M.E./M.TECH. Degree Examination, December 2020

Third Semester

IC18017 - Aircraft and Space Propulsion

(Regulation 2018)

(Use of Gas Table permitted)

Time: Three hours Maximum: 80 Marks

Answer **ALL** questions

PART A - (8 X 2 = 16 marks)

1. For oblique shock, the downstream Mach number
   (a) is always more than unity, (b) is always less than unity,
   (c) may be less or more than unity, (d) can never be unity.
2. A turbo-prop is preferred to turbo-jet because
   (a) it can fly at high elevations, (b) it has high propulsive efficiency at high speeds
   (c) it can fly at supersonic speeds, (d) it has high power for take off
3. A rocket works with maximum overall efficiency when air-craft velocity is---------- the jet velocity.
   (a) equal to (b) one-half (c) double
4. A plane travels with a velocity of 1000 kmph at an altitude where the pressure and temperature are 40kPa and –350C. The value of Mach number
   (a) M = 1, (b)M < 1, (c) M > 1
5. An aeroplane travels at an altitude where the temperature is –37°C with a Mach number of 1.2. Determine the velocity of the plane in km per hour.
6. What is the need of Aircraft matching.
7. Explain the Rocket heat transfer.
8. Explain chocking condition.

PART B - (4 X16 = 64 marks)

09. (a) (i) Air is discharged from a reservoir at 1 MPa and 500 K through a nozzle to an exit pressure of 0.09 MPa. If the flow rate through the nozzle is 3600 kg/h. Determine for isentropic flow (a) Area, pressure and velocity at throat section (b) Mach number and area at the exit. **(8)**

(ii) The Mach number and pressure at the entry of a subsonic diffuser are 0.9 and 4.165 bar. Determine the area ratio required and the pressure rise if the Mach number of the exit of diffuser is 0.2. Assume isentropic diffusion of air. **(8)**

(OR)

(b) (i) A combustion chamber of a gas turbine receives air at 350K, 0.55 bar and 75 m/s. The air fuel ratio is 29 and the calorific value of the fuel is 41.87 MJ/kg. Taking γ = 1.4 and R = 0.287 kJ/kgK for the gas. Determine (a). The initial and final Mach numbers, (b). Final pressure, temperature and velocity of the gas. **(8)**

(ii) A jet of air at 275 K and 69 kPa has an initial Mach number 2. If it passes through a normal shock wave, determine at downstream of the shock the following: Mach number, Pressure, Temperature and density. **(8)**

10. (a) (i) What is after burning in turbojet engines? Explain briefly with the aid of a diagram **(8)**

(ii) Explain the working of a pulsejet engine with suitable diagram. **(8)**

(OR)

(b) (i) Compare the working principle of Turboprop and Turbofan engine **(8)**

(ii) Derive the expression for thrust equation for Turbojet engine and specific impulse. **(8)**

11. (a) (i) Describe the layout of aircraft matching with neat sketches **(8)**

(ii) The diameter of an aircraft propeller is 4.0 meters. The speed ratio is 0.8 at a flight speed of 450 km/hr. If the ambient conditions of air at the flight altitude are T=256K and P=0.54bar, determine (i). Propulsive efficiency, (ii). Thrust and (iii). Thrust power. **(8)**

(OR)

(b) (i) Explain the steps involved to design the nozzle and diffuser in aircraft propulsion system. **(8)**

(ii) A turbojet aircraft flies at 875 kmph at an attitude of 10000 m above mean level. Calculate air flow rate through the engine, thrust, specific thrust, specific impulse, thrust power and TSFC from the following data,: diameter of the air inlet section = 0.75m, diameter of the jet pipe at exit = 0.5m, velocity of the gases at the exit of the jet pipe = 500m/s, pressure at the exit of the jet pipe 0.30bar, air fuel ratio = 40. **(8)**

12. (a) (i) A rocket nozzle has a throat area of $18cm^2$ and combustion chamber pressure of 25 bar, if the specific impulse is 127.42 sec, and weight flow rate 44.145 N/s, determine thrust coefficient, propellant weight flow coefficient, SPC and characteristic velocity. **(8)**

(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 the thrust, thrust power and propulsive efficiency. **(8)**

(OR)

(b) (i) Explain various methods of ignition employed in liquid propellant rocket? With suitable diagram. **(8)**

(ii) Explain the propellant feed system used for the liquid propellant rocket engine. **(8)**