ANNA UNIVERSITY – 2006

B.E/B.TECH V SEMESTER DEGREE EXAMINATION

GAS DYNAMICS AND SPACE PROPULSION

(MECHANICAL ENGINEERING)

TIME-3HOUR
MARK-100

ANSWER ALL QUESTIONS

PART A (10 * 2 = 20)

1. Derive the relationship between static temperature and stagnation temperature.

2. Define Zone of action and Zone of silence.

3. What is choked flow?

4. Heat addition to a gas may cool the gas. Explain with proper h-s diagram.

5. Explain the difference between normal and oblique shocks.

6. Define strength of shock wave?

7. What is ram effect?

8. What is the difference between shaft propulsion and jet propulsion?

9. How are rockets classified?

10. What is bi-propellant? Give examples.

PART B (5 * 16 = 80)

11.i) Sketch the variation of area, velocity and pressure for isentropic flow through subsonic and supersonic nozzle.

ii) Air enters an isentropic diffuser with a Mach number of 3.6 and is decelerated to a Mach number of 2. The diffuser passes a flow of 15 kg/s. The initial static pressure and temperature of the air are 1.05 bar and 40°C. Assuming g = 1.4, calculate area, total pressure and total temperature at inlet and exit and static temperature and pressure at exit.

12.a) Air is flowing through an insulated duct. The inlet Mach number is 0.25. The friction factor 4f = 0.01. The diameter of duct is 15 cm. i) What length of pipe would give a 10 % loss in stagnation pressure? What is the Much Number at this section? ii) What is the % of loss in pressure from inlet to a section at which the Mach number is 0.8? iii) What is the maximum length to reach chocking condition?

OR

12.b)i) Compare the flows through a constant area duct for isentropic and adiabatic conditions.
ii) A constant area combustion chamber receives air at 77°C, 0.55 bar and 75 m/s. If the air leaves the combustion chamber at a Mach number of 0.85, determine conditions of air and the amount of heat transferred. Also find the change in entropy.

13.a)i) Derive Prandtl Meyer relation.

ii) A gas stream ahead of a normal shock has pressure, temperature and velocity of 0.2 bar, 20°C and 1000 m/s respectively. Determine the Mach number, pressure, temperature down stream of the shock and the entropy changes across the shock wave. Take g = 1.3 and Cp = 0.95 kJ/ kgk.

OR

13.b) A supersonic nozzle is provided with a constant diameter circular duct at its exit. The diameter of the dust is same as the nozzle exit diameter. Nozzle exit cross section is three times that of its throat. The entry conditions of the gas are Po = 10 bar, To = 600K. Calculate the static pressure, Mach number and velocity of the gas in the duct,

i) When the nozzle operates at its design conditions.

ii) When a normal shock occurs at its exit and

iii) When a normal shock occurs at a section in a diverging part where the area ratio $A/A^* = 2$. Assume ? = 1.4, R = 0.287 kJ/kgk.

14.a) A simple turbojet unit operates with a turbine inlet temperature of 1050°C. The following data refer to this unit when tested at ground level. Compressor pressure ratio = 7.5; Process through the compressor and turbine is isentropic; Nozzle efficiency = 96%; Ambient pressure = 100 kPa; Ambient temperature = 27° C; Mass flow rate of air = 25 kg/s. Neglect mass of fuel for calculation of thrust and neglect pressure losses. Calculate thrust velocity and Mach number of the jet at the exit of nozzle and SFC. Assume Cp and g for gases and air as same as 1.005 kJ/kgk and 1.4 respectively.

OR

14.b)i) Explain clearly turbojet and turboprop system with suitable diagrams.

ii) Diameter of an aircraft propeller is 4.0m. The speed ratio is 0.8 at a flight speed of 450 kmph. If the ambient conditions of air at the flight altitude are T = 256 K and p = 0.54 bar, determine Propulsive efficiency, Thrust and Thrust power.

OR

15.a)i) Explain with sketch a liquid propelled rocket engine. What are its merits compared to solid propelled system?

ii) Write briefly on ‘Rockets Performance’.

OR

15.b)i) Discuss Multi-staging in rockets. Why is it employed?

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.