53 (FPT 303) FLMC

2017

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.*

1. *(a)* Define the following : 2×3=6

   (i) Hydraulics

   (ii) Fluid mechanics

   (iii) Fluid

   (b) Name some important properties of liquids. 2

   (c) State the effect of temperature and pressure on viscosity. 4

(d) Define the following : 1·5×4=6

(i) Atmospheric pressure

(ii) Gauge pressure

(iii) Vacuum pressure

(iv) Absolute pressure.

(e) How is pressure measured ? 2

2. (a) State and prove 'Pascal's Law'. 7

(b) How are fluid flows classified ? 2

(c) Define steady, non-steady, rotational and irrotational flows. 4

(d) Derive the continuity equation in Cartesian co-ordinates. 7

3. (a) A liquid has a specific gravity of 1·7 and kinematic viscosity of 9 stokes. What is its dynamic viscosity ? 5

(b) The space between two square flat parallel plates is filled with oil. Each side of the plate is $720mm$. The thickness of the oil film is $15mm$. The upper plate, which moves at $3m/s$ requires a force of $120N$ to maintain the speed. 6

Determine :

(i) The dynamic viscosity of the oil

(ii) The kinematic viscosity of oil if the specific gravity of oil is 0·95.

(c) The velocity distribution for flow over a plate is given by $u = 2y - y^2$, where *(u)* is the velocity in m/s at a distance *(y)m* above the plate. Determine the velocity gradient and shear stress at the boundary and $0{\cdot}15m$ from it. 4

(d) When a pressure of 20·7 MN/m^2 is applied to 100 litres of a liquid its volume decreases by 1 litre. Find the bulk modulus of the liquid. 5

4. (a) If a mercury barometer reads $700mm$ and a Bourdon gauge at a point in a flow system reads $500 kN/m^2$, what is the absolute pressure at the point ? 5

(b) Given that :

Barometer reading=$740mm$ of mercury

Specific gravity of mercury = 13·6

Intensity of pressure = 40 kPa

Express the intensity of pressure in S.I units, both gauge and absolute. 6

(c) Given that the velocity field :

$$V = \left(6 + 2xy + t^2\right) i - \left(xy^2 + 10t\right) j + 25k$$

What is the acceleration of a particle at (3, 0, 2) at time $t = 1$? 6

(d) Define and explain briefly the following : 3

(i) Velocity potential

(ii) Stream function

5. (a) A 6*m* long pipe is inclined at an angle of 20° with the horizontal. The smaller section of the pipe which is at lower level is of 100*mm* diameter and the larger section of the pipe is of 300*mm* diameter. If the pipe is uniformly tapering and the velocity of water at the smaller section is $1 \cdot 8\, m/s$, determine the difference of pressures between the two sections. 7

(b) Water is flowing through a pipe having diameters 600*mm* and 400*mm* at the bottom and upper end respectively. The intensity of pressure at the bottom end is $350 kN/m^2$ and the pressure at the upper end is $100 kN/m^2$. Determine the difference in datum head if the rate of flow through the pipe is 60 *litres/s*. 7

(c) Give some examples of viscous flow. 2

(d) Write some characteristics of laminar flow. 4

6. (a) An oil of viscosity 0·02 poise and specific gravity 0·8 is flowing through 50*mm* diameter pipe of length 500*m* at the rate of 0·19 *lt/sec.* Determine : 8

(i) Reynolds number of flow

(ii) Centre-line velocity

(iii) Pressure gradient

(iv) Wall shear stress.

(b) An oil of viscosity 1 poise and relative density 0·9 is flowing through a circular pipe of diameter 50*mm* and of length 300*m*. The rate of flow of liquid is 0·0035 m^3/s. Find the pressure drop in a length of 300*m* and shear stress at the wall. 6

(c) At a sudden enlargement of a water main from 240*mm* to 480*mm* diameter, the hydraulic gradient rises by 10*mm*. Calculate the rate of flow. 6

7. *(a)* Derive Hagen-Poiseuille equaton. 14

(b) Show that for velocity distribution

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

the ratio of $\frac{\theta}{\delta}=\frac{2}{15}$. 6