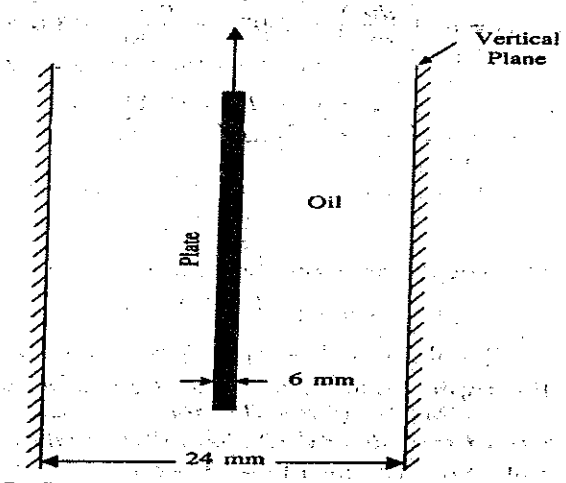
BITS, Pilani-Dubai
International Academic City, Dubai
Second Semester 2009-2010
ME C212 Transport Phenomena I
Comprehensive Examination (Closed Book)

Max. Marks: 80 **Weightage: 40%** **Date: 26.05.2010** **Duration: 3 Hours**

Note: 1.Answer all the questions sequentially 2.Assume suitable data, if required

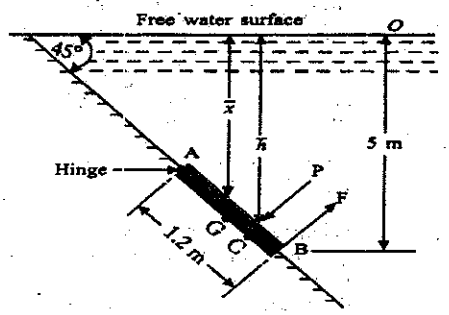
1. (a) Define the terms: (i) Newton's law of viscosity and (ii) No-Slip condition (2M)

(b) A metal plate 1.25 m x 1.25 m x 6 mm thick and weighing 90 N is placed midway in the 24 mm gap between the two vertical plane surfaces as shown in Fig. The gap is filled with an oil of specific gravity of 0.85 and dynamic viscosity 3 Ns/m^2. Determine the force required to lift the plate with constant velocity of 0.15 m/s (8M)



2 (a) Define the terms : (i) buoyancy and (ii) Pressure head (2M)

(b) An inclined rectangular gate 1.2 m by 5 m size as shown in Fig is installed to control the discharge of water. The end A is hinged. Determine the force normal to the gate applied at B to open it. (8M)



3.(a) Write the Euler's equation of motion. (2M)

(b) A vertical venturimeter carries a liquid of specific gravity 0.8 and has inlet and throat diameters of 150 mm 75 mm respectively. The pressure connection at the throat is 150 mm above that at inlet. If the actual discharge is 40 liters/sec and C_d=0.96, calculate the pressure difference between inlet and throat in N/m^2 (8M)

4(a) State the assumptions made in deriving the Hagen-Poiseuille equation. (2M)

(b) The velocity distribution in a pipe is given by

$$\frac{u}{u_{max}} = 1 - \left(\frac{r}{R}\right)^n \quad \text{(8M)}$$

Where u_{max} is the maximum velocity at the center of the pipe, u is the velocity at a distance r from the centre and R is the pipe radius. Obtain an expression for mean velocity in terms of u_{max} and n

5(a) What is flow net? Draw the sketch for flow net. (2M)

(b) The velocity potential for a flow is given by

$$\phi = U_o x + c\left(\cos\frac{2\pi x}{l}\right)e^{-\left(\frac{2\pi}{l}y\right)}$$

Determine the stream function for this flow (8M)

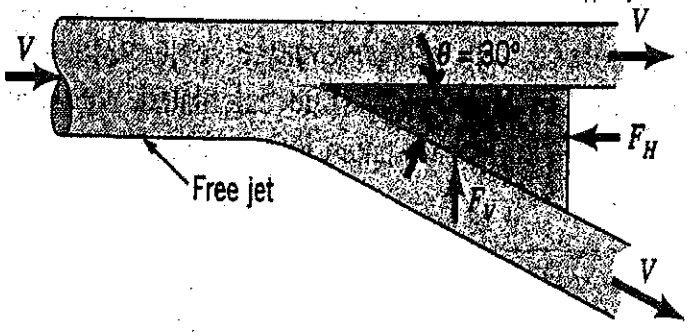
6(a) Explain the term dimensional homogeneity. (2M)

(b) The discharge Q of a centrifugal pump depends upon the density of a fluid (ρ), the speed of the pump (N), the diameter of the impeller (D), the manometric head (H_m) and viscosity of fluid (μ), Show that using the Buckingham π - theorem

$$Q = ND^3\phi\left[\frac{\mu}{\rho ND^2}, \frac{gH}{N^2D^2}\right] \quad \text{(8M)}$$

7(a) Define the terms: (i) Control Surface and (ii) Control Volume (2M)

