BITS Pilani
Dubai Campus

FIRST SEMESTER 2012 – 2013

COMPREHENSIVE EXAMINATION

Year	: 2[nd] Yr (CHEM/MECH)	**Date**	: 06.01.2013
Course No.	: CHE F212/ME F212	**Max. Marks**	: 80 (40%)
Course Title	: Fluid Mechanics	**Duration**	: 3 hours

1. Magnet wire is to be coated with varnish for insulation by drawing it through a circular die of 1.0 mm diameter. The wire diameter is 0.9 mm and is centered in the die. The varnish (μ = 0.02 Ns/m^2) completely fills the space between the wire and the die for a length of 50 mm. the wire is drawn through the die at a speed of 50 m/s. Determine the force required to pull the wire. **[9 M]**

2. A partitioned tank as shown in Fig. Q2 contains water and mercury. What is the gage pressure in the air trapped in the left chamber? What pressure would the air on the left need to be pumped to in order to bring the water and mercury free surfaces level? Take specific gravity of mercury as 13.6. **[9 M]**

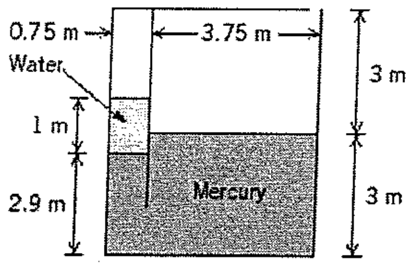

Fig. Q2

3. Water flows through a fire hose and nozzle as shown in Fig. Q3. Find the following:
   a. Coupling Force, R_x
   b. Indicate if it is tension or compression. **[9 M]**

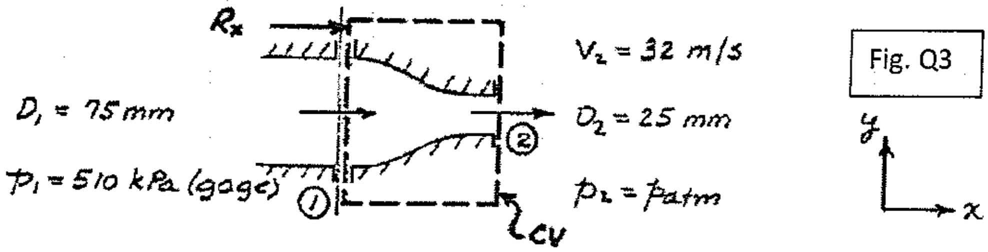

Fig. Q3

4. An incompressible frictionless flow is specified by $\Psi = -2tx-5ty$. x, y are in meters and t = 1 m/s.
   a. Sketch the streamlines $\Psi=0$ and $\Psi=5\ m^2/s$.
   b. Velocity vector at (0, 0).
   c. Flow rate between streamlines passing through points (2, 2) and (4, 1).

[9 M]

5. Water flows steadily up the vertical 0.1 m diameter pipe and out the nozzle as shown in Fig. Q5, which is 0.05 m in diameter, discharging to atmospheric pressure. The stream velocity at the nozzle exit must be 20 m/s. Calculate the minimum gage pressure required at section 1. If the device were inverted, what would be the required minimum pressure at section 1 to maintain the nozzle exit velocity at 20 m/s? **[9 M]**

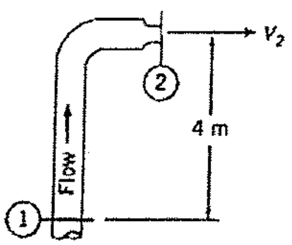

Fig. Q5

6. (a). Differentiate between laminar flow and turbulent flows. **[3 M]**
(b). A fluid of kinematic viscosity of 5.166×10^{-5} m^2/s and specific gravity 2.5 is flowing through a circular pipe of diameter 100 mm. The maximum shear stress at the pipe wall is 340 N/m^2. Find (i) the pressure gradient (ii) the average velocity & velocity at the line and (iii) the Reynolds number of the flow. **[7 M]**

