Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

B.E. Sem-III Examination December 2009

Subject code: 130602 **Subject Name: Fluid Mechanics**

Date: 23 / 12 / 2009 **Time: 11.00 am – 1.30 pm**

Instructions: **Total Marks: 70**

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

Q.1

(a) What do you understand by the Hydrostatic Law? The pressure intensity at a point in a fluid is given by 4 N/cm^2. Find the corresponding height of fluid when fluid is: (i) water and (ii) oil of specific gravity 0.85. **05**

(b) A rectangular plain surface is 2 m wide and 4 m deep. It lies in vertical plane in water. Determine the total pressure force and position of centre of pressure on the plane surface when its upper edge is horizontal and (i) coincides with water surface and (ii) 2.5 m below the free surface. **05**

(c) A rectangular pontoon is 4 m long, 3m wide and 1.2 m high. The depth of immersion of pontoon is 0.8 m in sea water having density = 1025 kg/m^3. Determine the meta-centric height if the centre of gravity is 0.6 m above the bottom of pontoon. Is the pontoon in stable equilibrium? **04**

Q.2

(a) Explain the following terms: **07**
(i) Steady flow (ii) Unsteady flow (iii) Uniform flow (iv) Non-uniform flow
(v) Incompressible flow (vi) Eulerian method of fluid flow (vii) Newtonian fluid

(b) (i)Explain the terms: Convective acceleration and local acceleration. **04**
The two velocity components of fluid flow are given below. Determine the third component of velocity such that the continuity equation is satisfied, given
$u = x^2 + 2y^2 + 3z^2$ and $v = 2xy^2 - yz^2 + 2xy$.
(ii). The stream function is given by $\psi = 8xy$, calculate the velocity at point P (4, 5) and find the velocity potential function. **03**

OR

(b) Define 'velocity potential function' and 'Stream function'. Sketch the stream lines represented by $\psi = x^2 + y^2$. Also find the velocity and direction at point P (1, 3). **07**

Q.3

(a) Define 'forced vortex flow'. **05**
An open circular tank 30 cm in diameter and 100 cm long contains water up to a height of 70 cm. The tank is rotated about its vertical axis at 240 r.p.m. Find the depth of parabola formed at the free surface of water.

(b) State Bernoulli's theorem. List out its engineering applications. **05**
A horizontal venturimeter with inlet and throat diameters 30 cm and 15 cm respectively is used to measure the flow of water. The readings of differential manometer connected to the inlet and throat is 10cm of mercury. Determine the discharge. Take $C_d = 0.98$.

(c) A pipe is 20 cm diameter and is conveying 0.20 m^3/s of water has a 90^0 bend in horizontal plane. Find the resultant force on the bend if pressure at inlet and outlet of bend are 23 N/cm^2 and 21 N/cm^2 respectively. **04**

OR

Q.3

(a) Describe with a sketch the construction, operation and use of Pitot-static tube. **04**

(b) Find the reading of oil-mercury differential manometer having C_d = 0.98 if discharge of oil flowing through the horizontal venturimeter is 50 litres per second. The venturimeter has inlet and throat diameters 30 cm and 15 cm respectively. Take specific gravity of oil = 0.9. **05**

(c) What is the difference between an orifice and a mouthpiece? **05**
Determine the discharge through an external cylindrical mouthpiece of 150 mm in diameter discharging water under a head of 7 m. Take C_d = 0.85.

Q.4

(a) Show that discharge over a rectangular notch is given by **05**

$$Q = \frac{2}{3} C_d L \sqrt{2g} H^{3/2}$$

Where L = length of notch, H = head over crest and C_d is coefficient of discharge.

(b) Determine (i) the loss of head due to sudden expansion and (ii) pressure intensity in large pipe and (iii) power lost due to enlargement for a flow of 0.3 m^3/s through a suddenly expanded pipe with diameter changing from 250 mm to 500 mm. The pressure intensity in smaller pipe is 13.74 N/cm^2. **06**

(c) An oil of viscosity 0.5 stoke is flowing through a pipe of 30 cm diameter at a rate of 320 litres per second. Find the head loss due to friction for the pipe length of 60 m. **03**

OR

Q.4

(a) Determine the difference in the elevation between the water surfaces in two reservoirs which are connected by a horizontal pipe of diameter 30 cm and length = 500m. The discharge through the pipe is 300 litres per second. Take Darcy's friction factor f = 0.032. Consider all losses. **06**

(b) Calculate the actual discharge and actual velocity of a jet at vena contracta considering the C_d=0.6 and C_v=0.98 for an orifice of 40 mm diameter if the head over the orifice is 9 m. **04**

(c) What is a flow net? What are the uses of a flow net? **04**

Q.5

(a) Explain the following terms: **06**
(i) Hydraulic grade line (ii) Total energy line and (iii) Equivalent pipe

(b) List the methods used for determining viscosity of a liquid. Explain any one method with a neat sketch. **04**

(c) A gas is flowing through a horizontal pipe having cross section area 45 cm^2 and pressure 50 N/cm^2 (absolute) and temperature 12^0C. At another section the cross section is reduced to 25 cm^2 and pressure is 40 N/cm^2 (absolute). Assuming isothermal process, find the velocities at these sections if the mass rate of flow of gas = 0.52 kg/s. Take gas constant R = 292 N-m/Kg ^{0}K. **04**

OR

Q.5

(a) Explain the following terms: **08**
(i) Subsonic flow (ii) Sonic flow (iii) Super sonic flow and (iv) Mach cone

(b) Show that the time of emptying a tank through an orifice at its bottom is given by **06**

$$T = \frac{2A\sqrt{H_1} - \sqrt{H_2}}{C_d a \sqrt{2g}}$$

Where A = area of tank; H_1= Initial height of liquid; H_2= final height of liquid; a = area of orifice; C_d = coefficient of discharge and T= time in seconds for liquid to fall from height H_1 to H_2.

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