BITS, Pilani-Dubai Campus

Dubai International Academic City, Dubai

Second Semester 2010-2011

ME C212 Transport Phenomena I

Comprehensive Examination (Closed Book)

Max. Marks: 80 Weightage: 40% Date: 05.06.2011 Duration: 3 Hours

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

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1.a. Differentiate between Newtonian fluid and Non- Newtonian fluid. (2)

b. A 400 mm diameter shaft is rotating at 200 rpm in a bearing of length 120 mm. If the thickness of oil film is 1.5 mm and the dynamic viscosity of the oil is 0.7 Ns/m^2 , determine

(i) Torque required to overcome friction in bearing

(ii) Power utilized in overcoming viscous resistance (8)

2. a. What are the conditions for flow to be irrotational ? (2)

b.Show that the stream lines and equipotential lines form a net of mutually perpendicular lines. (8)

3.a.Define the terms: (i) Centre of pressure and (ii) total pressure (2)

b. A triangular plate of 1 m base and 1.5 m altitude is immersed in water. A plane of the plate is inclined at 30^0 with free water surface and the base is parallel to and at a depth of 2 m from the water surface. Find the total pressure on the plate and the position of centre of pressure. (8)

4.a.Define the terms: (i) Control surface and (ii) Control volume (2)

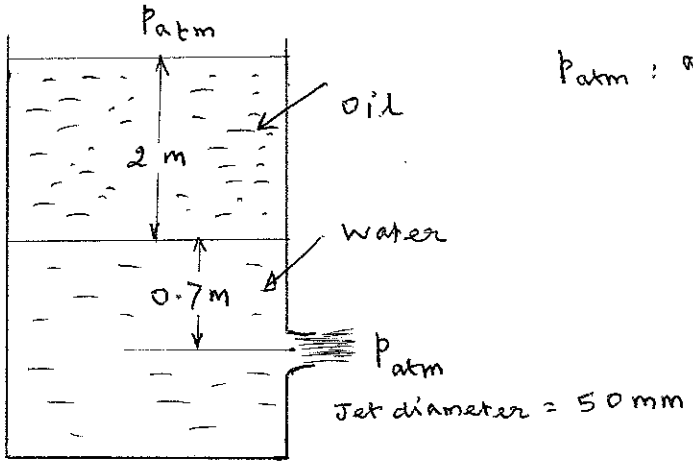
b. The two-dimensional velocity field for an incompressible, Newtonian fluid is given by

$$u = 12xy^2 - 6x^3 \quad \text{and} \quad v = 18x^2y - 4y^3$$

where the velocity has units of m/s when x and y are in meters. Determine the stresses σ_{xy}, σ_{yy} and τ_{xy} at the point x = 0.5 m, y = 1.0 m if the pressure at this point is 6 kPa and the fluid is having dynamic viscosity of 1.5 Ns/m^2 . (8)

5. a. Differentiate between venturimeter and orifice meter. (2)

b. If viscous effects are neglected and the tank is large, determine the flow rate from the tank as shown in Fig. Assume the specific gravity of oil is 0.81 and water is 1. (8)



6.a. State the important characteristics of laminar and turbulent flows. (2)

b. Laminar flow is taking place in a pipe of diameter of 200 mm. The maximum velocity is 1.5 m/s. Find the mean velocity and radius at which this occurs. Also calculate the velocity at 4 cm from the wall of the pipe. (8)

7.a. How do you select the repeating variables? (2)

b. Using Buckingham π-theorem, show that the velocity through a circular orifice is given by (8)

$V = \sqrt{2gH}\phi\left[\frac{D}{H}, \frac{\mu}{\rho VH}\right]$ where

H = head causing flow d = diameter of the orifice ρ = density
μ = viscosity of oil g = acceleration due to gravity

8.a. What are the characteristics of a boundary layer? (2)

b. The velocity distribution in the boundary layer is given by

$$\frac{u}{U} = \frac{3}{2}\frac{y}{\delta} - \frac{1}{2}\frac{y^2}{\delta^2}$$

If δ is boundary layer thickness, calculate the following:

(i)The ratio of displacement thickness to boundary layer thickness $\frac{\delta^*}{\delta}$

(ii)The ratio of momentum thickness to boundary layer thickness $\frac{\theta}{\delta}$ (8)

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ME C212 Transport Phenomena I
Test 2 (Open Book)

Max.Marks: 40 **Date: 17.04.2011**
Weightage: 20% **Time:50Min**

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

1. It is known that the velocity distribution for two-dimensional flow between the wide parallel plates is parabolic and is given by

$$u = U\left[1 - \left(\frac{y}{h}\right)^2\right] \text{ with } v = w = 0.$$

Determine the corresponding stream function and velocity potential. (10)

2. Water flows steadily up the vertical 0.1 m diameter pipe and out the nozzle, which is 0.05 m diameter, discharging to atmosphere as shown in Fig 2. If the stream velocity at the nozzle exit is 20 m/s, calculate the minimum gauge pressure required at section 1.

