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| **Name:**<br>**Enrolment No:** | UPES<br>UNIVERSITY WITH A PURPOSE |

**UNIVERSITY OF PETROLEUM AND ENERGY STUDIES**
**End Semester Examination, December 2020**

**Course: Flight Mechanics II** — **Semester: VIIth**
**Program: B.Tech ASE/ASE+AVE** — **Time 03 hrs.**
**Course Code: ASEG4001** — **Max. Marks: 100**

**Instructions: Assume the necessary data if not given. Use suitable plots wherever required.**

**SECTION A (6*5 =30)**

| S. No. | | Marks | CO |
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| Q 1 | Define the following terms.<br>(a) Neutral point<br>(b) Static margin. | **5** | **CO1** |
| Q 2 | Graphically represent a system, which is statistically stable but dynamically unstable. | **5** | **CO1** |
| Q 3 | What do you understand by tail efficiency? How does it change with the location of tail surface? | **5** | **CO2** |
| Q 4 | Define Stick-fixed maneuver point ($x_{mp}$). | **5** | **CO3** |
| Q 5 | Differentiate between yaw and sideslip angle. | **5** | **CO4** |
| Q 6 | What is the purpose of a dorsal fin and how is it achieved? | **5** | **CO4** |

**SECTION B (5*10=50)**

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| Q 7 | An airplane has the following characteristics.<br>$C_{L\alpha w} = 0.080\ deg^{-1}$ , $C_{L\alpha t} = 0.05\ deg^{-1}$ , $dC_L/d\delta e = 0.042$, $C_{h\alpha t} = -0.004\ deg^{-1}$ ,$C_{h\delta t} = -0.005$, $i_w = 0$, $\alpha_{0L} = -2^0$ , $i_t = -1^0$ , $\varepsilon = 0.5\ \alpha$, $S_t = 0.25S$, $l_t = 3c$ , W/S =1500 N/m$^2$ , a.c. location = 0.25c , $\eta = 1.0$, $(C_{m\alpha})_{f,n,p} = 0.32\ rad^{-1}$ .<br>Obtain<br>i) Stick-fixed neutral point<br>ii) Stick-free neutral point | **10** | **CO2** |
| Q 8 | Derive an expression for stick force gradient (dF/dV) and explain the requirement for proper stick force variation | **10** | **CO2** |
| Q 9 | Answer the following.<br>(a) Define the term maneuver point stick-fixed and maneuver point stick-free.<br>(b) For a given value of $C_L$ the elevator deflection required in pull-up is more than that in a steady level flight. Explain. | **10** | **CO3** |
| Q 10 | An airplane with the following characteristics is coming in to land at sea level at a speed of 1.2 times the stalling speed. What would be the amount of rudder deflection required ($\delta r$) if the airplane encounters crosswind of 10 m /s? | **10** | **CO4** |

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| | Additional parameters are given as, $W/S = 1500\ N/m^2$, $V_v = 0.05$, $C_{L\alpha v} = 2.87\ rad^{-1}$, $C_{n\beta} = 0.071\ rad^{-1}$, $C_{Lmax} = 1.8$, $\eta_v = 1.0$, $\tau_{rudder} = 0.5$.<br><br>**Or**<br><br>Explain how adverse yaw is brought about in an airplane. The wind tunnel tests on an airplane model indicate that full aileron deflection to right introduces an adverse yaw causing Cn = -0.008. How many degrees of rudder must be applied to keep the sideslip zero during the roll? Given that $S = 16.4\ m^2$, $S_v = 2.1\ m^2$, $l_v = 5.5$ m, b = 9.8 m, $\eta_v = 0.95$, $C_{L\alpha v} = 0.045\ deg^{-1}$, $\tau_{rudder} = 0.5$. | | |
| Q11 | Define the following axes system.<br><br>(a) Ground axes system<br>(b) Body axes system<br>(c) Stability axes system. | **10** | **CO5** |
| **SECTION-C (1*20=20)** | | | |
| Q 12 | a) The longitudinal stability quartic of an airplane is $\lambda^4 + 4\lambda^3 + 10\lambda^2 + \lambda + 3.8 = 0$. Extract the roots and describe the motion depicted by them**. (10M)**<br>**OR**<br>The roots of a longitudinal stability quartic are:- $2.57 \pm i\ 2.63$ ; +0.02 and- 0.26. Discuss the types of motions indicated by each mode. What would be the final motion of the airplane?<br><br>b) The lateral stability quartic for an airplane is: $\lambda^4 + 16\lambda^3 + 13.1\lambda^2 + 9.8\lambda + 0.73 = 0$ extract the roots of this quartic. Obtain the time to double or halve the amplitude and the period of the oscillatory mode(s). **(10M)**<br><br>**OR**<br><br>Derive the relationship between general body axes system and local horizon system for $\mathbf{i_h}$. | **20** | **CO5** |