BITS, Pilani-Dubai Campus

Dubai International Academic City, Dubai

Second Semester 2010-2011

CHE C213 FLUID FLOW OPERATIONS

Comprehensive Examination (Closed Book)

Max. Marks: 80 **Weightage: 40%** **Date: 07.06.2011** **Duration: 3 Hours**

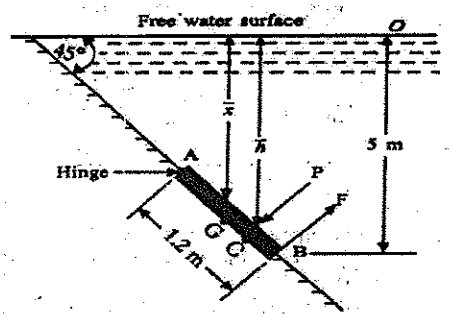
Note: 1.Answer all the questions sequentially 2.Assume suitable data, if required

1.a. Define the terms: non-uniform flow and specific weight of fluid. (2)

b. Two large fixed parallel plates are 12 mm apart. The space between the plate is filled with oil of dynamic viscosity 0.972 Ns/m^2. A flat thin plate 0.25 m^2 area moves through the oil at a velocity of 0.3 m/s. Calculate the shear force (i) when the thin plate is equidistant from both plates. (ii) When the thin plate is at a distance of 4 mm from one of the plate surface, will it require the same shear force as in (i) (8)

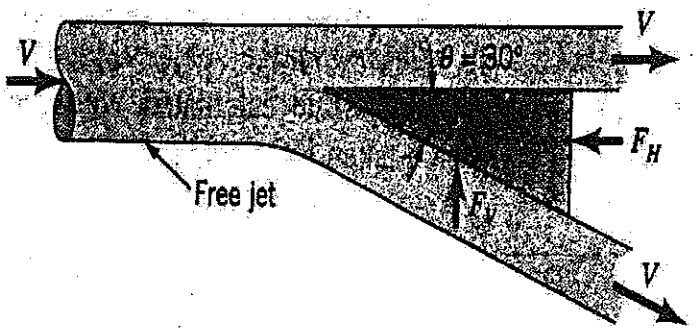
2.a. Define the terms : centre of pressure and total pressure (2)

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. (8)



3.a.Define the terms: (i) Control Surface and (ii) Control Volume (2)

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 (8)



the force ratio F_H/F_V.

4.a. Differentiate between orifice meter and pitot tube (2)

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 (8)

5.a.What do you understand by the term vorticity. (2)

b. A certain steady, incompressible, two-dimensional flow near a wall has the velocity component (8)

$$u(x,y) = U\left(\frac{2y}{ax} - \frac{y^2}{a^2x^2}\right)$$

where **a** is constant. Find the velocity component v(x,y) assuming that v=0 at the wall, y=0.

6.a. What are the assumptions made while deriving the Hagen-poiseulle equation? (2)

b. A viscous, incompressible, steady, laminar fluid flows upwards between the two vertical parallel plates. By use of Navier Stokes equation, find the expression for the pressure gradient in the direction of flow, in terms of mean velocity. (8)

7.a. Explain the term dimensional homogeneity (2)

b.Using Buckingham π-theorem, show that the discharge **Q** consumed by an oil rig is given by

$$Q = Nd3\phi\left[\frac{\mu}{\rho N d^2}, \frac{\sigma}{\rho N^2 d^3}, \frac{S}{\rho N^2 d}\right] \text{ where}$$

N = rotational speed d = internal diameter of rig ρ = density
μ = viscosity of oil σ = surface tension S = specific weight of oil. (8)

8.a. Is the flow within the boundary layer rotational or irrotational? Why? (2)

b. A plate 0.45 m x 0.15 m has been placed longitudinally in a crude oil (specific gravity 0.925 and kinematic viscosity of 0.9 x 10^{-4} m^2/s) which flows with velocity of 6 m/s. calculate the friction drag on the plate, thickness of the boundary layer at the tailing edge and shear stress at the trailing edge. (8)

