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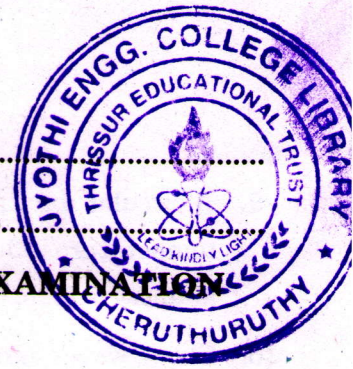
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Name.....

Reg. No.....

**EIGHTH SEMESTER B.TECH. (ENGINEERING) DEGREE EXAMINATION
APRIL 2017**

**ME 09 802—COMPRESSIBLE FLUID FLOW
(2009 Admissions)**



Time : Three Hours

Maximum : 70 Marks

Use of Gas table is permitted.

Part A

Answer all questions.

Each question carries 2 marks.

1. Define zone of action and zone of silence.
2. Determine the velocity of sound in air at 35°C. What should be the minimum temperature of air if it has to be hypersonic when it has a velocity of 1500 m/s ?
3. The pressure, temperature and Mach number of the gas at exit are 2 bar, 1200°C and 0.7 respectively. The ratio of stagnation temperature at exit to entry is 3.85. Calculate pressure and temperature of the gas at entry.
4. A circular duct passes 8.25 kg/s. of air at an exit Mach number of 0.5. The entry pressure and temperature is 3.5 bar and 38°C respectively and coefficient of friction is 0.005. If the Mach number at entry is 0.15, determine diameter of the duct.
5. Show the normal shock in $h-s$ diagram with the help of Rayleigh line and Fanno line.

(5 × 2 = 10 marks)

Part B

Answer any four questions.

Each question carries 5 marks.

6. Air enters a straight axisymmetric duct at 300 K, 3.45 bar and 150 m/s and leaves it at 277 K, 2.058 bar and 260 m/s. the area of cross-section at entry is 500 cm². Assuming adiabatic flow, determine stagnation temperature, maximum velocity, mass flow rate and area of cross-section at exit.
7. Derive an expression for the mass flow rate in flow through a convergent divergent nozzle in terms of pressure ratio and inlet conditions of the gas.
8. The pressure, temperature and Mach number of the gas at exit are 2 bar, 1200°C and 0.7 respectively. The ratio of stagnation temperature at exit to entry is 3.85. Calculate pressure and temperature of the gas at entry.

Turn over

9. A circular duct passes 8.25 kg/s. of air at an exit Mach number of 0.5. The entry pressure and temperature is 3.5 bar and 38°C respectively and coefficient of friction is 0.005. If the Mach number at entry is 0.15, determine diameter of the duct.
10. Shock waves cannot develop in subsonic flow ? Why ?
11. Briefly discuss about strength of normal shock wave.

(4 × 5 = 20 marks)

Part C*Answer all questions.*

12. (a) An aircraft is flying at an altitude of 11,000 metres, at 800 km/hr. The air is reversibly compressed in an inlet diffuser. The inlet temperature is 216.65 K and pressure is 0.226 bar. If the Mach number at the exit of the diffuser is 0.35, calculate the following :—
- Entry Mach number.
 - Velocity, pressure and temperature of air at the diffuser exit.

Or

- (b) Show that for a compressible fluid flow :

$$M^{*2} = \frac{\left[\frac{\gamma + 1}{2} \right] M^2}{1 + \frac{\gamma - 1}{2} M^2}$$

13. (a) In a supersonic nozzle air expands from $p_0 = 24$ bar and $T_0 = 1000$ K to an exit pressure of 4.3 bar. If the exit area of the nozzle is 110 cm², calculate the following :—
- Throat area.
 - Pressure and temperature at the throat.
 - Temperature at exit.
 - Mass flow rate.
 - Exit velocity as fraction of the maximum attainable velocity.

Or

- (b) Derive an expression for the mass flow rate in flow through a convergent-divergent nozzle in terms of pressure ratio and inlet conditions of the gas.

14. (a) Prove that for Reyleigh flow the static pressure ratio :

$$\frac{P_2}{P_1} = \frac{1 + \gamma M_1^2}{1 + \gamma M_2^2}$$

Or

- (b) A circular duct passes 8.25 kg/s. of air at an exit Mach number of 0.5. The entry pressure and temperature are 3.5 bar and 38°C respectively and co-efficient of friction is 0.005. If the Mach number at entry is 0.15, determine :
- Diameter of the duct.
 - Length of the duct.
 - Pressure and temperature at the exit.
 - Stagnation pressure loss.
15. (a) The following data refer to compressible fluid flow in a convergent-divergent nozzle.

Throat area = 2.4 cm², exit area = 5 cm², stagnation pressure = 7 bar, stagnation temperature = 100°C. Normal shock occurs at a section where the cross-sectional area is 3.4 cm². Taking the flow as isentropic before and after the shock. Determine (a) The properties of the fluid just after the shock ; (b) Exit Mach number ; and (c) Properties of the fluid at exit.

Or

- (b) Prove for a compressible fluid flow

$$M_y^2 = \frac{\frac{2}{\gamma - 1} + M_x^2}{\frac{2\gamma}{\gamma - 1} M_x^2 - 1}$$

(4 × 10 = 40 marks)