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Question Paper Code : 57577

B.E./B.Tech. DEGREE EXAMINATION, MAY/JUNE 2016

Sixth Semester

Mechanical Engineering

ME 6604 – GAS DYNAMICS AND JT PROPULSION

(Regulations 2013)

Time : Three Hours **Maximum : 100 Marks**

Answer ALL questions.

PART – A (10 × 2 = 20 Marks)

1. Write the steady flow energy equation for isentripic flow of an air.
2. Distinguish static and stagnation quantities.
3. What is known as chocked fanno flow ?
4. Define Rayleigh line and state its application.
5. List the applications of the moving shock wave.
6. State the necessary conditions for a normal shock to occur in compressible flow.
7. Differentiate turbojet and ramjet engine.
8. Define specific consumption.
9. Compare the merits and demerits of bipropellants with monopropellants.
10. What is weight flow co-efficient ?

PART – B (5 × 16 = 80 Marks)

11. (a) (i) Derive the energy equation $\frac{a^2}{\gamma - 1} + \frac{1}{2} c^2 = \frac{1}{2} c^2_{max} = \frac{a_0^2}{\gamma - 1} = h_0$ stating the assumptions used.

(ii) An air jet (γ = 1.4, R = 287 J/kg K) at 400 K has sonic velocity.

Determine :

(i) velocity of sound at 400 K.

(ii) velocity of sound at the stagnation conditions.

(iii) maximum velocity of the jet.

(iv) stagnation enthalpy.

OR

(b) A conical diffuser has entry and exit diameters of 15 cm and 30 cm respectively. The pressure, temperature and velocity of air at entry are 0.69 bar, 340 K and 180 m/s respectively. Determine :

(a) the exit pressure,

(b) the exit velocity and

(c) the force exerted on the diffuser walls.

Assume isentropic flow, γ = 1.4, c_p = 1.00 kJ kg-K.

12. (a) A circular duct passes 8.25 Kg/s of air at an exit Mach number of 0.5.The entry pressure and temperature are 3.45 bar and 38 °C respectively and the coefficient of friction 0.005. If the Mach number at entry is 0.15, determine.

I. The diameter of the duct. **(2)**

II. Length of the duct. **(4)**

III. Pressure and temperature at the exit. **(4)**

IV. Stagnation pressure loss, and **(4)**

V. Verify the exit Mach number through exit velocity and temperature. **(2)**

OR

(b) A combustion chamber in a gas turbine plant receives air at 350 K, 0.55 bar and 75 m/s. The air-fuel ratio is 29 and the cabrific value of the fuel is 41.87 MJ/Kg. Taking $\gamma = 1.4$ and $R = 0.287$ kJ/Kg K for the gas, determine

(a) The initial and final Mach numbers. (4)

(b) Final pressure, temperature and velocity of the gas. (4)

(c) Percent stagnation pressure loss in the combustion chamber, and (4)

(d) The maximum stagnation temperature attainable. (4)

13. (a) An air plane having a diffuser designed for subsonic flight, has a normal shock attached to the edge of the diffuser, when the flight is flying at supersonic Mach number. The diffuser exit mach no is 0.3. The inlet and exit area of the diffuser are 0.29 m^2, 0.44 m^2. What must be the flight mach if isentropic diffuser is assumed behind the shock.

OR

(b) Air approaches a symmetrical wedge (half wedge angle 15°) at mach no 2. Determine for a strong pressure wave (a) wave angle (b) pressure ratio across shock (c) temperature ratio across shock (d) density ratio across shock (e) Down stream mach number.

14. (a) An air craft flies at 960 kmph. Its turbojet engine takes in 40 kg/sec of air and uses air fuel ratio of 50 : 1, C.V = 43 MJ/kg, for maximum thrust power. Find (a) jet velocity (b) thrust (c) thrust power (d) propulsive, thermal and overall efficiency (e) specific impulse (f) TSFC.

OR

(b) A turbojet engine uses a mass flow rate of 50 kg/sec & propels air craft at speed of 880 kmph. Isentropic enthalpy drop 188 kJ/kg.Velocity co-efficient is 0.96. Fuel air ratio is 1.2%.Combustion efficiency 95% C.V = 44 MJ/kg. Determine (a) thermal efficiency (b) mass flow rate of fuel in kg/hr. (c) η_p (d) $\eta_{overall}$.

15. (a) A rocket has following data :

Propellant flow rate = 5 kg/s, Nozzle exit diameter = 10 cm, Nozzle exit pressure = 1.02 bar, atmospheric pressure = 1.013, thrust chamber pressure = 20 bar, thrust = 7 kN. Determine (a) the effective jet velocity, actual exhaust gas velocity, specific impulse, sp. Propellant consumption, (b) Recalculate values of thrust, specific impulse for an altitude where ambient pressure is 10 milli bar.

OR

(b) Write short note on :

(i) Theory of rocket propulsion **(8)**

(ii) Types of rocket engines. **(8)**
