CBCS SCHEME

USN | | | | | | | | | | |

15AE35

Third Semester B.E. Degree Examination, June/July 2023
Mechanics of Fluid

Time: 3 hrs. Max. Marks: 80

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Module-1

1 a. Distinguish between the following:
i) Mass density and specific gravity
ii) Ideal fluid and Newtonian fluid
iii) Dynamic viscosity and kinematic viscosity **(06 Marks)**

b. State: i) Pascal's law, ii) Hydrostic law. **(02 Marks)**

c. Two large surfaces are 2.5 cm apart. This space is filled with glycerin of absolute viscosity 0.82 NS/m^2. Find what force is required to drag a plate of area 0.5 m^2 between the two surfaces at a speed of 0.6 m/s.
i) When the plate is equidistant from the surfaces?
ii) When the plate is at 1 cm from one of the surfaces? **(08 Marks)**

OR

2 a. Explain: i) Bouyancy, ii) Centre of pressure, iii) Newton's law of viscosity. **(06 Marks)**

b. A circular plate of 3.0 m diameter is immersed in water in such a way that it's greatest and least depth below the free surface are 400 cm and 150 cm respectively. Determine the total pressure on one face of the plate and position of the centre of pressure. **(05 Marks)**

c. A horizontal pipe contains an oil of specific gravity 0.8. A differential manometer connected at the two points A and B of the pipe. If the pressure difference is found to be 25113.6 Pa, find out the manometer reading, show it in the diagram. **(05 Marks)**

Module-2

3 a. List and explain different types of fluid flow. **(08 Marks)**

b. With usual notations derive momentum equation in integral form for a compressible fluid flow. **(08 Marks)**

OR

4 a. Define velocity potential, stream function and prove that the product of the slope of the equipotential line and the constant stream line at a point of intersection is equal to (– 1). **(10 Marks)**

b. Explain source, sink and doublet flow. **(06 Marks)**

Module-3

5 a. Derive Euler's equation of motion for ideal fluids and hence deduce Bernoulli's equation of motion. State the assumptions made. **(06 Marks)**

b. Derive an expression for discharge through a venturi meter. **(06 Marks)**

c. A pitot-tube is inserted in a pipe of 300 mm diameter. The static pressure in pipe is 100 mm of mercury (vacuum). The stagnation pressure at the centre of the pipe, recorded by the pitot-tube is 0.981 N/cm^2. Calculate the rate of flow of water through pipe. If the mean velocity of flow is 0.85 times the central velocity. Take $C_V = 0.98$. **(04 Marks)**

OR

6 a. Using Buckingham's π-theorem, show that the velocity through a circular orifice is given by $V = \sqrt{2gH}\,\phi\left[\frac{D}{H}, \frac{\mu}{\rho VH}\right]$ where H is the head causing flow, d is the diameter of the orifice, μ is coefficient of viscosity, ρ is the mass density and g is the acceleration due to gravity. **(06 Marks)**

b. The efficiency η of a fan depends on the density ρ, the dynamic viscosity μ of the fluid, the angular velocity ω, diameter D of the rotor and the discharge Q. Express η in terms of dimensionless parameters. **(06 Marks)**

c. Briefly explain the advantages of the dimensional and model analysis. **(04 Marks)**

Module-4

7 a. Define: i) Lift force, ii) Drag force, iii) Resultant force. **(06 Marks)**

b. A jet plane which weighs 29.43 kN and having a wing area of 20 m^2 flies at a velocity of 950 km/hr, when the engine delivers 7357.5 KW power. 65% of power is used to overcome the drag resistance of the wing. Calculate the coefficients of lift and drag flow the wing. The density of the atmospheric air is 1.21 kg/m^3. **(10 Marks)**

OR

8 a. Explain: i) Displacement thickness, ii) Momentum thickness. **(08 Marks)**

b. A man descends to the ground from an aeroplane with the help of a parachute which is hemispherical having diameter of 4 m against the resistance of air with a uniform velocity of 25 m/s. Find the weight of the man if the weight of the parachute is 9.81 N. Take $C_D = 0.6$ and density of air = 1.25 kg/m^3. **(08 Marks)**

Module-5

9 a. Define stagnation point and derive an expression for stagnation pressure for a compressible flow. **(08 Marks)**

b. Define Mach number and derive an expression for the same. **(04 Marks)**

c. Sketch the propagation of pressure waves in a compressible fluid for supersonic flow and define Mach cone and Mach angle. **(04 Marks)**

OR

10 a. Derive an expression for :
(i) Velocity of sound in terms of Bulk modulus
(ii) Velocity of sound in isothermal process
(iii) Velocity of sound for adiabatic process. **(12 Marks)**

b. An airplane is flying at an altitude of 15 km, where the temperature is – 50°C. The speed of the plane corresponds to the Mach number of 1.6. Assuming k = 1.4 and R = 287 J/kg.K for air, find the speed of the plane and Mach angle. **(04 Marks)**

* * * * *