U.S.N.										

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

Autonomous Institute Affiliated to VTU

January / February 2025 Semester End Main Examinations

Programme: B.E. **Semester: V**

Branch: Aerospace Engineering **Duration: 3 hrs.**

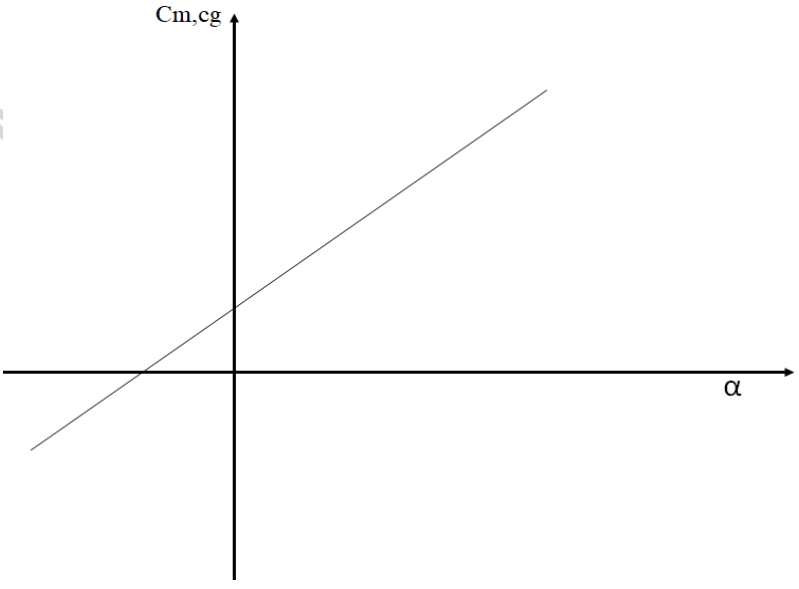
Course Code: 23AS5PCBFM **Max Marks: 100**

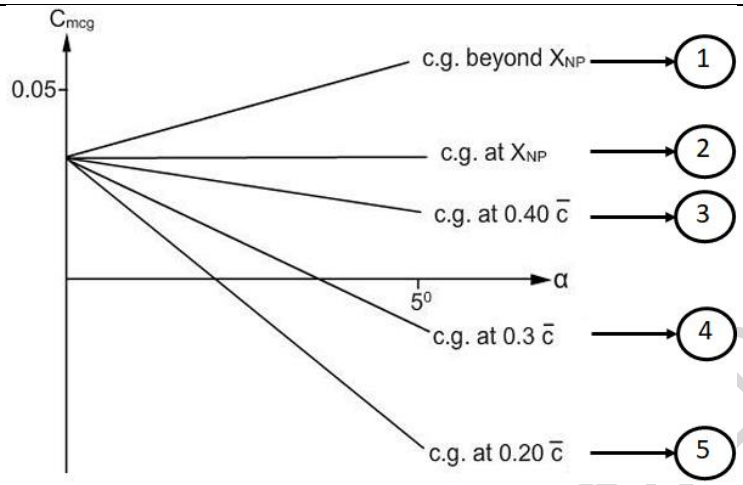
Course: BASIC FLIGHT MECHANICS

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)		Define pressure drag, skin-friction drag and lift-induced drag.	*CO1*	*PO1*	**6**
	b)		Compare the thrust required and power required for leveled, unaccelerated flight and derive the equation for the maximum velocity in terms of maximum thrust-to-weight ratio, wing loading, and zero-lift drag coefficient.	*CO1*	*PO1*	**14**
			OR			
2	a)		Consider the jet-powered executive aircraft CJ-1 having the normal gross weight, wingspan, and wing area to be 88,250.86 N, 16.256 m, and 29.581 m^2, respectively. The maximum lift-to-drag ratio for CJ-1 is 16.9 (C_L = 0.583). Calculate the minimum glide angle and the maximum range measured along the ground covered by the CJ-1 in a power-off glide that starts at an altitude of 3,048 m (ρ_∞ = 0.9048 kg/m^3) and 610 m (ρ_∞ = 1.1549 kg/m^3). Also, calculate the equilibrium glide velocities for the same altitudes, each corresponding to the minimum glide angle.	*CO1*	*PO2*	**10**
	b)		Calculate $\left(C_L/C_D\right)_{max}$ and $\left(C_L^{3/2}/C_D\right)_{max}$ for propeller driven airplane (CP1) whose aspect ratio is 7.37 and the zero-lift parasite drag co-efficient is 0.025. Also, calculate $\left(C_L^{1/2}/C_D\right)_{max}$ and $\left(C_L/C_D\right)_{max}$ for the Jet airplane (CJ-1) with aspect ratio 8.93, the zero-lift parasite drag co-efficient is 0.02. The value of Oswald's efficiency factor is 0.8 in both the cases.	*CO1*	*PO2*	**06**
	C)		Imagine a helicopter is hovering at Suvarnabhumi airport (BKK) in Thailand, which is located at GPS coordinates 13° 41' 23.9964" N (latitude) and 100° 45' 0.4104" E (longitude). The Earth rotates counter-clockwise, allowing the helicopter to reach Bangalore airport in the hovering status, located at GPS coordinates 13° 11' 57.7644" N (latitude) and 77° 42' 36.4896"	*CO1*	*PO3*	**04**

