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Question Paper Code: 49702

B.E. / B.Tech. DEGREE EXAMINATION, APRIL 2019

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

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   (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. Characteristic velocity is the ratio of

(a) thrust coefficient to effective jet velocity

(b) effective jet velocity to thrust coefficient

(c) effective jet velocity to friction coefficient

(d) stagnation velocity of sound to thrust coefficient

PART - B (5 x 2 = 10 Marks)

11. Differentiate nozzle and diffuser.

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

13. Define oblique shock.

14. List the different types of jet engines.

15. Name some oxidizer uses in rockets.

PART - C (5 x 16 = 80 Marks)

16. (a) (i) Discuss on Von Karman's rules of supersonic flow. (8)

(ii) A supersonic fighter plane flies at an altitude of 3000 m. An observer on the ground hears the sonic boom 7.5 seconds after the passing of the plane over his head. Estimate speed of plane in km/hr and Mach number. Assume the average temperature of air as $11^{o}C$. (8)

Or

(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) A gas (γ =1.3 and R = 0.46 kJ/kg K) at a pressure of 70 kPa and temperature of 295 K enters a combustion chamber at a velocity of 75 m/s. The heat supplied in a combustion chamber is 1250 kJ/kg. Determine, the Mach number, pressure and temperature of gas at exit. (16)

18.(a) A gas (γ =1.3, R=0.287 kJ/kg K) at P_1 =1 bar T_1=400 K enters a 30 cm diameter duct at a Mach number of 2.0. A normal shock occurs at a Mach number of 1.5 and exit Mach number is 1.0. If the mean value of friction factor is 0.003, determine,

(i) Lenghs of duct upstream and down stream of the shock wave

(ii) Mass flow rate of the gas, (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) Describe the main components of a gas turbine engine used for turbojet aircrafts with the aid of a simple layout. Show the various processes occurring in the engine on *T-s* diagram. (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) (i) Draw neat sketches explaining the general working of the following rocket engines: (a) Hybrid propellant rockets, and (b) Nuclear rockets. (10)

(ii) Mention any five important properties desired of a liquid propellant. (6)

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)

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