7. At a sudden contraction in a pipe the diameter changes from D_1 to D_2. The pressure drop, Δp, which develops across the contraction is a function of D_1 and D_2, as well as the velocity, V_1, in the larger pipe, and the fluid density ρ, and viscosity, μ. Use D_1, V_1 and μ as repeating variables to determine a suitable set of dimensionless parameters. Why would it be incorrect to include the velocity in the smaller pipe as an additional variable? **[10 M]**

8. 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 both sides of the plate (ii) thickness of the boundary layer at the trailing edge and (iii) shear stress at the trailing edge. **[10 M]**

9. What are the limitations of CFD? What are the 3 stages of CFD analysis? **[5 M]**

(OR)

Mention any two purposes for agitation of liquids. Name the various parts in a typical agitation process vessel. **[5 M]**

•**ALL THE BEST**•

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FIRST SEMESTER 2012 – 2013

TEST – 2 (Open Book)

Year	: 2^{nd} Yr (MECH/CHEM)	**Date**	: 09.12.2012
Course No.	: CHE F212 / ME F 212	**Max. Marks**	: 40 (20%)
Course Title	: Fluid Mechanics	**Duration**	: 50 minutes

1. A belt moves upward at velocity V, dragging a film of viscous liquid of thickness h, as in Fig. Near the belt, the film moves upward due to no-slip and at its outer edge, zero shear stress is zero. Derive a formula for $v(x)$ and also calculate average velocity and flow rate per unit width. **[10 M]**

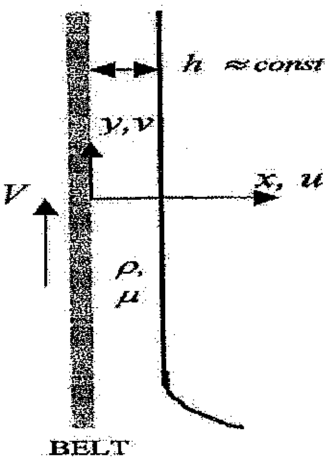

Fig.1

2. A nozzle as shown in Fig with D=80 mm, d= 20 mm, inlet pressure p_1 = 710 kPa (absolute) ,outlet pressure p_2 = 101 kPa and length L= 50 cm. Evaluate the discharge in m^3/sec. **[10 M]**

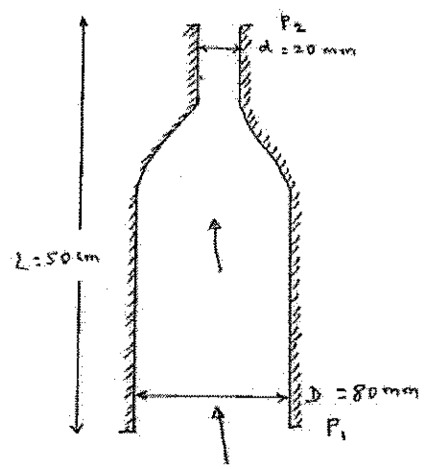

Fig.2

3. A geometrically similar model of an air duct is built to 1/28 scale and tested with water which is 45 times more viscous and 1000 times than air. When tested under dynamically similar conditions, the pressure at the end of the duct is 18 bar but the pressure of the flow at the beginning of the duct is 20 bar. Find the pressure drop in full scale prototype. **[10 M]**

4. (a) What do you mean by flow net? Explain **[4 M]**

(b) Write the Euler's equation of motion and its significance **[3 M]**

(c)In making dimensional analysis, what rules do you follow for choosing your scaling variables? **[3 M]**

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First Semester 2012 - 2013
Course: ME F 212/CHE F212 Fluid Mechanics
TEST: 1[Closed book]

