CBCS SCHEME

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18ME43

Fourth Semester B.E. Degree Examination, July/August 2022
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 and write the equations for the following properties of fluid:
(i) Specific weight (ii) Specific gravity (iii) Mass density
(iv) Dynamic viscosity (v) Kinematic viscosity **(10 Marks)**

b. Calculate the dynamic viscosity of an oil, which is used for lubrication between a square plate of size 0.8m × 0.8m and an inclined plane with angle of inclination 30° as shown in Fig.Q1(b). The weight of the square plate is 300 N and it slides down the inclined plane with a uniform velocity of 0.3 m/s. The thickness of oil film is 1.5 mm.

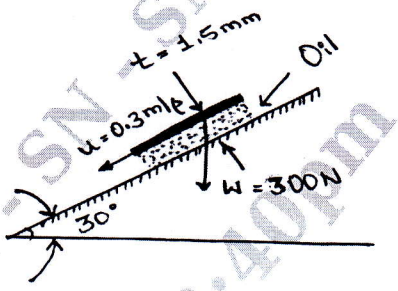

Fig.Q1(b) **(10 Marks)**

OR

2 a. Derive an equation for total pressure force and position of center of pressure for a plane surface submerged in static fluid making an angle with the free surface of fluid. **(10 Marks)**

b. Find the total pressure and position of center of pressure on a triangular plate of base 2m and height 3m which is immersed in water in such a way that plane of the plate makes an angle of 60° with free surface of water. The base of plate is parallel to water surface and at a depth of 2.5 m from water surface. **(10 Marks)**

Module-2

3 a. Define Buoyancy, center of buoyancy and metacenter. Derive an equation for metacentric height of a floating body. **(10 Marks)**

b. A solid cone floats in water with its apex downwards. Determine the least apex angle of cone for stable equilibrium. The specific gravity of material of cone is 0.8. **(10 Marks)**

OR

4 a. Define the following types of fluid flow:
(i) Steady and unsteady flows (ii) Laminar and Turbulent flows
(iii) Uniform and nonuniform flows (iv) Rotational and irrotational flows
(v) Compressible and incompressible flows **(05 Marks)**

b. Define rate of flow and explain the principle of continuity equation. **(05 Marks)**

c. A jet of water from a 25 mm diameter nozzle is directed vertically upwards. Assuming that jet remains circular and neglecting any loss of energy that will be the diameter at a point 4.5 m above nozzle, if the velocity of the jet leaves the nozzle is 12 m/s. **(10 Marks)**

Module-3

5 a. Derive Euler's equation of motion along a stream line and state and deduce Bernoulli's equation for fluid flow, mention its assumptions. **(10 Marks)**

b. Utilizing Bernoulli's principles, derive equations for discharge of fluid through the pipe using the following devices: (i) Venturimeter (ii) Orificemeter **(10 Marks)**

OR

6 a. Derive Darcy-Weisbach equation for loss of heat due to friction in pipe. **(04 Marks)**

b. A horizontal pipeline 40 m long is connected to tank at one end and discharges freely into atmosphere at other end for the first 25 m of its length from tank. The pipe is 150 mm diameter and its diameter is suddenly enlarged to 300 mm. The height of water level in tank is 8m above the center of pipe. Considering all losses of head, determine the rate of flow. Take f = 0.01 for both sections of pipe. **(06 Marks)**

c. Prove that the loss of pressure head for the viscous flow through a circular pipe is given by $h_f = 32\,\mu\,\bar{u}\,L/wd^2$, where $\bar{u}$ = average velocity, w = specific weight. **(10 Marks)**

Module-4

7 a. With a neat sketch, define the following :
(i) Laminar boundary layer (ii) Turbulent boundary (iii) Laminar sublayer
(iv) Boundary layer thickness (v) Displacement thickness **(10 Marks)**

b. The velocity profile for a laminar boundary layer flows is $u/U = 2(y/\delta) - (y/\delta)^2$. Find the thickness of boundary layer at the end of plate and drag force on one side of a plate 1m long and 0.8 m wide when placed in water flowing with a velocity of 150 mm/s. Calculate the value of coefficient of drag also. Take μ for water = 0.01 poise. **(10 Marks)**

OR

8 a. State and explain Buckingham's π theorem. **(08 Marks)**

b. Using Buckingham's π theorem, shown that discharge Q consumed by an oil ring is given by $Q = Nd^3\phi\left[\frac{\mu}{\rho Nd^2}, \frac{\sigma}{\rho N^2 d^3}, \frac{\omega}{\rho N^2 d}\right]$ where , d is internal diameter of ring, N is rotational speed, ρ is density, μ is viscosity, σ is surface tension and ω is specific weight of oil. **(12 Marks)**

Module-5

9 a. Define: (i) Mach number (ii) Sub-sonic flow (iii) Sonic flow (iv) Supersonic flow **(08 Marks)**

b. Define isothermal and adiabatic process during expansion or compression of perfect gas. **(04 Marks)**

c. Derive an expression for velocity of sound wave in a fluid. **(08 Marks)**

OR

10 a. Calculate the Mach number at a point on a jet propelled aircraft, which is flying at 1100 km/h at sea level where air temperature is 20°C. Take k = 1.4 and R = 287 J/kgK. **(08 Marks)**

b. Derive an expression for stagnation temperature (Ts). **(04 Marks)**

c. Mention the necessity, applications and limitation of CFD. **(08 Marks)**

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