CBCS SCHEME

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17AE/AS35

Third Semester B.E. Degree Examination, Aug./Sept. 2020
Mechanics of Fluids

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 with their units :
i) Mass density ii) Surface tension iii) Dynamic viscosity
iv) Capillarity v) Bulk modulus. **(10 Marks)**

b. Two large plane surfaces are 2.4cm apart. The space between the surfaces is filled with glycerin. What force is required to drag a very thin plate of surface area 0.5 square meter between the two large plane surfaces at a speed of 0.6m/s, if :
i) The thin plate is in the middle of the two plane surfaces
ii) The thin plate is at a distance of 0.8cm from one of the plane surfaces? Take the dynamic viscosity of glycerin is $8.10 \times 10^{-1} Ns/m^2$. **(10 Marks)**

OR

2 a. State and prove Pascal's law. **(06 Marks)**

b. Define the terms : i) Total pressure ii) Centre of pressure. **(04 Marks)**

c. A pressure gauge consists of two cylindrical bulbs B and C each of 10sq.cm cross sectional area, which are connected by a u–tube with vertical limbs each of 0.25sq.cm cross-sectional area. A red liquid of specific gravity 0.9 is filled into C and clear water is filled into B, the surface of separation being in the limb attached to C. Find the displacement of the surface of separation when the pressure on the surface in C is greater than that in B by an amount equal to 1cm head of water. **(10 Marks)**

Module-2

3 a. Derive an expression for continuity equation for the three dimensional flow. **(10 Marks)**

b. Show that stream lines of the doublet will be the family of circles tangent to the x-axis. **(10 Marks)**

OR

4 a. In a two-dimensional incompressible flow, the fluid velocity components are given by $u = x - 4y$, $v = -y - 4x$. Show that velocity potential exists and determine its form. Find also the steam function. **(10 Marks)**

b. Derive momentum equation in integral form for 3D steady incompressible viscous flow. **(10 Marks)**

Module-3

5 a. Define Euler's equation of motion. Derive Bernoulli's equation of motion, state the assumptions made. **(10 Marks)**

b. In a vertical pipe conveying oil of specific gravity 0.8, two pressure gauges have been installed at A and B where the diameters are 16cm and 8cm respectively. A is 2 meters above B. The pressure gauge readings have shown that the pressure at B is greater than at A by $0.981 N/cm^2$. Neglecting all losses, calculate the flow rate. If the gauges at A and B are replaced by tubes filled with the same liquid and connected to a U-tube containing mercury, calculate the difference of level of mercury in the two limbs of the U-tube. **(10 Marks)**

OR

6 a. Using Buckingham's π-theorem, show that the 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 the internal diameter of the ring, N is rotational speed, ρ is density, μ is viscosity, σ is surface tension and ω is the specific weight of oil. **(10 Marks)**

b. Define and derive expressions for the following dimensionless numbers.

i) Reynolds's number
ii) Froude's number
iii) Euler's number
iv) Weber's number
v) Mach's number. **(10 Marks)**

Module-4

7 a. Obtain Von Karman momentum integral equation for boundary layer flows. **(10 Marks)**

b. Find the displacement thickness, the momentum thickness and energy thickness for the velocity distribution in the boundary layer given by

$$\frac{u}{U} = 2\left(\frac{y}{\delta}\right) - \left(\frac{y}{\delta}\right)^2 .$$ **(10 Marks)**

OR

8 a. Define Boundary layer. Obtain an expression for momentum thickness. **(10 Marks)**

b. Air flows at 10m/s past a smooth rectangular flat plate 0.3m wide and 3m long. Assuming that the turbulence level in the oncoming stream is low and that transition occurs at $R_e = 5 \times 10^5$, calculate ratio of total drag when the flow is parallel to the length of plate to the when the flow is parallel to the width. **(10 Marks)**

Module-5

9 a. Write a note on propagation of pressure wave, and obtain an expression for velocity of sound. **(10 Marks)**

b. Calculate the velocity and mach number of a supersonic air craft flying at an altitude of 1000m where temperature is 280°k sound of the air craft is heard 2.15 seconds after the passage of air craft on the head of an observer. Take γ = 1.41 and R = 287J/kg·k. **(10 Marks)**

OR

10 a. An airplane is flying at 950km/hr through still air having an absolute pressure of 80kN/m^2 and temperature –7°C. Calculate stagnation pressure, stagnation temperature and stagnation density on the stagnation point on the noise of the plane. Take R = 287J/kg·k and γ = 1.4 for air. **(10 Marks)**

b. Define the following with suitable diagram :

i) Mach number ii) Mach cone iii) Mach angle
iv) Zone of action v) Zone of silence. **(10 Marks)**

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