Max.Marks :25 | **Date:17.10.2012**
Weightage: 50 % | **Time: 50 min**

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

1. An oil with specific gravity of 0.85 and viscosity of 1.12×10^{-3} Ns/m^2 flows steadily down a surface inclined $\Theta = 30^0$ as shown in Fig. 1. The value of h = 0.1mm and velocity profile is given by **[12 M]**

$$u = \frac{\rho g}{\mu}\left(hy - \frac{y^2}{2}\right) \sin \Theta$$

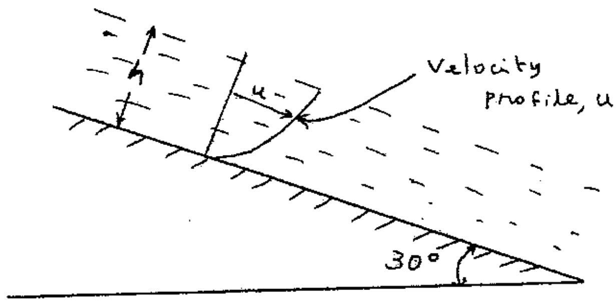

Fig. 1

Determine i) the magnitude and direction of the shear stress that acts on the surface and ii) shear force on a 5000 mm^2 section of the plate and its direction.

2. When a 5 kg mass is placed on the end of a floating 50 cm x 50 cm x 3 m wooden beam tilts at 1.5^0 with its right upper corner at the surface as shown in Fig 2. What is the specific weight of the wood? **[12 M]**

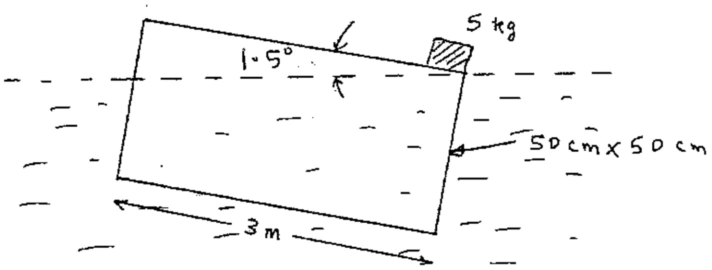

Fig. 2

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3. Incompressible fluid flows steadily through a diverging channel of width w, as shown in Fig 3. At the inlet of height H, the flow is uniform with magnitude u_1. At the outlet, height=2H and velocity profile is

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

where y is measured from channel centerline. Express U_m in terms of u_1. **[10 M]**

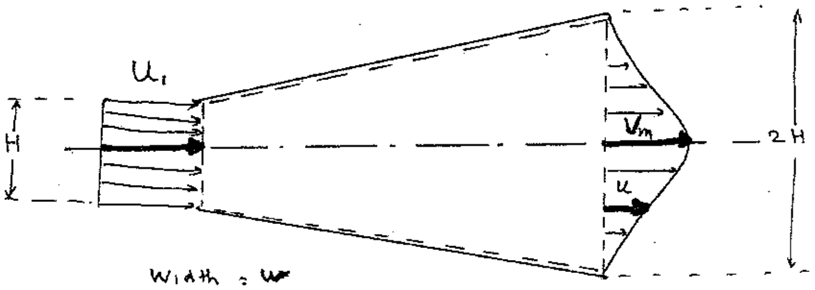

Fig. 3

4. a. Draw the velocity profiles for (i) viscous flow in a pipe and (ii) inviscid flow in a pipe. Justify your answer. **[6 M]**

   b. Write the expression for rate of shearing strain for two-dimensional flow. **[5 M]**

   c. How will you calculate the surface tension for liquid jet? **[5 M]**

Name:
ID. No:
Section:

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FIRST SEMESTER 2012 – 2013

QUIZ – 2 (Closed Book)

Year	: 2^{nd} Year	**Date**	: 21.11.2012
Course No.	: CHE F212/ME F212	**Max. Marks**	: 14 (7%)
Course Title	: Fluid Mechanics	**Duration**	: 20 minutes

1. Airflow just ahead of an aircraft, and above and below the wings away from the boundary layer is an example for ____________________ flow. **[1 M]**

