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BIME-006

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

Term-End Examination

00103

December, 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.*

1. (a) Distinguish between pathline, streamline and streakline.

(b) How does normal shock affect the following ?

(i) Fluid velocity

(ii) Static pressure

(iii) Stagnation temperature

(iv) Static temperature

(v) Stagnation pressure *5+5*

2. (a) If the velocity distribution over a plate is given by

$$u = \frac{3}{4}y - y^2,$$

where u is velocity in ms^{-1} at distance y metres above the plate, determine the shear stress at a distance of 0·15 m from the plate. Take the dynamic viscosity of fluid as 0·834 PaS.

(b) The velocity profile in fully developed laminar flow in a circular pipe of inner radius R = 4 cm, in m/sec, is given by

$$u(r) = 8\left(1 - \frac{r^2}{R^2}\right).$$

Determine the average and maximum velocities in the pipe and the volume flow rate. *5+5*

3. (a) What is cavitation ? Also define net positive suction head and required net positive suction head. Explain how these two quantities are used to ensure that cavitation does not occur in a pump.

(b) A 35 cm diameter pipe conveying water, branches into two pipes of diameters 25 cm and 20 cm respectively. If the average velocity in the 35 cm diameter pipe is 3 m/sec, find the discharge in this pipe. Also determine the velocity in 20 cm diameter pipe if the average velocity in 25 cm diameter pipe is 2·5 m/sec. *5+5*

4. (a) 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 at this section.

(b) What percentage of an iceberg floats visibly above the sea level, if the density of the iceberg is 900 kg/m^3 and the density of sea water is 1020 kg/m^3 ? *5+5*

5. (a) Define the stream function ψ and velocity potential ϕ and hence show that the lines of constant ψ and ϕ must intersect orthogonally.

(b) If for a two-dimensional potential flow, the velocity potential is given by the expression

$$\phi = x(2y - 1)$$

(i) Determine the velocity at the point P(4, 5).

(ii) What is the value of the stream function ψ at the point P ? *5+5*

6. (a) Consider the following steady, incompressible and two-dimensional velocity field :

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

Is this flow rotational or irrotational ? Justify your answer.

(b) If stream function for steady flow is given by

$$\psi = y^2 - x^2,$$

determine whether the flow is rotational or irrotational. Then determine the velocity potential. *5+5*

7. (a) Define surface tension. Explain the phenomenon of capillarity.

(b) Do the following potentials represent possible flows ? If so, determine the stream function

(i) $\phi = y + x^2 - y^2$

(ii) $\phi = x^2 + y^2 + z^4$ *5+5*

8. (a) Prove that the head loss due to friction is equal to one-third of the total head for maximum power transmission through the pipes.

(b) What are a nozzle and a diffuser ? *5+5*

9. (a) Derive the continuity equation for a three-dimensional, steady incompressible flow.

(b) Explain the characteristic curve for a hydraulic turbine. *5+5*

10. Write short notes on any ***four*** of the following : $4 \times 2\frac{1}{2} = 10$

(a) Boundary Layer Theory

(b) Lift and Drag Force

(c) Specific Speed of Turbine

(d) Water Hammer

(e) Venturimeter

(f) Viscosity