53 (FPT 303) FLMC

2014

FLUID MECHANICS

Paper : FPT 303

Full Marks : 100

Time : Three hours

The figures in the margin indicate full marks for the questions.

*Answer **any five** questions out of **seven.***

1. *(a)* What do you mean by the term 'Viscosity' ? 3

   (b) Discuss the effect of temperature and pressure on viscosity. 3

   (c) Explain briefly the following : 4

   (i) Surface tension, and

   (ii) Compressibility.

(d) State and prove 'Pascal's Law'. 8

(e) What are manometers ? How are manometers classified ? 2

2. (a) Explain briefly the following : 2·5×2=5

(i) Piezometer

(ii) U-tube manometer.

(b) A rectangular sluice gate is situated on the vertical wall of a lock. The vertical side of a sluice is 'd' metres in length and depth of the centroid of the area is 'p' metres below the water surface. Prove that the depth of pressure is equal to $\left(p+\frac{d^2}{12p}\right)$. 4

(c) How are fluid flows classified ? 2

(d) Derive Euler's equation of motion with neat diagram. 9

3. (a) Determine the mass density, specific volume and specific weight of a liquid whose specific gravity is 0·75. 6

(b). A liquid has a specific gravity of 1·75 and kinematic viscosity of 5 stokes. What is its dynamic viscosity ? 4

(c) When the pressure of liquid is increased from $3 \cdot 5 MN/m^2$ to $6 \cdot 5 MN/m^2$ its volume is found to decrease by 0·08 per cent. What is the bulk modulus of elasticity of the liquid ? 4

(d) A soap bubble 50*mm* diameter has an internal pressure in excess of the outside pressure of $25 N/m^2$. Calculate tension in the soap film. 3

(e) A rectangular plate $2m \times 4m$ is vertically immersed in water in such a way that $2m$ side is parallel to the water surface and $2 \cdot 5m$ below it. Find the total pressure and position of centre of pressure of the rectangular plate. 3

4. (a) Velocity for a two dimensional flow field is given by —

$$V = \left(3 + 2xy + 4t^2\right)i + \left(xy^2 + 3t\right)j$$

Find the velocity and acceleration at a point (1, 2) after 2*sec*. 6

(b) Find the velocity and acceleration at a point (2, 3, 4) after 2*sec* for a three-dimensional flow field given by $u = yz + t$, $v = xz - t$, $w = xy$, m/s. 7

(c) In a 3-D, incompressible fluid flow, the velocity components are — 5

$$u = x^2 + z^2 + 5, \; v = y^2 + z^2 - 3$$

(i) Determine the third component of velocity

(ii) Is the fluid flow irrotational ?

(d) Differentiate between the rotational and irrotational flows. 2

5. (a) A pipe 200*m* long slopes down at 1 in 100 and tapers from 800*mm* diameter at the higher end to 400*mm* diameter at the lower end, and carries 100*lt/s* of oil (specific gravity 0·85). If the pressure gauge at the higher end reads $50 kN/m^2$, determine :

(i) Velocities at the two ends, and

(ii) Pressure at the higher end.

Neglect all losses. 8

(b) A pipe (1) 400*mm* in diameter, conveying water, branches into two pipes (2 and 3) of diameters 300*mm* and 200*mm* respectively.

(i) Find the discharge in pipe (1) if the average velocity of water in this pipe is 3*m/s*.

(ii) Determine the velocity of water in 200*mm* pipe, if the average velocity in 300*mm* diameter pipe is 2*m/s*. 6

(c) A pipe 5*m* long is inclined at an angle of 15° with the horizontal. The diameters of pipe at smaller section (at lower level) and larger section are 80*mm* and 240*mm* respectively. If the pipe is uniformly tapering and the velocity of water at the smaller section is 1*m/s*, find the difference of pressures between the two sections. 6

6. (a) In a circular pipe of diameter 100*mm* a fluid of viscosity 10 poise and specific gravity 1·2 is flowing. If the maximum shear stress at the wall of the pipe is 210N/m^2, find :

(i) The pressure gradient

(ii) The average velocity, and

(iii) Reynolds number of flow. 8

(b) An oil of viscosity 0·02 poise and specific gravity 0·8 is flowing through $50mm$ diameter pipe of length $500m$ at the rate of $0{\cdot}19lt/sec$. Determine : 8

(i) Reynolds number of flow,

(ii) Centre-line velocity,

(iii) Pressure gradient, and

(iv) Wall shear stress.

(c) What are the characteristics of a laminar flow ? 4

7. (a) Show that for velocity distribution

$$\frac{u}{v} = 2\left(\frac{y}{\delta}\right) - \left(\frac{y}{\delta}\right)^2$$

the ratio of $\frac{\delta}{\delta^*} = 3$ 6

(b) In a 45° bend a rectangular air duct of $1m^2$ cross-sectional area is gradually reduced to $0{\cdot}5m^2$ area. Find the magnitude and direction of force required to hold the duct in position if the velocity of flow at $1m^2$ section is $10\,m/s$, and pressure is $30\,kN/m^2$. Take the specific weight of air as $0{\cdot}0116\,kN/m^3$. 8

(c) In a pipe of diameter 200*mm* and length 50*m* water is flowing at a velocity of 3·5*m/s*. Find the head lost due to friction using :

(i) Darcy-Weisbach formula

(ii) Chezy's formula for which $C = 55$.

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