Name:

Enrolment No:

UPES

End Semester Examination, May 2025

Course: Design of Aerospace Vehicle **Semester: VIII**

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

Course Code: ASEG 4022 **Max. Marks: 100**

Instructions: Use of Aircraft Design Data given is allowed in exam.

SECTION A
(5Qx4M=20Marks)

S. No.		Marks	CO
Q 1	Compare mission requirements of acrobatic and fighter Aircraft in diagram.	**4**	**CO1**
Q 2	Compare Gross take-off Weight expression for civil aircraft and UAV.	**4**	**CO1**
Q 3	If gross take-off weight is given by $W_{TO} = W_{Empty} + W_{Payload} + W_{Fuel} + W_{tfo}$, derive useful weight relation (W_{useful}) for a UAV.	**4**	**CO2**
Q 4	Why multi-stage rocket advantageous over SSTO Launch Vehicle?	**4**	**CO3**
Q 5	Compare different aerodynamic drag of different components of Civil and military aircrafts.	**4**	**CO4**
	SECTION B **(4Qx10M= 40 Marks)**		
Q 6	Compare *tossback trajectory* performance over *conventional trajectory* of Launch vehicles. Also, derive final expression for initial and final mass fractions for both trajectories.	**10**	**CO1**
Q 7	Given initial mass 20,000 kg, Payload mass 1000 kg, Structural mass 3000, *payload ratio(λ)* 0.0724 and *structural coefficient(ε)* 0.152, estimate final velocity of Single stage Launch vehicle. Compare with 2 stage Launch Vehicle if stage 1 initial mass 20,000 kg and stage 2 initial mass 5000 kg (consider $\lambda_1 = \lambda_2$ *and* $\varepsilon_1 = \varepsilon_2$)	**10**	**CO2**
Q 8	An airplane under design has the following features: Weight of payload = 40000 N , Weight of 5 crew members = 5000 N, Estimated fuel fraction (W_f/W_O) = 0.38 , Empty weight fraction (We/W_O) = 0.837 $Wo^{-0.7}$ here, W_O is in Newtons. a) Obtain the gross weight (W_O) of the airplane, b) Compute and plot payload trade graph.	**10**	**CO3**
Q 9	Consider an aircraft with following characteristics: Cruise Mach number 0.2; at sea level, wing loading 100 kg/m^2, Takeoff weight 4000 kg. Design the main wing that would be suitable for this aircraft and provide sketches. Compare your results for Mach number 0.7.	**10**	**CO4**

	OR Estimate Gross take-off weight of small regional jet airplane having 5700 kg payload with 1600 km range at 2,000 m altitude. Provide mission profile.		
	SECTION-C **(1Qx40M=40 Marks)**		
Q 10	Design 4 seater aircraft for following design requirements. i) Provide mission profile, Estimate Gross take-off Weight, least W/S among all flight phases (25 Marks), ii) Wing/Tail Sizing and detailed Weight and aerodynamic performance estimation(10 Marks), iii)Sketch 3 views of Aircraft (5Marks). Payload: 4 to 6 passengers and 2 pilots + baggage High Comfort Level: 4×100 (averaged) $+ 200 = 600$ kg Medium Comfort Level: 6×80 (averaged) $+ 120 = 600$ kg Range: 2,000 miles + reserve Maximum Cruise Speed: Mach 0.7 Cruise Altitude: Above 40,000 ft (ceiling over 50,000 ft) Takeoff Distance: 800 m @ sea level to 15 m Landing Distance: 800 m (at takeoff weight) @ sea level from 15 m **OR** Design a 150 Passenger Aircraft for given FAR 25 requirements. i) Provide mission profile, Estimate Gross take-off Weight, least W/S among all flight phases (25 Marks), ii) Wing/Tail Sizing and detailed Weight and aerodynamic performance estimation(10 Marks), iii) Sketch 3 views of Aircraft (5 Marks). Payload: 150 passengers $= 90 \times 150 = 14{,}500$ kg Range: 2,800 nm (nautical miles) + reserve Crew: 2 pilots + 5 attendants Maximum Cruise Speed: 0.75 Mach Cruise Altitude: Above 30,000 ft (ceiling over 40,000 ft) Takeoff Distance: 2,000 m @ sea level to 15 m Landing Distance: 2,000 m (at 95% takeoff weight) @ sea level from 15 m Initial Rate of Climb: 14 m/s Undercarriage: Retractable Cabin Comfort: Pressurized cabin with air conditioning and oxygen supply, cabin interior diameter = 144 in. Technology Level: Advanced Power Plant: Turbofan engine	**40**	**CO4** **CO3** **CO1**