**BITS, Pilani-Dubai Campus**
Dubai International Academic City, Dubai
Second Semester 2011-2012

**CHE C213 Fluid Flow Operations Comprehensive Examination (Closed Book)**

**Max. Marks: 80 Weightage: 40% Date: 10.06.2012 Duration: 3 Hours**

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

1.(a)What are the main characteristics of laminar flow and turbulent flow . (2)

(b) A large thin plate is pulled at a constant velocity **U** through a narrow gap of height **h** as shown in Fig.1. On one side of the plate is oil of viscosity **μ** and on the other side oil of viscosity **αμ** where **α** is constant. Calculate the position of the plate, **a** so that the drag force on it will be minimum. (8)

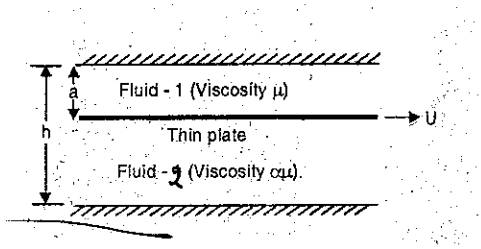


Fig.1

2.(a) Define the terms: Centre of buoyancy and Centre of pressure. (2)

(b) A circular plate 1.5 m diameter is submerged in water with its greatest and least depths below the water surface being 2 m and 0.75 m respectively. Determine (i) the total pressure on one side of the plate and (ii) position of the center of pressure. (8)

3. (a) State the advantages and limitations of manometers. (2)

(b) A manometer arrangement is shown in Fig.3. Find the gauge pressure at A if the manometric fluid is mercury and filled in the pipe and in the tubing which connects the U-tubes is water. (8)

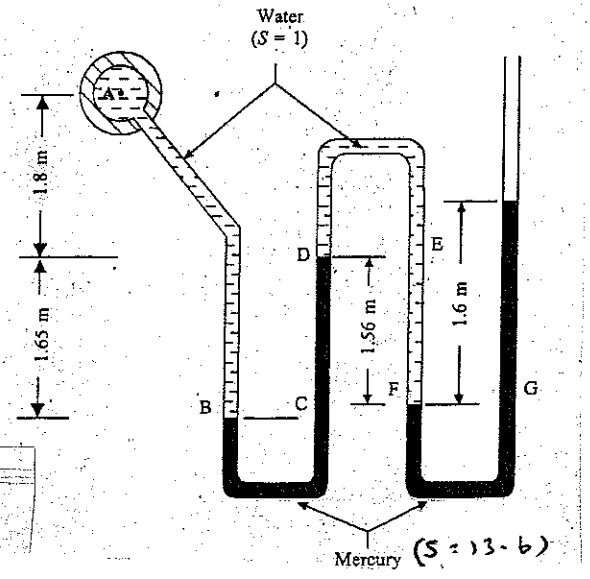


Fig.3

S : specific gravity

(2)

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

(b) In some wind tunnels the test section is perforated to suck out fluid and provide a thin boundary layer. The test section wall is in Fig.4 contains 1200 holes per square meter of wall area and each hole diameter is 5 mm. The suction velocity through each hole is 8 m/s and test section entrance velocity is 35 m/s. Assume steady incompressible air is flowing with density of 1.225 kg/m$^3$. Calculate velocities $V_o$, $V_2$ and $V_f$ (8)

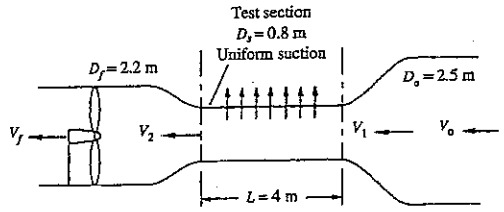


Fig. 4

5.(a) Define the term: Vena Contracta in orifice meter (2)

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

6.(a) Define the term: Fully developed flow in a pipe (2)

(b) A lubricating oil of viscosity 0.1 Ns/m$^2$ and specific gravity 0.9 is pumped through a 30 mm diameter pipe. If the pressure drop per meter length is 20 kN/m$^2$, determine (i) the mass flow rate in kg/s (ii) the shear stress at the wall and at the centre (iii) Reynolds number of the flow and (iv) power required per 50 m length of the pipe to maintain the flow. (8)

7. (a) State the Buckingham π-theorem (2)

(b) A ship 300 m long moves in sea water, whose density is 1030 kg/m$^3$. 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 sea water. Assume the following: the density of air is 1.24 kg/m$^3$, kinematic viscosity of sea water is 0.012 x 10$^{-4}$ m$^2$/s and kinematic viscosity of air is 0.018 x 10$^{-4}$ m$^2$/s . (8)

