FLUID MECHANICS (MECH 2103)

Time Allotted : 3 hrs

Full Marks: 70

(d) $ML^{-1}T^{-1}$

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and <u>any 5 (five)</u> from Group B to E, taking <u>at least one</u> from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A (Multiple Choice Type Questions)

1.	Choose the correct alternative for the following:		$10 \times 1 = 10$
	(i)	Dynamic viscosity has dimension of	

(c) $L^2 T^{-1}$

(ii) For a Newtonian fluid

(a) $L^{-2}T^{1}$

- (a) shear stress is proportional to shear strain
- (b) rate of shear stress is proportional to shear strain

(b) MLT^{-1}

- (c) shear stress is proportional to rate of shear strain
- (d) rate of shear stress is proportional to rate of shear strain.

(iii) Moody's diagram depicts variation of friction factor f with

- (a) Reynolds number and relative roughness
- (b) Relative roughness only
- (c) Reynolds number and absolute roughness
- (d) Reynolds number only.

(iv) For the stability of floating body under the influence of gravity alone, which of the following is true?

- (a) Metacentre should be below centre of gravity
- (b) Metacentre should be above centre of gravity
- (c) Metacentre and centre of gravity must lie on the same horizontal line
- (d) Metacentre and centre of gravity must lie on the same vertical line.

(v) Vorticity is

(a) thrice the rotation	(b) twice the rotation
(c) 1 to 1.5 times the rotation	(d) equal to the rotation.
The boundary layer exists due to	

(vi) The boundary layer exists due t(a) gravitational force(c) density of fluid

- (b) surface tension
- (d) viscosity of fluid

- (vii) In a venturimeter, the pressure of liquid at throat is
 (a) equal to inlet
 (b) higher than at inlet
 (c) lower than at inlet
 (d) equal to an outlet.
- (viii) At the point of separation of boundary layer
 (a) pressure gradient is positive
 (b) pressure gradient is negative
 (c) pressure gradient is zero
 (d) pressure gradient is infinite.
- (ix) Non-zero value of temporal acceleration indicates

 (a) non-uniform flow
 (b) turbulent flow
 (c) irrotational flow
 (d) unsteady flow.
- (x) The repeating variables in dimensional analysis should
 - (a) be equal in number to that of the fundamental dimensions involved in the problem variables
 - (b) collectively contain all the fundamental dimensions
 - (c) include the dependent variable
 - (d) both (a) and (b) are correct.

Group-B

- 2. (a) Two large fixed parallel planes are 20 mm apart. The space between the surfaces is filled with a lubricating oil of viscosity 0.85 Ns/m². A flat thin plate 0.4 m² area moves through the oil at a velocity of 0.5 m/s. Determine the drag force when the thin plate is at a distance of 6 mm from one of the plane surfaces.
 - (b) Define compressibility of fluid. How does it related to modulus of elasticity? Discuss how viscosity of liquid varies with temperature.

6 + 6 = 12

- 3. (a) The velocity vector in a fluid flow is given by: $\overline{V} = 2x^3\hat{i} 6x^2y\hat{j}$. Find the equation of streamline when it passes through a point A (3,2).
 - (b) In a 2-D incompressible flow over a solid plate, the velocity component perpendicular to the plate is $V = 2x^2y^2 + 3y^3x$, where x is the coordinate along the plate and y is perpendicular to the plate. Hence find out
 - (i) The velocity component u, along the plate, assuming at x=0, u=0.
 - (ii) An expression for stream function.

Verify whether the flow is irrotational or not.

6 + 6 = 12

Group - C

- 4. (a) What is an Orificemeter ? What are the merits and demerits of Orificemeter? Write down the assumptions, limitations of Bernoulli's equation.
 - (b) A venturimeter has a diameter of 0.2 m at the inlet and 0.1 m diameter at the throat. It is fitted in a horizontal pipeline to measure the flow of oil of specific gravity 0.82. If 5900 kg of oil is collected in 2 minutes and the difference of levels in the U-tube differential manometer reads 0.185 m Hg, then determine

MECH 2103

the discharge coefficient for the pipe venturimeter. Take specific gravity of mercury as 13.6.

(1+2+3)+6=12

- 5. (a) A 0.3 m diameter pipe carries water under a head of 20.6 m with a velocity of 4 m/s. If the axis of the pipe turns through 45°, then find the magnitude and direction of the resultant force on the bend.
 - (b) A rectangular notch of length 1 m and height 40 cm discharges water. If the same quantity of water is allowed to flow over a right-angled V-notch, then determine the height to which water will rise above the apex of the notch. Take coefficient of discharge for both notches as 0.623.

6 + 6 = 12

Group - D

- 6. (a) The maximum velocity of flow in a pipe of diameter 250 mm is measured to be 2.4 m/s. If the flow through the pipe is laminar, then determine the average velocity and the radius at which it occurs. Also determine the velocity at 40 mm from the wall of the pipe.
 - (b) What power will be required per km length of a pipeline, to overcome viscous resistance, to the flow of oil, of viscosity 2 Poise, through a horizontal 10 cm diameter pipe, at a rate of 200 litres/min. Find the Reynolds number of flow if the specific gravity of oil is 0.92.

6 + 6 = 12

- 7. (a) Briefly discuss different types of minor losses that occur in pipe flow, with relevant expressions.
 - (b) Three pipes connected in series have diameters as 0.3 m, 0.2 m and 0.4 m and lengths as 400 m, 200 m and 300 m and coefficients of friction as 0.007, 0.0072 and 0.0074, respectively. If the pipes join two water reservoirs A and B having a difference in water surface levels as 15 m, then determine the discharge of water considering minor energy losses and neglecting minor energy losses.

5 + 7 = 12

Group – E

- 8. (a) For flow over a flat plate of length L, the velocity profile is given by $\frac{u}{U} = \frac{y}{\delta}$. The symbols have their usual meanings. Find the expression for the displacement thickness (δ^*) and momentum thickness (θ) in terms of boundary layer thickness(δ).
 - (b) A truck having a projected area of 6.5 m² travelling at 70 km/hr has a total resistance of 2000 N. Of this 20% is due to rolling friction and 10% is due to surface friction. The rest is due to form drag. If the density of air is 1.24 kg/m³, then determine the coefficient of form drag.

6 + 6 = 12

- 9. (a) What do you mean by drag force and lift force of an object submerged in a fluid?
 - (b) In a centrifugal pump, the rate of discharge Q is assumed to depend on the mass density ρ of fluid, speed of the pump N, the diameter of impeller D, acceleration due to gravity g, head H and dynamic viscosity μ of the fluid. Using Buckingham's pi theorem obtain an expression for discharge Q in terms of N, H, D, μ , ρ and g.

4 + 8 = 12

Department & Section	Submission Link
ME	https://forms.gle/7pseko79k4qMHjqU6