Code No: A109210105 **R09** **Set No. 2**

II B.Tech I Semester Examinations,November 2010
FLUID MECHANICS
Civil Engineering

Time: 3 hours **Max Marks: 75**

Answer any FIVE Questions
All Questions carry equal marks

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1. Find the displacement thickness, the momentum thickness and energy thickness for the velocity distribution in the boundary layer given by u/U = 2(y/δ) - $\left(\frac{y}{\delta}\right)^2$. [15]

2. (a) Write the units of the following terms in SI and MKS systems:
   i. mass density
   ii. specific weight
   iii. surface tension
   iv. dynamic viscosity and
   v. Kinematic viscosity.

   (b) Explain:
   i. How certain insects are able to walk on the surface of water?
   ii. Why petrol evaporates more readily than water at ordinary temperature? [10+5]

3. Determine the rate of flow of water through a pipe of diameter 20 cm and length 50m when one end of the pipe is connected to a tank and other end of the pipe is open to the atmosphere. The pipe is horizontal and the height of water in the tank is 4 m above the centre of the pipe. Consider all minor losses and take f = 0.009 in the formula $h_f = \frac{4fLV^2}{2gd}$. [15]

4. A reducer bend having an outlet diameter of 20cm discharges freely. The bend is connected to a pipe of 25cm diameter and has a deflection of 60^0. Determine the magnitude and direction of force when a discharge of $0.3 m^3/s$ passes through the pipe. [15]

5. (a) What type of acceleration is to be expected if:
   i. stream lines are parallel and equidistant
   ii. stream lines are straight and converging
   iii. stream lines are curved but equispaced
   iv. stream lines are curved and converging

   (b) Derive the equation for a stream line. [7+8]

6. (a) Explain pitot tube and pitot static tube.

   (b) A sub-marine moves horizontally in sea and has its axis 15 m below the surface of water. A pitot-tube properly placed just in front of the sub-marine and along its axis is connected to the two limbs of a U-tube containing mercury.

The difference of mercury level is found to be 170 mm. Find the speed of the sub-marine knowing that the sp. gr. of mercury is 13.6 and that of sea-water is 1.026 with respect of fresh water. [7+8]

7. A pipe of diameter 20 cm and length 10,000 m is laid at a slope of 1 in 200. An oil of Specific gravity = 0.9 and $\mu = 1.l5$ poise is pumped up at the rate of 20 litres per second. Find the head lost due to friction. Also find the power required to pump the oil. [15]

8. The profile of a vessel is quadrant of a circle of radius 'r'. Obtain from first principles the horizontal and vertical components of the total pressure force. [15]

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Code No: A109210105 **R09** **Set No. 4**

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Time: 3 hours **Max Marks: 75**

Answer any FIVE Questions
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1. (a) Define stream function and velocity potential function. Deduce the relation between the two.

   (b) In a two dimensional incompressible flow, the fluid velocity components are given by u = x - 3y and v = - 4y - 9x. Show that the velocity potential exists and determine its form as well as stream function. [5+10]

2. For the velocity profile for turbulent boundary layer $u/U = \left(\frac{y}{\delta}\right)^{1/7}$ obtain an expression for boundary layer thickness, shear stress and drag force on one side of the plate, in terms of Reynold's number. Given the shear stress for turbulent boundary layer as 0.0225 ρu^2 $(\mu/\rho\ u\delta)^{1/4}$. [15]

3. (a) State the momentum principle. How will you apply momentum equation for determining the force exerted by a flowing liquid on a pipe bend?Explain in detail.

   (b) Write Euler's equation of motion along a stream line and integrate it to obtain Bernoulli's equation. State all assumptions made. [7+8]

4. (a) State Pascal's law. What do you understand by the terms atmospheric, gauge and vacuum pressures.

   (b) Prove that the pressure intensity in the liquid is directly proportional to the height of a point from free surface of liquid. [7+8]

5. (a) Explain Francis's and Bazin's formulae.

   (b) The head of water over a rectangular weir is 40 cm. The length of the crest of the weir with end contraction suppressed is 1.5 m. Find the discharge using the following formulae:

      i. Francis's Formula and
      ii. Bazins Formula. [7+8]

6. (a) Derive an expression for the depth of centre of pressure from free surface of liquid of an inclined plane surface submerged in the liquid.

   (b) Find the total pressure and position of centre of pressure on a triangular plate of base 2.4m and height 3.6m which is immersed in water in such a way that the plan of the plate makes an angle of 60^0 with the free surface of the water. The base of the plate is parallel to water surface and is at a depth of 3.0m from water surface. [7+8]

7. A pipe of diameter 20 cm and length 2000 m connects two reservoirs, having difference of water levels as 20 m. Determine the discharge through the pipe.
   If an additional pipe of diameter 20 cm and length 1200 m is attached to the last 1200 m length of the existing pipe, find the increase in the discharge.
   Take f = 0.015 and neglect minor losses. [15]

8. Lubricating oil of specific gravity 0.82 and dynamic viscosity 12.066×10^2 N.s/m^2 is pumped at a rate of 0.02 m^3/s through a 0.15 m diameter 300m long pipe. Calculate the pressure drop, average shear stress at the wall of the pipe and the power required to maintain flow, if the pipe is inclined at 15 degree with the horizontal and the flow is in upward direction. [15]

