Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

B.E. Sem-Vth Examination December 2010

Subject code: 152003

Subject Name: Fluid Mechanics & Machines

Date: 16 /12 /2010 **Time: 03.00 pm - 05.30 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)** Develop Euler's equation of motion and then derive Bernoulli's equation. **07**

(b) In an incompressible flow field, the velocity vector is given by **07**
$V = (6xt + yz^2)i + (3t + xy^2)j + (xy – 2xyz – 6tz)k$
Verify whether the flow exists or not? If so, then find the acceleration vector at a point (1, 2, 3) at t = 2 sec.

Q.2 **(a)** Derive an expression for the depth of centre of pressure from free surface of liquid of an inclined plane surface submerged in the liquid. **07**

(b) (i) Prove that "Intensity of pressure at any point in a fluid at rest is same in all direction" **05**

(ii) Two horizontal flat plates are placed 0.15 mm apart and the space between them is filled with an oil of viscosity 0.1 Ns/m^2. The upper plate of area 1.5 m^2 is required to move with a speed of 0.5 m/s relative to the lower plate. Determine the necessary force and power required to maintain this speed. **02**

OR

(b) (i) Explain the terms meta-centre and meta-centric height and prove that it is given by, $GM = I/V \pm BG$ **05**
The notations carry the usual meaning.

(ii) Consider a double-fluid manometer attached to an air pipe shown in fig.1. If the specific gravity of one fluid is 13.55, determine the specific gravity of the other fluid for the indicated absolute pressure of air. Take the atmospheric pressure to be 100 kPa **02**

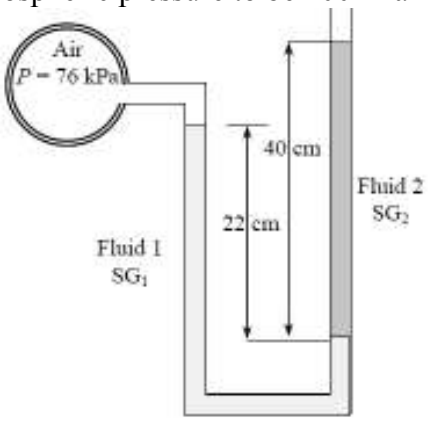

Fig.1

Q.3 **(a)** Derive an expression for the continuity equation for a three dimensional flow using the control volume approach. **07**

(b) (i) A 30 cm diameter pipe carries water under a head of 20 m with a velocity of 3.5 m/s. If the axis of the pipe turns through 45°, find the magnitude and direction of the resultant force on the bend. **04**

(ii) A wooden cylinder (specific gravity = 0.6) of 1 m diameter floats in water as shown in fig.2. What should be its maximum height in order that it may float upright (with longitudinal axis vertical)? **03**

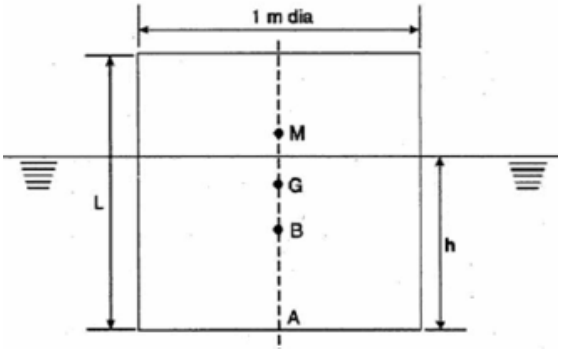

Fig.2

OR

Q.3 **(a)** Describe a venture-meter and find an expression for measuring discharge of fluid through a pipe with this device. **07**

(b) (i) Fig.3 shows a curved surface LM, which is in the form of a quadrant of a circle of radius 3 m, immersed in the water. If the width of the gate is unity, calculate the horizontal and vertical components of the total force acting on the curved surface. **04**

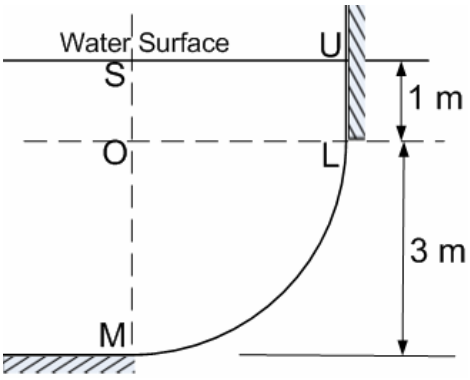

Fig.3

(ii) Define surface tension. Discuss the factors affecting surface tension. **03**

Q.4 **(a)** An inward flow turbine runner has an outer diameter of 0.6 m and an inner diameter of 0.3 m and runs at 750 rpm. The radial velocity of flow at inlet and exit is 6 m/s. Water enters the runner making an angle of 12° to the direction of motion of the blades at inlet. It leaves at the runner radially. The mass flow rate is 1 kg/s. calculate, **07**

1. Power developed.
2. Angle between the relative velocity of water and tangential velocity of the runner at exit.

(b) (i) Why a draft-tube is used with reaction turbine? Explain how the net head on the reaction turbine is increased with the use of draft tube. **04**

(ii) A Pelton wheel is to be designed for the following specifications: **03**

Power(break power) = 9560 kW
Head = 350 metre
Speed = 750 r.p.m
Overall efficiency = 85 %
Jet diameter = 1/6 of diameter of the wheel
Determine the following:

1. The well diameter
2. Diameter of the jet
3. The number of jets required

Take Co-efficient of velocity, Cv = 0.985 and Speed ratio = 0.45

OR

Q.4 **(a)** Prove that for a steady laminar flow between two fixed parallel plates, the velocity distribution across a section is parabolic and that the average velocity is 2/3 of maximum velocity. **07**

(b) An oil having viscosity of 0.7 Ns/m^2 and specific gravity 0.85 flows through a horizontal 50 mm diameter pipe with a pressure drop of 18 kN/m^2 per meter length of pipe. **07**

Determine: (i) the flow rate of oil and the centre line velocity, (ii) the total friction drag over 100 m length of pipe and the power required to maintain the flow, (iii) the velocity and shear stress at 8 mm from the wall.

Q.5 **(a)** In a single acting reciprocating pump with plunger diameter of 120 mm and stroke of 180 mm running at 60 rpm. The diameter of the delivery pipe is 90 mm and the length is 25 m. Friction factor is 0.02. If the pump is equipped with an air vessel on the delivery side at the same level as the pump, find the reduction in accelerating head and the friction head due to the fitting of an air vessel. **07**

(b) (i) Explain the different efficiency ratings of a centrifugal pump. **04**

(ii) What is priming of centrifugal pump? Explain clearly why priming is essential before starting a centrifugal pump. **03**

OR

Q.5 **(a)** What are coefficients of drag and lift? Show that these are dependent on Reynolds number and characteristic area of a body immersed in a fluid. **07**

(b) What do you understand by the boundary layer? Illustrate with reference to flow over a flat plate. **07**

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