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Question Paper Code: 49702

B.E. / B.Tech. DEGREE EXAMINATION, MAY 2018

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)

- Mach number is the ratio between
 - velocity of fluid/ velocity of sound
 - velocity of sound/ velocity of fluid
 - stagnation velocity of sound/ velocity of fluid
 - critical velocity of fluid/ velocity of fluid
- The flow in which the fluid characteristics do not change with respect to time
 - continuous flow
 - one dimensional flow
 - two dimensional flow
 - steady flow
- For an isothermal flow in long constant area duct, _____ remains constant.
 - Static temperature
 - Viscosity
 - Friction factor
 - All the above
- The value of mach number of air at the maximum point of Rayleigh flow is
 - 0.5
 - 0.25
 - 0.75
 - 1
- The stagnation pressure across normal shock may
 - increase
 - decrease
 - remains constant
 - increase or decrease

6. Shock can be develop in a _____ flow.
 (a) supersonic (b) subsonic (c) sonic (d) none of these
7. Pick up the wrong statement:
 (a) Pulse-jet requires no ambient air for propulsion
 (b) Ramjet engine has no turbine
 (c) Turbine drives compressor in a Turbojet
 (d) Bypass turbojet engine increases the thrust without adversely affecting, the propulsive efficiency and fuel economy
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. Draw the TS diagram of aircraft engine
15. State the advantages of liquid propellant rockets over solid propellant 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°C. (8)

Or

- (b) A conical diffuser has entry diameter 20 cm. The Mach number, temperature and pressure are 0.6, 120 kN/m² and 340 K. The Mach number at exit is 0.2. For one dimensional isentropic flow, calculate: (i) Pressure, temp and velocity at exit (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 38⁰C 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 ($\gamma = 1.3$ 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 ($\gamma = 1.3$, $R = 0.287$ 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) Lengths 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°C. The pressure and temperature of the air are 1 bar and 27°C. 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) 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)
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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