(b) A free jet of water strikes a wedge as shown in Fig . Of the total flow, a portion is deflected 30^0 ; the remainder is not deflected. The horizontal and vertical components of force needed to hold the wedge stationary are F_H and F_V respectively. Water velocity remains constant. Determine the force ratio F_H/F_V. (8M)



8(a) Define the terms: (i) Streamlined (ii) bluff bodies (2M)

(b) A plate 450 mm x 150 mm has been placed longitudinally in a stream of crude oil, with density 925 kg/m^3 and kinematic viscosity of 0.00009 m^2/s, which flows with velocity of 6 m/s. Calculate (i) the friction drag on the plate (ii) thickness of the boundary layer at the trailing edge and (iii) shear stress at the trailing edge (8M)

BITS,Pilani - Dubai
Second Semester 2009 - 2010
Course: ME C212 Transport Phenomena I
TEST: 2[Open book]

Max.Marks :20 Date:09.05.2010
Weightage: 20 % Time: 50 min

Note: (i) Answer all Questions (ii) Assume suitable value if required

1. The flow field of a fluid is given by (5)

   u=xy v=2yz and w= -(yz+z^2)

   (i) Is the flow physically possible?
   (ii) Is this flow rotational or irrotational? and
   If rotational, find at point A(2,4,6), angular velocity, vorticity.

2. Determine the flow through the pipe as shown in Fig. 2 (5)

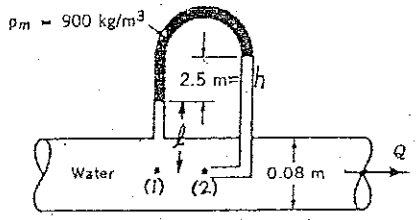


FIGURE.2

3 A ship 300 m long moves in sea water, whose specific gravity is 1.030. A 1: 100 model of this ship is to be tested in a wind tunnel. The velocity of air in the wind tunnel around the model is 30 m/s and the resistance of the model is 60 N. Determine the velocity of ship in sea water and also the resistance of the ship in the sea water. The density of air as 1.24 kg/m^3. Assume the kinematic viscosity of sea water as 0.012x10^{-4} m^2/s and for air as 0.018x1010^{-4} m^2/s. (5)

4 A simple flow system to be used for steady flow tests consists of a constant head tank is connected to a length of 4 mm diameter as shown in Fig 4. The liquid has viscosity of 0.015 Ns/m^2, a density of 1200 kg/m^3 and discharges into the atmosphere with a mean velocity of 2 m/s. (a)Verify the flow will be laminar (b) the flow is fully developed in the last 3 m of the tube. What is the pressure at the pressure gage? (c) What is the magnitude of the wall shearing stress in the fully developed region (5)

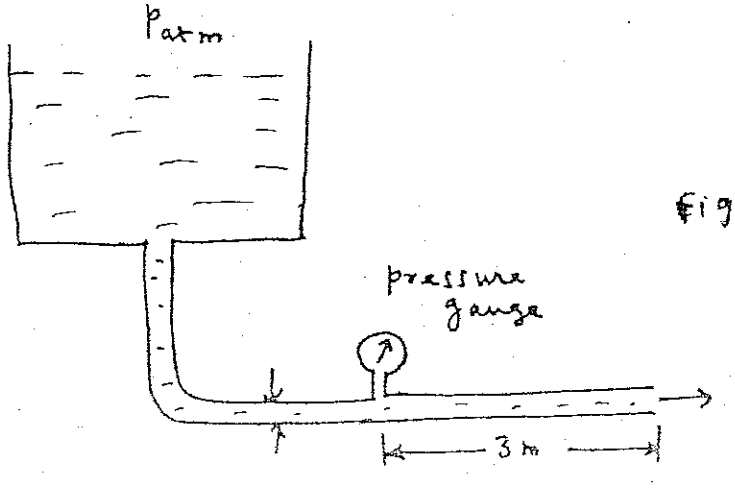


Fig. 4

BITS,Pilani - Dubai

Second Semester 2009 - 2010

Course: ME C 212 Transport Phenomena I

TEST: 1[Closed book]

Max.Marks :25 **Date:28.03.2010**

Weightage: 25 % **Time: 50 min**

Note: *(i) Answer all Questions*
(ii) Assume suitable value if required

1.If 1 cup of cream having a density of 1005 kg/m^3 is turned into 3 cups of whipped cream, determine the specific gravity and specific weight of the whipped cream. (Assume cups are same size) (5)

2. A 25 mm diameter shaft is pulled through a cylindrical bearing of length L = 0.5 m. The lubricant that fills the 0,3 mm gap between the shaft and bearing is an oil having a kinematic viscosity of 0.8 X 10^{-4} m^2/s and specific gravity of 0.91. Determine the force required to pull the shaft at a velocity of 3 m/s. Assume the velocity distribution in the gap is linear. (5)

3. A wooden beam with specific gravity of 0.6 and dimension 15 cm x 15 cm and 4 m long is hinged at A as shown in Fig 3. At what angle Θ will the beam float in the water? (8)

