

B.E./B.Tech (Full-Time) DEGREE END SEMESTER EXAMINATION, APRIL/MAY 2012
Mechanical Engineering Branch
Sixth Semester- REGULATIONS 2008

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ME 9026 GAS DYNAMICS AND JET PROPULSION

Time: 3 hours

Max. Marks : 100

Note: 1. State clearly any assumption made with justification
(Use of Approved Gas Tables allowed)

Answer all Questions

PART A (10 x 2 =20 marks)

1. What is stagnation state?
2. Distinguish between nozzle and diffuser.
3. Why nozzle or diffusers are generally designed by having CD configuration? Why not DC configuration? Explain.
4. What is mach cone?
5. What are the assumptions used in simple diabatic flow?
6. How oblique shock is differ from normal shock?
7. Why axial compressors are mostly preferred for aircraft propulsion application?
8. What is hybrid aircraft propulsion?
9. What is escape velocity?
10. A rocket engine ejects mass at a rate of 25 kg/s with an exhaust velocity of 3,000 m/s. The pressure at the nozzle exit is 5.2 kPa and the exit area is 0.7 m^2 . What is the thrust of the engine in a vacuum?

PART B (5 x 16 =80 marks)

- 11 (i) Explain clearly by means of a sketch, the operating characteristics of both Converging and Converging-Diverging (CD) nozzle for various cases of decreasing back pressure.
- 12 a A CD nozzle having a throat diameter of 7.5 mm supplies air to an insulated duct of diameter 0.015 m. The total conditions of air at nozzle entry are 0.75 MPa and 27°C . The flow through the nozzle is isentropic. The friction coefficient 'f' is 0.005. Calculate the L_{max} of the duct that can be provided without any discontinuity in the nozzle or duct. Find the static as well as stagnation temperature and pressure of medium at duct exit for maximum duct length condition.

OR

- 12 b Solve the above problem by considering the discontinuity (shock) at just exit side of the nozzle.
- 13 a Prove that the Mach numbers at the maximum enthalpy and maximum entropy points on the Rayleigh line are $1/\sqrt{\gamma}$ and 1.0 respectively.

OR

- 13 b A mach 2 aircraft engine employs a subsonic inlet diffuser of area ratio 3. A normal shock is formed just upstream of the diffuser inlet. The free stream conditions upstream of the diffuser are $p=10$ bar, $T=300$ K. determine:

- (a) Mach number, pressure and temperature at the diffuser exit,
(b) Diffuser efficiency including the shock.

Assume isentropic flow in the diffuser downstream of the shock.

- 14 a A turbojet has the following data: Speed = 775 km/hr, Altitude = 13 km, Propulsive efficiency = 52%, Overall efficiency = 18%, Thrust = 6500 N, Fuel calorific value = 47000 J/g. Calculate : Flight Mach number, Effective velocity of the jet, Fuel flow rate, Air flow rate, TSFC and power output of the engine:

OR

- 14 b With neat sketches briefly explain the working of different types of turbofan engine.

- 15 a What is chemical propellant rocket system? With suitable diagram discuss the working method of different types of chemical propellant rocket system.

OR

- 15 b A thrust of 6 kN is developed by a liquid based rocket engine with 20 bar of chamber pressure. The ambient pressure is 0.01 bar. The CD nozzle ejects the propellant at 0.005 MPa. The nozzle diameter is 200 mm at exit side. The propellant flow rate is 3.2 kg/s. Find the velocity of the jet (V_e), specific impulse (I_s), combustor temperature (T_c), thrust coefficient (C_F), propellant mass flow coefficient (C_m) and characteristic velocity (c^*).