LIB
3/6/13FN

Reg. No. : | | | | | | | | | | | | |

Question Paper Code : 21572

B.E./B.Tech. DEGREE EXAMINATION, MAY/JUNE 2013.

Sixth Semester

Mechanical Engineering

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

(Regulation 2008/2010)

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

Time : Three hours Maximum : 100 marks

Use of Gas Tables is permitted.

Answer ALL questions.

PART A — ($10 \times 2 = 20$ marks)

1. What are the basic differences between compressible and incompressible flows?

2. Name the four reference velocities that are used in expressing the third velocities in non-dimensional form.

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. State assumptions made to drive the isothermal flow equations.

6. Differentiate between Fanno flow and Rayleigh flow.

7. List out the different types of jet engines.

8. Give the components of a turbo jet.

9. What is mono-propellants? Give examples.

10. What are the types of rocket engines based on source of energy employed?

PART B — (5 × 16 = 80 marks)

11. (a) (i) Air at 2 bar pressure flows with a velocity of 180 $\frac{km}{hr}$. Find the mach number if the density of air is 3.0 kg/m^3. (4)

(ii) Prove that $\frac{P_0 - P_1}{\frac{1}{2}\rho C^2} = 1 + \frac{M^2}{4} + \frac{M^4}{40} + \ldots$ (12)

Or

(b) Air at $P_1 = 3$ bar and $T_1 = 227°C$ is flowing with a velocity of 200 m/s in a 0.3 m diameter duct. If $C_p = 1050$ J/kg C and $\gamma = 1.38$, determine the following

(i) Stagnation temperature and pressure (4)

(ii) Mass flow rate of air (4)

(iii) Mach number (4)

(iv) Stagnation pressure assuming the flow is incompressible. (4)

12. (a) (i) Show that $\frac{dA}{A} = \frac{dP}{\rho C^2}\left(1 - M^2\right)$ for one dimensional isentropic flow. (4)

(ii) Air at $P_0 = 10$ bar, $T_0 = 400K$ is supplied to a 5 cm diameter pipe. The friction factor for the pipe surface is 0.002. If the mach number changes from 3.0 at the entry to 1.0 at the exit, determine, the length of the pipe and the mass flow rate. (6 + 6)

Or

(b) Air is supplied to a combustion chamber is a gas turbine plant at 350K, 0.55 bar and 75 m/s. The air-fuel ratio is 29 and the calorific value of the fuel is 42 mJ/kg. Assuming $\gamma = 1.4$ and $R = 287$ J/kgK for the gas, determine

(i) The initial and final mach numbers (4)

(ii) Final pressure, temperature and velocity of the gas (4)

(iii) The maximum stagnation temperature attainable (4)

(iv) Stagnation pressure loss in the combustion chamber. (4)

13. (a) The ratio of the exit to entry area in a subsonic diffuser is 4.0. The mach number of a jet of air approaching the diffuser at $P_0 = 1.013$ bar, $T = 290K$ is 2.2. There is a standing normal shock wave just outside the diffuser entry. The flow in the diffuser is isentropic. Determine at the exist of the diffuser,

(i) Mach number (4)

(ii) Temperature and pressure (6)

(iii) Stagnation pressure loss between the initial and final states of the flow. (6)

Or

(b) Derive the Prandtl' equation for flow through an oblique shock $a^{X^2} - \left(\frac{r-1}{r+1}\right) C_t^{\,2} = C_{n1} C_{n2}$. (16)

14. (a) The diameter of the propeller of an aircraft is 2.5 m. It flies at a speed of 500 kmph 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) What are the advantages of liquid propellant rocket engines? (4)

(ii) 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 propellant is 6500 kJ/kg of the propellant mixture determine, (1) the propulsive efficiency and power, (2) engine output and thermal efficiency and (3) overall efficiency. (4 + 4 + 4)

Or

(b) (i) Calculate the orbital and escape velocities of a rocket at mean sea level and an altitude of 300 km from the following data :

Radius of earth at mean sea level = 6341.6 km

Acceleration due to gravity at mean sea level : 9.809 m/s^2. (8)

(ii) List out the important properties of solid propellants. (8)