

**FLUID MECHANICS
(CHEN 2102)**

Time Allotted : 3 hrs

Full Marks : 70

Figures out of the right margin indicate full marks.

*Candidates are required to answer Group A and
any 5 (five) from Group B to E, taking at least one 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 × 1 = 10**
- (i) Shear stress in a Newtonian fluid flowing in a round pipe
(a) varies parabolically across the cross-section
(b) remains constant over the cross section
(c) is zero at the centre and varies linearly with the radius
(d) is zero at the wall and increases linearly to the centre
- (ii) A streamline is a line in flow field,
(a) that is traced by all the fluid particles passing through a given point.
(b) along which a fluid particle travels
(c) such that at every point on it, the velocity is tangential to it.
(d) none of these.
- (iii) The hydraulic diameter of an annulus of inner and outer radii R_i and R_o respectively is
(a) $4(R_o - R_i)$ (b) $\sqrt{R_o - R_i}$
(c) $2(R_o - R_i)$ (d) $R_o + R_i$
- (iv) In case of laminar flow of fluid in a pipe, kinetic energy correction factor is
(a) 2 (b) 1/2
(c) 1 (d) 3/2
- (v) Blood is a fluid
(a) Bingham plastic (b) Pseudoplastic
(c) Newtonian (d) Dilatant
- (vi) Which of the following can be applied for estimation of pressure drop during fluid flow in a smooth circular pipe at low Reynolds number
(a) Ergun equation (b) Burke-Plummer equation
(c) Hagen- Poiseuille equation (d) Kozney-Karman equation

- (vii) For ensuring uni-directional flow through a pipeline you must use
(a) Globe valve (b) Check valve
(c) Butterfly valve (d) Gate valve
- (viii) For pumping viscous liquids, generally _____ pump is used.
(a) Gear (b) Plunger
(c) Centrifugal (d) Axial flow
- (ix) Mach number > 1 signifies _____ flow
(a) Ultrasonic (b) Supersonic
(c) Subsonic (d) Sonic
- (x) The pressure drop during turbulent flow through packed bed is mainly due to
(a) Gravity (b) Viscosity
(c) Inertia (d) Buoyancy

Group – B

2. (a) Derive barometric equation.
(b) The velocity distribution in a circular pipe is given by

$$u = u_{\max} \left(\frac{R-r}{R} \right)^n$$

where u is the velocity at a distance r from the centre, $u_{\max}$ is the maximum velocity at the centre of the pipe and R is the pipe radius. Find the ratio of average velocity to maximum velocity.

- (c) Discuss rheological properties of Bingham plastic and dilatant fluid.

4 + 5 + 3 = 12

3. (a) In case of submerged vertical surface, obtain the relation between *centre of pressure* and *centre of gravity*.
(b) A thin plate of very large area is placed in a gap of height h with oils of viscosities μ_1 and μ_2 ($\mu_1 < \mu_2$) and densities ρ_1 and ρ_2 ($\rho_1 > \rho_2$) on the two sides of the plate. The plate is pulled at a constant V . Assuming linear variations of velocity, determine the position of the plate so that the shear force on the two sides of the plate is equal.
(c) Write down continuity equation for an incompressible fluid.

6 + 5 + 1 = 12

Group – C

4. (a) A Newtonian fluid is confined between two broad, parallel, vertical plates separated by a distance B . The plate on left is stationary, that on right is moving

vertically upward with a constant velocity u_0 . Assuming that the flow is laminar, find the steady-state velocity profile in the fluid.

- (b) What is the significance of kinetic energy correction factor? Find out the value of 'kinetic energy correction factor' for a Newtonian fluid flowing through a smooth circular straight tube in laminar condition.

6 + (2 + 4) = 12

5. (a) A pump (efficiency = 60%) draws water (density 998 kg/m^3 , and viscosity = 1 c.p.) from a storage tank through a 75 mm (I.D.) diameter pipe. The velocity in the suction line is 0.91 m/s. The pump discharges through 50 mm (I.D.) pipe to an overhead tank. The end of discharge pipe is 15 m above the level of the solution in the tank. Friction losses in the entire system are 29.9 J/Kg. What pressure must the pump develop?

- (b) Obtain the expression of velocity profile during flow of a Newtonian fluid through a circular pipe in laminar motion.

7 + 5 = 12

Group – D

6. (a) Derive the working formula of a venturimeter.

- (b) (i) Draw the characteristic curve for a centrifugal pump.
(ii) What is the significance of affinity laws for a centrifugal pump?

6 + (3 + 3) = 12

7. (a) The actual velocity of a liquid issuing through a 7 cm diameter orifice fitted in an open tank is 6 m/s under a head of 3 m. If the discharge measured in a collecting tank is $0.020 \text{ m}^3/\text{s}$, calculate the coefficient of velocity, coefficient of contraction and the theoretical discharge through the orifice.

- (b) (i) What do you understand by cavitation?
(ii) Define NPSH.

6 + (3 + 3) = 12

Group – E

8. (a) Particles of sphalerite (specific gravity 4.0) are settling under the force of gravity in CCl_4 at 20°C . The specific gravity of CCl_4 is 1.594. The particle diameter is 0.10 mm. The volume fraction of sphalerite in CCl_4 is 0.20. The viscosity of CCl_4 at this temperature is 1.03 cP. What is the settling velocity of sphalerite assuming free settling conditions?

- (b) Differentiate between skin drag and form drag. Which type of drag is predominant on an aeroplane when it flies through the atmosphere? Justify.

9. (a) (i) What do you understand by 'minimum fluidization velocity'?
- (ii) Give examples of the industrial applications of fluidization.
- (b) Derive the mechanical energy balance equation for a compressible fluid.

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CHE	https://classroom.google.com/c/Mjk4MDcwNDczMjI3/a/Mjk4MDcwNDczMjU4/details