U.S.N.										

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

Autonomous Institute Affiliated to VTU

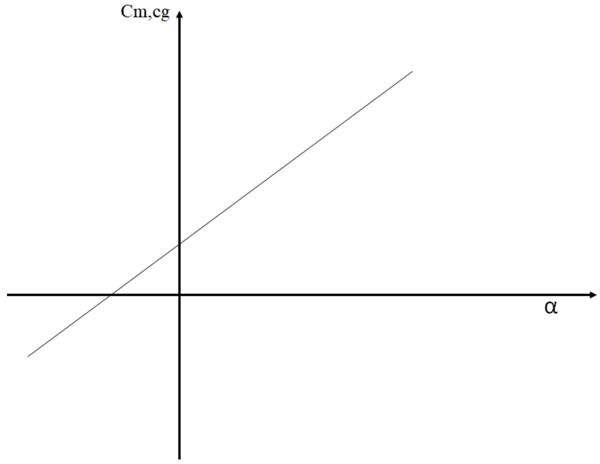
September / October 2024 Supplementary Examinations

Programme: B.E. **Semester: V**
Branch: Aerospace Engineering **Duration: 3 hrs.**
Course Code: 22AS5PCBFM **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)	The drag polar equation of an advanced light twin airplane is $C_D = 0.0358 + 0.0405\, C_L^2$. Its weight is 2180 kg and wing area is 15 m^2. Calculate: (i) Maximum lift to drag ratio (ii) Minimum drag speed (iii) Minimum power required with the corresponding flight speed. Assume standard sea level conditions.	CO1	PO2	10
	b)	Prove that $C_{D,o} = \frac{1}{3} C_{D,i}$ for the power required for a level, unaccelerated flight.	CO1	PO1	10
		UNIT - II			
2	a)	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
	b)	Explain elaborately on V-n diagram.	CO1	PO1	10
		OR			
3	a)	Derive the equation for the gyroscopic couple with necessary explanations, when the disc is rotating in the counter-clockwise direction with constant angular velocity when viewed from the front.	CO2	PO1	10
	b)	An aeroplane makes a complete half circle of 50 m radius, towards left, when flying at 200 km per hr. The rotary engine and the propeller of the plane has a mass of 400 kg and a radius of gyration of 0.3 m. The engine rotates at (i) 2400 r.p.m. clockwise when viewed from the front, (ii) 2400 r.p.m. counter-clockwise when viewed from the front and draw the necessary axis and planes for describing the reactive gyroscopic couple. Also, find the gyroscopic couple.	CO2	PO2	10

			UNIT - III			
	4	a)	Draw and explain the degrees of freedom in an aircraft.	*CO3*	*PO1*	**05**
		b)	Is the airplane having $C_{m,cg}$ vs α graph as shown in the figure 4b, controllable and flyable? Justify.  Figure 4b: $C_{m,cg}$ vs α	*CO3*	*PO3*	**03**
		c)	Explain static stability and instability with an illustration and hence state the criteria for longitudinal static stability from the same.	*CO3*	*PO1*	**12**
			OR			
	5	a)	Derive the total pitching moment for the wing-body combination and tail configuration about the center of gravity.	*CO3*	*PO1*	**05**
		b)	A wing-body model is tested in a subsonic wind tunnel. The lift is found to be zero at a geometric angle of attack $\alpha = -1.5^o$. At $\alpha = 5^o$ the lift co-efficient is measured as 0.52. Also, at $\alpha = 1.0^o$ and 7.88^o, the moment coefficient about the center of gravity are measured as -0.01 and 0.05, respectively. The center of gravity is located at 0.35c from the leading edge. Calculate the location of the aerodynamic center and the value of $C_{M,acwb}$.	*CO3*	*PO2*	**05**
		c)	Prove that the free elevator factor $$F = 1 - \frac{1}{a_t}\frac{\partial C_{L_t}}{\partial \delta_e}\left(\frac{\partial C_{h_e}/\partial \alpha_t}{\partial C_{h_e}/\partial \delta_e}\right)$$	*CO3*	*PO1*	**10**
			UNIT - IV			
	6	a)	Explain how the elevator helps in changing the value of C_{M0} and hence changing the trimmed angle of attack for different flight speeds.	*CO3*	*PO1*	**20**
			UNIT - V			
	7	a)	Draw and describe the parts of a helicopter.	*CO3*	*PO1*	**10**
		b)	Describe the applications of helicopter.			**05**
		c)	A tilt rotor has a gross weight of 30,000 kg. The rotor diameter is 15 m. Estimate the power required for the helicopter to hover at the sea level conditions. Assume that the figure of merit of the rotor is 0.80 and the transmission losses ≈ 8%. [Density of air at sea level = 1.225 kg/m^3]	*CO3*	*PO2*	**05**

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