Name: **Enrolment No:**	UPES UNIVERSITY OF TOMORROW

UPES

End Semester Examination, December 2023

Course: Gas Dynamics and Jet Propulsion **Semester :V**

Program: B. Tech Aerospace **Time : 03 hrs.**

Course Code: ASEG3022 **Max. Marks: 100**

Instructions:

1. **The Question paper has three sections: Section A, B and C.**
2. **Section B and C have internal choices.**
3. **Assume suitable data if needed**

SECTION A
(5Qx4M=20Marks)

S. No.		Marks	CO
Q 1	Discuss the advantages and disadvantages of turbojet engines	**4**	**CO1**
2	Explore the principles behind the variable geometry intake in supersonic jet engines	**4**	**C02**
3	Classify the different types of combustion chamber with suitable examples.	**4**	**C01**
4	Define the following parameters of combustion for aircraft combustor. 1. Combustion efficiency 2. Combustion instability 3. Skin friction 4. Pressure loss	**4**	**C01**
5	State that the bypass ratio influences the efficiency of a turbofan engine.	**4**	**C02**
SECTION B **(4Qx10M= 40 Marks)**			
6	Discuss the complete design procedure of aircraft nozzles through block diagram.	**10**	**CO2**
7	A compact unmanned aerial vehicle (UAV) is equipped with a Ramjet engine. The net thrust generated is 9000 N, and the vehicle is cruising at a speed of 350 km/h. The gases exit the engine with an average velocity of 450 m/s. The fuel-to-air ratio is 0.07, and pressure equilibrium exists at the outlet plane (a) Compute the mass flow rate required. (b) Calculate the inlet area (assume 23 ^{0}C and one atmosphere). (c) Calculate the thrust power. (d) Calculate the propulsive efficiency.	**10**	**C03**

8	An 150 mm diameter straight insulted pipe having a mean friction factor 0.005 is used for carrying compressed air to an industrial unit at a distance 390 m from the source . The compressed air ,at entry to the pipe , has a Mach number 0.1 . The pressure and temperature of air at intel are 0.8 MPa and 27ºC . Calculate the mass flow rate through the pipe . Also , find the pressure , temperature , velocity and Mach number of air at the delivery end of the pipe.	**10**	**C02**
9	The calorific value of a hydrocarbon fuel used in a tubular can – type combustor is 42000 kJ/kg. The fuel is introduced and mixed with air which enters the combustor with a velocity of 75 m/s , pressure of 55 kPa and temperature of 350 K. The proportion of mass of fuel with air is 0.0345. Assuming the thermodynamic properties of the combustion gases to be the same as that of air , calculate the Mach number , pressure and temperature of the combustion products leaving the combustor. **OR** Air enters the nozzle of a Mach 2 wind tunnel with a static pressure and temperature of 671 kPa and 307.55 K respectively . The measured average velocity at inlet to the nozzle is 70.3 m/s . The throat area of the nozzle is 0.1m2 . Find the area, velocity and static properties of air at test section . Find also the power required to drive the compressor.	**10**	**C03**
	SECTION-C **(2Qx20M=40 Marks)**		
10	Compare the performance of twin-spool turbofan engine with separate fan and compressor to that of a turbojet engine, both with an overall pressure ratio of 30 and a TIT of 1300 K, and designed for an altitude of 12 km and a flight speed of 275 m/s. The BPR is 6 and the fan pressure ratio is 1.6. Assume that the polytropic efficiency of fan, compressor, and turbine efficiencies of 90% and a combustor loss of 3% of the compressor exit total pressure. Compare specific thrusts for engines built from the same core engine. Compare also specific fuel consumption and jet velocities. **OR** A single-spool turbofan engine has the following data:	**20**	**CO4**

	<table><tr><td>Ambient temperature</td><td>288 K</td></tr><tr><td>Ambient pressure</td><td>101.3 kN/m^2</td></tr><tr><td>BPR (β)</td><td>0.7</td></tr><tr><td>Overall pressure ratio</td><td>25</td></tr><tr><td>Fan pressure ratio</td><td>3.375</td></tr><tr><td>Fuel heating value (Q_R)</td><td>44,000 kJ/kg</td></tr><tr><td>Turbine inlet temperature</td><td>2000 K</td></tr><tr><td>Diffuser pressure recovery factor (r_d)</td><td>0.9</td></tr><tr><td>Compressor efficiency (η_c)</td><td>0.89</td></tr><tr><td>Fan efficiency (η_f)</td><td>0.91</td></tr><tr><td>Combustion efficiency (η_b)</td><td>0.98</td></tr><tr><td>Burner pressure recovery factor (r_b)</td><td>0.95</td></tr><tr><td>Turbine efficiency (η_t)</td><td>0.98</td></tr><tr><td>Nozzle efficiency (η_n)</td><td>1.0</td></tr><tr><td>Flight Mach number</td><td>0.3</td></tr></table> Calculate the thrust per unit mass flow rate and the TSFC		
11	Calculate the specific thrust and the TSFC of a single-spool turbojet engine having the following peculiarities: Cruise velocity of 280 m/s at altitude of 7000 m Intake efficiency of 93% Compressor pressure ratio of 8:1 and efficiency of 87% Burner efficiency of 98% Pressure drop in the combustion chamber of 4% of the delivery pressure of the compressor TIT of 1200 K and efficiency of 90% Mechanical efficiency of 99% Nozzle efficiency 95% Fuel heating value 44,000 kJ/kg.	**20**	**C04**