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CHE C213 Fluid Flow Operations
TEST: 2 [Open book]

Max.Marks :20 **Date:01.05.2011**
Weightage: 20 % **Time: 50 min**

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

1. In a two dimensional incompressible fluid flow, x- velocity component is given by

$$-\frac{3}{2}x^2+\frac{1}{3}x^3$$

Calculate the y- velocity component if it satisfies continuity equation. (5)

2. 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 (5)

3. Water flows from the very large tank through a 5 cm diameter tube as shown in Fig 3. The dark liquid in the manometer is mercury. Calculate the velocity in the pipe and the rate of discharge from the tank. (5)

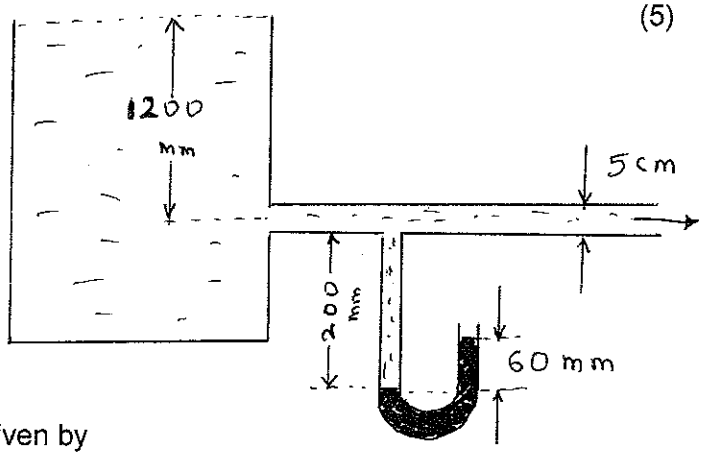

Fig 3.

4. The velocity distribution in a pipe is given by

$$\frac{u}{U_{max}} = 1-\left(\frac{r}{R}\right)^n$$

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)

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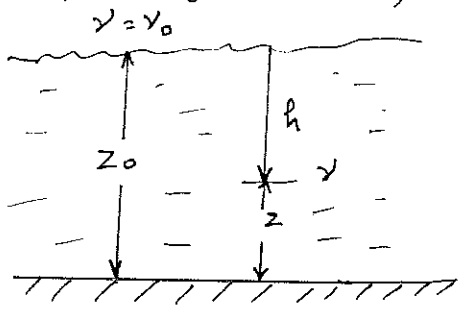
CHE C213 Fluid Flow Operations
Test 1 (Closed Book)

Max.Marks: 50 **Date: 10.03.2011**
Weightage: 25% **Time:50Min**

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

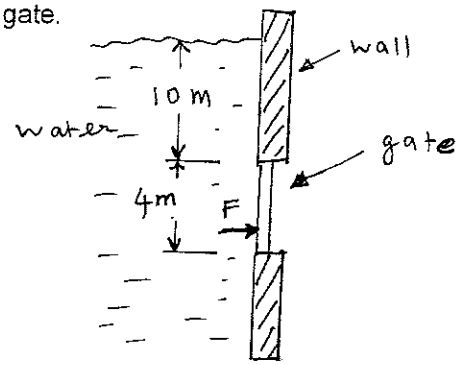
1. Develop an expression for the pressure variation in a liquid in which the specific weight γ increases with depth, h as $\gamma = Kh + \gamma o$, where K is a constant and γo is the specific weight at free surface, as shown in Fig. 1 (15)

Fig. 1



2.A rectangular gate that is 2 m wide is located in the vertical wall of a tank containing water as shown in Fig 2. Find the centre of pressure on the gate when the depth of water above the top of the gate reaches 10 m and also find the total pressure or force on the gate. (15)

Fig. 2



3.A 25 mm diameter shaft is pulled through a cylindrical bearing as shown in Fig 3. The lubricant that fills the 0.3 mm gap between the shaft and bearing is an oil having a kinematic viscosity of 8 x 10^{-4} m^2/s and density of oil of 910 kg/m^3. Determine the force P required to pull the shaft at a velocity of 3 m/s. (10)

