Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

SEMESTER– 3 EXAMINATION – WINTER 2012

Subject code: 130101 **Date: 05/01/2013**

Subject Name: Fluid Mechanics

Time:10:30 – 01:00 **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)**	Define: Viscosity, Surface tension, Specific weight, Newtonian fluid, Ideal fluid.	**05**
	(b)	An equilateral triangular plate having 2.5 m side is immersed in water with its base coinciding with the free surface. Calculate total force and center of pressure if, i) the plate is vertical and, ii) angle of inclination of the plate with the free surface is 60^{o}.	**05**
	(c)	State and prove Pascal's law.	**04**
Q.2	**(a)**	Enlist types of manometers. Differentiate between u-tube manometer and u-tube differential manometer.	**07**
	(b)	A 20 cm diameter vertical cylinder rotates concentrically inside another cylinder of diameter 20.1 cm. The space between the cylinders is filled with an oil whose viscosity is to be determined. If a torque of 30 N-m is required to rotate inner cylinder at 100 r.p.m., find the viscosity of the oil. Take height of both the cylinders as 0.3 m.	**07**
		OR	
	(b)	Derive equations for total force and center of pressure for a vertical plane surface immersed in a static liquid.	**07**
Q.3	**(a)**	Define: Sub-sonic flow, Super-sonic flow, Mach angle and Mach cone.	**04**
	(b)	Calculate the stagnation pressure and temperature on the stagnation point on the nose of a plane, which is flying at 900 km/hr through still air having an absolute pressure 9.0 N/cm^2 and temperature -10^{o} C. Take R = 287 J/Kg K and k = 1.4.	**04**
	(c)	Derive the equation for velocity of sound wave in a compressible fluid in terms of bulk modulus and density.	**06**
		OR	
Q.3	**(a)**	Obtain an expression for continuity equation for a three dimensional flow.	**04**
	(b)	Differentiate between: (i) Compressible flow and Incompressible flow (ii) Uniform flow and Non-uniform flow	**04**
	(c)	The head of water over an orifice of diameter 7.5 cm is 7.5 m. The jet of water coming out from the orifice is collected in a tank having cross-sectional area of 1 m x 1 m. The rise of water level in this tank is 0.87 m in 25 seconds. The co-ordinates of a point on the jet measured from vena-contracta are 3.75 m horizontal and 0.5 m vertical. Find the	**06**

co-efficient of discharge, co-efficient of velocity and co-efficient of contraction.

Q.4 **(a)** Discuss different types of similarities that must exist between a prototype and its model. **04**

(b) Explain significance of any two dimensionless numbers in the model analysis. **04**

(c) The pressure difference Δp in a pipe of diameter d and length L due to viscous flow, depends on velocity v, viscosity μ and density ρ. Using Buckingham's π-theorem, obtain an expression for Δp. **06**

OR

Q.4 **(a)** Derive Darcy-Weisbach equation for the loss of head due to friction in pipes. **06**

(b) A horizontal venturimeter with inlet and throat diameters 0.3 m and 0.15 m respectively is used to measure the flow of water in a pipe. The reading of differential manometer connected to the inlet and the throat is 0.25 m of mercury. Determine the rate of flow, if the coefficient of discharge is 0.97. **04**

(c) The stream function for a two dimensional flow is given by $\psi = 3xy$. Calculate the velocity at point P (2, 4). Also find the velocity potential function, Φ. **04**

Q.5 **(a)** Define buoyant force, center of buoyancy, metacenter and metacentric height. Also describe conditions of equilibrium for floating and submerged bodies. **07**

(b) A ship 250 m long moves in sea-water, whose density is 1025 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 25 m/s and the resistance of the model is 50 N. Determine the velocity of ship in sea-water and also resistance of the ship in sea-water. The density of air is 1.24 kg/m^2. The kinematic viscosity of sea-water is 0.012 stokes and viscosity of air is 0.018 stokes. **07**

OR

Q.5 **(a)** Derive and sketch the velocity distribution for viscous flow through a circular pipe. Using that prove that the ratio of maximum velocity to the average velocity is 2. **07**

(b) The left limb of a u-tube manometer containing mercury is connected to a pipe in which a fluid of specific gravity 0.85 is flowing. The right limb is open to atmosphere. Mercury levels in the left and right limbs are 0.12 m and 0.4 m below center of the pipe respectively. Calculate the vacuum pressure in the pipe. Also express this vacuum pressure in terms of: i) absolute pressure and, ii) m of water. Take atmospheric pressure as 101.3 KN/m^2 and specific gravity of mercury as 13.6. **07**

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