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BIME-006

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

1342

Term-End Examination

December, 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. Assume missing data suitably.*

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

(b) A tank is filled with oil whose density is $\rho = 850\ kg/m^3$. If the volume of the tank is $V = 2\ m^3$, determine the amount of mass in the tank.

(c) A 100 litres container is filled with 1 kg of air at a temperature of 27°C. What is the pressure in the container ?

Take R = 0·287 kJ/kg K.

(d) Is it possible to accelerate a gas to a supersonic velocity in a converging nozzle ? Explain in brief.

(e) Show that the Reynolds number for flow in a circular pipe of diameter D can be expressed as $R_e = \frac{4\,\dot{m}}{\pi\,D\,\mu}$. *5×2=10*

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

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

3\. (a) The velocity profile in a fully developed laminar flow in a circular pipe of inner radius R = 2 cm in m/s, is given by $u(r) = 4\left(1 - \frac{r^2}{R^2}\right)$. Determine the average and maximum velocities in the pipe and the volume flow rate.

(b) Define Drag and Lift. Why do we usually try to minimize drag ? *5+5*

4. (a) Consider the steady two-dimensional velocity field given by

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

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*

5. (a) Differentiate between a nozzle and a diffuser.

(b) What is meant by choking in nozzle flows ? *5+5*

6. Show that the discharge through a nozzle is maximum when there is a sonic condition at its throat. *10*

7. What is a Rayleigh line ? Why do the end states of a normal shock also lie on the Rayleigh line ? *10*

8. What do you mean by gross head, net head and efficiency of a turbine ? Explain the different types of efficiency of turbines. *10*

9. Explain the following in brief : *5×2=10*

(a) Total Energy Line

(b) Hydraulic Gradient Line

(c) Pipes in Series

(d) Pipes in Parallel

(e) Equivalent Pipe

10. Prove that the maximum velocity in a circular pipe for a viscous flow is equal to two times the average velocity of the flow. *10*