Register Number……

B.E. DEGREE EXAMINATIONS: NOV/DEC 2012

Fifth Semester

MECHANICAL ENGINEERING

MEC112: Gas Dynamics and Jet Propulsion

(Use of standard Gas Table is permitted)

Time: Three Hours **Maximum Marks: 100**

Answer All Questions:-

PART A (10 x 1 = 10 Marks)

1. When the Mach Number M <<1, the flow is called

   a) Sonic b) Subsonic c) Incompressible d) Supersonic

2. The angle between Mach lines and direction of motion of body is called

   a) Mach wave angle b) Mach angle c) Mach cone angle d) Angle of zone of silence.

3. An isentropic, converging-diverging nozzle operates with stagnation conditions 400 kPa, 500 K. This nozzle has a throat area of 0.01 m^2 and is chocked. What is the mass flow rate through this nozzle?

   a) 5.01 kg/s b) 7.23 kg/s c) 8.32 kg/s d) 9.81 kg/s

4. The critical pressure ratio is the ratio of

   a) Inlet pressure to exit pressure b) Exit pressure to throat pressure

   c) Inlet pressure to throat pressure d) Throat pressure to exit pressure.

5. In compressible flow through a constant area duct, the velocity

   a) Increases continuously b) Decreases continuously

   c) Remains constant d) Increases and then drops

6. In Fanno and Rayleigh flows, choking occurs when Mach number (M) is

   a) M <1 b) M >1 c) M=1 d) M<<1

7. The shock phenomena is a

   a) Reversible process b) Irreversible process

   c) Adiabatic process d) Constant pressure process

8. After normal shock

   a) Stagnation enthalpy increases b) Stagnation pressure increases

   c) Temperature drops d) Change in entropy increases

9. RAM effect takes place when the air is passed through

a) Diffuser b) Nozzle c) Turbine d) Combustion chamber

10. Example for the mono propellant is

a) Gasoline b) Hydrazine c) Nitro methane d) Ethyl alcohol

PART B (10 x 2 = 20 Marks)

11. Define the term “stagnation state”.
12. What is meant by Mach number?
13. Write the Fleingner’s equation.
14. Sketch the shape of diffuser for supersonic flow indicating direction of fluid flow.
15. Define Fanning’s coefficient of friction.
16. Give the assumptions made on Rayleigh flow.
17. Give the expression for Prandtl Meyer’s equation.
18. What are causes for a normal shock in a nozzle flow?
19. Differentiate turbojet and turbo prop.
20. Define the term “propulsive efficiency”.

PART C (5x14 = 70 Marks)

21. a) (i) A stream of air at a given temperature passes from a duct of uniform cross sectional area of 0.001 m^2 through a converging diverging diffuser having same exit area correctly designed so as to increase the air pressure. The air enters the diffuser at 105 kPa pressure and 75°C temperature with a velocity of 600 m / sec. Assuming isentropic diffusion. Determine the area at throat and pressure of air at exit. (9)

(ii) Prove that $\frac{T^*}{T} = \frac{2}{\gamma + 1} + \frac{\gamma - 1}{\gamma + 1} M^2$ (5)

(OR)

b) (i) An aircraft is flying at an altitude of 12,000 meters (T = 216.65 K, P = 0.193 bar) at a Mach number of 0.82. The cross sectional area of the inlet diffuser before the Low pressure compressor stage is 0.5 m^2. Determine a) the mass of air entering the compressor per second b) the speed of the aircraft and c) the stagnation pressure and temperature of air at the diffuser entry . (9)

(ii) Derive an equation for the mass flow rate in terms of Mach number. (5)

22. a) A supersonic nozzle expands air from P_o = 25 bar and T_o = 1050 K to an exit pressure of 4.35 bar; the exit area of the nozzle is 100 cm^2. Determine a) throat area b) pressure and temperature at the throat c) temperature at exit d) exit velocity as fraction of the maximum attainable velocity and e) mass flow rate .

(OR)

b) The Mach number and pressure at the entry of a subsonic diffuser are 0.9 and 4.165bar. Determine the area ratio required and the pressure rise of 17 the Mach number at the exit of diffuser is 0.2. Assume isentropic diffusion of air.

23. a) A circular duct passes 9kg/s of air at an exit mach number of 0.5. The entry pressure and temperature are 3.5 bar and 313 K respectively and the coefficient of friction of 0.005. If the Mach number at entry is 0.15, determine 1) the diameter of duct 2) length of the duct 3) pressure and temperature at the exit 4) stagnation pressure loss

(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 the gas at exit are 2.5 bar and 1000°C respectively. Determine 1) mach number 2) the heat supplied per kg of the gas 3) the maximum heat that can be supplied.

24. a) (i) A convergent-divergent air nozzle has exit to throat area ratio of 3. A normal shock appears at the divergent section where the existing area ratio is 2.2. Find the Mach number before and after the shock. If the inlet stagnation properties are 500kPa and 450K, find the properties of air at exit and entropy increase across the shock. (10)

(ii) Explain the phenomenon of normal shock and oblique shock. (4)

(OR)

b) (i) A normal shock wave occurs in an air flow at a point where the velocity is 680 m/s, the static pressure is 80kPa and the static temperature is 60°C. Find the velocity, static pressure and static temperature downstream of the shock. Also find the stagnation temperature and stagnation pressure upstream and downstream of the shock. (9)

(ii) Derive the Prandtl - Meyer relation for a normal shock. (5)

25. a) (i) What is Rocket propulsion ? Why it is called as a non breathing engine? (7)

(ii) With neat diagram, describe the working of Ram jet engine. (7)

(OR)

b) (i) With the help of neat sketch, explain any one arrangement used for fuel feeding in liquid propellant rocket systems. (4)

(ii) With neat sketches explain the principle of operation of Turbo fan engine and Turbo-propeller engine. (10)

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