Total No. of printed pages = 3

ME 131503

Roll No. of candidate | | | | | | | | | | |

2017

B.Tech. 5th Semester End-Term Examination

Mechanical

FLUID MECHANICS — II

Full Marks – 100 Time – Three hours

The figures in the margin indicate full marks for the questions.

Answer Question No. 1 and any *six* from the rest.

1. Answer the following questions : (10 × 1 = 10)
   (a) What is Mach number?
   (b) What is incompressibility factor?
   (c) Define shockwave.
   (d) What is normal shockwave?
   (e) What do you understand by Reynolds's number?
   (f) Define Momentum thickness.
   (g) Explain the term boundary layer.
   (h) What do you understand by laminar and turbulent boundary layer?
   (i) What is difference between model and prototype?
   (j) What do you understand by intensity of turbulence?

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2. (a) If v_{max} and v^* are the maximum fluid velocity and critical fluid velocity show that

$$v_{max} = v^* \sqrt{\frac{\gamma+1}{\gamma-1}}. \quad (8)$$

(b) Calculate the velocity and Mach No. of supersonic aircraft flying at an altitude of 1000 m where the temperature is 280 K. Sound of the aircraft is heard 2.15 seconds after the passage of the aircraft over the head of an observer. (7)

3. The state of a gas at upstream of a normal shock wave is given as Mach number, pressure and temperature 2.5 m, 2 bar and 275 K respectively. Calculate Mach number, pressure, temperature and velocity of the gas at downstream of the shock. Take $\gamma = 1.3$ $R = 0.469$ kJ/kg-K. (15)

4. Air enters a long circular duct diameter 12.5 cm and frictional factor of 0.0045 at a Mach number 0.5 pressure 3.0 bar and temperature 312 K. If the flow is isothermal throughout the duct determine : (a) The length of the duct required to change the Mach number to 0.7, (b) Pressure and temperature of air at Mach number 0.7. (c) The length of duct required to attain limiting Mach number. (15)

5. (a) What is Rayleigh flow? Under what conditions the assumption of Rayleigh flow is not valid in a heat exchanger. (5)

(b) Atmospheric air at 25°C flows parallel to a flat plate at a velocity 3 m/s. Use Blasius solution to estimate the boundary layer thickness and local skin friction coefficient at $x = 1$ m from the leading edge of the plate. (10)

6. (a) Find the displacement and momentum thickness for fluid flowing over a flat plate, when $u = A + By + Cy^2$ where u is fluid velocity. (10)

(b) For the given velocity profile determine whether the flow has separated or is on the verge of separation or will attach with the surface.

$$\frac{u}{U_\infty} = \frac{3}{2}\left(\frac{y}{\delta}\right) - \frac{1}{2}\left(\frac{y}{\delta}\right)^3. \quad (5)$$

7. (a) What do you understand by Prandtl's mixing length theory? Derive an expression for that. (8)

(b) What is meant by turbulence? How does it affect the flow properties? (7)

8. Define the terms dimensional analysis and model analysis. Find expression for the power P developed by a pump when P depends upon the head H, the discharge Q and specific weighty γ of the fluid. (7 + 8 = 15)