ELIZADE UNIVERSITY, ILARA-MOKIN,
ONDO STATE, NIGERIA
DEPARTMENT OF MECHANICAL ENGINEERING

SECOND SEMESTER EXAMINATIONS

2018/2019 ACADEMIC SESSION

COURSE: GNE 214 – Fluid Mechanics (3 Units)

CLASS: 200 Level General Engineering

TIME ALLOWED: 3 Hours

INSTRUCTIONS: Answer **Question 1** and any other **FOUR** questions

HOD'S SIGNATURE

Date: July, 2019

Question 1 (Fluids and fluid properties) **[14 Marks]**

1. The property of a fluid which determines its resistance to shearing stress is called ___ (a) viscosity (b) surface tension (c) compressibility (d) none of the above.
2. Compressibility is the reciprocal of ____ (a) bulk modulus of elasticity (b) shear modulus of elasticity (c) Young's modulus of elasticity (d) any of the above.
3. Any pressure measured above the absolute zero of pressure is termed as _____ (a) atmospheric pressure (b) gauge pressure (c) absolute pressure (d) none of the above.
4. The manometers are suitable for comparatively _____ pressures. (a) low (b) high (c) very high (d) none of the above.
5. The point of application of the total pressure on the surface is _____ (a) centroid of the surface (b) centre of pressure (c) either of the above (d) none of the above.
6. Centre of pressure (y_p) in case of an inclined immersed surface is given by _____ (a) $y_p = \frac{I_G \sin\theta}{Ay_G} + y_G$ (b) $y_p = \frac{I_G \sin\theta}{A^2 y_G} + y_G$ (c) $y_p = \frac{I_G^2 \sin\theta}{Ay_G} + y_G$ (d) $y_p = \frac{I_G \sin^2\theta}{Ay_G} + y_G$
7. The tendency for an immersed body to be lifted up in the fluid, due to an upward force opposite to the action of gravity is known as _____(a) buoyancy (b) centre of buoyancy (c) buoyant force (d) none of the above
8. ____ and ____ are used control the movement of the submarine in water. (a) diving planes and rudders (b) trim tank and main ballast tank (c) Pressure hull and trim tank (d) diving planes and main ballast tank
9. A floating body is in stable equilibrium when _____ (a) the metacentre is below its centre of gravity (b) the metacentre is above its centre of gravity (c) the metacentric height is zero. (d) its centre of gravity is below the centre of buoyancy.
10. In which of the following methods, the observer concentrates on a point in the fluid system? (a) Langrangian method (b) Eulerian method (c) Any of the above (d) None of the above.

11. A....is an imaginary line within the flow so that the tangent at any point on it indicates the velocity at that point. (a) streak line (b) stream line (c) path line (d) none of the above.
12. In fluidmechanics, thecontinuity equation is a mathematical statement embodying the principle of ____ (a) conservation of momentum (b) conservation of mass (c) conservation of energy (d) none of the above.
13. The co-efficient of discharge (C_d) of venturimeter lies within the limits: (a) 0.96 to 0.98 (b) 0.8 to 0.85 (c) 0.7 to 0.8 (d) 0.6 to 0.7
14. In which of the following measuring devices is Bernoulli's equation used: (a) Venturimeter (b) Orificemeter (c) Pitot tube (d) All the above.

Question 2 (Fluids and fluid properties)

a. (i) What differentiate plasma from gases (ii) What is the effect of temperature on viscosity of liquids and gases? (iii) what is the difference between dilatant and pseudoplastic fluids **[7 Marks]**

b. Consider the flow of a fluid with viscosity μ through a circular pipe shown **Fig. 2(b)**. The velocity profile in the pipe is given as $u(r) = u_{max}(1 - r^n/R^n)$, where u_{max} is the maximum flow velocity, which occurs at the centerline; r is the radial distance from the centerline; and u(r) is the flow velocity at any position r. Develop a relation for the drag force exerted on the pipe wall by the fluid in the flow direction per unit length of the pipe.

