Seat No.: _____ **Enrolment No._____**

GUJARAT TECHNOLOGICAL UNIVERSITY

B.E SEM-V Examination-Nov/Dec.-2011

Subject code: 152003 **Date: 26/11/2011**

Subject Name: Fluid Mechanics & Machines

Time: 02.30 pm-05.00 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)** Differentiate between tangential and normal acceleration and find out the expression for both. **07**

(b) (i) State and prove the hydrostatic law. **04**

(ii) The diagram below shows a cross section view of two pipes connected by a U-tube manometer. Pipe A contains oil with a specific gravity of SG = 0.92. Pipe B contains oil with a Specific gravity of SG = 0.88. The fluid in the manometer is water. The manometer readings are h_1 = 12.0 cm, h_2 = 50.0 cm, h_3= 16.0 cm. What is the pressure difference between the two pipes? **03**

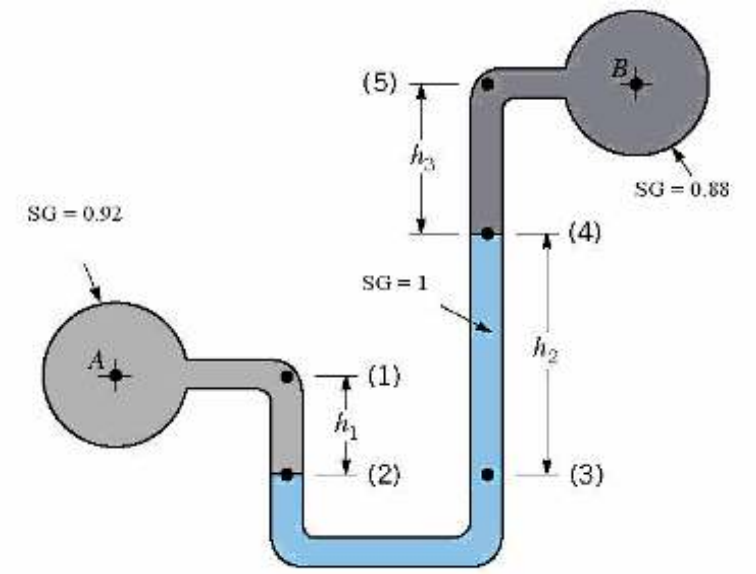

Fig.1

Q.2 **(a)** A centrifugal pump coupled to a diesel engine runs at 900 r.p.m. Water enters the impeller radially and velocity of now through the impeller (radial component of velocity) is constant. Other particulars of impeller are: **07**

Inner diameter =0.2 m
Inlet blade angle 20º
Inlet width =0.02 m
Outer diameter = 0.4 m

Neglecting losses and vane thickness. Find (1) discharge through the pump (2) head developed (3) power available at pump curter and (4) input power, if overall pump efficiency is 70%.

(b) (i) Derive the expression for total pressure and centre of pressure for a vertical plate submerged in the liquid with usual notations. **04**

(ii) State and explain the Newton's law of viscosity. **03**

OR

(b) (i) What is capillarity? Derive an expression for height of capillary rise. **04**

(ii) A shaft of 145 mm diameter runs in journals with a uniform oil film thickness of 0.5 mm. Two bearings of 200 mm width are used. The viscosity of the oil is 0.019 Ns/m^2. Determine the speed if the power absorbed is 15 W. **03**

Q.3 **(a)** A 45° reducing bend is connected in a pipe line, the diameter of inlet and outlet bend being 600 mm and 300 mm respectively. Find the force exerted by the water on the bend if the intensity of pressure at inlet to bend is 8.829 N/cm^2 and rate of flow of water is 600 litres/s. **07**

