BITS, PILANI – DUBAI

2nd Year, SECOND SEMESTER 2009 – 2010

COMPREHENSIVE EXAMINATION

Course Code:	CHE C213	Date:	25.05.2010
Course Title:	Fluid Flow Operations	Maximum Marks:	40
Duration:	3 hours	Weightage:	40 %

Answer all the questions.

Q1. A 400 mm diameter shaft is rotating at 200 rpm in a bearing of length 120 mm as shown in Fig. Q1.

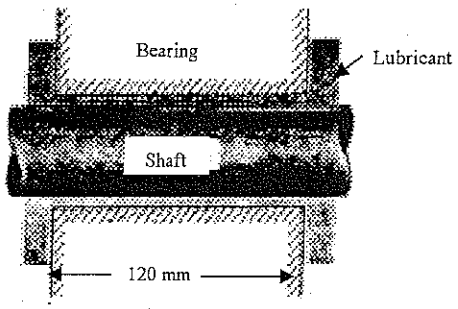

Fig. Q1

If the thickness of oil film is 1.5 mm and the dynamic viscosity of oil is 0.7 Ns/m^2, determine the following assuming linear velocity profile:

a. Torque required to overcome friction in bearing

b. Power utilized in overcoming viscous resistance **(4 M)**

Q2. A piston having a cross-sectional area of 0.07 m^2 is located in a cylinder containing water as shown in Fig. Q2. An open U-tube manometer is connected to the cylinder. For h_1 = 60 mm and h = 100 mm, what is the value of the applied force, P (in Newtons), acting on the piston? The weight of the piston is negligible. Take specific gravity of mercury = 13.6 and density of water = 1000 kg/m^3. **(4 M)**

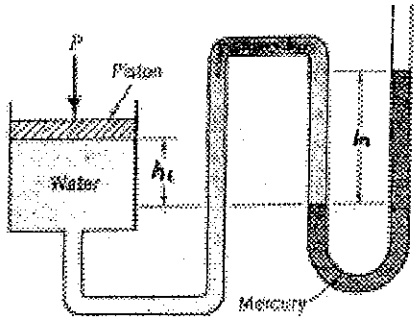

Fig. Q2

Q3. Water flows through the 20° reducing bend as shown in Fig. Q3, at a rate of 0.025 m^3/s. The pressure and diameter at section 1 is 150 kPa and 0.1 m respectively. The diameter at section 2 is 0.05 m. Determine the X and Y components of the force required to hold the bend in place. **(5 M)**

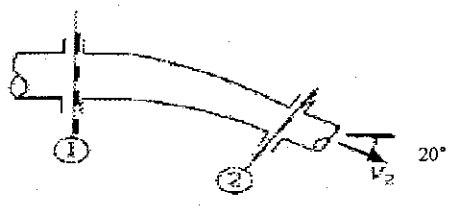

Fig. Q3

Q4. A two-dimensional flow field is given by $\Phi = 3xy$. Determine the following:
a. Stream function.
b. Velocity at L (2, 6) and M (6, 6).
c. Pressure difference between the points L and M.
d. Discharge between the streamlines passing through the points L and M.

(4 M)

Q5. Water flows at a speed of 7 m/s through a circular tube with inside diameter D = 50 mm as shown in Fig. Q5. A smoothly contoured body of diameter d = 40 mm is held in the end of the tube where the water discharges to atmosphere. Neglect frictional effects and assume uniform velocity profiles at each section. Determine the pressure measured by the gage and the force required to hold the body. **(5 M)**

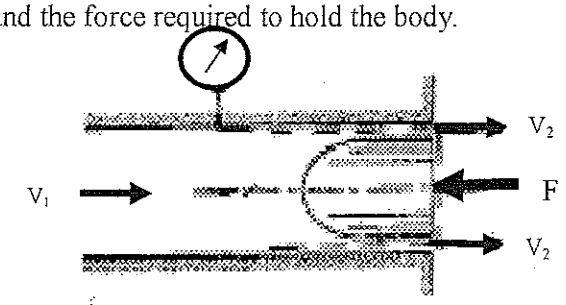

Fig. Q5

Q6. The resistance R experienced by a partially submerged body depends upon the velocity V, length L, viscosity of the fluid μ, density of the fluid ρ and gravitational acceleration g. Obtain a dimensionless expression for R. **(5 M)**

