

Seat No.: _____

Enrolment No. _____

GUJARAT TECHNOLOGICAL UNIVERSITY

B.E. Sem-III Examination December 2009

Subject code: 130101

Subject Name: Fluid Mechanics

Date: 23 /12/ 2009

Time: 11.00 am – 1.30 pm

Total Marks: 70

Instructions:

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

Q -1

- (a) (i) A U – tube manometer (Fig.1) measures the pressure difference between two points A and B in a liquid of density ρ_1 . The U-tube contains mercury of density ρ_2 . Calculate the difference of pressure between points A and B if the liquid contain at A is water. Take $a= 1.5\text{m}$, $b = 0.75\text{m}$ and $h= 0.50\text{ m}$ 03
- (ii) A sharp edged orifice , 5 cm in diameter, in the vertical side of large tank discharges water under a head of 5 m. If $C_c = 0.62$ and $C_v = 0.98$, determine (a) the diameter of jet at the venacontracta, (b) the velocity at the venacontracta and (c) discharge in m^3/s . 04
- (b) (i) Determine whether the following flows are rotational or ir-rotational 03
- (1) $u = -2y$ $v = 3x$
- (2) $u = 0$ $v = 3xy$
- (3) $u = 2x$ $v = -2y$
- (ii) At what speed the shock wave propels in the flow in the air at 1750 kN/m^2 , absolute, is moving at 150 m/s in the high pressure wind tunnel at 40 C^0 . Take $R=287$. State whether the flow super sonic or not. 04

Q- 2

- (a) (i) A source of strength of $8\text{ m}^2/\text{s}$ at $(2,0)$ and sink of the same strength $(-2,0)$ are combined with uniform flow of 30m/s in x – direction. Determine the stagnation points and length of the Rankine's body. 04
- (ii) Calculate the loss of head and power required to maintain the flow in a horizontal circular pipe of 40 mm diameter and 750m long when water flow at a rate of 30 liters / minute. Take Darcy's friction factor as 0. 032. 03
- (b) (i) Explain the continuum concept used in fluid mechanics 02
- (ii) Explain the difference between the behavior of solids and fluids under an applied force. 03
- (iii) With neat sketch write about the Newtonian and Non – Newtonian fluids 02

OR

- (b) (i) A flat plate 30 cm x 50 cm slides on oil ($\mu = 0.8 \text{ N-s/m}^2$) over a large plane surface. What is the force required to drag the plate at 2m/s if separating oil film is 0.4 mm thick? **04**
- (ii) Derive an expression for capillary rise (depression) between two vertical parallel plates. **03**

Q-3

- (a) A circular lamina 125 cm in diameter is immersed in water so that the distance of it's edge measured vertically below the free surface varies 60 cm to 150 cm. Find the total force due to water on one side of the lamina, and the vertical distance of the center of pressure below the water surface. **07**
- (b) A rectangular sluice door (Figure – 2) hinged at the top point A and kept closed by a weight fixed on the door. The door is 120 cm wide and 90 cm long. The center of gravity of complete door and weight at G, the combined weight being 9810 N. Find the height of water h inside of the door which will just cause the door to open. **07**

OR

Q-3

- (a) A sluice gate is in the form of circular arc having radius of 5m as shown in Figure – 3 . Calculate the magnitude and direction of the resultant force on the gate, the location with respect to O point on it's line of action. **07**
- (b) (i) A vessel 1.4 m wide and 2.0 m long is filled to a depth of 0.8 m with a liquid of mass density 840 kg/m^3 . What will be the force in Newton on the bottom of the vessel (i) when being accelerated vertically upward (ii) when acceleration ceases and the vessel continuous to move at constant velocity 7 m/s vertically upward? **04**
- (ii) In the laboratory, the floating pontoon 30cm x 45 cm and height of 12 cm, weighing 120 N, is immersed in the water container having dimensions 35 cm x 50 cm. Before immersion the liquid is 10 cm deep. At what level pontoon will float? **03**

Q-4

- (a) Explain momentum correction factor required for the flow past a section. A liquid flows through the circular pipe 0.6 m diameter. Measurements of velocity taken at interval along a diameter as under. **07**

Distance

From wall,m	0	0.05	0.1	0.2	0.3	0.4	0.5	0.55	0.6
Velocity,m/s	0	2.00	3.8	4.6	5.0	4.5	3.7	1.6	0

The total momentum per unit time is 2394.00 kg. Find the true momentum in context of average velocity and find the momentum correction factor.

