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**Question Paper Code: 49071**

B.E. / B.Tech. DEGREE EXAMINATION, NOV 2017

Sixth Semester

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)

- The flow in which the fluid characteristics do not change with respect to time
  - Continuous flow
  - One dimensional flow
  - Two dimensional flow
  - Steady flow
- Subsonic Converging passage of nozzle may be acted as
  - Subsonic diffuser
  - Sonic throat
  - Supersonic diffuser
  - Hypersonic diffuser
- The value of mach number of air at the maximum point of Rayleigh flow is
  - 0.5
  - 0.25
  - 0.75
  - 1
- Stagnation enthalpy is not a constant straight line for
  - Isentropic flow
  - Fanno flow
  - Rayleigh flow
  - Isothermal flow
- Oblique shocks are found to occur
  - at the exit of turbine blade passages in supersonic flow
  - at the throat of turbine blade passages
  - at the entry of turbine blade passages
  - None of the above
- Shock can be develop in a \_\_\_\_\_ flow.
  - Supersonic
  - Subsonic
  - Sonic
  - 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. 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
10. 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

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) A conical diffuser has entry diameter 20 cm. The Mach number, temperature and pressure are 0.6, 120 kN/m<sup>2</sup> 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)

Or

(b) Derive the relations for

(i)  $A/A^*$  (8)

$$(ii) \frac{P_0 - P_1}{\frac{1}{2}\rho c^2} = 1 + \frac{M^2}{4} + \frac{M^2}{40} + \dots \quad (8)$$

17. (a) A long pipe of 25.4mm diameter has a mean co-efficient of friction of 0.003. Air enters the pipe at a mach number of 2.5, stagnation temperature 310 K and static Pressure 0.507 bar. Determine for a section at which the mach number reaches 1.2,  
a) Static Pressure and Temperature b) Stagnation Pressure and Temperature.  
c) Velocity of air d) Distance of this section from the inlet  
e) Mass flow rate of air. (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) Air having a Mach number 3.0, approaches a symmetrical wedge having a wedge angle of  $30^\circ$ . The pressure and temperature of the air are 1 bar and  $27^\circ\text{C}$ . 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)

Or

- (b) 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, (16)
- (i) Lengths of duct upstream and down stream of the shock wave  
(ii) Mass flow rate of the gas

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 lower calorific value of the fuel is 43MJ/kg. For maximum thrust power determine (16)
- a)Jet velocity                      b)Thrust c)Specific thrust  
d)Thrust power                      e)Propulsive, thermal and overall efficiency f)TSFC

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) A rocket nozzle has a throat area of  $18\text{cm}^2$  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)
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