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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: 20AE5DCBFM

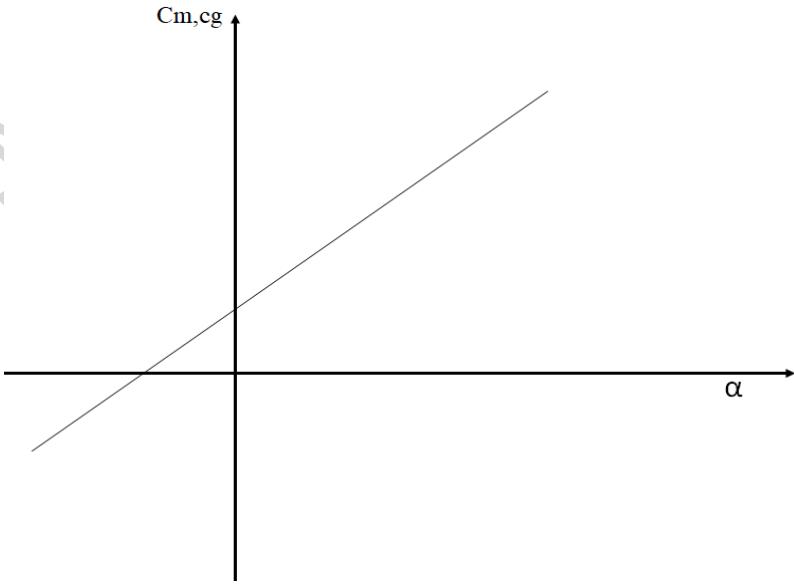
Max Marks: 100

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.

UNIT - I			CO	PO	Marks
1	a)	Prove that $C_{D,0} = \frac{1}{3}C_{D,i}$ for the thrust required based on static equilibrium conditions described by the aerodynamic forces and how this condition is related to the aerodynamic efficiency is compared with the minimum thrust required on a thrust required curve. Also derive the aerodynamic efficiency for both the cases. Here, $C_{D,0}$ is the parasite drag at zero-lift and $C_{D,i}$ is the lift-induced drag.	CO1	PO2	10
	b)	Show that the rate of climb of an airplane is the ratio of excess power to its weight.	CO1	PO1	5
	c)	A jet-powered executive aircraft having the following characteristics Wingspan = 10.919 m, Wing area S = 16.16 m ² , Normal gross weight = 13138.533 N. Parasite Drag coefficient = 0.025 and Oswald efficiency factor e = 0.8 with $V_\infty = 50$ m/s. Calculate the thrust required.	CO1	PO2	5
OR					
2	a)	Define Range and Endurance. Explain the quantitative considerations for deriving a propeller airplane's range and endurance. How the range and endurance can be maximized?	CO1	PO2	10
	b)	Consider an airplane with mass 2268 kg, plan form area 9.29 m ² , parasite drag coefficient at zero lift 0.015, Oswald's efficiency factor 0.6 and aspect ratio 6. The velocity at the sea level is 152.4 m/s, then calculate the coefficient of drag (i) if the airplane is in level flight and (ii) if the same airplane is in 30° climb with the same velocity. Write the conclusions and discussion about the coefficient of lift, coefficient of drag and the aerodynamic efficiency in both the cases.	CO1	PO1	07
	c)	Why can stalling speed not be reached in a level, steady flight?	CO1	PO1	03

6Important 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 - II					
3	a)	Write the formulae for the distance required along the ground during landing and draw the force diagram based on aerodynamic and frictional force parameters.	CO1	PO1	10
	b)	Derive the expression for the distance required for the landing of an aircraft in a levelled straight runway.	CO1	PO1	10
OR					
4	a)	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 $\mu_r = 0.02$. Also, during the ground roll, the angle of attack of the airplane is restricted by the requirement that the tail not drags the ground, and therefore, assumes that $C_{L\max}$ 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 free stream velocity].	CO1	PO2	10
	b)	Derive the expression for the take off of an aircraft from a sloped runway having a certain angle Θ under small angle assumption.	CO2	PO2	10
UNIT - III					
5	a)	How many degrees of freedom does an aircraft have? What are they? Explain the control surfaces of an aircraft with its location and their control over the motion.	CO3	PO2	5
	b)	Is the airplane having $C_{m,CG}$ vs. α graph as shown in the figure 5 b), controllable and flyable? Justify.	CO3	PO2	5
					
Figure 5(b): $C_{m,CG}$ versus α					

	c)	A wing-body model is tested in a subsonic wind tunnel. The lift is found to be zero at a geometric angle of attack $\alpha = -2.5^\circ$. At $\alpha = 4^\circ$ the lift co-efficient is measured as 0.42. Also, at $\alpha = 1.5^\circ$ and 7° , the moment coefficient about the center of gravity are measured as -0.02 and 0.08, respectively. The center of gravity is located at 0.4c from the leading edge. Calculate the location of the aerodynamic center and the value of $C_{M,acwb}$.	CO3	PO2	10
		OR			
6	a)	State the criteria for longitudinal static stability of an aircraft from the illustration of static stability and instability.	CO3	PO2	15
	b)	Describe and derive the moments about the center of gravity due to tail.	CO3	PO2	5
		UNIT - IV			
7	a)	Explain how the elevator helps in changing the value of $C_{M,0}$ and hence changing the trimmed angle of attack for different flight speeds.	CO3	PO2	20
		OR			
8	a)	Describe the illustration of aerodynamic moment of elevator-hinge moment and the factors that produce it and hence derive for the free elevator factor.	CO3	PO2	20
		UNIT - V			
9	a)	Describe the applications of helicopter.	CO3	PO1	05
	b)	Derive an expression for the ratio of induced to hovering velocity through axial-climb momentum analysis.	CO3	PO2	15
		OR			
10	a)	Derive an expression for the effect of induced velocity in forward flight.	CO3	PO2	15
	b)	Draw and list the major parts of the helicopter.			05
