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Question Paper Code : 20820

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

Sixth Semester

Mechanical Engineering

ME 6604 — GAS DYNAMICS AND JET PROPULSION

(Regulations 2013)

(Common to PTME 6604 — Gas Dynamic and Jet Propulsion for B.E. (Part-Time) – Sixth Semester – Mechanical Engineering – Regulations 2014)

Time : Three hours Maximum : 100 marks

(Use of Standard Gas Tables are permitted)

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. How is static temperature of low related to total temperature?
2. Draw the Mach cone for M=2 and mark all the features.
3. In Rayleigh flow, what is the Mach number at which the total enthalpy is maximum?
4. How do you specify the equivalent diameter for noncircular cross sections?
5. What is the nature of Mach number of flow after the Normal shock wave?
6. How does the total temperature and total pressure change across the oblique shock wave?
7. What are the sources of Thrust in Jet engines?
8. Express the propulsive efficiency in terms of flight speed to jet speed ratio.
9. What is meant by equivalent jet speed?
10. What is meant by Specific Propellant Consumption?

PART B — (5 × 13 = 65 marks)

11. (a) (i) Derive the energy equation for the compressible gas flow through the nozzle. (5)

(ii) Describe various flow regions of fluid flow. (8)

Or

(b) (i) Derive the energy equation as applicable for the nozzle. (5)

(ii) The pressure, temperature and Mach Number at the entry of the flow passage is 245 kPa, 26.5°C and 1.4 respectively. If the exit Mach number reaches 2.5, taking specific heat ratio as 1.3 and gas constant as 0.469 kJ/kg.K, determine the stagnation temperature and temperature and velocity of the gas at the exit. (8)

12. (a) Air enters a constant area duct at Mach No. of 0.2, pressure of 1 atm, temperature of 273K. Inside the duct, the heat added per unit mass is 1 MJ/kg. Estimate the Mach No., pressure, temperature, density, total temperature and total pressure of the air at the exit of the duct. Also summarise the effect of heat addition to subsonic frictionless flow in a constant area duct. (8 + 5)

Or

(b) Air enters a constant area pipe of 150 mm diameter at Mach No. of 0.3 pressure of 1 atm, temperature of 273 K and flows through a length of 30 m. Inside the pipe, the friction coefficient f = 0.005. Estimate the Mach No., pressure, temperature and total pressure of the air at the exit of the duct Also summarise the effect of friction to subsonic adiabatic flow in a constant area duct. (8 + 5)

13. (a) (i) Derive the expression for the pressure ratio across the normal shock wave. (5)

(ii) A normal shock wave is standing in the test section of a supersonic wind tunnel.

Upstream of the wave, Mach No = 3 and pressure = 0.5 atm and Temperature = 200 K.

Find Mach No, pressure, temperature and velocity after the shock wave. (8)

Or

(b) (i) Explain the formation of attached and detached oblique shock over the wedge and sharp corner. (5)

(ii) A supersonic stream at Mach No. = 3, pressure = 1 atm, and temperature = 288 K encounters a compression corner which deflects the stream by an angle 20°. Calculate the shock wave angle and pressure, temperature and Mach Number after the shock wave. (8)

14. (a) (i) Draw and neat figure of Ramjet engine and explain its function. (5)

(ii) A ramjet engine operates at M = 1.5 at an altitude of 6500 m. The diameter of the inlet entry is 50 mm and the stagnation temperature at the nozzle entry is 1600 K. The calorific value of the fuel used is 40 MJ/kg. Take specific heat ratio as 1.4 and gas constant as 287 J/kg.K. Find the efficiency of ideal cycle, ramjet speed, air flow rate, diffuser pressure ratio and air-fuel ratio. Assume diffuser efficiency as 90%, combustion efficiency as 90% and nozzle efficiency as 96% and stagnation pressure loss in the combustion chamber as 0.2% of its inlet pressure. (8)

Or

(b) (i) Explain the terms Propulsive efficiency, thermal efficiency and overall efficiency of Jet Engine. (5)

(ii) 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. For maximum thrust power, find jet velocity, thrust, specific thrust and thrust power. (8)

15. (a) (i) Give the complete classification of Rocket Engines. (5)

(ii) Explain the working of Turbo pump feeding system in LPR. (8)

Or

(b) (i) Derive the relation among SFC, weight flow coefficient and thrust coefficient. (5)

(ii) A rocket flies at 10,080 kmph with an effective jet velocity of 1400 m/s and propellant flow rate of 5 kg/s. If the heating value of the propellant is 6500 kJ/kg of the propellant mixture, determine propulsive efficiency, propulsive power, engine output and thermal efficiency. (8)

PART C — (1 × 15 = 15 marks)

16. (a) Derive the expression for change in area in isentropic flow and hence deduce the shape of subsonic and supersonic nozzle and diffusers. (10)

(b) Determine the maximum velocity of a rocket and altitude attained, if the Mass Ratio = 0.15, Burn out time = 75s and effective jet velocity = 2500 m/s. (5)

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