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Question Paper Code : 60859

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2016.

Sixth Semester

Mechanical Engineering

ME 2351/ME 64/10122 ME 602 — GAS DYNAMICS AND JET PROPULSION

(Regulations 2008/2010)

(Common to PTME 2351/10122 ME 602 — Gas Dynamics and Jet Propulsion for B.E. (Part-Time) Fifth Semester — Mechanical Engineering — Regulations 2009/2010)

Time : Three hours — Maximum : 100 marks

Use of Gas Tables is permitted.

Answer ALL questions.

PART A — ($10 \times 2 = 20$ marks)

1. How mach number changes in nozzle?

2. Define zone of action and zone of silence.

3. What are the various conditions needed to describe the flow is Rayleigh flow?

4. How Fanno flow is differ from Rayleigh flow?

5. How Oblique shock is differ from normal shock?

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

7. What is Turbojet engine?

8. Define Specific Thrust.

9. Give two reasons for addition of additives with principal ingredients.

10. Write down the merits of hybrid propellant rockets.

PART B — (5 × 16 = 80 marks)

11. (a) A nozzle in a wind tunnel gives a test-section Mach number of 2.0. Air enters the nozzle from a large reservoir at 0.69 bar and 310 K. The cross-sectional area of the throat is 1000 cm^2. Determine the following quantities for the tunnel for one dimensional isentropic flow:

(i) Pressures, temperatures and Velocities at the throat and test Section.

(ii) Area of cross-section of the test section

(iii) Mass flow rate

(iv) Power required for driving the compressor.

Or

(b) Derive the energy equations : $a^2 / \gamma - 1 + \frac{1}{2} c^2 = \frac{1}{2} c^2{}_{max} = a_0^2 / \gamma - 1 = h_0$. Stating the assumptions used.

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 = 1.005 kJ/kg-K, γ = 1.4.

13. (a) A normal shock occurs in the diverging section of a convergent-divergent air nozzle. The throat area is 1/3 of exit area and the static pressure at exit is 0.4 times of stagnation pressure at the entry. The flow is throughout isentropic except through shock. Determine:

(i) The Mach numbers M_x and M_y

(ii) The static pressure

(iii) The area of cross-section of the nozzle at the section of the nozzle where the normal shock occurs.

Or

(b) Starting from the energy equation for flow through a normal shock obtain the following relations:

(i) $C_x C_y = a^{*2}$

(ii) $M^*_x \, M^*_y = 1$.

14. (a) An aircraft flies at 960 kmph. One of its turbojet engines takes in 40 kg/s of air and expands the gases to the ambient pressure. The air-fuel ratio is 50 and the lower calorific value of the fuel is 43 MJ/kg. For maximum thrust power determine:

(i) Jet velocity

(ii) Thrust

(iii) Specific thrust

(iv) Thrust power

(v) Propulsive, thermal and overall efficiencies and

(vi) TSFC.

Or

(b) Explain with a neat sketches the principle of operation of:

(i) Turbo fan engine and

(ii) Ram jet engine.

15. (a) Explain with a neat sketch the working of a turbo-pump feed system used in a liquid propellant rocket.

Or

(b) A rocket flies at 10,080 kmph with an effective exhaust jet velocity of 1400 m/s and propellant flow rate of 5.0 kg/s. If the heat of reaction of the propellants is 6500 kJ/kg of the propellant mixture, determine:

(i) propulsion efficiency and propulsion power

(ii) engine output and thermal efficiency

(iii) overall efficiency.
