Roll No : ____________________

B.E. / B. TECH. (FULL TIME) DEGREE END SEMESTER EXAMINATIONS, NOV / DEC 2012
MECHANICAL ENGINEERING BRANCH
SIXTH SEMESTER
ME 9026 GAS DYNAMICS AND JET PROPULSION
(REGULATION 2008)

Time : 3 hr **Max. mark : 100**

Instructions : Use of Standard Gas Tables Permitted

PART A **10 x 2 = 20**

1. How will you differentiate compressible fluid flow from incompressible fluid flow?
2. What is meant by Mach waves?
3. What are the assumptions of Raleigh flow?
4. What is the influence of friction on the subsonic flow in a constant area duct?
5. How do static and stagnation - pressure and temperature vary across the normal shock wave?
6. Define flow deflection and shock wave angle in an oblique shock wave?
7. Distinguish pressure thrust from momentum thrust.
8. What is the operating principle of turboprop engine?
9. What are the desirable properties of propellants?
10. What is meant by specific impulse?

PART B 5 x 16 = 80

11) (i) Derive the expression for the stagnation temperature in terms of static temperature and Mach Number. (6)

(ii) A supersonic nozzle expands air from p_o = 25 bar and T_o = 1050 K to an exit pressure of 4.35 bar. The exit area of the nozzle is 100cm^2. Determine a) throat area b) pressure and temperature at the throat c) temperature at exit and d) mass flow rate. (10)

12) a) (i) Derive the expression for the pressure ratio across the normal shock wave in terms of inlet Mach Number. (6)

(ii) The stagnation pressure and temperature of air at the entry of a nozzle are 5bar and 500 K respectively. The exit Mach number is 2.0 where a normal shock occurs. Calculate the following quantities before and after the shock: Static and stagnation pressures and temperatures, air velocities and Mach numbers. What are the values of stagnation pressure loss and increase in entropy across the shock? (10)

(OR)

b) (i) Explain the variation of oblique shock wave angle with the flow deflection angle. (6)

(ii) 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 and wave angle. (10)

13) a) (i) Draw the fanno line on the h – s diagram label it properly. (6)

(ii) The friction factor for a 25 mm diameter 11.5 m long pipe is 0.004. The conditions of air at entry are p_1 = 2.0 bar, T_1 = 301 k, M_1 = 0.25. Determine the mass flow rate and the pressure, temperature and the Mach number at exit. (10)

(OR)

b) (i) Explain the influence of heat addition to the subsonic and supersonic flow under Rayleigh conditions. (6)

(ii) A gas at a pressure of 0.69 bar and temperature 278 K enters a combustion chamber at a velocity of 60 m/s. The heat supplied in the combustion chamber is 1400 kJ/kg. Determine the Mach number, pressure, temperature and velocity of the gas at the exit. (Take γ = 1.4 and c_p = 1.004 kJ/kg. k for the gas). (10)

14) (a) An aircraft flies at 960 kmph. One of its turbojet engines takes in 40kg/s of air and expands the gases to the ambient pressure. The air-fuel ratio is 50 and the lower calorific value of the fuel is 44 MJ/kg. For maximum thrust power determine a) jet velocity b) thrust c) specific thrust d) thrust power e) propulsive, thermal and overall efficiencies and f) TSFC. (16)

(OR)

(b) A ramjet engine has the following data: Altitude = 6.5 km, flight Mach number = 4.0, Air fuel ratio = 50, Calorific value of the fuel used = 44 MJ/kg. Diffuser inlet diameter = 0.5 m, γ = 1.4, R = 287 kJ/kg K for both air and the products of combustion. Efficiencies of the diffuser, combustor and the nozzle are 0.85, 0.98 and 0.95 respectively. Determine a) ideal cycle efficiency b) flight speed c) air and fuel consumption rate (16)

15) a) (i) Classify rocket engines and briefly indicate their principle of operation. (6)

(ii) Draw and explain the working of a turbo pump feeding system for Liquid propellant Rockets. (10).

(OR)

(b) A rocket flies at 10,000 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 propellants is 6500 kJ/kg of the propellant mixture determine a) Propulsion efficiency and propulsion power b) engine output and thermal efficiency c) overall efficiency. (16)