Reg. No. :

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B.E./B.Tech. DEGREE EXAMINATION, APRIL/MAY 2018
Sixth Semester
Mechanical Engineering
ME 2351 – GAS DYNAMICS AND JET PROPULSION
(Regulations 2008)
(Common to PTME 2351 – Gas Dynamics and Jet Propulsion for BE (Part-Time) Fifth Semester – Mechanical Engineering – Regulations 2009)

Time : Three Hours | Maximum : 100 Marks

Use of Gas Tables is permitted.

Answer ALL questions.

PART – A (10×2=20 Marks)

1. How mach number changes in nozzle ?
2. Define zone of action and zone of silence.
3. What do you mean by friction choking ?
4. Complete the following table with increases, decreases, remains constant for a flow through a constant-area duct with heat transfer :

Parameter	Subsonic flow		Supersonic flow	
	Heating	Cooling	Heating	Cooling
Static Temperature				

5. Define compression and rarefaction shocks.
6. What are the assumptions used for oblique shock flow ?
7. Define Propulsive efficiency.
8. What is the type of compressor used in turbo jet ?

9. What is mono-propellants ? Give examples.

10. What are the types of rocket engines based on source of energy employed ?

PART – B (5×16=80 Marks)

11. a) A nozzle in a wind tunnel gives a test-section Mach number of 2.0. Air enters the nozzle from a large reservoir at 0.69 bar and 310 K. The cross sectional area of the throat is 1000 cm^2. Determine the following quantities for the tunnel for one dimensional isentropic flow :

i) Pressures, temperatures and velocities at the throat and test section.

ii) Area of cross-section of the test section

iii) Mass flow rate

iv) Power required for driving the compressor.

(OR)

b) Derive the energy equations : $a^2/\gamma - 1 + \frac{1}{2}c^2 = \frac{1}{2}c^2 \max = a_0{}^2/\gamma - 1 = h_0$.

Stating the assumptions used.

12. a) i) 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 075 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. **(12)**

ii) A converging nozzle (unchoked) is provided between big tank and insulated 1 D duct. Flow starts from big tank to the duct via a nozzle. Sketch the pressure and Mach number variation along the system. **(4)**

(OR)

b) Prove that the Mach numbers at the maximum enthalpy and maximum entropy points on the Rayleigh line are $\frac{1}{\sqrt{\gamma}}$ and 1.0 respectively.

13. a) Derive the expression for change in entropy across the shock and state the necessary conditions for a normal shock to occur in compressible flow. **(16)**

(OR)

b) An oblique shock wave at an angle of 33° occurs at the leading edge of a symmetrical wedge. Air has a mach number of 2.1 upstream temperature of 300 K and upstream pressure of 11 bar. Determine the following i) Downstream pressure ii) Downstream temperature iii) Wedge angle and iv) Downstream mach number. **(16)**

14. a) Explain with neat sketches the principle of operation of i) Turbofan engine and ii) Turbojet engine.

(OR)

b) An aircraft propeller flies at a speed of 440 kmph. The diameter of the propeller is 4.1m and the speed ratio is 0.8. The ambient conditions of air at the flight altitude are T = 255 K and P = 0.55 bar. Find the following :

i) Thrust

ii) Thrust power

iii) Propulsive efficiency.

15. a) i) What are the advantages of liquid propellant rocket engines ?

ii) A rocket flies at 10,080 kmph with an effective exhaust jet velocity of 1400 m/s and propellant flow rate of 5.0 kg/s. If the heat of reaction of the propellant is 6500 kJ/kg of the propellant mixture determine, the propulsive efficiency and power, engine output and thermal efficiency and overall efficiency.

(OR)

b) i) Calculate the orbital and escape velocities of a rocket at mean sea level and an altitude of 300 km from the following data :
Radius of earth at mean sea level = 6341.6 km
Acceleration due to gravity at mean sea level 9.809 m/s^2.

ii) List out the important properties of solid propellants.