Q7. A fluid of viscosity 0.8 Ns/m^2 and specific gravity 1.2 is flowing through a circular pipe of diameter 100 mm. The maximum shear stress at the pipe wall is 210 N/m^2. Find:
a. Pressure gradient
b. Average velocity
c. Reynolds's number of flow **(4 M)**

Q8. The velocity distribution in the boundary layer is given by

$$\frac{u}{U} = \left(\frac{y}{\delta}\right)^{\frac{1}{7}}$$

Find the following:
a. displacement thickness
b. momentum thickness
c. energy thickness
d. energy loss due to boundary layer if at a particular section boundary layer thickness is 25 mm and the free stream velocity is 15 m/s. If the discharge through the boundary layer region is 6 m^3/s per meter width, express this energy loss in terms of meters of head. Take ρ = 1.2 kg/m^3. **(5 M)**

Q9. Draw a neat diagram of an agitation process vessel and label the important parts. **(4 M)**

********** ALL THE BEST **********

BITS, PILANI – DUBAI

Dubai International Academic City, Dubai

2nd Year, SECOND SEMESTER 2009 – 2010

TEST – 2 (Open Book)

Course Code :	**CHE C213**	Date :	**02.05.2010**
Course Title :	**Fluid Flow Operations**	Maximum Marks:	**20**
Duration :	**50 minutes**	Weightage :	**20 %**

Note:

i. Answer all the questions.

ii. Only the prescribed text book and hand written class notes are permitted.

Q1. The two-dimensional flow field for an incompressible, Newtonian fluid is described by the relationship

$$V = (12xy^2 - 6x^3)\hat{i} + (18x^2y - 4y^3)\hat{j}$$

where the velocity has units of m/s when x and y are in meters. Determine the stresses σ_{xx}, σ_{yy} and τ_{xy} at the point $x = 0.5$ m, $y = 1.0$ m if pressure at this point is 6 kPa and the fluid is glycerin at 20°C with viscosity 1.5 Ns/m^2. **[5 M]**

Q2. A fire nozzle is coupled to the end of a hose with inside diameter $D = 10$ cm. The nozzle is smoothly contoured and its outlet diameter is $d = 3$ cm. The nozzle is designed to operate at an inlet water pressure of 700 kPa (gauge).

a. Determine the design flow rate of the nozzle.

b. Evaluate the axial force required to hold the nozzle in place. **[5 M]**

Q3. The boundary-layer thickness δ, on a smooth flat plate in an incompressible flow without pressure gradients depends on the freestream speed, U, the fluid density, ρ, the fluid viscosity, μ, and the distance from the leading edge of the plate, x. Based on these parameters obtain a dimensionless expression for δ. **[5 M]**

Q4. A venturimeter with inlet diameter 50 mm and throat diameter 25 mm is to be replaced by an orifice meter. If both meters give the same difference for pressure at the discharge of 0.01 m^3/s, determine the diameter of the orifice of the orifice meter. Take coefficient of discharge of venturimeter as 0.97 and coefficient of discharge of orifice meter as 0.60. **[5 M]**

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BITS, PILANI – DUBAI

2nd Year, SECOND SEMESTER 2009 – 2010

TEST - 1

Course Code:	CHE C213	Date:	21.03.2010
Course Title:	Fluid Flow Operations	Maximum Marks:	25
Duration:	50 minutes	Weightage:	25 %

Answer all the questions.

Q1. For the velocity fields given below, mention whether the flow is: one-, two-, or three-dimensional, with proper justification. **(5 M)**

a. $\vec{V} = [ae^{-bx}]\hat{i} + bx^2\hat{j}$

b. $\vec{V} = ax\hat{i} - by\hat{j}$

c. $\vec{V} = ax^2\hat{i} + bx\hat{j} + c\hat{k}$

d. $\vec{V} = a(x^2 + y^2)^{1/2}(1/z^3)\hat{k}$

e. $\vec{V} = [ax^2e^{-bt}]\hat{i}$

Q2. The variation of temperature of the viscosity of air is represented by the empirical Southerland correlation $\mu = \frac{bT^{1/2}}{1 + S/T}$.