8. (a) State the different methods for preventing boundary layer separation. (2)

(b) The velocity distribution in laminar boundary layer over a flat plate is given by a polynomial expression $u=a+by+cy^2$. The free stream velocity is U and boundary layer thickness is δ as shown in Fig.8. Determine (i) velocity profile u and (ii) momentum thickness θ. (8)

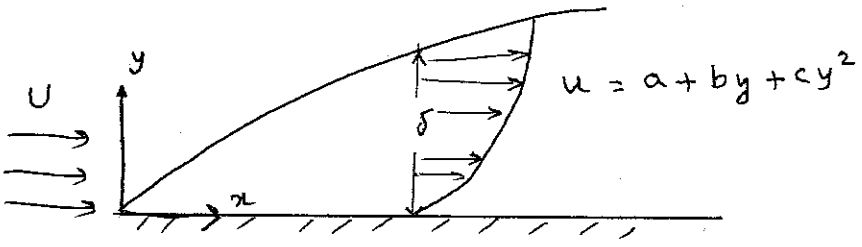


Fig. 8

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**Second Semester 2011-2012**
**CHE C213 Fluid Flow Operations**
**Test 2 (Open Book)**

**Max.Marks: 20** **Date: 06.05.2012**
**Weightage: 20%** **Time: 50Min**

1.(a) The stream function for an incompressible two dimensional flow field is $\Psi = ay - by^2$ where a and b are constants. Is this an irrotational flow? Explain.

(b) An incompressible viscous fluid is placed between two large parallel plates . The bottom plate is fixed and the upper plate is moving with a constant velocity, U. For these conditions the velocity distribution between the plates is linear and is given by $u = U \frac{y}{b}$. Determine (i) value for $\omega_z$ and vorticity and (ii) rate of angular deformation.

2.(a) A steady , 1-D and invisid fluid is flowing through a pipe. Find the pressure drop for a 100 m length.

(b) Water flows steadily through the large tanks as shown in Fig.2. Determine the water depth. $h_A$

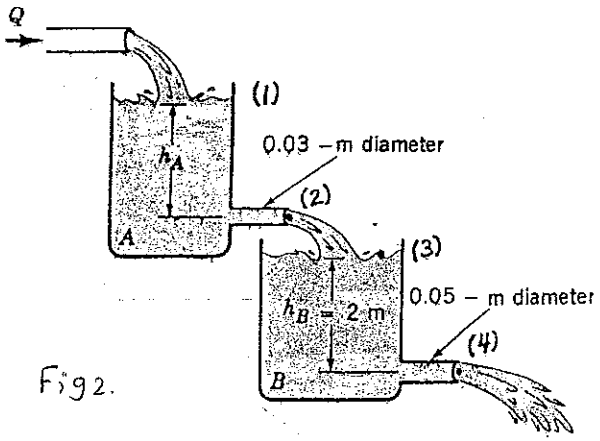

Fig 2.

3.(a) Distinguish between static and stagnation pressures

(b) In a pipe of 300 mm diameter the maximum velocity of flow is found to be 2 m/s. If the flow in the pipe is laminar and steady, calculate

(i) the average velocity and the radius at which it occurs and

(ii) the velocity at 50 mm from the pipe wall

**BITS PILANI, DUBAI CAMPUS**
**Second Semester 2011-2012**
**CHE C213 Fluid Flow Operations**
**Test 1 (Closed Book)**

**Max.Marks: 25** **Date: 18.03.2012**

**Weightage: 25%** **Time: 50Min**

1. A 25 mm diameter shaft is pulled through a cylindrical bearing. The lubricant that fills the 0.3 mm gap between the shaft and bearing is oil having a dynamic viscosity of 0.728 $Ns/m^2$ and density 910 $kg/m^3$. The length of bearing is 50 cm. Find the force P required to pull the shaft at a velocity of 3 m/s. (5)

2. A manometer is shown in Fig 2 with inside diameter of 6.35 mm. Specific gravity of oil is 0.827. Volume of oil in the tube is 3.25 $cm^3$. Calculate the height H. (5)

