196231

No. of Printed Pages : 4

BIME-006

B. TECH. VIEP Mechanical Engineering (BTMEVI) Term-End Examination June, 2019

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) In fully developed laminar flow in a circular pipe, the velocity at R/2 (midway the wall surface and the centerline) is measured to be 10 m/s. Determine the velocity at the centre of the pipe. 5

   (b) Find the head loss when a pipe of diameter 200 mm is suddenly enlarged to a diameter of 400 mm. The rate of water through the pipe is 250 litres/second. 5

2. (a) Differentiate between laminar flow and turbulent flow. 5

   (b) What is stagnation state ? What do you mean by stagnation properties ? 5

3. (a) What is a shock ? Where does it occur in a nozzle ? 5

(b) A flat plate 1.5 m × 1.5 m moves at 50 km/hour in stationary air of density 1.15 kg/m³. If the coefficient of drag and lift are 0.15 and 0.75 respectively, determine : 5

(i) The lift force

(ii) The drag force

(iii) The resultant force

4. (a) Derive an expression for area velocity relationship for a compressible fluid in the form : 5

$$\frac{dA}{A} = \frac{dV}{V}\left(M^2 - 1\right).$$

(b) Why does the viscosity of a gas increase with the increase in temperature while that of a liquid decrease with increase in temperature ? 5

5. (a) The u velocity component of a steady, two-dimensional, incompressible flow field is :

$$u = 3ax^2 - 2bxy,$$

where a and b are constant. Velocity component v is unknown. Generate an expression for v as a function of x and y. 5

(b) For a pump, discuss the difference between brake horse power and water horse power and also define pump efficiency in terms of these quantities. 5

6. (a) Determine the total pressure and depth of centre of pressure on a plane rectangular surface of 2 m wide and 5 m deep when its upper edge is horizontal and : 5

(i) Coincides with water surface, and

(ii) 3 m below the free water surface

(b) In a two-dimensional incompressible flow, the fluid velocity components are given by :

$$u = x - 4y \text{ and } v = -y - 4x.$$

Show that velocity potential ϕ exists and determine its form. Find also the stream function. 5

7. (a) A vacuum gauge connected to a chamber reads 45 kPa at a location where atmospheric pressure 101 kPa. Determine the absolute pressure in the chamber. 5

(b) The stream function for a two-dimensional flow is given by :

$$\psi = 2xy.$$

Calculate the velocity at the point (2, 3). Find the velocity potential function ϕ. 5

8. (a) Show that the following stream function : 5

$$\psi = 6x - 4y + 7xy + 9$$

represents an irrotational flow.

(b) A water pump increases the pressure of the water passing through it. The flow is

assumed to be incompressible. For each of the three cases listed below, how does average water speed change across the pump ? In particular, is V_{out} less than, equal to, or greater than V_{in}. Show your equation and explain : 5

(i) Outlet diameter is less than inlet diameter ($D_{out} < D_{in}$)

(ii) Outlet and inlet diameters are equal ($D_{out} = D_{in}$)

(iii) Outlet diameter is greater than inlet diameter ($D_{out} > D_{in}$)

9. (a) Derive the Bernoulli's equation. Also write the assumptions made in Bernoulli's equation. 5

(b) Define and explain the Newton's law of viscosity. 5

10. Write short notes on any ***four*** of the following : $2\frac{1}{2}$ each

(a) Impulse turbine

(b) Orifice meter

(c) Mach number

(d) Displacement thickness

(e) Fanno line

(f) Head loss