B.E / B.Tech (Full Time) DEGREE END SEMESTER EXAMINATIONS, NOV / DEC 2011

MECHANICAL ENGINEERING BRANCH

FIFTH SEMESTER - (REGULATIONS 2004)

ME 371 – GAS DYNAMICS AND SPACE PROPULSION

Time : 3 hr Max Mark : 100

Answer ALL questions

Part A – (10 × 2 = 20 mark)

1. Define stagnation pressure.
2. Write down the adiabatic energy equation.
3. Sketch the different regions of compressible flow.
4. State the assumptions used in Rayleigh flow.
5. List the applications of Fanno flow.
6. Why are expansion shocks impossible?
7. What do you mean by oblique shock wave?
8. Define Propulsive efficiency.
9. Give an example for a solid propellant?
10. What is bi-propellant? Give example

Part B – (5 × 16 = 80 mark)

11.a) i The jet of a gas at 400 K (γ = 1.3 R= 355 J/ kg.K)has a Mach number of 1.1 Determine for local and stagnation conditions velocity of sound and enthalpy. And also get the Maximum attainable velocity of this jet? **(10)**

ii Describe the behavior of flow in convergent nozzle for various back pressure **(6)**

12.a) Air at P_0=8 bar, T_0= 460 K is supplied to a 50 mm diameter pipe. The friction factor for the pipe surface is 0.002. The inlet mach number is 2.3 and it is changed to 1.0 at the exit determine (i) the length of the pipe (ii) the mass flow rate

(Or)

b) Explain the theory of Rayleigh flow. State the assumptions used and the governing equations of flow. Also represent the Rayleigh flow in T-s and p-v diagram.

13.a) The stagnation pressure and temperature of air at the entry of a nozzle are 4 bar and 420K respectively. The exit Mach number is 2 where a normal shock occurs. Calculate the following quantities before and after the shock: static and stagnation temperatures and pressures, air velocities and mach numbers. What are the values of stagnation pressure loss and increase in entropy across the shock?

(Or)

b) A Mach 2 aircraft engine employs a subsonic inlet diffuser of area ratio 3. A normal shock is formed just upstream of the diffuser inlet. The free stream conditions upstream of the diffuser are p=6 bar, T=300 K. determine:

(a) Mach number, pressure and temperature at the diffuser exit,

(b) Diffuser efficiency including the shock.

Assume isentropic flow in the diffuser downstream of the shock.

14 a) Discuss the working principle of main components of a gas turbine engine used for turbojet aircrafts? Show the various processes occurring in the engine on a T-s diagram.

(Or)

b) Diameter of the aircraft propeller is 4.0 meters. The speed ratio is 0.8 at a flight speed of 450 kmph. If the ambient conditions of at the flight altitude are T=256 K and P= 0.54 bar. Find :(a) Propulsive efficiency (b) Thrust and (c) Thrust power.

15 a) Describe with sketches the propellant feed arrangements of solid propellant grains employed for restricted and unrestricted burning. Indicate the directions of burning and flow of gases.

(Or)

b) Calculate thrust, specific impulse, propulsive, thermal, and overall efficiencies of a rocket engine from the following data:

Effective jet velocity : 1350 m/s

Flight to jet speed ratio: 0.80

Oxidizer flow rate : 2.5 kg/s

Fuel flow rate :1.0 kg/s