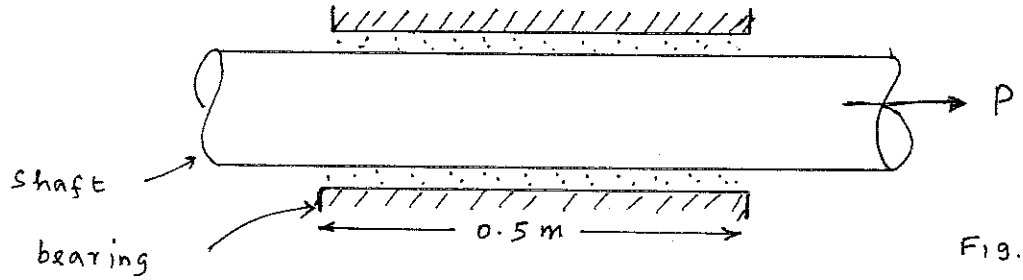


Fig.3

4.A 12 mm diameter of jet of water discharges 1 m vertically. If pressure inside the jet is 12.2 Pa, calculate the surface tension force.

(10)

(A)

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Quiz 2 (Closed Book)

Max.Marks: 7
Weightage: 7%

Date: 17.05.2011
Time:20Min

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

1. How are the static pressure and stagnation pressure measured in Pitot tube?

2. Can you use Pitot tube to find the flow rate of liquid? Why or why not?

3. Why is the throat diameter smaller in venturimeter?

4.Prove that the following in the case of Pitot tube measurement:
$V = C_v\sqrt{2gh}$

5. Why is orifice plate thickness thin in orifice meter?

6. Write the expression for flow rate in Venturimeter.

7. Write the expression for Bernoulli's principle and give the meaning for each term.

A

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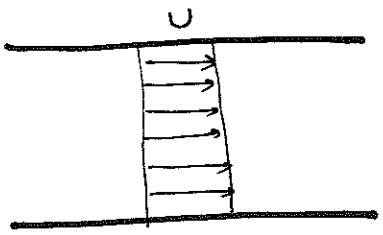
CHE C213 Fluid Flow Operations
Quiz 1 (Closed Book)

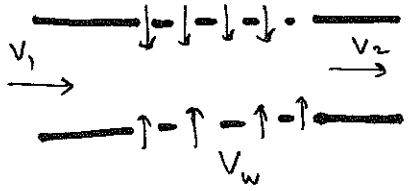
Max.Marks: 16 **Date: 05.04.2011**
Weightage: 8% **Time:20Min**

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

1. Find the volume flow rate for the given velocity profile in a flow through pipe of radius R as shown in Fig.. what is the location for maximum and minimum velocity. (2)



2. 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 = 10 cm/s into the pipe through the walls, find the exit velocity V_2. (5)

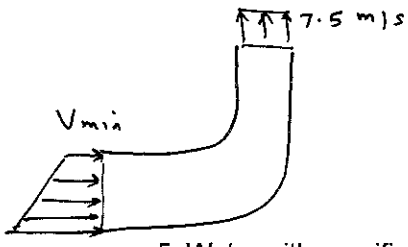


3. Write the Continuity equation for flow through a pipe with inlet radius R_1 and velocituy V_1 and exit radius R_2 and velocity V_2. (1.5)

4.Find the value of V_{min} for the flow as shown in Fig. What is the value of ΣF_x ? (3)

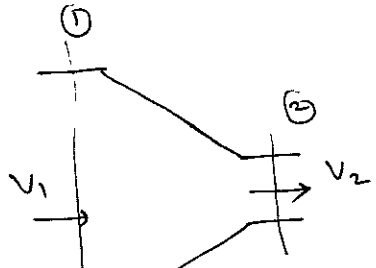
$\frac{V_{max}}{V_{min}} = 2$

Dia of pipe = 75.5 mm



5. Water with specific gravity of 1 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)

What is the value of ΣF_x.



6. Write X- Momentum equation for a pipe at inlet velocity V_1, area A_1 and pressure p_1 and exit velocity V_2 with mass flow rate $\dot{m}$. (1.5)