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

M 2499

B.E./B.Tech. DEGREE EXAMINATION, APRIL/MAY 2008.

Fifth Semester

Mechanical Engineering

ME 333 — GAS DYNAMICS AND SPACE PROPULSION

Time : Three hours Maximum : 100 marks

(Use of Standard Gas Tables Permitted)

Answer ALL questions.

PART A — ($10 \times 2 = 20$ marks)

1. How will you classify the compressible flow based on Mach Number range?

2. What are the difference between nozzle and diffuser?

3. Sketch the Fanno flow on the T-S plane and explain the significance of it.

4. Write down the ratio of velocities between any two sections in terms of their Mach number in a Fanno flow.

5. What do you understand by oblique shock?

6. Define strength of shock wave.

7. What are the main parts of Ram jet engine?

8. State any two difference between Ram jet and Pulse jet.

9. Write an expression for thrust of jet propulsion.

10. What is bi-propellant? Give an example.

PART B — (5 × 16 = 80 marks)

11. (a) Air flow through a nozzle which has inlet area of 10 cm^2. If the air has a velocity of 80 m/s, temperature of 28° C and pressure of 700 KPa at the inlet section and a pressure of 250 KPa at the exit, find the mass flow rate through the nozzle and assuming one dimensional isentropic flow, the velocity at the exit section of the nozzle. (16)

Or

(b) A nozzle in a wind tunnel gives a test section Mach Number is 2, with a throat section 1000 cm^2 in area. The supply pressure and temperature at the nozzle inlet, where the velocity is negligible are 0.69 bar and 310 K respectively. The preliminary design is to be based on the assumptions that the flow is isentropic, with $\gamma = 1.4$ and that the flow is one dimensional at the throat and test section. Determine

(i) Pressure, temperature, velocities at the throat and test section

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

(iii) Mass flow rate and

(iv) Power required to drive the compressor. (16)

12. (a) The stagnation temperature of air in a combustion chamber is increased to 3.5 times its initial value. If the air at entry is at 5 bar, 105° C and Mach number of 0.25, determine :

(i) The Mach number, pressure and temperature at the exit

(ii) Stagnation pressure loss and

(iii) Heat supplied per kg of air. (16)

Or

(b) A long pipe of 25.4 mm diameter has a mean coefficient of friction of 0.003. Air enters the pipe at a Mach number of 2.5, stagnation temperature 310 K and static pressure 0.507 bar. Determine the following for a section at which the Mach number reaches 1.2,

(i) Static pressure and temperature

(ii) Stagnation pressure and temperature

(iii) Mass flow rate of air

(iv) Distance of this section from the inlet. (16)

13. (a) A jet of air at 275 K and 0.69 bar has an initial Mach Number of 2.0. If it passes through a normal shock wave, determine

(i) Mach Number

(ii) Pressure and temperature,

(iii) Speed of sound and

(iv) Jet velocity downstream of the shock. (16)

Or

(b) An air stream at a Mach number of 2.0 is isentropically deflected by 10° in the clockwise direction. If the initial pressure and temperature are 98 kN/m^2 and 97° C, determine the final state of air after expansion. (16)

14. (a) (i) Compare the constructional features and operating performance of Turbo prop and Turbojet engines. (6)

(ii) Derive an expression for the thrust power, propulsive efficiency, thermal efficiency and optimum value of flight to jet speed ratio for a turbo jet engine. (10)

Or

(b) A turbo jet propels an aircraft at a speed of 900 $\frac{km}{hr}$, while taking 3000 kg of air per minute. The isentropic enthalpy drop in the nozzle is 200 kJ/kg and the nozzle efficiency is 90%. The air-fuel ratio is 85 and the combustion efficiency is 95%. The calorific value of the fuel is 42,000 kJ/kg. Calculate :

(i) The propulsive power

(ii) Thrust power

(iii) Thermal efficiency and

(iv) Propulsive efficiency. (16)

15. (a) (i) Explain with sketch a liquid propelled rock engine and its merits compared to solid propelled system. (10)

(ii) Write briefly on 'Rockets Performance'. (6)

Or

(b) (i) Write about the Multi-staging in rockets. (6)

(ii) The effective jet exit velocity of a rocket is 2400 m/s, the forward flight velocity is 1200 m/s and propellant consumption is 72 kg/s. Calculate thrust, thrust power and propulsive efficiency. (10)