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II B.Tech I Semester Examinations,November 2010
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1. Caculate the power required to over come the friction in a journal bearing with the following data. Diameter of shaft = 75mm; Dia of sleeve = 76mm; length of sleeve = 150mm; speed of the shaft = 500rpm viscosity of the lubricant = 1.8 poise. [15]

2. Show that ψ=x^2-y^2 represents on two dimentional irrotational flow. Find the potential function [15]

3. For the velocity profile for laminar boundary layer u/U = 3/2 (y/δ) -1/2(y/δ)^2. Find the boundary layer thickness, shear stress, force and co-efficient of drag in terms of Reynolds number. [15]

4. The angle of a reducing bend is 60^0 (that is deviation from initial direction to final direction). Its initial diameter is 200mm and final diameter is 100mm and is fitted in a pipeline, carrying a discharge of 260 litres/sec. Sketch the configuration. The pressure at the commencement of the bend is 4.39bar. The friction loss in the pipe bend may be assumed as 10 percent of kinetic energy at exit of the bend. Determine the force exerted by the reducing bend. [15]

5. A trapezoidal plate of parallel sides 'l' and '2l' and height 'h' is immersed vertically in water with its side of length 'l' horizontal and topmost. The top edge is at a depth 'h' below the water surface. Determine:
   (a) Total force on one side of the plate
   (b) Location of the centre of pressure. [15]

6. Water is flowing in a rectangular channel of 1 m wide and and 0.75 m deep. Find the discharge over a rectangular weir of crest length 60 cm if the head of water over the crest of weir is 20 cm and water from channel flows over the weir.
   Take C_d = 0.62. Neglect end contractions. Take velocity of approach into consideration. [15]

7. A pumping plant forces water through a 600 mm diameter main, the friction head being 27 m. In order to reduce the power consumption, it is proposed to lay another main of appropriate diameter along the side of the existing one, so that two pipes may work in parallel for the entire length and reduce the friction head to 9.6 m only. Find the diameter of the new main with the exception of diameter, it is similar to the existing one in every respect. [15]

8. (a) A shaft 150 mm diameter runs in a bearing of length 300 mm, with a radial clearance of 0.04 mm at 40 r.p.m. Find the viscosity of the oil, if the power required to overcome the viscous resistance is 220.275 W.

(b) Water is flowing through a 150 mm diameter pipe with a co-efficient of friction f=0.05. The shear stress at a point 40 mm from the pipe wall is 0.01962 N/cm^2. Calculate the shear stress at the pipe wall. [7+8]

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1. (a) A rectangular notch 40 cm long is used for measuring a discharge of 30 litres per second. An error of 1.5 mm was made, while measuring the head over the notch. Calculate the percentage error in the discharge. Take $C_d = 0.60$.
   (b) A weir 36 metres long is divided into 12 equal bays by vertical posts, each 60 cm wide. Determine the discharge over the weir, if the head over the crest is 1.20 m and velocity of approach is 2 metres per second. [7+8]

2. (a) Find the pressure gradient along flow, the average velocity and the discharge for an oil of viscosity 0.02 Ns/m^2 flowing between two stationary parallel plates 1 m wide maintained 10 mm apart. The velocity midway between the plates is 2 m/s.
   (b) Determine the pressure gradient, the shear stress at the two horizontal parallel plates and the discharge per metre width for the laminar flow of oil with a maximum velocity of 2 m/s between two horizontal parallel fixed plates which are 100 mm apart. Take $\mu = 2.4525$ Ns/m^2. [7+8]

3. A cylinder of 2m diameter is kept in the tank which is 1m long. The water and oil are poured to two sides of the cylinder in the tank so the height of oil is 1m and height of water is 0.5m. Determine the horizontal and vertical components of the forces acting on the cylinder and their points of action. [15]

4. Air is flowing over a smooth plate with a velocity of 8 m/s. The length of the plate is 1.5 m and width 1 m. If the laminar boundary exists upto a value of Reynold number = 5×10^5, find the maximum distance from the leading edge upto which laminar boundary layer exists. Find the maximum thickness of laminar boundary layer if the velocity profile is given by $u/U = (y/\delta) - (y/\delta)^2$. Take Kinematic viscosity for air = 0.15 stokes. [15]

5. A horizontal pipe of diameter 500 mm is suddenly contracted to a diameter of 250 mm. The pressure intensities in the large and smaller pipe is given as 13.734 N/cm^2 and and 11.772 N/ cm^2 respectively. The rate of flow of water is 300 lps. Find the value of co-efficient of contraction. [15]

6. 200 litres per second of water is flowing in a pipe having a diameter of 40cm. The pipe is bent by 135^0 and the pressure of water flowing in the pipe is 350KPa. Sketch the configuration. Find the magnitude and direction of resultant force on the bend. [15]

7. Briefly explain the classification of various types of fluid flow. Also give three examples for each type of flow. [15]

8. A thin plate is placed between two flat surfaces kept h cm apart, such that the viscosities on top and bottom of the plates are μ_1 and μ_2 respectively. Determine the position of the thin plate such that the viscous resistance to uniform motion of the thin plate is minimum. Assume 'h' to be very small. [15]

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