B.Tech. – VIEP – MECHANICAL ENGINEERING (BTMEVI)

Term-End Examination

00285   June, 2017

BIME-006 : THERMOFLUID ENGINEERING

Time : 3 hours   *Maximum Marks : 70*

*Note : Answer any **seven** questions. All questions carry equal marks. Use of scientific calculator is permitted.*

1. (a) How is the Mach number of a flow defined ? What does a Mach number of 2 indicate ? What is a compressible fluid ?

   (b) Show that the Reynolds number for flow in a circular pipe of diameter D can be expressed as $R_e = \dfrac{4\,\dot{m}}{\pi D \mu}$

   where $\dot{m}$ = mass flow rate, and

   μ = dynamic viscosity.   *5+5*

2. (a) Considering the steady, two-dimensional velocity field given as

   $\overline{V} = (u, v) = (1 \cdot 6 + 1 \cdot 8\,x)\,\hat{i} + (1 \cdot 5 - 1 \cdot 8y)\,\hat{j}$,

   verify that this flow field is incompressible.

(b) For a certain incompressible two-dimensional flow field, the velocity component in the y-direction is given by the equation

$$v = 3xy - x^2y.$$

Determine the velocity component in the x-direction so that the continuity equation is satisfied. 5+5

3. (a) A two-dimensional steady flow has velocity components

$$u = y; \ v = x.$$

Show that the streamlines are rectangular hyperbolas :

$$x^2 - y^2 = \text{constant}.$$

(b) A vacuum gauge connected to a chamber reads 40 kPa at a location where the atmospheric pressure is 100 kPa. Determine the absolute pressure in the chamber. 5+5

4. A stream of air flows in a duct of 100 mm diameter at a rate of 1 kg/sec. The stagnation temperature is 37°C. At one section of the duct, the static pressure is 40 kPa. Calculate the Mach number, velocity and stagnation pressure at this section. 10

5. Three pipes of lengths 800 m, 600 m and 300 m and of diameters 400 mm, 300 mm and 200 mm respectively are connected in series. The end of the compound pipe is connected to two tanks whose water surface levels are maintained at a difference of 15 m. Determine the rate of flow of water through the pipes if the coefficient of friction f = 0·005. What will be the diameter of a single pipe of length 1700 m and f = 0·005 which replaces the three pipes ? *10*

6. (a) Someone claims that the shear at the centre of a circular pipe during fully developed laminar flow is zero. Do you agree with this claim ? Explain.

(b) In fully developed laminar flow in a circular pipe, the velocity at $\frac{R}{2}$ (midway between the wall surface and the centre line) is measured to be 8 m/sec. Determine the velocity at the centre of the pipe. *5+5*

7. Distinguish between any *two* of the following : *5+5*

(a) Laminar flow and Turbulent flow

(b) Steady flow and Unsteady flow

(c) Uniform flow and Non-uniform flow

8. The velocity distribution in the boundary layer is

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

where 'δ' is the boundary layer thickness. Calculate the following : *5+5*

(a) Displacement thickness

(b) Momentum thickness

9. Derive Bernoulli's equation starting from fundamentals and state all the assumptions made. *10*

10. What is the normal shock wave and how is it obtained ? How does the normal shock affect

(a) fluid velocity ?

(b) static pressure and stagnation pressure ?

(c) static temperature and stagnation temperature ? *10*

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