NAME_____ ROLL NO_____

# 2008 ANNA UNIVERSITY

## B.E/B.TECH DEGREE EXAMINATION

## GAS DYNAMICS AND JET PROPULSION

## (MECHANICAL ENGINEERING)

NOV-2008

TIME-3HOUR
MARKS-100

ANSWER ALL QUESTIONS

**PART - A [10X2=20]**

1. What is the advantage of using M* (second kind of Mach number) instead of M(Local Mach number) in some cases?

2. The wave front caused by firing a bullet gave a Mach angle of 35°. Find the velocity of the bullet if the static temperature of atmosphere is 276K.

3. Draw h-s (Enthalpy-Entropy) diagram for the flow through a nozzle showing stagnation states.

4. Show graphically the variation of Mach number across a convergent-divergent nozzle.

5. What are the assumptions made on Rayleigh flow?

6. What is the limiting Mach number in isothermal flow?

7. Give two useful applications of the shock waves.

8. Define strength of shock wave.

9. What is after burning in turbojet engines?

10. Why a rocket

is called non-air breathing engine?

**PART - B [5X16=80]**

11. (a) (i) Air (Cp=1.05 kJ/kg – K, ?=1.38) at P1=3 x 10^5 N/m^2 and T1=500 K flows with a velocity of 200 m/s in a 0.3 m diameter duct. Calculate : Mass flow rate, Stagnation temperature, Mach number and Stagnation pressure values assuming the flow as compressible and incompressible respectively.

(ii) An air plane travels at Mach 1.2 at an elevation where the temperature is 233K.Determine the speed of the air plane in km/hr. Assume ?=1.4

Or

(b) (i) A jet fighter is flying at Mach number 2.5. It is observed directly overhead at a height of 10km. How much distance it would cover before a sonic boom is heard on the ground?

(ii) An air jet at 400 K has sonic velocity. Determine: Velocity of sound at 400 K, Velocity of sound at stagnation condition, Maximum velocity of jet, Stagnation enthalpy.

12. (a) (i) Derive area ratio as a function of Mach number for one dimensional isentropic flow.

(ii) Explain for a convergent nozzle the variation of pressure and Mach number when the back pressure is gradually lowered from stagnation pressure.

Or

(b) A conical diffuser has entry and exit diameters as 0.15 m and 0.3 m respectively. The pressure, temperature and velocity of air at entry are 0.96 bar, 340 K and 185 m/s respectively. Determine : Exit pressure, Exit velocity and Force exerted on the Diffuser walls. Assume ?=1.4 and Cp=1.005 kJ/kg – K.

13 (a) A long pipe of 0.0254 m diameter has a mean coeffiecient 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 : (i) State pressure and temperature (ii) Stagnation pressure and temperature (iii) Velocity of air (iv) Distance of this section from the inlet and (v) Mass flow rate of air.

Or

(b) The Mach number at the exit of a combustion chamber is 0.9. The ratio of stagnation temperatures at exit and entry is 3.74 . If the pressure and temperature of glass at exit are 2.5 bar and 1273 K respectively, determine :(i) Mach Number, pressure and temperature of the gas at entry (ii) the heat supplied per kg of the gas and (iii) the maximum heat that can be supplied.

14. a) The ratio of the exit to entry area in a subsonic diffuser is 4. The Mach number of a jet of air approaching the diffuser at P=1.013 bar, T =290 K is 2.2. There is a standing normal shock wave just outside the diffuser entry. The flow in the diffuser is isentropic. Determine at the exit of the diffuser,

(i) Mach number
(ii) Temperature
(iii) Pressure. What is the stagnation pressure loss between the initial and final states of the flow?

Or

(b) Starting from the energy equation for flow through a normal shock, obtain the following relations : Cx.Cy =a^2; M*x. M*y = 1 (where Cx,Cy –fluid velocity *x. M*y –second kind of Mach number at upstream and downstream of shock respectively; a* -critical velocity of sound)

15 (a) (i) Derive the thrust equation for rocket engines.

(ii) The diameter of the propeller of an aircraft is 2.5m; it flies at a speed of 500 km/hr at an altitude of 8000 m. For a flight to jet speed ratio of 0.75, determine : the flow rate of air through the propeller, Thrust produced, Specific thrust, Specific impulse and Thrust power.

Or

(b) (i) Draw the sketch of a pulse jet engine. Write down its main advantages and disadvantages

(ii) The effective jet velocity from a rocket is 2700 m/s. The forward flight velocity is 1350 m/s and the propellant consumption is 78.6 kg/s Calculate : Thrust, Thrust power and Propulsive efficiency.