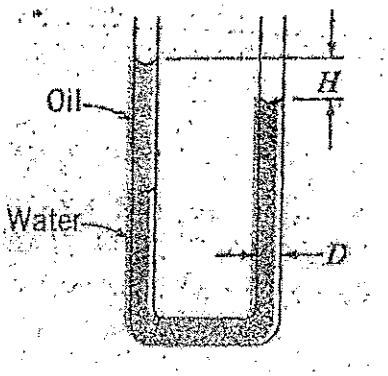


Fig 2

3. A converging elbow as shown on Fig 3 turns the water at flow rate of 0.4 $m^3/s$ through an angle of 135 $^0$ in a vertical plane. The flow passage volume is 0.2 $m^3$ between inlet and outlet. The pressure at section 1 and 2 are 150kPa and 90 kPa respectively. The elbow mass is 12 kg. Calculate

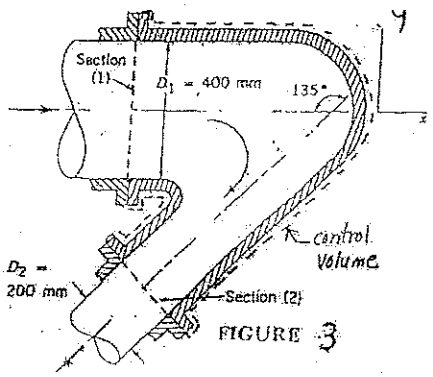


FIGURE 3

the vertical force required to hold in place. (7)

4. 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 4. The gap is filled with an oil of specific gravity of 0.85 and dynamic viscosity of 3 $Ns/m^2$. Determine force required to lift the plate with constant velocity of 0.15 m/s (8)

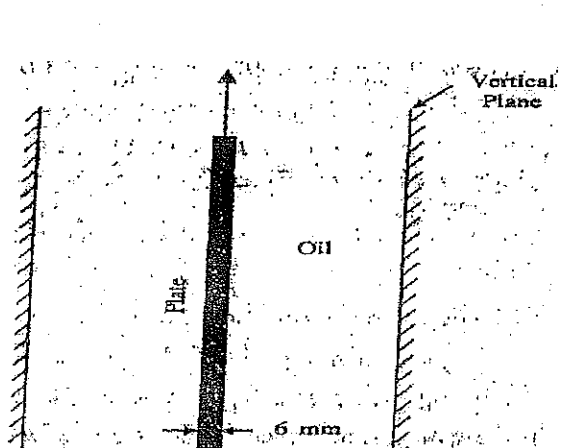


Fig 4

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**Second Semester 2011-2012**
**CHE C213 Fluid Flow Operations**
**Quiz 2 (Closed Book)**
**Part-A**

**Max.Marks: 7** **Date: 16.04.2012**
**Weightage: 7%** **Time:20Min**

Name: _____ ID No: _____

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

1. The two-dimensional velocity field for an incompressible, Newtonian fluid is given by $u= 12\ xy^2 - 6\ x^3$ and $v=18x^2y - 4\ y^3$ where velocity has units of m/s when x and y are in meters. Determine the stress $\sigma_{xx}$ at the point x=0.5 and y= 1.0 m if the pressure at this point is 6kPa and dynamic viscosity is 1.5 $Ns/m^2$. (2)

2. What are the main assumptions in Bernoulli's equation? (1)

3. Determine the value vorticity for given flow field
   $u = -xy^3$ and $v = y^4$ (2)

4. Write the x-momentum Euler's equation for steady state, uniform and one-dimensional flow (1)

5. The stream function for a flow field is given by $\psi = -2(x - y)$ .Is the continuity equation satisfied? (1)

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**Second Semester 2011-2012**
**CHE C213 Fluid Flow Operations**
**Quiz 1 (Closed Book)**
**Part-B**

**Max.Marks: 8** **Date: 27.03.2012**
**Weightage: 8%** **Time:20Min**

Name: _____ ID No:_____

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

1 For flow through a parallel plates, the shear stress 150 kPa is developed on upper plate, when it is pulled with a velocity of 1 m/s . Determine the viscosity of liquid between the plates, if the distance between the two plate is 2mm. (2)

2 Write the expression for the rate of shearing strain for two -dimensional flow. (1)

3 Draw the velocity profile in a pipe for (i) viscous flow and (ii) inviscid flow (1)

4 Write the expression for surface tension $\sigma$, for a liquid jet of long length **L** and diameter **D**. (1)

5 Differentiate between Newtonian and non-Newtonian fluid with examples. (1)

6 Oil with viscosity $\mu = 1.12 \times 10^{-3,}$ Ns/m$^2$ is flowing with velocity of (2)

$$\frac{u}{U} = 2\frac{y}{h} - \frac{y^2}{h^2}$$

through narrow parallel plates of gap **h** = 3 mm. Calculate the shear force on bottom plate, if the value of U= 2 m/s, plate area is **A = 5** m$^2$