Reg. No.										

Manipal Institute of Technology, Manipal

(A Constituent Institute of Manipal University)

IV SEM. B.TECH. (MECH. ENGG.) END SEM. EXAMINATIONS MAY 2016

SUBJECT: FLUID MECHANICS [MME-2202]

(REVISED CREDIT SYSTEM)

Time: 3 Hours. MAX. MARKS: 50

Instructions to Candidates:

- Answer **ALL** the questions.
- Additional data, if any, may be appropriately assumed.
- Assumptions made must be clearly mentioned.
- Sketches are to be drawn wherever necessary.

1A) Derive the continuity equation in 3D Cartesian coordinate differential form for a compressible, unsteady and non-uniform fluid flow problem. 03

1B) Fig. (Q1B) shows a closed container consisting of three immiscible fluids: water, oil and air, connected with manometers.

(i) Compute the pressure read by the pressure gauge at A.

(ii) What will be the pressure gauge reading if the air column in the manometer (below the pressure gauge) is replaced with a fluid of relative density 0.85.

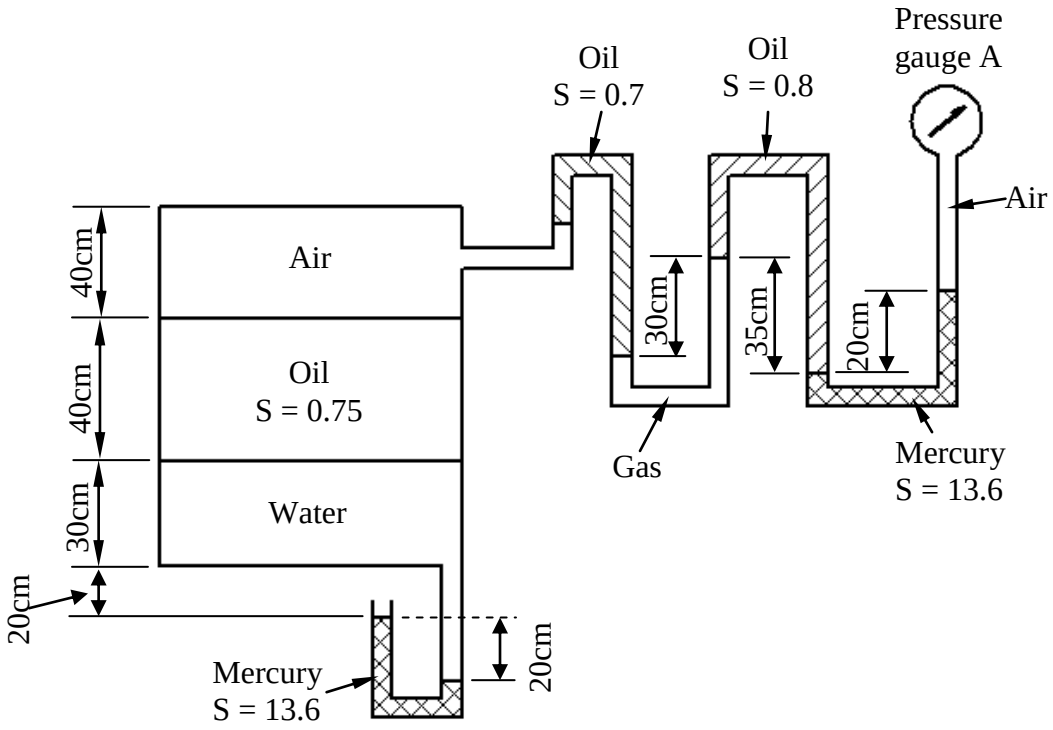

Fig. (Q1B) 03

1C) The velocity in a fluid field is given by $\vec{V} = xy\hat{i} + 2yz\hat{j} - (yz + z^2)\hat{k}$.

(i) Determine whether this is a possible steady incompressible flow.

(ii) If so, calculate the total acceleration at the point (1, 2, 3).

(iii) Also calculate the inclinations of the acceleration components with x, y and z axes. 04

2A) Derive the Euler's equation for fluid flow along a streamline. Derive the Bernoulli's equation from it. 04

2B) The atmospheric pressure and temperature at sea level are 101.43 kPa and 15°C respectively. Calculate the pressure at an elevation of 8 km above sea level, assuming that the pressure varies

(i) Iso-thermally

(ii) Non-isothermally with a lapse rate of 6.5°C/km

Consider that the density of air at sea level is 1.285 kg/m^3. 03

2C) A square plate AB of dimensions 1m × 1m is used to cover a square hole (of dimensions 1m × 1m) on a tank containing water under pressure as shown in Fig. (Q2C). The plate is held in position by a force F which is acting perpendicular to the plane of AB. Calculate the force F and the reaction at the hinge B. 03

