53 (FPT 303) FLMC

2014

FLUID MECHANICS

Paper : FPT 303

Full Marks : 100

Pass Marks : 30

Time : Three hours

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

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

1. *(a)* What is a fluid ? How are fluids classified ? 1+3=4

   (b) What is the difference between an ideal and real fluid ? 3

   (c) Explain briefly the following terms : 1·5×4=6

   (i) Mass density

   (ii) Weight density

   (iii) Specific volume

   (iv) Specific gravity

(d) What is kinematic viscosity ? What are its units ? 2

(e) Define steady, uniform, rotational and irrotational flows. 5

2. (a) Define the following terms : 5

(i) Velocity potential

(ii) Stream function.

(b) What is an impulse-momentum equation. 2

(c) Differentiate between a laminar flow and a turbulent flow. 3

(d) Explain the term boundary layer. 2

(e) Write *any five* characteristics of a boundary layer. 5

(f) Define momentum thickness and energy thickness. 3

3. *(a)* The space between two parallel plates $5mm$ apart is filled with crude oil. A force of $2N$ is required to drag the upper plate at a constant velocity of $0{\cdot}8m/s$. The lower plate is stationary. The area of the upper plate is $0{\cdot}09\,m^2$. Determine : 6

(i) The dynamic viscosity, and

(ii) The kinematic viscosity of the oil in stokes if the specific gravity of oil is 0·9.

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

(c) Find the height of water column corresponding to a pressure of $100\,kN/m^2$. 3

(d) A plate having an area of $0{\cdot}6m^2$ is sliding down the inclined plane at 30° to the horizontal with a velocity of $0{\cdot}36\,m/s$. There is a cushion of fluid $1{\cdot}8mm$ thick between the plane and the plate. Find the viscosity of the fluid if the weight of the plate is $280N$. 5

4. *(a)* In a three-dimensional incompressible flow, the velocity components in y and z-directions are

$$v = ax^3 - by^2 + cz^2$$

$$w = bx^3 - cy^2 + az^2x \cdot$$

Determine the missing component of velocity distribution such that continuity equation is satisfied. 5

(b) A pipe 200*m* long slopes down at 1 in 100 and tapers from 600*mm* diameter at the higher end to 300*mm* diameter at the lower end, and carries 100 litres/s of oil (sp. gravity 0·8). If the pressure gauge at the higher end reads $60\,kN/m^2$, determine : 8

(i) Velocities at the two ends

(ii) Pressure at the lower end.

(c) In a smooth inclined pipe of uniform diameter 250*mm*, a pressure of 50*kPa* was observed at section (1) which was at elevation 10*m*. At another section (2) at elevation 12*m*, the pressure was 20*kPa* and the velocity was 1·25*m/s*. Determine the direction of flow and the head loss between these two sections. The fluid in the pipe is water. The density of water at 20°*C* is $998\,kg/m^3$. 7

5. (a) Derive the continuity equation in Cartesian co-ordinates. 10

(b) Derive Navier-Stokes equations of motion. 10

6. (a) In a circular pipe of diameter 100*mm* a fluid of viscosity 7 poise and specific gravity 1·3 is flowing. If the maximum shear stress at the wall of the pipe is 196·2 N/m^2, find :

(i) The pressure gradient

(ii) The average velocity, and

(iii) Reynolds number of flow. 7

(b) 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 *litre/sec*. Determine :

(i) Reynolds number of flow

(ii) Centre-line velocity

(iii) Pressure gradient

(iv) Wall shear stress. 8

(c) What are characteristics of a laminar and turbulent flow. 5

7. (a) A horizontal pipe carries water at the rate of 0·04 m^3/s. Its diameter which is 300*mm* reduces abruptly to 150*mm*. Calculate the pressure loss across the contraction. Take the co-efficient of contraction = 0·62. 7

(b) Show that for velocity distribution 5

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

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

(c) Find the ratio of displacement thickness to momentum thickness and momentum thickness to energy thickness for the velocity distribution in the boundary layer given by

$$\frac{u}{v} = 2\left(\frac{y}{\delta}\right) - \left(\frac{y}{\delta}\right)^2$$ 8
