



B.E DEGREE EXAMINATIONS: NOV/DEC 2014

(Regulation 2009)

Fifth Semester

MECHANICAL ENGINEERING

MEC112: Gas Dynamics And Jet Propulsion

Time: Three Hours

Maximum Marks: 100

Answer all the Questions:-

PART A (10 x 1 = 10 Marks)

- When the Mach Number $M > 1$, the flow is called
 - Sonic
 - Subsonic
 - Incompressible
 - Supersonic
- The line at which pressure difference is concentrated is called
 - Mach waves
 - Mach angle
 - Mach cone angle
 - Angle of zone of silence
- At what condition the convergent section acts as a diffuser
 - sonic
 - sub sonic
 - supersonic
 - normal flow
- 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 choked. What is the mass flow rate through this nozzle?
 - 5.01 kg/s
 - 7.23 kg/s
 - 8.32 kg/s
 - 9.81 kg/s
- In compressible flow through a constant area duct, the velocity
 - Increases continuously
 - Decreases continuously
 - Remains constant
 - Increases and then drops
- The Fanning's coefficient of skin friction is the ratio between

- a) wall shear stress /static head b) static head/ wall shear stress
 c) dynamic head/ wall shear stress d) wall shear stress /dynamic head
7. After normal shock
- a) Stagnation enthalpy increases b) Stagnation pressure increases
 c) Temperature drops d) Change in entropy increases
8. The strength of shock wave when normal shock appears at $M=2$ is
- a) 1 b) 2.5
 c) 2 d) 3.5
9. RAM effect takes place when the air is passed through
- a) Diffuser b) Nozzle
 c) Turbine d) Combustion chamber
10. Example for the Bipropellant is
- a) Gasoline b) Hydrazine
 c) Nitro methane d) Hydrogen peroxide

PART B (10 x 2 = 20 Marks)

11. Define the term “stagnation pressure”.
12. What is meant by Mach cone?
13. Show the shape of diffuser for supersonic flow indicating direction of fluid flow.
14. Spell what is impulse function.
15. Define Chocking in Fanno flow.
16. Compare Rayleigh flow and Fanno flow.
17. What is normal shock?
18. State the properties change across a normal shock.
19. Differentiate jet propulsion and rocket propulsion.
20. Define the term “specific impulse” of a rocket.

PART C (5 x 14 = 70 Marks)

21. a) (i) An air stream enters into a duct at a pressure of 1.2 bar, temperature of 300 K and Mach number of 1.25. If the Mach number at exit of the duct is 0.6, determine the following: 1) Temperature of air at the (9)

duct exit 2) Velocity of air at the duct exit. Assuming adiabatic flow.

(ii) Develop and prove that $C_{\max}^2 = C^{*2} \frac{\gamma + 1}{\gamma - 1}$ (5)

(OR)

- b) (i) An aircraft is flying at an altitude of 10,000 meters. The inlet Mach number is 0.82, temperature is 223.15 K and pressure is 0.264 bar. The cross sectional area of the inlet diffuser before the Low pressure compressor stage is 0.45 m². Make use of the above datas, calculate a) the mass of air entering the compressor per second b) the speed of the aircraft and c) the stagnation pressure at diffuser entry d) the stagnation temperature at diffuser entry. (9)
- (ii) Develop an equation for the mass flow rate in terms of Mach number. (5)

22. a) A supersonic nozzle air expand from $P_o = 24$ bar and $T_o = 1000$ K to an exit pressure of 4.3 bar. If the exit area of the nozzle is 110 cm², Apply the above datas to calculate 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 0.88 and 5.15 bar respectively. If the Mach number at the exit of the diffuser is 0.22, solve for i) area ratio ii) pressure rise. Assume isentropic flow.

23. a) Air at a pressure of 25 bar, -223 °C and velocity of 125 m/s flows through a constant area duct adiabatically and leaves with a velocity of 25 m/s. Experiment with the above datas and find the heat transferred and properties of air at exit. Take $\gamma = 1.4$ and $R = 287$ J/kgK.

(OR)

- b) A gas at a pressure of 0.69 bar and temperature of 278 K enters a combustion chamber at a velocity of 60 m/s. The heat supplied in the combustion chamber is 1405.6 kJ/kg. Identify the Mach number, pressure, temperature and velocity of gas at the exit. Take $\gamma = 1.4$ and $C_p = 1.004$ kJ/kgK.

24. a) (i) A convergent-divergent nozzle is operated at off-design condition a normal shock occurs at a section where the cross sectional area is (9)

18.75 cm² in the diverging portion. At inlet to the nozzle the stagnation state is given as 0.21MPa and 36 °C. The throat area is 12.5 cm² and exit area is 25 cm². Identify the exit Mach number, exit pressure and loss in stagnation pressure for flow through nozzle

- (ii) Illustrate the phenomenon of oblique shock. (5)

(OR)

- b) (i) 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. (9)

Determine

- 1) downstream pressure 2) downstream temperature 3) wedge angle
4) downstream Mach number.

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

25. a) (i) Demonstrate with a sketch, the principle of operation of turbo jet engine. (7)

- (ii) With neat diagram, explain the working of Pulse jet engine. (7)

(OR)

- b) (i) Demonstrate with the help of neat sketch, explain the construction and working of solid propellant rocket engine (7)

- (ii) With a neat sketch, explain the turbo pump feed system. (7)