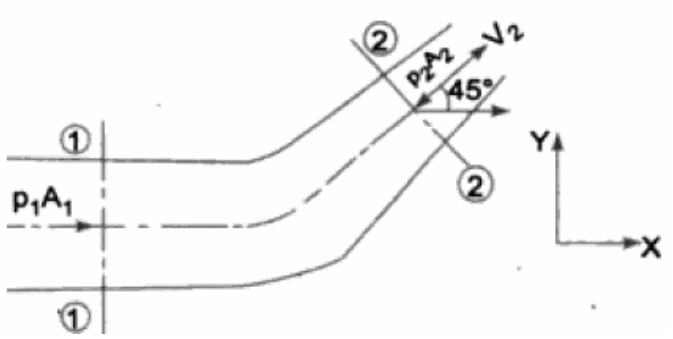

Fig.2

(b) (i) Compute the horizontal and vertical components of the total force acting on a curved surface AB, which is in the form of a quadrant of a circle of radius 2 m as shown in fig.3.Take the width of the gate as unity. **04**

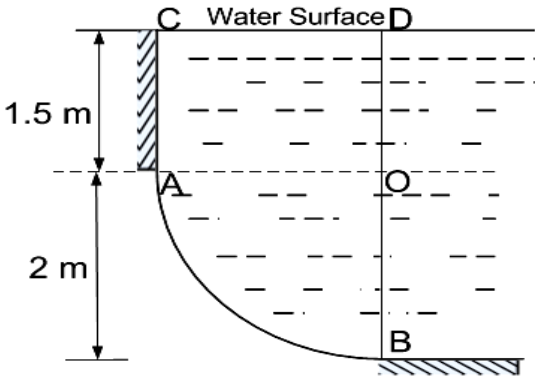

Fig.3

(ii) For an incompressible fluid the velocity components are: **03**

$$u = x^3 - y^3 - z^2x,\ v = y^3 - z^3,\ w = -3x^2z - 3^2z + \frac{z^3}{3}$$

Determine whether the continuity equation is satisfied or not.

OR

Q.3 **(a)** Sketch a venturimeter and manometer arrangement, apply the steady flow energy equation and derive an expression for the actual flow rate of an incompressible fluid. **07**

(b) (i) A two-dimensional flow field is given by $4x^3yi - 6x^2y^2j$ **04**

Determine the velocity and acceleration at a point x=2, y=1

(ii) A sphere 1 m in diameter is made up of two hemispheres, one resting on the other with interface horizontal. The sphere is filled completely with oil of specific gravity 0.75 through a hole on the top. Determine the minimum weight of the upper hemisphere to prevent it from lifting? **03**

Q.4 **(a)** (i) Differentiate clearly between Francis turbine and Kaplan turbine. **04**

(ii) What are different types of pump casings? Explain their functions. **03**

(b) (i) Prove that hydraulic efficiency of Pelton turbine is maximum when **04**

$\frac{u}{V} = 0.5$

(ii) A Pelton wheel develops 12,900kW at 425 rpm under a head of 505 m. The efficiency of the machine is 84%. Find (1) discharge of the turbine, (2) diameter of the wheel, and (3) diameter of the nozzle. Assume Cv = 0.98, and ratio of bucket speed to jet speed = 0.46. **03**

OR

Q.4 **(a)** Define the term unit speed, unit discharge, unit power and specific speed as used in connection with the operation of a hydraulic machine. **07**

(b) Define displacement thickness. Derive an expression for the displacement thickness. **07**

Q.5 **(a)** Design a Francis turbine with the following specifications: **07**

Head available = 68m
Speed = 750 rpm
Power output = 330kw
Hydraulic efficiency = 94%
Overall efficiency = 85%
Flow ratio = 0.15
Breadth to diameter ratio at inlet = 0.1
Outer to inner diameter ratio = 0.5

Assume 6% of circumferential area of runner occupied by thickness of vanes and flow velocity remains constant and flow is radial at exit.

(b) A single acting reciprocating of pump handles water. The bore and stroke of the unit are 20 cm and 30 cm. The suction pipe diameter is 12 cm and length is 8 m. The delivery pipe diameter is 12 cm and length is 24 m. Friction factor is 0.02. The speed of operation is 32 rpm. Determine the friction power with and without air vessels. **07**

OR

Q.5 **(a)** Derive the Hagen-Poiseuille equation and state the assumptions made. **07**

(b) Explain the total energy gradient line and the hydraulic gradient line for fluid flow through a piping system **07**

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