F 3348 (Pages : 3) Reg. No.....

Name.....

B.TECH. DEGREE EXAMINATION, NOVEMBER 2014

Seventh Semester

Branch : Mechanical Engineering

ME 010 703—GAS DYNAMICS AND JET PROPULSION (ME)

(New Scheme—2010 Admission onwards)

[Regular/Supplementary]

Time : Three Hours Maximum : 100 Marks

Part A

Answer **all** *questions.*
Each question carries 3 *marks.*

1. Explain Mach cone and Mach angle.
2. Give assumptions regarding Fanno Flow. What is Fanno line ?
3. How is turbo fan engine different from turboprop engine ?
4. What is an isentropic flow ? Give its assumptions.
5. Write down the properties of flow across a normal shock.

(5 × 3 = 15 marks)

Part B

Answer **all** *questions.*
Each question carries 5 *marks.*

6. What is the effect of Mach number on compressibility ?
7. With neat sketch explain the working of a pulse jet engine. Write down its advantages and disadvantages.
8. Derive $\frac{A}{A^*} = \frac{1}{M}\left(\frac{2}{r+1} + \frac{r-1}{r+1} M^2\right)^{\frac{r+1}{2(r-1)}}$ for one dimensional isentropic flow.
9. Starting from the Energy equation for flow through a normal shock obtain the relation $M_x^* \, M_y^* = 1$.
10. Derive the unsteady flow continuity equation for a control volume :

$$\int_{CV} \frac{\partial p}{\partial t} \, dv = \int_{in} \rho cn \, dA - \int_{out} \rho cn \, dA$$

hence show that for one dimensional steady flow $\rho AC = \text{const.}$

(5 × 5 = 25 marks)

Turn over

Part C

Answer **all** *questions.*
Each question carries 12 *marks.*

11. Starting from continuity and momentum equation derive the equation for velocity of sound in a perfect gas, in terms of characteristic gas constant and static temperature.

Or

12. (a) What is velocity temperature ? Determine the velocity of air corresponding to a velocity temperature of 1°C.

(5 marks)

(b) Determine the Mach number of an aircraft at which the velocity temperature of air at the entry of the engine equals the static temperature.

(7 marks)

13. Air is discharged from a reservoir at $P_0 = 6.91$ and $t_o = 325°C$, through a nozzle to an exit pressure of 0.98 bar. If the flow rate is 3000 kg/hr determine the isentropic flow

(a) Throat area and velocity.

(b) Exit area and Mach number.

Or

14. Describe the behaviour of flow in a convergent-divergent nozzle when it is operated at :

(i) design pressure ratio ;

(ii) pressure ratio higher than design value ;

(iii) pressure ratio lesser than design value.

15. A gas at a pressure of 0.7 bar and 280 K enters a combustion chamber at a velocity of 55 m/s. The heat supplied in the combustion chamber is 1500 kJ/kg. Determine the Mach number, pressure, temperature of the gas at the exit. (Take $\gamma = 1.4$, $C_p = 1.005$ kJ/kg K for gas).

Or

16. (a) What is the value of Mach number of air at the maximum enthalpy point in Rayleigh heating process ? Depict static and stagnation values of pressure and temperature at this point and the sonic point on Rayleigh line.

(b) If the conditions at sonic point are $p^* = 1$ bar $T^* = 500$ K. Calculate pressure, temperature and velocity at maximum enthalpy point. What is the change of entropy between these points ?

17. The ratio of exit to entry area in a sub-sonic diffuser is 4.0. The Mach number of a jet of air approaching the diffuser at $p_0 = 1$ bar. $T = 300$ K is 2.2. There is a standing normal shock wave just outside the diffuser entry. Determine ; (a) Mach number ; (b) temperature and (c) pressure at the exit of the diffuser.

What is the stagnation pressure loss between the initial and final states of flow ?

Or

18. (a) Derive the equation for temperature ratio across a normal shock.

(b) A gas (r = 1.4, R = 0.287 kJ/kg K) at a Mach number of 2, p = 0.9 bar and T = 373 K passers through a normal shock. Determine its density after the shock.

19. (a) What are the main components of a gas turbine engine used for turbo jet aircrafts ? Show the various processes occurring in the engine on a T-S diagram.

(b) Describe the working of a scram jet engine. What is its advantages over the ramjet ?

Or

20. An aircraft flies at 960 km/hr are of its turbo jet engine takes in 40 kg/s of air and expands the gases to the ambient pressure. The air fuel ratio is 50 and the LCV of the fuel is 43 MJ/kg. For maximum thrust power determine :

(a) jet velocity ;

(b) specific thrust ; and

(c) propulsive, thermal and overall efficiencies.

[5 × 12 = 60 marks]