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

Question Paper Code : 51046

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2014.

Sixth Semester

Mechanical Engineering

080120037 — GAS DYNAMICS AND JET PROPULSION

(Regulation 2008)

Time : Three hours Maximum : 100 marks

(Use of Gas Tables is permitted)

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Define stagnation state and critical state.

2. The jet of gas with static temperature 600K ($\square$ = 1.3 and R = 469 J/KgK) has a Mach number of 1.2. Determine the velocity of sound and jet velocity.

3. Draw the variation of P/P_0 along the length of a convergent divergent duct when it acts as a (a) Nozzle (b) Diffuser (c) Venturi.

4. When does the maximum mass flow occur for an isentropic flow with variable area?

5. How does chocking occur in a Fanno Flow and give two practical examples where the Fanno Flow occurs.

6. Draw Rayleigh line in h — s diagram with isentropic stagnation line and show various regions.

7. Define strength of shock wave. Calculate the strength of shock wave when normal shock appears at M = 2.

8. What is an oblique shocks? Where it occurs?

9. List the different types of jet engines.

10. Define thrust for a jet engine and how it is produced.

PART B — (5 × 16 = 80 marks)

11. (a) (i) Name the four reference velocities that are used in expressing the fluid velocities in non-dimensional form. (6)

(ii) The flight speed is 800 km / hr. The stagnation conditions are 105 kPa and 35° C. Find the static conditions and the flight Mach number. (10)

Or

(b) (i) An a jet has a velocity temperature equal to twice its static temperature. The static pressure and temperature are 2 bar and 300K respectively. Determine Mach numbers M and M* of the air jet, stagnation temperature and pressure and critical velocity of sound and flow. (8)

(ii) Air at stagnation condition has a temperature of 800 K. Determine the velocity of sound and the maximum possible fluid velocity. What is the velocity of sound and when the flow is at half the maximum velocity? (8)

12. (a) (i) Air is flowing at the rate of 1.15 kg/s with an approach velocity of 80m/s, is expanded in a convergent — divergent nozzle. The static properties of air at inlet are 412 kPa and 160° C. The static pressure at the exit is 103 kPa. Calculate the required throat and exit area for isentropic flow. If the isentropic efficiency of the nozzle is 85% and the loss occurs only in the divergent section find the loss in total head pressure. (10)

(ii) Derive the expression for mass flow rate in terms of pressure ratio and derive the condition for maximum mass flow rate. (6)

Or

(b) (i) Air stores in a reservoir at stagnation pressure of 7 bar and stagnation temperature of 325°C is passed through a nozzle to an exit pressure of 1 bar. For a mass flow rate of 1Kg/Sec, estimate the throat area, pressure and velocity, exit area exit mach number and maximum velocity. (10)

(ii) Find the mass flow rate of a supersonic wind tunnel designed for Mach number 2.5 and having a throat section of 930 cm^2. The air supply is at stagnation condition with 1.05 bar and 21°C. (6)

13. (a) (i) Air is flowing in an insulated duct with a Mach number of $M_1 = 0.25$. At a section down stream the entropy is greater by an amount of 0.124 units, as a result of friction. Find the Mach number at this section. The static properties at inlet are 700kPa and 60° C. Also determine the velocity, temperature and pressure at exit and properties at critical section. (12)

(ii) Differentiate Fanno flow and isothermal flow. (4)

Or

(b) The mach numbers at inlet and exit for a Rayleigh flow are $M_1 = 3$ and $M_2 = 1.5$. Air inlet static pressure 50kPa and stagnation temperature 295K find

(i) All properties at exit.

(ii) Stagnation pressure.

(iii) Heat transferred.

(iv) Maximum possible heat transfer

(v) Change in entropy between section 1 and 2

(vi) Is it a cooling or heating? (16)

14. (a) (i) Derive the Prandtl-Meyer equation. (10)

(ii) The state of a gas ($\gamma = 1.3$, R = 0.469 kJ/kgK) upstream of a normal shock wave is given by the following data: Mach number 2.5, static pressure = 2bar, static temperature = 275 K. Calculate the Mach number, pressure, temperature and velocity of the gas downstream of the shock. (6)

Or

(b) A gas ($\square$= 1.3, R = 0.287, kJ/Kgk, $P_1 = 1$ bar and $T_1 = 400K$) enters a 30Cm diameter duct at a Mach number of 2.0. A normal shock occurs at a Mach number of 1.5 and the exit Mach number is 1.0. If the mean value of the function factor is 0.003, determine

(i) Length of the duct upstream and down stream of the shock.

(ii) Man flow rate of the gas.

(iii) Change of entropy upstream of the shock across the shock and down-stream of the shock. (16)

15. (a) A turbo jet plane has two jets of 250mm diameter and net power at the turbine is 3000 kW. The fuel consumption per kWhr is 0.42 kg with a fuel of calorific value 49MJ/kg when flying at a speed of 300m/s in atmosphere having a density of 0.168kg/m^3 the air fuel ratio is 53. Calculate (i) the absolute velocity of jet (ii) the drag of plane (iii) the overall efficiency and the efficiency of the turbine. (16)

Or

(b) (i) Explain the various component and working of Turbo jet engine aircraft system. (8)

(ii) Write short notes on (1) Trust Augmentation (2) Difference between ram jet and pulse jet engine. (8)