U.S.N.										

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

Autonomous Institute Affiliated to VTU

June / July 2025 Semester End Main Examinations

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

Branch: AEROSPACE ENGINEERING **Duration: 3 hrs.**

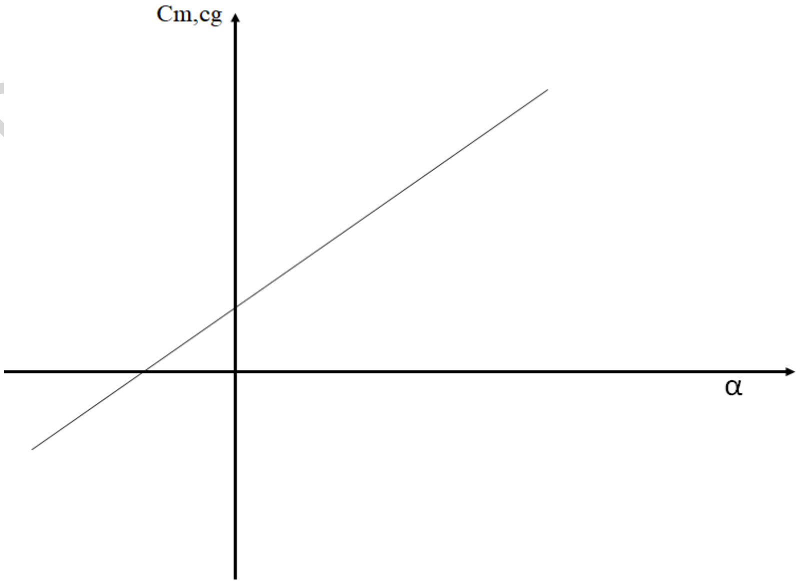
Course Code: 20AE5DCBFM **Max Marks: 100**

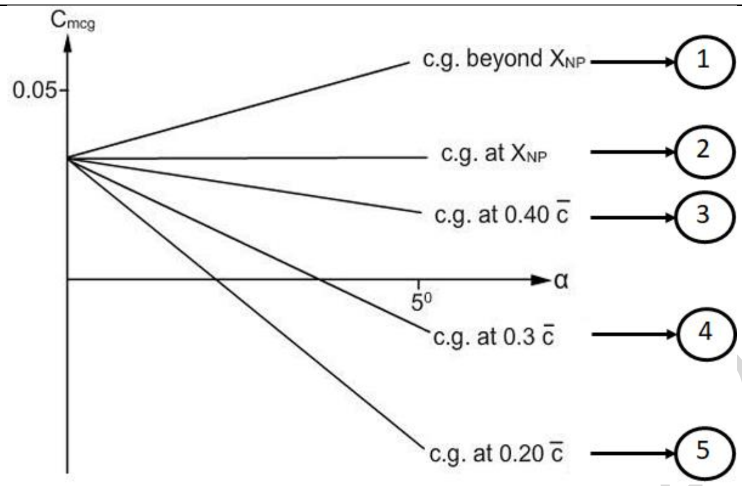
Course: BASIC FLIGHT MECHANICS

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)	Derive the equation for the maximum velocity in terms of maximum thrust-to-weight ratio, wing loading, and zero-lift drag coefficient.	*CO1*	*PO1*	**8**
	c)	Prove that $C_{D,o} = C_{D,i}$ for the thrust required for a level, unaccelerated flight, , where $C_{D,o}$ is the coefficient of parasite drag at zero-lift and $C_{D,i}$ is the lift-induced drag coefficient.	*CO1*	*PO1*	**6**
		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	*CO1*	*PO3*	**04**

			reach Bangalore airport in the hovering status, located at GPS coordinates 13° 11' 57.7644" N (latitude) and 77° 42' 36.4896" 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 formulae for the distance travelled along the ground during take-off and landing and draw the graphs of force versus distance along the ground based on aerodynamic and frictional force parameters.	*CO1*	*PO2*	**10**
			OR			
	4	a)	Explain the V-n diagram with necessary equations.	*CO1*	*PO1*	**10**
		b)	Estimate the landing ground roll distance at sea level for the Jet powered aircraft (CJ-1) whose mass is 5603 kg with wing area 29.54 m^2. The zero-lift drag co-efficient is 0.02. No thrust reversal is used; however, spoilers are employed such that L=0. The spoilers increase the zero-lift drag-coefficient by 10 percent. The fuel tanks are essentially empty, so neglect the weight of any fuel carried by the airplane. The maximum lift co-efficient, with flaps fully employed at touchdown is 2.5 and the co-efficient of rolling friction is 0.4.	*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.	*CO3*	*PO2*	**05**
		b)	 Figure: 5(b) $C_{m,cg}$ vs α From the figure 5(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)	Explain by deriving, what are the factors that produces hinge moment on the elevator?	*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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