GUJARAT TECHNOLOGICAL UNIVERSITY
BE - SEMESTER–VI (NEW) EXAMINATION – SUMMER 2023

Subject Code:3160102   **Date:04-07-2023**

Subject Name:Fundamentals of Jet Propulsion

Time:10:30 AM TO 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. **Simple and non-programmable scientific calculators are allowed.**

			MARKS
Q.1	**(a)**	Define thrust. Derive the thrust equation for the rocket engine.	**03**
	(b)	Classify the rocket engines.	**04**
	(c)	Draw and explain liquid propellant rocket engines. List out its advantages and disadvantages against the solid propellant rocket engines.	**07**
Q.2	**(a)**	Why and when thrust augmentation techniques are needed?	**03**
	(b)	Write a short note on ramjet engine.	**04**
	(c)	Draw h-s diagram for a turbojet engine and derive the expression of thrust obtained by the turbojet engine.	**07**
		OR	
	(c)	Explain in detail the factors affecting the performance of a jet engine combustor.	**07**
Q.3	**(a)**	Summarize the different types of combustors used in aircraft engines.	**03**
	(b)	Derive the expression of efficiency of ramjet engine as a function of flight Mach number.	**04**
	(c)	What is bypass ratio and bypass fraction of a turbofan engine? Derive the expression of Thrust as a function of bypass ratio for a turbofan engine.	**07**
		OR	
Q.3	**(a)**	Why flame tube cooling is required in a combustion chamber?	**03**
	(b)	Explain the effect of compressor pressure ratio on the thermal efficiency and propulsive efficiency of a jet engine.	**04**
	(c)	Derive the expression of maximum mass flow that can pass through the variable area duct. Draw its variation with the change in pressure ratio.	**07**
Q.4	**(a)**	What is back pressure? How it affects the pressure thrust?	**03**
	(b)	Derive the Mach area relation and explain its significance.	**04**
	(c)	Air with stagnation pressure 1.013 bar and static temperature 290K is approaching a ramjet diffuser with an area ratio of 4. Air inlet Mach number is 2.2. A normal shock occurs just outside the diffuser entry and flow through diffuser is isentropic. Determine Mach number, pressure and temperature at the exit of the diffuser. Also find stagnation pressure loss between the initial and final states of the flow.	**07**
		OR	
Q.4	**(a)**	How the rocket engines differ than jet engines. List applications of rocket engines.	**03**
	(b)	Discuss the three types of ram inlets.	**04**
	(c)	A converging, nozzle operating with air and inlet conditions of $P_1 = 4$ N/m^2, $T_{01} = 450°C$ and $T_1 = 400°C$ is expected to have an exit static pressure of 2.5 N/m^2 under ideal conditions. Estimate the exit temperature and Mach number at entry and exit from the nozzle and stagnation and area ratio of the nozzle for this expansion of pressure.	**07**

Q.5 **(a)** Draw and explain any of the propellant feed system in a rocket engine. **03**

(b) How the Future Fuels and Energy Sources help in Sustainable Aviation. **04**

(c) A turbojet power aircraft uses a aviation kerosene having a calorific value of 43 MJ/kg. The fuel consumption is 0.18 kg per hour per N of thrust, when the thrust is 9 kN. The aircraft velocity is 500 m/s the mass of air passing through the engine is 27 kg/s. Calculate the air fuel ratio and overall efficiency of the engine. **07**

OR

Q.5 **(a)** Explain the role of a subsonic inlet and supersonic inlet in an aircraft. **03**

(b) Draw and explain the working of a pulsejet engine in detail. **04**

(c) Write a short note on over-expanded nozzles. **07**

****