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Question Paper Code : 23854

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2018.

Sixth Semester

Mechanical Engineering

ME 2351 — GAS DYNAMICS AND JET PROPULSION

(Regulations 2008)

(Common to PTME 2351 – Gas Dynamics and Jet Propulsion for B.E. (Part-Time) Fifth Semester – Mechanical Engineering – Regulations 2009)

Time : Three hours Maximum : 100 marks

(Use of gas Tables is permitted)

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. What is meant by gas dynamics?

2. Define Mach number.

3. What is impulse function and give its uses?

4. Give the expression for $\frac{T_0}{T}$ and $\frac{T^*}{T}$ for isentropic flow through variable area in terms of mach number.

5. How oblique shock is differ from normal shock?

6. State the necessary conditions for a normal shock to occur in compressible flow.

7. Why ramjet engine does not require a compressor and a turbine?

8. Find optimum propulsive efficiency when the jet velocity is 500 m/s and flight velocity is 900 m/s.

9. What is bi-propellant? Give example.

10. What is the role of inhibitors in rocket propulsion system?

PART B — (5 × 16 = 80 marks)

11. (a) An aircraft flies at a velocity of 700 kmph in an atmosphere where the pressure is 75 kPa and temperature is 5°C. Calculate the Mach number and stagnation properties.

Or

(b) Air expands isentropically through the convergent nozzle from constant inlet conditions $P_0 = 4$ bar, $T_0 = 550$ K. Exit area of nozzle is $1000\,cm^2$. Determine the exit velocity and mass flow rate for the following two cases at exit.

(i) $M = 1$

(ii) $M = 0.85$.

12. (a) Air enters a long circular duct ($d = 12.5$ cm, $\bar{f} = 0.0045$) at a mach number 0.5, pressure 3.0 bar and temperature 312 K. If the flow is Fanno flow throughout the duct determine :

(i) The length of the duct required to change the mach number to 0.7

(ii) Pressure and temperature of air at M = 0.7

(iii) The length of the duct required to attain limiting mach number

(iv) State of air at the limiting mach number.

Or

(b) The conditions of a gas in a combustor at entry : $P_1 = 0.343$ bar, $T_1 = 310$ K, $C_1 = 60$ m/s. Determine the mach number, pressure, temperature and velocity at the exit if the increase in stagnation enthalpy of the gas between entry and exit is 1172.5 kJ/kg. Take cp = 1.0 kJ/kg-K, $\gamma = 1.4$.

13. (a) Air flows through a C-D nozzle from a reservoir where stagnation temperature is known to be 333 K. At some section 'x' in the diverging section, a normal shock occurs. The location of the shock is such that the static pressure measured at the throat is 0.8 times the total pressure measured after the shock. If the flow is inentropic except across the shock, determine

(i) The area ratio A_x/A_{throat}

(ii) The air velocity behind the shock.

Or

(b) Air having a Mach number 3.0, approaches a symmetrical wedge having a wedge angle of 30°. The pressure and temperature of the air are 1.0 bar and 27°C. Find the mach number and velocity of flow downstream of the shock wave, assuming that a weak oblique shock is formed. Also find the pressure, density, temperature and total pressure downstream of the shock wave.

14. (a) The diameter of the propeller of an aircraft is 2.5 m. It flies at a speed of 500 km/hr at an altitude of 8000 m. For a flight to jet speed ratio of 0.75 determine

(i) The flow rate of air through the propeller (3)

(ii) Thrust produced (3)

(iii) Specific thrust (3)

(iv) Specific impuse and (3)

(v) The thrust power. (4)

Or

(b) Explain the working principle of the ramjet engines with neat sketch and state its advantages and disadvantages. (16)

15. (a) (i) Draw a neat sketch explaining the general working of the Hybrid propellant rocket. (10)

(ii) Comparison between solid and liquid propellant propulsion. (6)

Or

(b) A rocket operating at an altitude of 19 km with the following data : Propellant flow rate 1 kg/s. Thrust chamber pressure = $28 \times 10^5 N/m^2$. Thrust chamber temperature = 2500 K and Nozzle area ratio = 10.12. Calculate : (i) Thrust (ii) Effective jet velocity and (iii) Specific impulse, Take $\gamma = 1.3$ and R = 355 J/kgK. (16)