- (b) A flat plate is struck normally by a jet of water 50 mm diameter with a velocity of 18 m/s. Calculate (i) the force on the plate when it is stationary, (ii) the force on the plate when it moves in the same direction as the jet with a velocity of 6 m/s and (iii) the work done per second in case (ii). **07**

OR

Q-4

(a) (i) Explain

03

- (1) Hydraulic Grade Line
- (2) Total Energy Line
- (3) Piezometric Head

(ii) The pipe AB is of uniform diameter (Figure – 4) and the pressure at A and B are 150 and 250 kN/m² respectively. Find the direction of the flow and head loss in meters of liquid if liquid has a specific gravity of 0.85

04

(b) Referring to the Figure – 5 ,assume that the flow to be friction less in the siphon. Find the discharge in m³/s and the pressure head at the point B if the pipe is of uniform diameter of 15 cm .

07

Q – 5

(a) A 50m long pipe of 10 cm diameter carries water at a velocity 5 m/s. It has been decided to replace 25 m of above pipe by enlarged diameter pipe of 20 cm , the change of section being sudden. Assuming $f = 0.02$ and coefficient of contraction $C_c = 0.62$, find saving in the head loss due to replacement of pipe.

07

(b) Describe the procedure of measurement of velocity with the Pitot tube. Find flow rate of water for venturimeter if mercury manometer reads $y = 10$ cm for the case where $D_1 = 20$ cm and $D_2 = 10$ cm and $\Delta z = 0.45$ m (Refer Figure 6.)

07

OR

Q – 5

(a) What is cipoletti weir? For cipoletti weir, derive the slope ($\frac{1}{4} : 1$) of the sides of the trapezoidal notch by setting the reduction in discharge due to contraction equal to the increase in discharge due to triangulation area added.

07

(b) In an experiment on 90⁰ Vee notch, the flow is collected in a 0.90 m diameter vertical cylindrical tank . It is found that the depth of water increases by 0.685 m in 16.8 seconds when the head over the notch is 0.2 m. Determine the coefficient of discharge. If the error in observation of head over the notch is 1mm ,what will be the error in discharge?

07

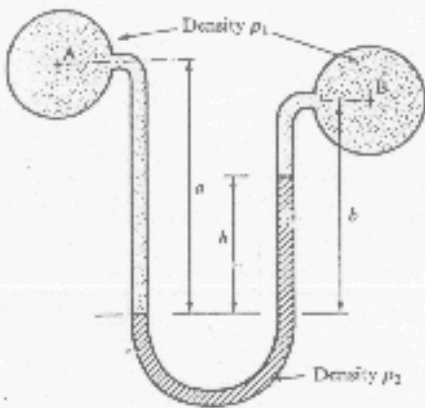


Figure - 1 Q - 1 (a)

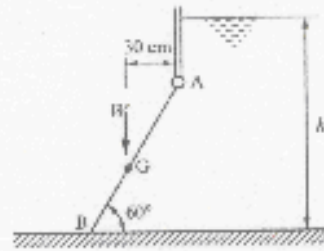


Figure - 2 Q - 3 (b)

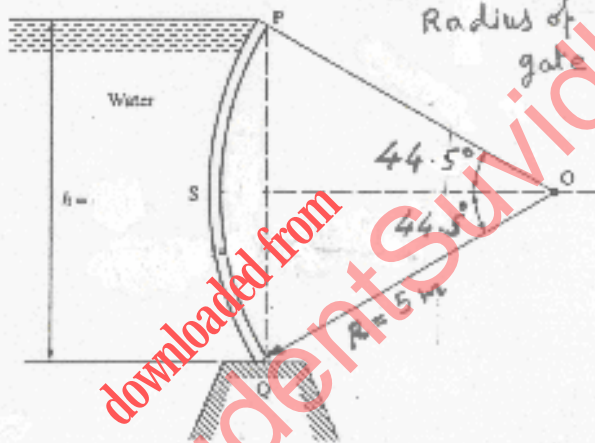


Figure - 3 / OR - Q - 3 (a)

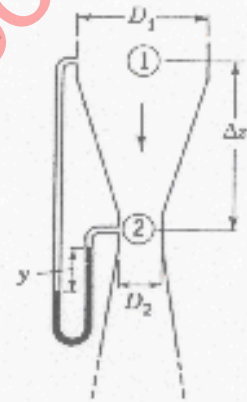


Figure - 6 Q - 5 (b)

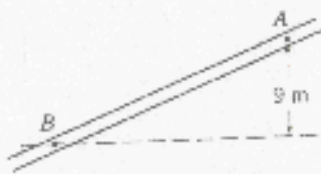


Figure - 4 / OR - Q - 4 (a - ii)

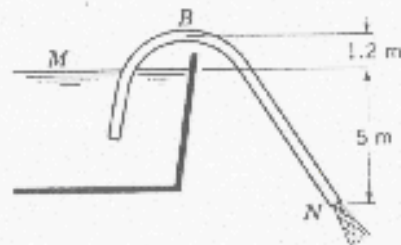


Figure - 5 / OR - Q - 4 (b)