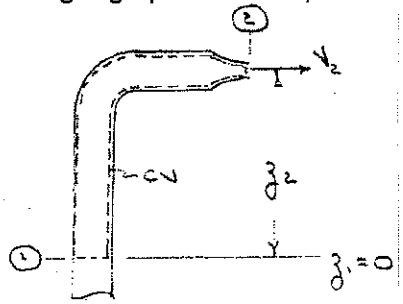

Fig 2.

(10)

3. 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 3. 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?

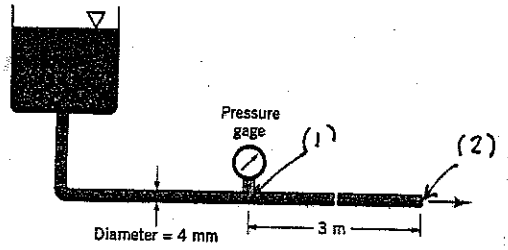

Fig. 3

(10)

4.The velocity distribution for flow of a thin viscous film down an inclined plane surface is given by $u=\frac{\rho g}{\eta}\sin\theta\left[hy-\frac{y^2}{2}\right]$. Consider the fluid film of 5.63 mm thick, specific gravity of 1.26 and viscosity of 1.40 Ns/m^2. Derive the expression for shear stress distribution. Evaluate the volume flow rate per unit width and Reynolds number. (Fig 4) (10)

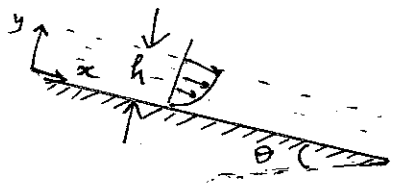

Fig 4

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Test 1 (Closed Book)

Max.Marks: 50 **Date: 27.02.2011**
Weightage: 25% **Time:50Min**

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

1. A differential mercury manometer is connected to pipe A containing oil with density 650 kg/m^3 and pipe B containing water as shown in Fig 1. Determine the differential reading, h corresponding to pressure in A of 20 kPa and of vacuum of 150 mm Hg in B. Assume specific gravity of mercury is 13.6 **(15)**

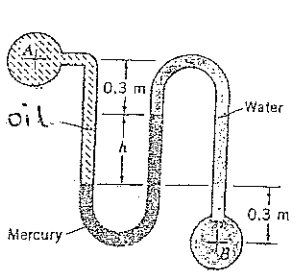

Fig 1

2. A long vertical wall separates seawater from freshwater as shown in Fig 2. If the seawater stands at a depth of 7 m, what depth of fresh water is required to give the same total pressure or force on either side of the wall? Are forces collinear? **(15)**

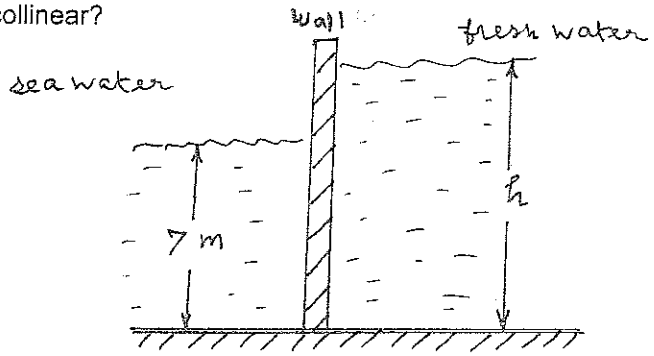

Fig 2

3. There are two layers fluid between a fixed plate and a moving plate as shown in Fig 3.The top fluid puts shear stress on the upper plate and the lower fluid puts a shear stress on bottom plate. Determine the ratio of these two shear stresses. **(10)**

