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

Question Paper Code: 49702

B.E. / B.Tech. DEGREE EXAMINATION, MAY 2022

Elective

Mechanical Engineering

14UME902 - GAS DYNAMICS AND JET PROPULSION

(Regulation 2014)

Duration: Three hours Maximum: 100 Marks

Answer ALL Questions

PART A - (10 x 1 = 10 Marks)

1. In _____ regions, fluid velocity is equal to the sound velocity.

   (a) Incompressible flow (b) Subsonic flow
   (c) Sonic flow (d) Hypersonic flow

2. Subsonic Converging passage of nozzle may be acted as

   (a) Subsonic diffuser (b) Sonic throat (c) Supersonic diffuser (d) Hypersonic diffuser

3. For an isothermal flow in long constant area duct, _____ remains constant.

   (a) Static temperature (b) Viscosity
   (c) Friction factor (d) All the above

4. The value of mach number of air at the maximum point of Rayleigh flow is

   (a) 0.5 (b) 0.25 (c) 0.75 (d) 1

5. The stagnation pressure across normal shock may

   (a) increase (b) decrease
   (c) remains constant (d) increase or decrease

6. Shock can be develop in a _____ flow.

   (a) supersonic (b) subsonic (c) sonic (d) none of these

7. Propulsive efficiency is defined as the ratio of

(a) Thrust power and fuel energy (b) Engine output and propulsive power

(c) Propulsive power and fuel input (d) Thrust power and propulsive power

8. In jet engines, for the efficient production of large power, fuel is burnt in an atmosphere of

(a) Vacuum (b) Atmospheric air

(c) Compressed air (d) Oxygen alone

9. The thrust per unit weight flow rate of the propellant for a rocket engine is known as its

(a) Specific impulse (b) Specific propellant consumption

(c) Weight flow co-efficient (d) Thrust co-efficient

10. Theoretically the maximum achievable speed by a body in space is equal to

(a) 1,97,600 km/s (b) 2,97,600 km/s

(c) 330 m/s (d) 330 km/s

PART - B (5 x 2 = 10 Marks)

11. Find the acoustic velocity of sound when the temperature of the medium is 300K

12. Give two practical examples where the Fanno flow occurs.

13. Define oblique shock where it occurs.

14. List the different types of jet engines.

15. Name some oxidizer uses in rockets.

PART - C (5 x 16 = 80 Marks)

16.(a) The pressure, temperature and Mach number at the entry of a flow passage are 2.45 bar, 26.5°C and 1.4 respectively. If the exit Mach number is 2.5 determine for adiabatic flow of perfect gas (γ=1.3, R=0.469 kJ/kg K). (16)

(i) stagnation temperature

(ii) maximum velocity

(iii) mass flow rate

(v) Area of cross-section at exitOr

(b) A conical diffuser has entry diameter 20 cm. The Mach number, temperature and pressure are 0.6, 120 kN/m^2 and 340 K. The Mach number at exist is 0.2. For one dimensional isentropic flow, calculate: (i) Pressure, temp and velocity at exist (ii) Mass flow rate, and exit diameter, and (iii) Change in impulse function. (16)

17. (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 345 kPa and 38^0C respectively and the co-efficient of friction is 0.005. If the Mach number at entry is 0.15, determine: (i) The diameter of the duct (ii) Length of the duct (iii) Pressure and temperature at exit, and (iv) Stagnation pressure loss. (16)

Or

(b) The Condition of a gas in combustion chamber at entry are T_1= 375K, P_1= 0.050 bar, C_1=70m/s. The air–fuel ratio is 29 and the calorific value of the fuel is 42MJ/Kg.

Calculate,

Initial and final mach number

Final pressure, temperature and velocity

Percentage of stagnation pressure loss

Maximum stagnation temperature

18. (a) An Aircraft flies at a Mach number of 1.1 at an altitude of 15,000 meters. The compression in its engine is partially achieved by a normal shock wave standing at the entry of the diffuser. Determine the following for downstream of the shock: (i) Mach number (ii) Temperature of the air (iii) Pressure of the air (iv) Stagnation pressure loss across the shock. (16)

Or

(b) Air having a Mach number 3.0, approaches a symmetrical wedge having a wedge angle of 30^oC. The pressure and temperature of the air are 1 bar and 27^oC. Find the Mach number and velocity of flow downstream of the shock wave, assuming that a weak oblique shock is formed. Also, find the pressure, density, temperature and stagnation pressure downstream of the shock wave. (16)

19. (a) Illustrate the working of ramjet engine and depict the various thermodynamic processes occurring in it on *h-s* diagram. Write down its main advantages and disadvantages. (16)

Or

(b) An aircraft flies at 960kmph. One of its turbo jet engines takes in 40kg/s of air and expands the gases to the ambient pressure. The air-fuel ratio is 50 and the ower calorific value of the fuel is 43MJ/kg. For maximum thrust power determine

a) Jet velocity b) Thrust c) Specific thrust

d) Thrust power e) Propulsive, thermal and overall efficiency (16)

20. (a) A rocket nozzle has a throat area of $18cm^2$ and combustor pressure of 25bar.If the specific impulse is 127.42sec and the rate of flow of propellant is 44.145N/s, determine the thrust coefficient, propellant weight flow coefficient, specific propellant consumption and characteristic velocity. (16)

Or

(b) (i) Describe with the aid of neat sketches the two arrangements of solid propellant grains employed for restricted and unrestricted burning. (10)

(ii) List out any three important applications of rocket propulsion. (6)