Hint: $\tau_w = \mu\frac{\delta u}{\delta y} = -\mu\frac{\delta u}{\delta r}$; $A_w = \pi DL$ **[4 ½ Marks]**

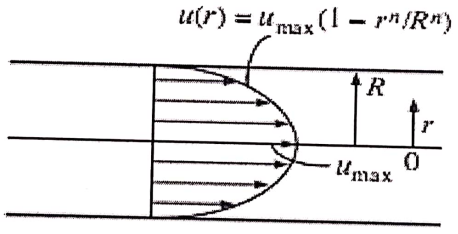

Fig. 2(b)

Question 3 (Pressure and Pressure Measurement)

a. Write short note on the following terms in relation to Fluid Mechanics: (i) Principle of transmission of fluid pressure (ii) Stratified fluids (iii) Piezometer **[3 ½ Marks]**

b. State and prove Pascal's law using **Fig. 3(b)** **[4 ½ Marks]**

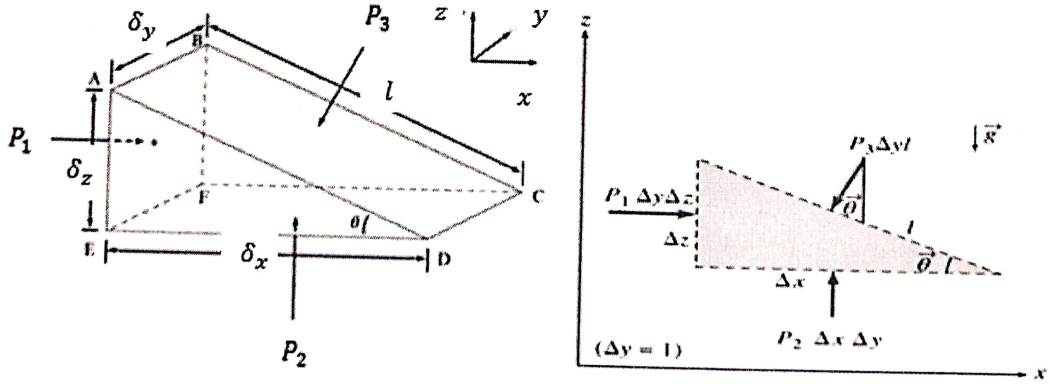

Fig. 3(b)

c. A U-tube differential manometer shown in **Fig. 3(c)** connects two pressure pipes A and B. Pipe A contains carbon tetrachloride having a specific gravity 1.594 under a pressure of 103 kN/m^2 and pipe B contains oil of specific gravity 0.8 under a pressure of 171.6 kN/m^2 and the manometric fluid is mercury, find the difference h between the levels of mercury. **[3 ½ Marks]**

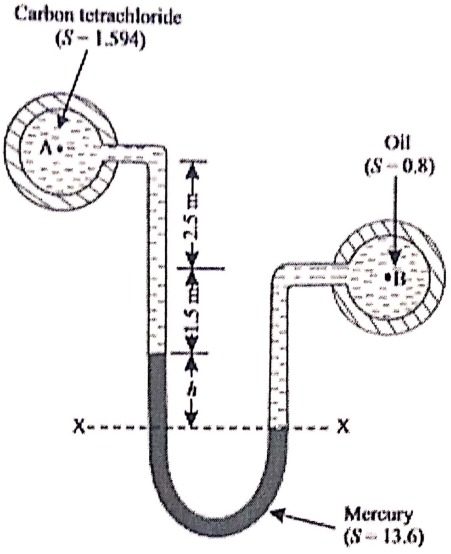

Fig. 3(c)

Question 4 (Hydrostatics)

a. Write short note on the following terms in relation to Fluid Mechanics:
(i) Submerged surface (ii) Total pressure **[3 Marks]**

b. Derive an expression for the force exerted on a submerged inclined plane surface shown in **fig 4 (b)** by static fluids and locate the position of centre of pressure.
[5 ½ Marks]

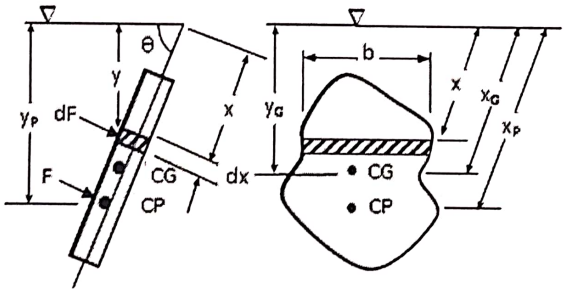

Fig. 4(b)

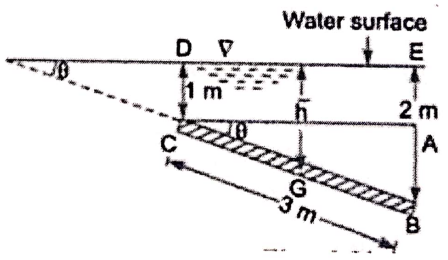

Fig. 4(c)

c. A circular plate 3 m diameter is submerged in water as shown in **fig 4(c)**. Its greatest and least depths are below the surface being 2 m and 1 m, respectively. Find: (i) The total pressure on front face of the plate (ii) The position of centre of pressure.
Hint: $I = I_G + AY_G^2;\ y_p = I/AY_G\ I_G = \pi d^4/64;\ A = \pi d^2/4;\ F = \rho g A y_G$ **[3 Marks]**