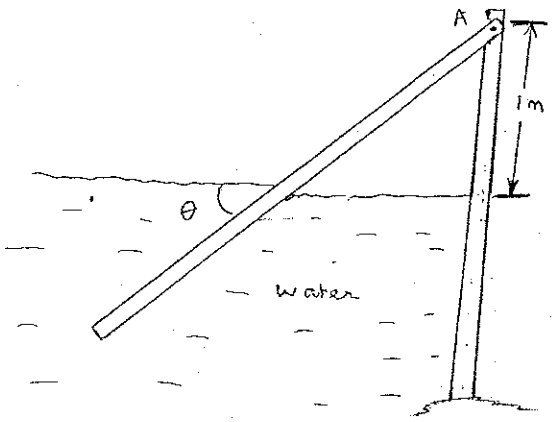


Fig 3

4. A conical water spray head is shown in Fig 4. Calculate axial force exerted by the spray head on the supply pipe.(Assume atmospheric pressure 101 kPa) Flow rate Q=0.03 m^3/s (7)

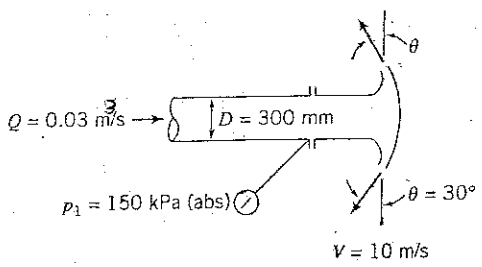


Fig 4

BITS, PILANI – DUBAI

SECOND SEMESTER 2009 – 2010

B

QUIZ-2

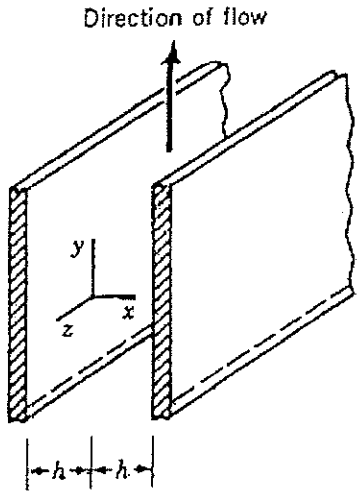
Course Code: MC C212 **SECOND YEAR** Date: 06.04.10

Course Title: TRANSPORT PHENOMENA -I Max Marks: 7

Duration: 20 minutes Weightage: 7%

Name: ..... **ID No:** ..... **Sec :** .....

1.



A viscous, incompressible fluid flows between the two infinite, vertical, parallel plates of Fig. 1. Determine, by use of the Navier–Stokes equations, an expression for the velocity profile in the direction of flow. Express your answer with constants C_1 and C_2.

(5)

2. Find the σ_{xx} for given velocity profile u= $12xy^2 - 6x^3$ and v= $18x^2y - y^3$ at a point x=0.5 m , y= 1 m. The fluid is having dynamic viscosity of 1.5 Ns/m^2 and pressure 6 kPa. (2)

3. Water flows steadily through a diverging channel. At the outlet, height 2H, width W, centerline velocity V_m and exit velocity profile is

$$u = V_m \cos(\frac{\pi y}{2H})$$

Find volume flow rate. (2)

4. It is known that the velocity distribution for two-dimensional flow of a viscous fluid between wide parallel plates (Fig. P6.31) is parabolic; that is

$$u = U_c \left[1 - \left(\frac{y}{h}\right)^2\right]$$

with $v = 0$. Determine, if possible, the corresponding stream function

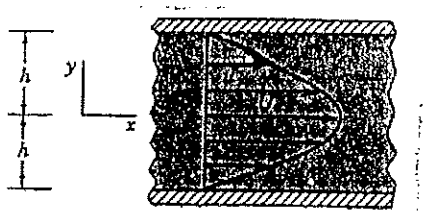


FIGURE 4

(2)

BITS, PILANI – DUBAI

SECOND SEMESTER 2009 – 2010

B

QUIZ-1

Course Code: MC C212 **SECOND YEAR** Date: 23.02.10

Course Title: TRANSPORT PHENOMENA -I Max Marks: 16

Duration: 20 minutes Weightage: 8%

Name: ..... **ID No:** ..... **Sec :** .....

Instructions: Attempt all questions

1. The viscosity of water at temperature T (K) can be computed from $\mu = Ax10^{B/(T-C)}$ where A = 2.414 x 10^{-5} N.s/m^2, B = 247.8 K, and C = 140 K. Determine the viscosity of water at 293 K. If specific gravity of water is 1 find also kinematic viscosity. (5 Marks)

2.The velocity distribution for laminar flow between parallel plates is given by

$$\frac{u}{U} = 1 - \left(\frac{2y}{h}\right)^2$$

where h is the distance separating the plates and the origin is placed midway between the plates. Find the shear stress at bottom and top of the plates. (5 Marks)

3.For a fluid density ρ in which solid particles of density ρ_s are uniformly dispersed, show that if (1-x) is mass fraction fluid in the mixture , the density is given by

$$\rho_{mixtures} = \frac{\rho_s \rho}{\rho x + \rho_s (1-x)}$$ (6 Marks)