a. Develop an equation in SI units for kinematic viscosity versus temperature for air at atmospheric pressure. Assume ideal gas behavior with R_{air} = 286.9 N-m/kg-K and P_{atm} = 101.3 kN/m^2. **(3 M)**

b. Calculate the kinematic viscosity of air. Take S = 110.4; b = 1.458 x 10^{-6} and T = 20°C. **(3 M)**

Q3. A triangular access port must be provided in the side of a form containing liquid concrete having a specific gravity of 2.4. Using the coordinates and dimensions shown in the figure Q3, determine the resultant force that acts on the port and its point of application. **(7 M)**

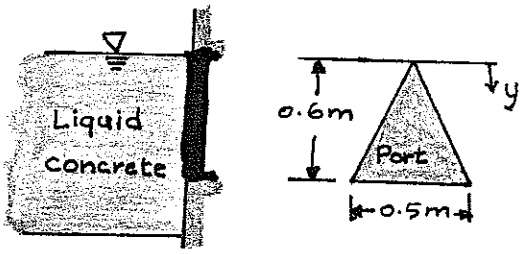

Fig. Q3.

Q4. Find the force required to hold the plug in place at the exit of the water pipe. The flow rate is 1.5 m^3/s and the upstream pressure is 3.5 MPa. **(7 M)**

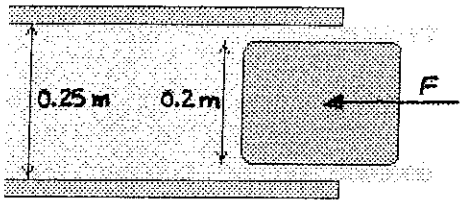

Fig. Q4

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BITS, PILANI – DUBAI

A

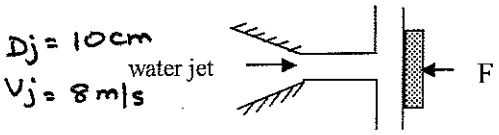
2nd Year, SECOND SEMESTER 2009 – 2010

QUIZ - 2

Course Code:	**CHE C213**	Date:	**13.04.2010**
Course Title:	**Fluid Flow Operations**	Maximum Marks:	**7**
Duration:	**20 minutes**	Weightage:	**7 %**
Name	_____		
ID No:	_____ Program:	Section	

Instruction : *Answer all the questions.*

1. The water jet in figure below strikes normal to the plate. Calculate the force, F, required to hold the plate.



(2 M)

2. For a certain incompressible flow field it is suggested that the velocity components are given by the equations $u = 2xy$; $v = -x^2y$. Examine if the flow is physically possible. **(1 M)**

3. A 2-D flow field is given by $\phi = 3xy$. Determine:
   a. stream function
   b. velocity at a point (2, 6).

(2 M)

4. For a 2-D flow the velocity function is given by $\phi = x^2 - y^2$. Show that the streamlines and potential lines intersect orthogonally.

(2 M)

A

BITS, PILANI – DUBAI

2nd Year, SECOND SEMESTER 2009 – 2010

QUIZ - 1

Course Code:	CHE C213	Date:	02.03.2010
Course Title:	Fluid Flow Operations	Maximum Marks:	8
Duration:	20 minutes	Weightage:	8 %

Name : _____

ID No: _____ Program: Section

Instruction : *Answer all the questions.*

1. What are units? Name any one secondary dimension with its units. **(2 M)**

2. Based on the frictional effects how can the fluid flows be classified? **(1 M)**

3. Mention any one example for Bingham (Ideal) plastic fluids. **(1 M)**

4. A circular disc of 100 mm diameter rotates on a table separated by an oil film of 2.2 mm thickness. Find the viscosity of the oil if the torque required to rotate the disc at 50 rpm is 3.8×10^{-4} N-m. **(2 M)**

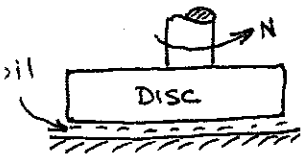


Fig. Q4.

5. Small gas bubbles form in a Pepsi bottle or can, when it is opened. The average bubble diameter is 0.1 mm. Estimate the pressure difference between the inside and outside of such a bubble if the surface tension is 72.8×10^{-3} N/m. **(2 M)**