Question 5 (Buoyancy, Stability and Floating Bodies)

a. Write short note on the following terms in relation to Fluid Mechanics:
(i) Buoyancy (ii) Upthrust (iii) Archimedes' principle **[3 Marks]**

b. In relation to Archimedes' principle, explain (i) The principle of operation of a submarine (ii) Why do a hot air balloons rise into the air? **[4 Marks]**

c. A wooden block of width 2.5 m, depth 1.5 m and length 6m is floating horizontally in water. If the specific gravity of the block is 0.65 find: (i) The volume of water displaced, and (ii) Position of centre of buoyancy. **[4 ½ Marks]**

Question 6 (Metacentre and Metacentric height)

a. Briefly explain the following terminologies:
(i) Metacentre (ii) Metacentric height **[3 Marks]**

b. Show that the distance between the metacentre and centre of buoyancy is given by $BM = \frac{I}{\forall}$, where I is the moment of inertia of the floating body at the surface of water about longitudinal axis, $\forall$ is the volume of the body submerged in liquid. **[5 Marks]**

c. A solid cylinder 2 m in diameter and 2 m high is floating in water with its axis vertical as shown in **fig 6(c)**. If the specific gravity of the material of cylinder is 0.65 find its metacentric height. State also whether the equilibrium is stable or unstable.

Hints: $(i) GM = BM - BG = \frac{I}{\forall} - BG$ $(ii) I_{yy} = \frac{\pi d^4}{64}$ **[3 ½ Marks]**

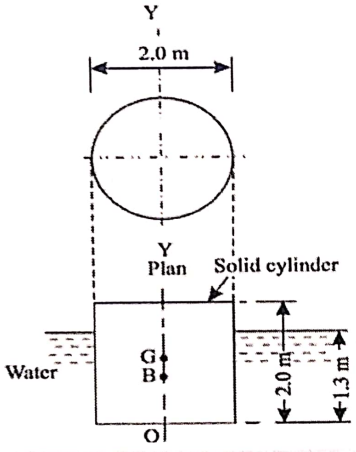

fig 6(c)

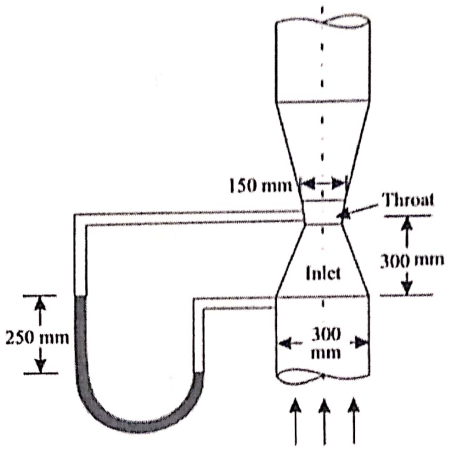

fig 7(c)

Question 7 (Fluid Dynamics and Flow Measurement)

a. Distinguish between the following:
(i) Steady and Unsteady (ii) Vortex and Potential flow (iii) Laminar and Turbulent flow **[4 Marks]**

b. Derive the Bernoulli's equation from the first principle. **[4 Marks]**

c. A 300 mm × 150 mm venturimeter shown in **fig 7 (c)** is provided in a vertical pipeline carrying oil of specific gravity 0.9, flow being upward. The difference in elevation of the throat section and entrance section of the venturimeter is 300 mm. The differential U-tube mercury manometer shows a gauge deflection of 250 mm. Calculate: (i) The discharge of oil, and (ii) The pressure difference between the entrance section and the throat section. Take the co-efficient of meter as 0.98 and specific gravity of mercury as 13.6. **[3 ½ Marks]**

$$\text{Hint: } \frac{P_1}{\rho g} + \frac{V_1^2}{2g} + Z_1 = \frac{P_2}{\rho g} + \frac{V_2^2}{2g} + Z_2 = C; Q = A_1V_1 = A_2V_2; A = \frac{\pi D^2}{4}$$

$$Q_{act} = C_d \times \frac{A_1A_2}{\sqrt{A_1^2 - A_2^2}} \times \sqrt{2gh} \quad h = y\left[\frac{S_{hl}}{S_p} - 1\right]$$

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