CBCS SCHEME

USN | | | | | | | | | | 18ME43

Fourth Semester B.E. Degree Examination, Jan./Feb. 2021
Fluid Mechanics

Time: 3 hrs. Max. Marks: 100

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

Module-1

1 a. Define the following fluid properties and state their units :
i) Specific weight ii) Viscosity iii) Surface tension iv) Specific volume. **(08 Marks)**

b. What is cavitation? Explain the importance of cavitations in the study of fluid mechanics. **(04 Marks)**

c. An oil film of thickness 1.5mm is used for lubrication between a square plate of size 0.9m × 0.9m and an inclined plane having an angle of inclination 20° with the horizontal. The weight of the square plate if 392.4N and it slides down the plane with a uniform velocity of 0.2m/s. Find the dynamic viscosity of oil. **(08 Marks)**

OR

2 a. State and prove hydrostatic law. **(06 Marks)**

b. Define metacentre and explain its importance in stability of floating bodies. **(04 Marks)**

c. A circular plate of 3.0m diameter with a concentric circular hole of diameter 1.5m is immersed in water in such a say that its greatest and least depth below the free surface are 4m and 1.5m respectively. Determine the total pressure on face of the plate and position of centre of pressure. **(10 Marks)**

Module-2

3 a. Derive continuity equation in Cartesian co-ordinates for a fluid flow in 3-dimensions. **(06 Marks)**

b. The velocity potential for ϕ is given by $\phi = -\frac{xy^3}{3} - x^2 + \frac{x^2y}{3} + y^2$. Calculate the velocity components in the X and Y direction. Check the possibility of such a flow. **(10 Marks)**

c. A wooden block of size 3m × 2m × 1m and specific gravity 0.8 floats in water. Determine its meta centric height. **(04 Marks)**

OR

4 a. State Bernoulli's equation for fluid flow. Derive an expression for Bernoulli's equation from first principle. Also state the assumption made for such a derivation. **(10 Marks)**

b. A pipeline carrying oil of specific gravity 0.8 changes in diameter from 300mm at a position A to 500mm to a position B which is 5m at a higher level. If the pressure at A and B are 1.962 bar and 1.491 bar respectively and the discharge is 150 lit/s. Determine the loss of head during the fluid flow. Also state the direction of the fluid flow. **(10 Marks)**

Module-3

5 a. Derive Hagen Poiseuille equation for laminar for through a circular pipe. **(10 Marks)**

b. Oil of viscosity 10 poise flow between two parallel plates are kept at a distance of 50mm apart. Find the rate of oil flow between the plates if the pressure drop per meter length is $0.3N/cm^2$ width of plates is 200mm and length of plate is 1.8m. Specific gravity is 0.85. **(10 Marks)**

OR

6 a. Derive Darcy – Weisbach relation for a fluid flow through pipe. **(10 Marks)**

b. A 10cm diameter pipe takes off abruptly from a large tank and run 5m, then expands to 20cm diameter abruptly and runs 50m and next discharge directly to open air with a velocity of 20m/s. Calculate the height of water surface above point of discharge. **(10 Marks)**
Take Darcy's coefficients 0.0065.

Module-4

7 a. What is the meaning of boundary layer separation? What is the effect of pressure gradient on boundary layer separation? **(12 Marks)**

b. Defines :
i) Boundary thickness
ii) Momentum thickness
iii) Displacement thickness
iv) Energy thickness **(08 Marks)**

OR

8 a. The frictional torque T of a diameter D rotating at a speed N in a fluid of viscosity μ and density ρ in turn flow is given by $T = D^5N^2\rho\phi\left[\frac{\mu}{D^2N\rho}\right]$ prove this by the method dimensions. **(10 Marks)**

b. A kite 0.8m × 0.8m weighing 3.924N assumes an angle 12° to the horizontal the string attached to the kite makes an angle of 45° to the horizontal. The pull on the string is 24.525N when the wind is flowing at a speed of a 30km/hr, find the corresponding coefficient of drag and lift. Take density of air = 1.25kg/m^3. **(10 Marks)**

Module-5

9 a. Show that the velocity of a sound wave in compressible fluid medium if given by $C = \sqrt{\frac{k}{\rho}}$ where K and P are bulk modules of elasticity and density of the fluid. **(10 Marks)**

b. Calculate the velocity and mach number of a supersonic aircraft flying at an altitude of 1000m where the temperature is 280K, sound of the aircraft is heard 2.15 seconds after the passage of the aircraft on the head of an observer.
Take $\gamma = 1.41$ and R = 2.87J/kg K. **(10 Marks)**

OR

10 a. Define stagnation temperature of a fluid. Show that the stagnation temperature and static temperature are related by $\frac{T_0}{T} = 1 + \left(\frac{\gamma - 1}{2}\right)M^2$
where γ = ratio of specific heats
M = Mach number. **(10 Marks)**

b. Mention the application and limitation of Computational Fluid Dynamics (CFD) **(10 Marks)**

* * * * *