Name: **Enrolment No:**	UPES UNIVERSITY OF TOMORROW

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Sem Examination, May 2023

Programme Name: B.Tech ASE **Semester : VI**
Course Name : Flight Stability and Control **Time : 03 hrs**
Course Code : ASEG 3023 **Max. Marks : 100**
Nos. of page(s) :3
Instructions: Assume appropriate values for any missing DATA.

SECTION A (4x5=20 Marks)

S. No.		Marks	CO
Q 1	Compare longitudinal and directional Stability conditions of Airplane.	**4**	**CO1**
Q 2	How Set-back-hinge *Aerodynamic Balancing methods* of airplane's control surfaces works?	**4**	**CO2**
Q 3	Compare stick fixed and stick free *Neutral Point*s of airplane	**4**	**CO3**
Q 4	How R*udder design requirements* meets asymmetric power condition of aircraft?	**4**	**CO4**
Q 5	Describe *Phugoid (Long Period)* longitudinal motions of Airplane.	**4**	**CO5**
	SECTION B (10x4=40 Marks)		
Q6	Derive the expression for *stick force variation with flight speed*. Comment on effect of TAB deflection with help of required graph.	**10**	**CO1**
Q7	**Show that** $\left(\frac{dC_m}{dC_L}\right)_{free} = -\frac{C_{m\delta}(\delta_{e,R} - \delta_{e,f})}{C_L}$	**10**	**CO2**
Q8	Examine maneuver neutral point of aircraft in pull-up Maneuver.	**10**	**CO3**
Q9	Derive *short period* and *long period* characteristics equations from give longitudinal perturbation equation of airplane. Estimate short period and long period characteristic of given aircraft data: (wing Area 500 m^2, Span 50 m , chord 10 m)	**10**	**CO5**

	$$\begin{bmatrix}\Delta\dot{u}\\ \Delta\dot{w}\\ \Delta\dot{q}\\ \Delta\dot{\theta}\end{bmatrix}=\begin{bmatrix}X_u & X_w & 0 & -g\\ Z_u & Z_w & u_0 & 0\\ M_u+M_{\dot{w}}Z_u & M_w+M_{\dot{w}}Z_w & M_q+M_{\dot{w}}u_0 & 0\\ 0 & 0 & 1 & 0\end{bmatrix}\begin{bmatrix}\Delta u\\ \Delta w\\ \Delta q\\ \Delta\theta\end{bmatrix}+\begin{bmatrix}X_\delta & X_{\delta_T}\\ Z_\delta & Z_{\delta_T}\\ M_\delta+M_{\dot{w}}Z_\delta & M_{\delta_T}+M_{\dot{w}}Z_{\delta_T}\\ 0 & 0\end{bmatrix}\begin{bmatrix}\Delta\delta\\ \Delta\delta_T\end{bmatrix}$$		
SECTION-C (20x2=40 Marks)			
Q 10	An Aircraft has a wing loading of 2500N/m^2, a wing span of 20 m, a maximum lift coefficient of 1.75, and vertical tail lift slope of 0.082/deg. ($\mathbf{C_{n\beta}}$)$_{fix}$ = 0.015/deg, vertical tail volume ratio is 0.2 and the coefficient k=0.90. Assuming that one degree of rudder deflection changes the vertical tail slip by 0.3 degree and the maximum rudder deflection is restricted to + 25 deg to -25 deg. Determine the maximum crosswind speed that can be permitted for take-off at sea level. Assume the unstick velocity is 1.2 times the stall velocity airplane	**20**	**CO4**
Q 11	A) If Airplane elevator is left to float, then show that the tail lift curve is modified as $$C'_{L_{\alpha_t}}=C_{L_{\alpha_t}}\left(1-\frac{C_{L_{\delta_e}}C_{h_{\alpha_t}}}{C_{L_{\alpha_t}}C_{h_{\delta_e}}}\right)$$ B) Describe the in-flight Neural Point measurement Method. Derive the relevant expression and graphs for I\in-Flight Neutral Pint measurement of airplane. **OR** B) An aircraft has the following data: ***$x_{cg/c}$ = 0.3, $x_{ac/c}$ = 0.24, $C_{L.w}$ = 0.010(α_0 + 2.5), C_{Lmax} = 1.2, $C_{mac,w}$ =0.06, ε=0.3α, C_{mf} = 0.05 + O.1C_L, $C_{L\alpha}$ =0.08/deg, η_t = 0.9, V_H = 0.6, i_w = 0, i_t = 2deg, $C_{h\alpha}$ = -0.002/deg, $C_{h\delta e}$. = -0.003/deg, and τ = 0.20.*** Determine the angle of attack in steady level flight if the elevator is locked in neutral position, 2) the permissible most forward position of the center of gravity if the maximum up elevator deflection is limited to 30 deg, and 3) stick-free neutral point and stick-free margin.	**20**	**CO2**

Transport aircraft: Boeing 747[a]

Longitudinal	C_L	C_D	C_{L_α}	C_{D_α}	C_{m_α}	$C_{L_{\dot\alpha}}$	$C_{m_{\dot\alpha}}$	C_{L_q}	C_{m_q}	C_{L_M}	C_{D_M}	C_{m_M}	$C_{L_{\delta e}}$	$C_{m_{\delta e}}$
M = 0.25														
Sea level	1.11	0.102	5.70	0.66	−1.26	6.7	−3.2	5.4	−20.8	−0.81	0.0	0.27	0.338	−1.34
M = 0.90														
40,000 ft	0.5	0.042	5.5	0.47	−1.6	0.006	−9.0	6.58	−25.0	0.2	0.25	−0.10	0.3	−1.2

Lateral	C_{y_β}	C_{l_β}	C_{n_β}	C_{l_p}	C_{n_p}	C_{l_r}	C_{n_r}	$C_{l_{\delta a}}$	$C_{n_{\delta a}}$	$C_{y_{\delta r}}$	$C_{l_{\delta r}}$	$C_{n_{\delta r}}$
M = 0.25												
Sea level	−0.96	−0.221	0.150	−0.45	−0.121	0.101	−0.30	0.0461	0.0064	0.175	0.007	−0.109
M = 0.90												
40,000 ft	−0.85	−0.10	0.20	−0.30	0.20	0.20	−0.325	0.014	0.003	0.075	0.005	−0.09

[a] All derivatives are per radian.