2. A stream function is given by $\psi = 3x^2y + (3+x)y^2$. Find the flow rate between M(2,9) and P(1,4). **[3 M]**

3. For a two dimensional flow field defined by $\Phi=x^2-y^2$, show that the slope of stream function and velocity potential intersect orthogonally. **[3 M]**

4. Navier-Stokes equation is the differential form of the ____________________ equation. [1 M]

5. A certain incompressible flow field is defined by: $u = 2xy^2z + t(x^3y^2-y^3) - 2x^2z^3$; $v = -(4xyz^3 + x^2y + x^2y^3t)$; $w = x^2z - y^2z^2$. Is this a physically possible flow field? [3 M]

6. Find the velocity at a point (3, 4) associated with potential function $\Phi = 3x^2-3xy+3y^2$. [3 M]

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First Semester 2012 - 2013

Course: ME F 212/CHE F212 Fluid Mechanics **B**

QUIZ- 1[Closed book]

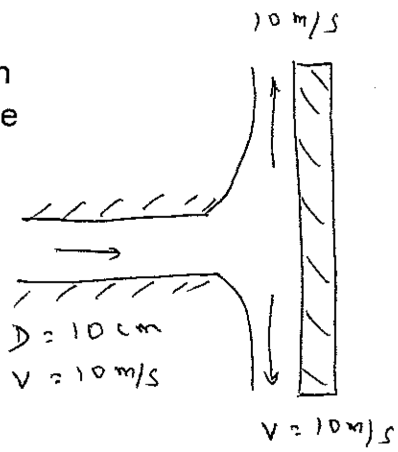
Max.Marks :16 **Date:31.10.2012**
Weightage: 8 % **Time: 20 min**

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

1. How do you relate kinematic viscosity and dynamic viscosity? (1)

2. What is meant by fully developed flow? (1)

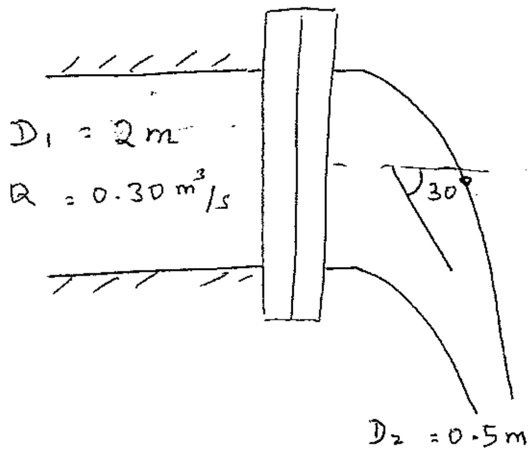
3. The jet of water strikes the vertical plate and deflecting with same velocities as shown in Fig. Calculate the vertical force acting on the plate. (3)



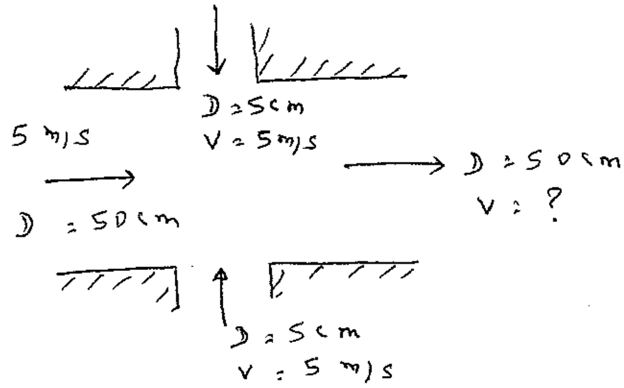
4. Differentiate between pressure and shear stress. (1)

5. Define Reynolds number. (1)

6. Water flows through the 30 degree reducing bend as shown in fig.
Calculate the x component of force required to hold the bend. (3)



7. Water flows through the circular pipe as shown in Fig.
Calculate the exit velocity. (3)



8. The flow rate of water in nozzle is ~~10 m³/s~~ 0.1 m³/s . If inlet diameter of nozzle is 10 cm, find exit diameter, if exit velocity is 20 m/s (3)