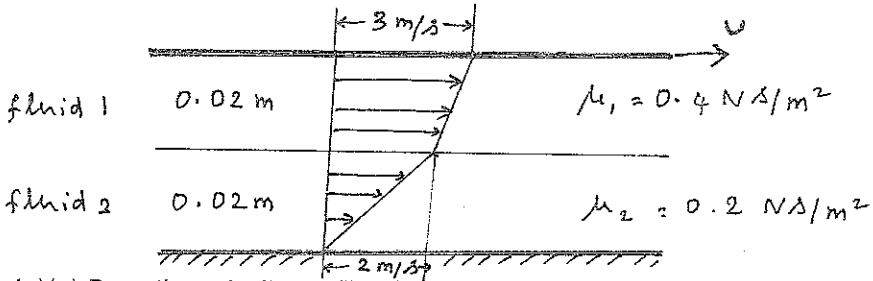

Fig 3

4.)(a) Draw the velocity profiles for (i) viscous flow in pipe and (ii) inviscid flow in pipe. Justify your answer **(4)**
(b) Write the expression for rate of shearing strain for two-dimensional flow **(3)**
(c) How will you calculate the surface tension for liquid jet? **(3)**

(A)

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ME C212 Transport Phenomena I
Quiz 2 (Closed Book)

Max.Marks: 14 **Date: 03.05.2011**
Weightage: 7% **Time:20Min**

Note: (i) Answer all Questions (ii) Assume suitable value if required
(iii) All questions carry equal marks

1. Define the following terms: (a) Static pressure and (b) Stagnation pressure

2. What is the significance of Vena Contracta in orifice meter?

3. The relation between the difference of pressure head and difference of manometer liquid level is given by.....

4. Distinguish between coefficient of discharge and coefficient of velocity.

5. Can you use venturimeter to find the flow rate of liquid in vertical pipe? Why or why not?

6. Can you select water as a manometer liquid for measuring the volume flow rate of water in venturimeter? Why or why not?

7.If density of air is 1.22 kg/m^3 . Find the specific gravity value.

A

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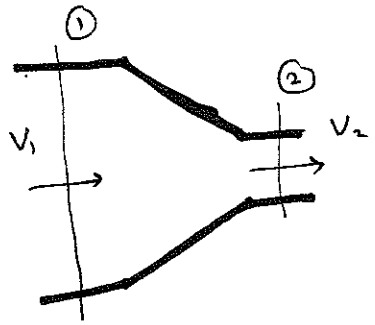
Quiz 1 (Closed Book)

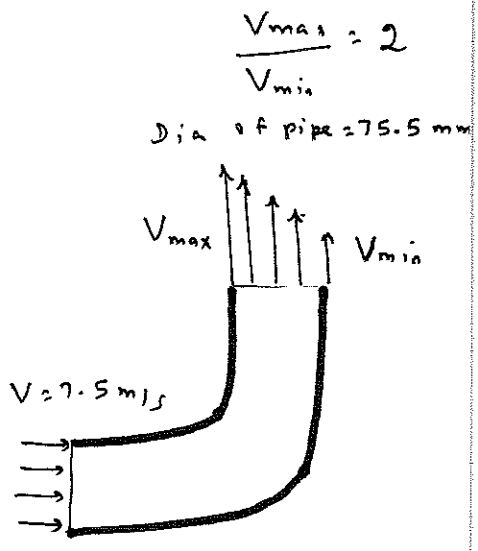
Max.Marks: 16 **Date: 22.03.2011**
Weightage: 8% **Time:20Min**

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

1. Water with specific gravity of 0.998 flows steadily at 40 kg/s through the nozzle in Fig. If D_1 = 18 cm and D_2 = 5 cm, compute the average velocity, in m/s, at section 1 and section 2. as shown in Fig. (3)

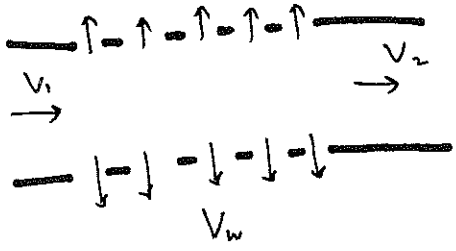


2.Find the value of V_{min} for the flow as shown in Fig. (3)



3. Momentum equation is derived based on ---------- (1.5)

4. Water flowing through an 8-cm-diameter pipe enters a porous section, as in Fig. , which allows a uniform radial velocity v_w through the wall surfaces for a distance of 1.2 m. If the entrance average velocity V_1 is 12 m/s and v_w = 15 cm/s out of the pipe walls, find the exit velocity V_2 (5)



5. Continuity equation is derived based on ---------- (1.5)

6. Find the volume flow rate for the given velocity profile in a flow through pipe of diameter **D** as shown in Fig.. (2)