the pipe, if 100 kg of the oil is collected in a tank in 30 seconds.

7. For the distribution main of a city water supply a 0.3 m main is required. As pipes above 0.25m dia are not available it is decided to lay two parallel mains of same diameter. Find the diameter of the parallel main.

8. (a) Give the 3 different empirical formulae for calculating the discharge over rectangular weirs.

   (b) Find the discharge over a suppressed rectangular weir 4 m long with a head over the crest as 0.35 m. Assume C_d=0.60.

   (c) A rectangular weir 6 m long is divided into 3 bays by two vertical posts each 0.3 m wide. Find the discharge when the head is 0.45 m. Take C_d=0.62.

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