			E (longitude). Considering the approximate constant latitude coordinates for both Thailand and Bangalore Airport, can the helicopter land at Bangalore airport or nearby based on the Earth's rotation over time? Explain.			
			UNIT - II			
	3	a)	Derive the expression for the distance required for the take-off of an aircraft from a levelled straight runway.	*CO1*	*PO2*	**10**
		b)	Write the equation along with the force diagram for distance travelled during landing while the pilot applies the brakes for it. What are the other methods to poly to shorten the ground roll?	*CO1*	*PO2*	**10**
			OR			
	4	a)	Explain the V-n diagram with necessary equations.	*CO1*	*PO1*	**10**
		b)	Estimate the lift-off distance for the Jet powered airplane (CJ-1) at sea level with mass 8987.93 kg, wingspan 16.25 m, wing area 29.54 m^2 with zero-lift parasite drag co-efficient is 0.02 having a thrust of 32,472 N and the Oswald's efficiency factor is 0.81. Assume a paved runway having μ_r = 0.02. Also, during the ground roll, the angle of attack of the airplane is restricted by the requirement that the tail not drag the ground, and therefore, assume that C_{Lmax} during the ground roll is limited to 1.0. Also, when the airplane is on the ground, the wings are 1.83 m above the ground. [Note: The average force is calculated based on Shevell's suggestion of being equal to 0.7 V_{LO} which is considered as the freestream velocity].	*CO1*	*PO2*	**10**
			UNIT - III			
	5	a)	Is the airplane having $C_{m,cg}$ vs α graph as shown in the figure 5 b), controllable and flyable? Justify.  Figure 5(b): $C_{m,cg}$ versus α	*CO3*	*PO2*	**05**

		b)	Describe and derive the moments about the center of gravity due to wing-tail combination.	*CO3*	*PO2*	**15**
			OR			
	6	a)	Aerodynamic center and the neutral point should be before the center of gravity in an airfoil and airplane. Comment on the statement with necessary explanations.	*CO3*	*PO2*	**05**
		b)	 Figure: 6 (b) $C_{m,cg}$ vs α From the figure 6(b) mention the numbers 1 to 5 as stable, unstable and neutrally stable.	*CO3*	*PO2*	**05**
		c)	Explain the contribution of wing to moments about the center of gravity by deriving the equations and also explain how it is applied for a wing-body configuration.	*CO3*	*PO2*	**10**
			UNIT - IV			
	7	a)	Prove that elevator angle to trim is $$\delta_{trim} = \frac{\frac{\partial C_{M,cg}}{\partial \alpha}\alpha + C_{M,0}}{V_H \frac{\partial C_{L,t}}{\partial \delta_e}}$$	*CO3*	*PO2*	**10**
		b)	What are the factors that produces aerodynamic hinge moment on the elevator? Explain.	*CO3*	*PO2*	**10**
			OR			
	8		Explain how the elevator helps in changing the value of $C_{M,o}$ and hence changing the trimmed angle of attack for different fight speeds.	*CO3*	*PO2*	**20**
			UNIT - V			
	9	a)	Draw and list the major parts of the helicopter.	*CO3*	*PO1*	**05**
		b)	How can you determine the performance of hovering in helicopters? What are the non-dimensional quantities that help to determine the same?	*CO3*	*PO1*	**15**

			OR			
	10	a)	An inventor claims to have built a "flying car" that can hover, where the lifting force is provided by two ducted fans. The car weighs 1000 kg and has a 149.14 kW engine. The unducted fans are 2.13 m in diameter. Is hovering flight possible? [Hint:A ducted fan can be considered to have an effective area that is twice that of an unducted rotor.]	*CO3*	*PO2*	**10**
		b)	What are the functions of main and tail rotors in a helicopter?	*CO3*	*PO1*	**05**
		c)	Enumerate the differences between the fixed wing aircraft and the rotor wing aircraft.	*CO3*	*PO1*	**05**

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