

Reg. No. :

Question Paper Code : R 3778

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2009.

Fifth Semester

Mechanical Engineering

ME 333 — GAS DYNAMICS AND SPACE PROPULSION

(Regulation 2001)

Time : Three hours

Maximum : 100 marks

(Use of Standard Gas Tables Permitted)

Assume suitable data wherever necessary.

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Define Stagnation enthalpy.
2. Distinguish between Mach wave and Normal shock.
3. Give any two assumptions regarding Fanno flow.
4. Why is expansion shock impossible?
5. Define 'Strength of a shock wave'.
6. What is shock polar?
7. Give any two differences between Turbo fan and Turbo prop engine.
8. What is turbojet?
9. Name any two Solid Propellants and Liquid Propellants used for Rocket Propulsion.
10. List out any two uses of Solid Propellant Rocket Systems.

PART B — (5 × 16 = 80 marks)

11. (a) (i) Explain the difference between flow and non flow work. (6)
- (ii) Carbon-dioxide expands isentropically through a nozzle from a pressure of 3.2 bar to 1.0 bar. If the initial temperature is 475°K determine the final temperature, the enthalpy drop and the change in internal energy. (10)

Or

- (b) What is meant by velocity of sound? Derive the expression for the velocity of sound. (16)
12. (a) Air enters a constant area duct at $M_1 = 3$, $P_1 = 1$ atm, $T_1 = 300$ K. Inside the duct the heat added per unit mass is $q = 3 \times 10^5$ J/kg. Calculate the flow properties M_2 , P_2 , T_2 , ρ_2 , T_{02} and P_{02} at the exit. (16)

Or

- (b) Air at an inlet temperature of 60°C flows with subsonic velocity through an insulated pipe having diameter of 50 mm and a length of 5 m. The pressure at the exit of the pipe is 101 kPa and the flow is choked at the end of the pipe. If the friction factor $4f = 0.005$, determine the inlet Mach number, the mass flow rate and the exit temperature. (16)
13. (a) (i) Discuss under what condition a compression wave changes into a shock wave. (4)

- (ii) The state of a gas ($\gamma = 1.3$; $R = 0.469$ kJ/kg°K) up stream of a normal shock wave is given by the following data.

$$M_x = 2.5; P_x = 2 \text{ bar}; T_x = 275^\circ \text{ K}.$$

Calculate the Mach number, pressure, temperature of the gas downstream of the shock. (12)

Or

- (b) (i) What is meant by normal shock in a flow through convergent and divergent nozzle? Explain. (8)
- (ii) If a normal shock in a flow of Nitrogen at a velocity of 700 meter/sec, find the Mach number and the properties at the down stream of shock. The temperature and pressure before shock are 30°C and 2 bar respectively. (8)

14. (a) (i) Compare solid and liquid propellant systems. (8)
- (ii) With neat sketches explain the constructional features and working of (1) Ramjet engine and (2) Turbofan engine. (8)

Or

- (b) Briefly explain the following : (2 × 8 = 16)
- (i) Turbofan engine.
- (ii) Aircraft combustors.
15. (a) (i) Explain the construction and operation of a solid propellant rocket engine. Also name any four solid propellants. (8)
- (ii) Explain any two arrangements used for fuel feeding in liquid propellant rocket system with the help of neat sketches. (8)

Or

- (b) (i) Explain the working principle of Liquid Propellant Rocket Engine with aid of a suitable sketch. (8)
- (ii) List out the merits and demerits of Liquid Propellant Rocket systems over solid propellant rocket systems. (8)