Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

B E Sem-VI Examination May 2011

Subject code: 160102

Subject Name: Fundamentals of Jet Propulsion

Date:17/05/2011 **Time: 10.30 am – 01.00 pm**

Total Marks: 70

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Use of gas tables is permissible.**

Q.1 **(a)** Define and derive the expression for the terms thermal efficiency, overall efficiency, propulsive efficiency, specific fuel consumption, specific thrust and specific impulse for the turbojet engine. **07**

(b) With a neat sketch explain the effect of compressor pressure ratio and cycle temperature ratio on the performance of turbojet engine. **07**

Q.2 **(a)** Explain the different diffuser operations for the ram jet engine. **07**

(b) A rocket nozzle has a throat area of 20 cm^2 and combustion chamber pressure of 25 bar. If the specific impulse is 150 seconds, speed ratio 2.1, heat release rate is 6500KJ/kg and weight flow rate 45 N/s, determine: thrust coefficient, propellant weight flow coefficient, specific propellant consumption, characteristic velocity, propulsive efficiency, thermal efficiency and overall efficiency. **07**

OR

(b) Why thrust chamber cooling is essential in rocket engines? Write a short note on thrust chamber cooling. **07**

Q.3 **(a)** With a neat sketch explain the Liquid Propellant Rocket Engine. What are the advantages and disadvantages of Liquid Propellant Rocket Engine compare to others? **07**

(b) A turbojet engine propels an aircraft at a mach number of 0.6 in level flight. Stagnation temperature at turbine entry is 1300K, stagnation temperature rise through the compressor is 180K, calorific value of the fuel is 43MJ/Kg, mechanical efficiency of power transmission is 0.98, specific impulse 30 seconds and free stream conditions at entry are static temperature 224K and sound speed 300m/s. Calculate fuel air ratio, compressor pressure ratio turbine pressure ratio, exhaust nozzle pressure ratio and the mach number of exhaust jet. **07**

OR

Q.3 **(a)** Write down the assumptions for an ideal ramjet engine and derive the conditions at diffuser exit section, combustion chamber exit section and expansion nozzle exit section. **07**

(b) A ramjet engine operates at Mach 2. The diameter of the inlet diffuser at entry is 30 cm and the stagnation temperature at nozzle entry is 1700K. The calorific value of fuel is 43MJ/Kg. velocity of the air at the diffuser exit is negligible. Efficiency of diffuser, burner and nozzle are 95%, 96% and 94% respectively. The stagnation pressure loss in the combustion chamber is $0.02P_{02}$. The free stream conditions are 245K, 0.44bar and sound speed of 315m/s. Calculate efficiency of the ideal cycle, flight speed, mass flow rate of air, diffuser pressure ratio, fuel to air ratio and nozzle pressure ratio. **07**

Q.4 **(a)** Explain in detail the factors affecting the combustion chamber design. **07**

(b) What is the purpose of a diffuser in the inlet? Explain supersonic inlets with aid of sketches. **07**

OR

Q.4 **(a)** List out the factors affecting the combustion chamber performance and explain the pressure loss in detail. **07**

(b) A supersonic diffuser has inlet Mach number of 4, exit Mach number 0.6 and area ratio $A_2/A_1 = 2$. A normal shock occurs within the diffuser at Mach number M_x and area ratio A_x/A_1. Calculate the value of Mx, A_x/A_1 and P_2/P_1. Comment whether shock is formed inside the diffuser of outside the diffuser? Use gas tables. **07**

Q.5 **(a)** Derive the expression for maximum mass flow rate in terms of Mach number and find the numerical value of maximum mass flow parameter in SI units. **07**

(b) Air is discharged form a reservoir at 6.91 bar and 325ºC through a nozzle to an exit pressure of .98 bar. If the flow rate is 3600 Kg/hr, determine for isentropic flow: throat area, pressure and velocity at throat, exit area and mach number and maximum velocity. (Use gas table if required) **07**

OR

Q.5 **(a)** The following data relates to the gas turbine set employing a heat exchanger: isentropic efficiency of compressor, turbine and burner are 0.75, 0.85and 0.98 respectively. Mass flow rate is 22.7kg/s and pressure ratio is 6. Maximum cycle temperature is 1000K and heat exchanger effectiveness is 0.75. The free stream conditions are 15ºC and 1.03 bar. Calculate the net power output, specific fuel consumption and thermal efficiency of the cycle with heat exchanger. **07**

(b) With a neat sketch explain the turbo pump feed system employed in rocket engines. What its purpose in rocket engines? **07**

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