Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–VI • EXAMINATION – WINTER 2013

Subject Code: 160102 Date: 29-11-2013

Subject Name: Fundamentals of Jet Propulsion

Time: 02:30 pm to 05:00 pm Total Marks: 70

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

Q.1 **(a)** Explain thrust chamber cooling of solid rocket motor and liquid rocket engine with the help of suitable diagram. **07**

(b) Explain effect of various parameters that affect the thrust and propulsive of turbojet engine. Justify your answer using suitable diagrams. **07**

Q.2 **(a)** With a neat sketch or schematic diagram explain the feed system employed in liquid rocket engines. **07**

(b) A converging-diverging nozzle operates at an atmospheric pressure of 68.95 kPa. It has a minimum area of 0.1393 m^2 and exit area of 0.2786 m^2. The inlet total pressure and temperature are 241.3kPa and 611.1 K respectively. The effective specific heat ratio is 1.340 and the nozzle efficiency is 98 %. Find the overall general operating conditions and mass flow rate. **07**

OR

(b) A gas turbine plant draws air at 1 bar and 295 K. Air is compressed to 4 bars and then heated to a temperature of 850 K. The efficiencies of compressor and turbine are 81 % and 87 % respectively. Neglect the pressure drop. Determine the overall efficiency of the plant: (1) Without regenerator and (2) With the regenerator of 71 % effectiveness. Take C_p = 1 kJ/kg K and γ = 1.4 for air and gases both. Give your concluding remarks on efficiency **07**

Q.3 **(a)** For turbofan with a fan exhaust show that the general equation of the thrust is **07**

$$F = A_e(P_e - P_a) + A_s(P_s - P_a) + \dot{m}_e(u_e - u_a) + \dot{m}_s(u_s - u_a)\,.$$

(b) List the need and basic requirements of gas turbine burner. With the help of gas turbine burner diagram show and explain various zone of burner. **07**

OR

Q.3 **(a)** For a turbojet engine show that the resulting thrust has contributions due to the mass flux and flow acceleration as well as the pressure difference between the engine exit and atmosphere **07**

(b) Flow with an incoming Mach number of 0.8 and an inlet total pressure of 15 psia enters a diffuser channel in 36 in. long and with a 36 in. diameter. The flow has a fanning friction factor of 0.020 and an exit to inlet area ratio of 1.5. The total temperature remains constant at 500 $^{\circ}$R. What is the total pressure ratio if the specific heat ratio is 1.4. **07**

Q.4 **(a)** For ramjet engine, show that for constant altitude, heating value and T_4/T_3, the minimum value of TSFC occurs at optimum Mach number given as **07**

$$M_{a_{opt}} = \sqrt{\frac{2}{\gamma - 1}}$$

(b) Derive area Mach relationship for convergent divergent nozzle and show that how area ratio varies with respect to Mach number **07**

OR

Q.4 **(a)** Explain advance rocket propulsion and with the help of suitable diagram write brief notes on any two advance propulsion techniques. **07**

(b) A ramjet is travelling at Mach 3 at an altitude of 4572 m, the external static pressure and temperature are 57.1kPa and 258.5 K. The heating value of the fuels if 46,520 kJ/kg. Air flow through the engine at 45.35 kg/s. The buner exit total temperature is 1944 K. Find the thrust, fuel ratio and TSFC. The specific heat ratio can be assumed to be 1.40. **07**

Q.5 **(a)** Explain working of open cycle gas turbine and closed cycle gas turbine with the help of P-V and T-S diagram. How actual gas turbine cycles differ from ideal gas turbine cycle? What are the various techniques for performance improvement of gas turbine? **07**

(b) A turbojet operates at 20,000 ft and moves at Mach 0.75. The nozzle exit pressure is 19.7 psia, and the exit velocity is 1965ft/sec and the exit density is 0.000979 slugs/ft^3. The developed thrust is 8995 lbf and the fuel flow rate is 3.16 lbm/s (a) Find the ingested air mass flow rate. (b) If the exit nozzle is round, what is the nozzle exit diameter? **07**

OR

Q.5 **(a)** Using suitable diagram explain internal compression inlet, external compression inlet and mixed compression inlet **07**

(b) A turbofan operates at sea level and moves at 269.7 m/s. It ingests 121.1 kg/s of air into the core and five times this amount into the fan, which all exhaust through the fan exhaust. The fuel flow is negligible. The exit areas of the fan and core are 1.580 and 1.704 m^2 respectively. The exit pressure from the fan and core are 154.4 and 144.8 kPa respectively. The exhaust velocity from fan and core are 328.6 and 362 m/s respectively. Find the thrust. **07**

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