U.S.N.										

B.M.S. College of Engineering, Bengaluru-560019

Autonomous Institute Affiliated to VTU

January 2024 Semester End Main Examinations

Programme: B.E. **Semester: VII**
Branch: Aerospace Engineering **Duration: 3 hrs.**
Course Code: 21AE7DCAVD **Max Marks: 100**
Course: Aerospace Vehicle Design and Analysis

Instructions: 1. Answer any FIVE full questions, choosing one full question from each unit.
2. Missing data, if any, may be suitably assumed.

Important Note: Completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages. Revealing of identification, appeal to evaluator will be treated as malpractice.

		UNIT - I	CO	PO	Marks
1	a)	Show that, the induced drag is equal to parasite drag at the minimum thrust required condition.	CO 1	PO 1 PO 2	**5**
	b)	For the propeller-driven aircraft, derive the expression of range in terms of weight fraction.	CO 1	PO 1 PO 2	**5**
	c)	Describe the take-off gross weight estimation procedure to design an aircraft that has simple mission segments, such as take-off, climb, cruise, loiter, and land. Write down step-by-step methods using block diagrams.	CO 1	PO 1 PO 2	**6**
	d)	Discuss briefly the trade studies.	CO 1	PO 1	**4**
		OR			
2	a)	Consider a jet aircraft that has to fulfill the mission requirements mentioned in the mission profile (Figure 1). It has to fly at a velocity of V = 0.6 Mach at 30,000 ft altitude. Estimate the fuel fraction for the entire mission considering a 6% allowance for reserve and trapped fuel. Consider, Payload = 10,000 lb and the Crew weight = 800 lb. Specific fuel consumption for jet aircraft during cruise, $C = 0.5\ \text{l/hr}$ during loiter, $C = 0.4\ \text{l/hr}$ 1 n mile = 6076 ft Speed of sound at 30,000 ft = 994.8 ft/s Aspect ratio of the wing (A) = 7 Wetted area ratio (S_{wet}/S_{ref}) = 5.5 Wetted aspect ratio, $A_{\text{wetted}} = \frac{b^2}{S_{\text{wetted}}} = \frac{A}{(S_{\text{wet}}/S_{\text{ref}})}$	CO 1	PO 3	**15**

$$(L/D)_{max} = K_{LD}\sqrt{A_{wetted}} = K_{LD}\sqrt{\frac{A}{(S_{wet}/S_{ref})}}$$

Consider, $K_{LD} = 13$

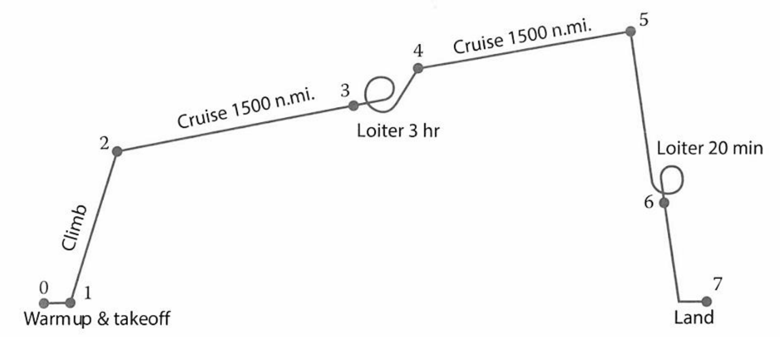

Figure 1

Historical Mission-Segment Weight Fractions

Mission Segment	(W_i/W_{i-1})
Warmup and takeoff	0.970
Climb	0.985
Landing	0.995

Lift-to-Drag Ratio

	Cruise	Loiter
Jet	$0.866\ L/D_{max}$	L/D_{max}
Prop	L/D_{max}	$0.866\ L/D_{max}$

	b)	Describe three primary phases of aircraft design.	CO 1	PO 1	5
		UNIT - II			
3	a)	Describe the advantages and disadvantages of T-tail.	CO 2	PO 1	4
	b)	Why wing sweep is used? Write down two major detrimental consequences associated with wing sweep.	CO 2	PO 1 PO 2	6
	c)	Show that, at an infinite wing aspect ratio, the coefficient of lift of the wing is the same as the coefficient of lift of the airfoil.	CO 2	PO 1 PO 2	6
	d)	Explain two major disadvantages when the camber is introduced in increasing the maximum coefficient of lift.	CO 2	PO 1	4
		UNIT - III			
4	a)	What do you understand by instantaneous turn rate and sustained turn rate? Explain along with the mathematical descriptions.	CO 3	PO 1	6
	b)	Describe how wing loading and thrust loading are interconnected by taking an example of the take-off distance as a design parameter.	CO 3	PO 1 PO 2	5
	c)	Derive the thrust-to-weight ratio for climb and cruise states. In which case, the thrust-to-weight ratio will be higher.	CO 4	PO 1 PO 2	5

		d)	Describe thrust matching.	CO 4	PO 1 PO 2	**4**
			OR			
	5	a)	For developing a conceptual design of an aircraft, the design goals are mentioned below: $V_{max} \geq 130$ knots, $V_{stall} \leq 50$ knots, Take-off distance (over 50 foot of obstacle clearance) ≤ 1000 ft V_{cruise}= 115 knots V_{climb}=70 knots Rate of Climb=1500 foot per minute Aspect Ratio of the wing = 6 Oswald span efficiency factor e = 0.8 Density of fluid(air) at sea-level condition (ρ)= 0.00238 slug/ft^3 C_{D0}=0.02 V_{TO}=1.1 V_{stall} Hp/W = 1/8 Propeller efficiency = 0.8 Maximum lift-coefficient of Airfoil (C_l, max)=1.3 Dynamic pressure at cruise altitude = 35 lb/ft^2 1 knot = 1.689 ft/s 1 n mile = 6076 ft. Take off Parameter (TOP) (for 50 foot obstacle clearance) $= \frac{\frac{W}{S}}{\sigma (C_L)_{TO} \frac{Hp}{W}}$ = 120 (fps), $\sigma = \frac{\rho_{TO}}{\rho_{Sea-level}}$, C_L= Coefficient of lift of the wing, TO = Take-off condition Consider, takeoff happens at sea-level conditions. Calculate the wing loading based on (i) Stall velocity, (ii) Take-off distance (till 50 foot of obstacle clearance distance), (iii) Climb rate, and (iv) cruise considerations	CO 4	PO 3	**20**
			UNIT - IV			
	6	a)	Define rubber and fixed-size engines.	CO 5	PO 1	**5**
		b)	What is Known-time fuel burn? Derive the mission segment weight fraction during Known-time fuel burn for the rubber engine.	CO 5	PO 1 PO 2	**10**
		c)	Describe conic lofting.	CO 5	PO 1	**5**
			UNIT - V			
	7	a)	Explain maneuver and gust loads.	CO 6	PO 1 PO 2	**6**
		b)	Describe four different types of flaps with the appropriate diagrams.	CO 6	PO 1	**8**
		c)	Briefly describe “Installed Engine Thrust”.	CO 6	PO 1	**6**

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