U.S.N.										

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

Autonomous Institute Affiliated to VTU

October 2024 Supplementary Examinations

Programme: B.E. **Semester: VI**

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

Course Code: 22AS6PCFLD **Max Marks: 100**

Course: Flight Dynamics

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.

			CO	PO	Marks
		UNIT - I			
1	a)	Derive the three-moment equations of motion (with necessary assumptions) in the Body-Axis system of an aircraft, starting from the angular momentum equation $\vec{H} = I\,\vec{\omega}$, where I is the Inertia tensor and ω is the angular velocity.	CO1	PO 2	**10**
	b)	Given the following vectors, find the inertial acceleration in the body axis system. $$\vec{a_t} = \dot{\vec{V_B}} + \vec{\omega} \times \vec{V_B}$$ $$\dot{\vec{V_B}} = \begin{Bmatrix}3\\0\\0\end{Bmatrix} m/s^2,\ \vec{\omega} = \begin{Bmatrix}0\\0\\0.3\end{Bmatrix} rad/s,\ \vec{V_B} = \begin{Bmatrix}0\\0\\3\end{Bmatrix} m/s$$	CO1	PO2	**04**
	c)	Draw the vector diagram for the stability axis system of an aircraft and convert it into a body axis system in terms of the aerodynamic forces.	CO1	PO2	**06**
		UNIT - II			
2		Linearize the kinematic equations below. (i) $P = -\sin\Theta\,\dot{\Psi} + \dot{\Phi}$ (ii) $Q = \sin\Phi\cos\Theta\,\dot{\Psi} + \cos\Phi\ \dot{\Theta}$	CO2	PO2	**20**
		OR			
3		Derive the expression for stability derivatives due to the change in the forward speed.	CO2	PO1	**20**
		UNIT - III			
4	a)	Illustrate the influence of yaw rate on velocity distribution on the wing and tail with a neat sketch.	CO3	PO1	**16**
	b)	Derive the expression for stability derivatives due to the yawing rate.	CO3	PO1	**04**

			UNIT - IV			
	5	a)	The α/δe transfer function for a T-37 cruising at 9,000 m and 0.46 Mach is given below by the equation. Find the natural frequency, damping ratio, damped frequency, and time constant for the short period and phugoid modes. $\frac{\alpha}{\delta_e} = \frac{(S + 336.1)(s^2 + 0.0105s + 0.0097)}{s^4 + 4.5898s^3 + 21.6536s^2 + 0.2204s + 0.1879}$	*CO3*	*PO2*	**10**
		b)	Consider a Lear Jet flying at 0.7 Mach and 12,192 m. The 3-DOF longitudinal transfer functions are approximated, and the characteristic equation is given by $675.9s^4 + 1371s^3 + 5459s^2 + 86.31s + 44.78 = 0$ Find the (a) natural frequency, (b) damping ratio, (c) damping frequency, (d) time constant, and (e) period of oscillation for the short period and Phugoid modes.	*CO3*	*PO2*	**10**
			OR			
	6	a)	Find the natural frequency and the damping ratio based on two degrees of freedom for the Phugoid mode approximation is given by the standard equation given below $\begin{bmatrix} (s - X_u - X_{T_u}) & -X_\alpha & g\cos\Theta_1 \\ -Z_u & s(U - Z_{\dot\alpha}) - Z_\alpha & [-(Z_q + U_1)s + g\sin\Theta_1] \\ -(M_u + M_{T_u}) & -(M_{\dot\alpha}s + M_\alpha + M_{T_\alpha}) & (s^2 - M_q s) \end{bmatrix} \begin{bmatrix} \frac{U(s)}{\delta_e s} \\ \frac{\alpha(s)}{\delta_e s} \\ \frac{\theta(s)}{\delta_e s} \end{bmatrix} = \begin{bmatrix} X_{\delta_e} \\ Z_{\delta_e} \\ M_{\delta_e} \end{bmatrix}$	*CO3*	*PO2*	**15**
		b)	Explain briefly dynamic stability.	*CO3*	*PO1*	**05**
			UNIT - V			
	7	a)	Explain briefly Dutch roll mode.	*CO3*	*PO1*	**05**
		b)	Explain autorotation and spin with necessary equations.	*CO3*	*PO1*	**15**

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