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BIME-006

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

Term-End Examination

00483

June, 2018

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. Assume missing data suitably.*

1. (a) What is a Newtonian fluid ? How does the dynamic viscosity of liquids and gases vary with temperature ?

(b) Determine the density, specific gravity and mass of the air in a room whose dimensions are 4 m × 5 m × 6 m at 100 kPa and 25°C.

Given : Gas constant of air,

$$R = 0{\cdot}287 \text{ kPa m}^3/\text{kg K}.$$

5+5

2. (a) What is cavitation ? What causes it ?

(b) Define streamline. What do streamlines indicate ? Also explain steam function ψ and velocity potential function ϕ. *5+5*

3. (a) Consider the following steady, incompressible two-dimensional velocity field

$$\mathbf{V} = x^2 \hat{\mathbf{i}} + (-2xy - 1)\, \hat{\mathbf{j}},$$

Is this flow rotational or irrotational ? Justify your answer.

(b) A steady incompressible two-dimensional velocity field is given by the following components in the xy plane :

$$u = 1{\cdot}85 + 2{\cdot}33x + 0{\cdot}656y;$$

$$v = 0{\cdot}754 - 2{\cdot}18x - 2{\cdot}33y;$$

Calculate the acceleration components a_x and a_y and calculate the acceleration at the point $(-1, 2)$. *5+5*

4. (a) The absolute pressure in water at a depth of 5 m is read to be 145 kPa. Determine :

(i) The local atmospheric pressure, and

(ii) The absolute pressure at a depth of 5 m in a liquid whose specific gravity is 0·78 at the same location.

(b) A steady two-dimensional incompressible flow field in the xy-plane has a stream function given by

$$\psi = ax^2 - by^2 + cx + dxy$$

where a, b, c and d are constants.

(i) Obtain expression for velocity components u, v, and

(ii) Verify that the flow field satisfies the incompressible continuity equation. *5+5*

5. Prove that for a one-dimensional isentropic flow through a nozzle, the area velocity relationship for a compressible fluid is given by *10*

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

6. (a) What is stagnation state ? What do you mean by stagnation properties ?

   (b) What is a nozzle and a diffuser ? State their applications. *5+5*

7. What is a shock ? Where does it occur in a nozzle ? *10*

8. What is a Fanno line ? Why does the end states of a normal shock lie on the Fanno line ? *10*

9. A Pelton wheel is to be designed for the following specifications :

   Shaft power = 11,772 kW, Head = 380 m,
   Speed = 750 rpm, Overall efficiency = 86%;
   Jet diameter is not to exceed one-sixth of the wheel diameter.
   Determine :

   (a) The wheel diameter,

   (b) The number of jets required, and

   (c) Diameter of the jet.

   Take co-efficient of velocity K_{v_1} = 0·985 and speed ratio K_{u_1} = 0·45. *10*

10. Derive an expression for the velocity distribution for viscous flow through a circular pipe. Also sketch the velocity distribution and shear distribution across a section of the pipe. *10*