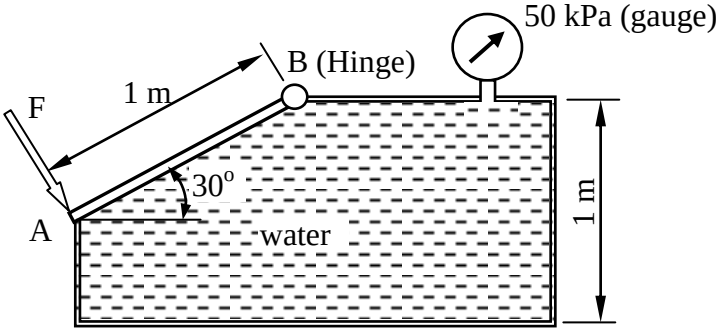

Fig. (Q2C)

3A) Show that the resistance of deeply submerged body is given by $R = \rho V^2 L^2$ f(R_e, F_r) where 'R' is the Resistance experienced by the body, 'ρ' is the density of fluid, 'V' is the velocity of motion of the body, 'L' is the length of the body, 'R_e' is Reynold's number and 'F_r' is the Froude's number. 04

3B) A thin 30 cm × 30 cm flat plate is pulled at 3 m/s horizontally through a 3.6 mm thick oil layer sandwiched between two plates, one stationary and the other moving at a constant velocity of 0.3 m/s, as shown in Fig. (Q3B). The dynamic viscosity of the oil is 0.027 Pa.s. Assuming the velocity in each oil layer to vary linearly,

(i) plot the velocity profile

(ii) find the location where the oil velocity is zero, and

(iii) determine the force that needs to be applied on the plate to maintain this motion.

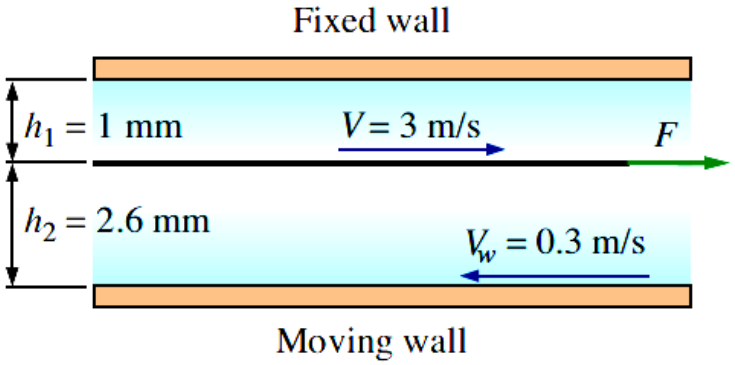

Fig. (Q3B) 04

3C) Prove that the maximum velocity in a circular pipe for viscous flow is equal to two times the average velocity of the flow. 02

4A) Find the displacement thickness, momentum thickness and energy thickness for the velocity distribution in the boundary layer is given by $\frac{u}{U}=\frac{y^2}{\delta}$, where u is the velocity at a distance y from the plate, and u = U at y = δ; where, δ is the boundary layer thickness. 03

4B) A pipe line, 300 mm in diameter and 3200 m long is used to pump up 50 kg per second of an oil whose density is 950 kg/m^3 and whose kinematic viscosity is 210 cS. The center of the pipe line at the upper end is 40 m above than that at the lower end. The discharge at the upper end is atmospheric.

(i) Determine the head lost due to friction.

(ii) Find the pressure at the lower end

(iii) Draw the hydraulic gradient line and total energy line. 04

4C) Derive an expression for the pressure difference between the inside and outside of a hollow spherical bubble of diameter D and surface tension of σ with respect to air. 03

5A) Find the discharge of water flowing through a pipe of 20 cm diameter placed in an inclined position, where a venturimeter is inserted having a throat diameter of 10 cm. The difference of pressure between the main and throat is measured by a liquid of specific gravity 0.4 in an inverted tube, which gives a reading of 20 cm. The loss of head between main and throat is 25% of the kinetic head of pipe. 04

5B) A barge has a uniform rectangular cross section of width 2*L* and vertical draft of height *H*, as shown in Fig. (Q5B).

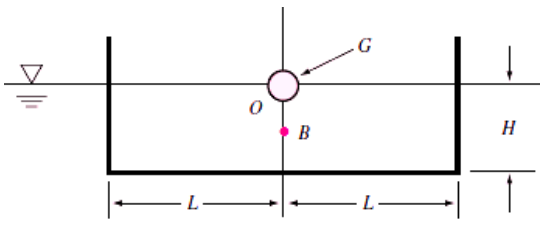

Fig. (Q5B)

(*i*) Determine the metacentric height for a small tilt angle, and

(*ii*) Determine the range of ratio *L*/*H* for which the barge is statically stable if *G* is exactly at the waterline as shown.

(iii) If the submerged height of the barge increases by 20%, what will be the new range of the ratio *L/H* 03

5C) With neat sketch derive an expression for the force exerted by a fluid flowing over a stationary body. Also, state and define the components of forces experienced by the body. 03

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