CBCS SCHEME

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18AE71

Seventh Semester B.E. Degree Examination, Dec.2023/Jan.2024
Aircraft Stability and Control

Time: 3 hrs. Max. Marks: 100

Note: ***Answer any FIVE full questions, choosing ONE full question from each module.***

Module-1

1 a. Mention the important historical perspective for the Aircraft Stability. **(05 Marks)**

b. What is down wash? Derive the expression due to this on C_{Lt}. **(10 Marks)**

c. With a neat sketch, briefly explain the types of motion with different disturbances. **(05 Marks)**

OR

2 a. Briefly explain Stick fixed Neutral point and using suitable graph derive the expression for the same. **(10 Marks)**

b. A sailplane has the following characteristics $C_D = 0.02 + 0.025C_L^2$, $C_{L\alpha w} = 0.093$, $\alpha_{OLw} = -4$ $i_w = 0$, a.c location = $0.24\,\overline{C}$, $S_t = S/7$, $L_t = 4\,\overline{C}$, $\xi = 0.4\alpha$, $C_{L\alpha t} = 0.05$ and $\eta = 0.9$. All the angles are in degree. Neglect the contribution of fuselage. Find the C.G location for which the equilibrium is reached with zero lift on the tail at the lift co.efficient corresponding to the best guiding angle. Calculate the tail setting. Is the sailplane is stable? $C_D = 0.02 + 0.025\,C_L^2$. **(10 Marks)**

Module-2

3 a. Using suitable graph and diagram, derive the equation for stick force gradient. **(10 Marks)**

b. Define Trim? With proper graph and diagram, derive how trim tabs are support for longitudinal static stability. **(10 Marks)**

OR

4 a. An Airplane has the following characteristics :
$C_{L\alpha w} = 0.085\ deg^{-1}$, $C_{L\alpha t} = 0.058\ deg^{-1}$, $dc_L/D\delta_e = 0.032$, $i_w = 0$, $C_{h\alpha t} = -0.003\ deg^{-1}$, $C_{h\delta t} = -0.0055\ deg^{-1}$, $\alpha_{OL} = -2°$, $i_t = -1°$, $\varepsilon = 0.5\alpha$, $S_t = 0.25s$, $\ell_t = 3\,\overline{C}$, $W/s = 1500\ N/m^2$ a.c. location = $0.25\,\overline{C}$, $\eta = 1.0$ $(C_{m\alpha})_{f.n.p} = 0.37\ rad^{-1}$.
Obtain : i) Stick fixed Neutral point ii) Stick free Neutral point
iii) Stick free Neutral point when $C_{h\alpha t}$ is changed to 0.003. **(10 Marks)**

b. Explain how Elevator Hinge is helpful for the Aircraft stability. **(05 Marks)**

c. With a neat diagram, briefly explain the other means of Aerodynamic balance. **(05 Marks)**

Module-3

5 a. With a proper diagram, explain the critical condition for the design of Rudder. **(10 Marks)**

b. With a neat diagram, explain the effect of wing sweep flaps and power on dihedral effect. **(10 Marks)**

OR

6 a. List the different effect caused by Roll, yaw and pitch and derive the expression for the contribution of wing to $C_{n\beta}$. **(10 Marks)**

b. Derive an expression for the contribution of wing and vertical tail to $C_{n\beta}$. **(10 Marks)**

Module-4

7 a. Derive an expression due to the Time rate of change of Angle of Attack. (10 Marks)
b. Derive the equation of motion for a Rigid body. (10 Marks)

OR

8 a. Obtain an derivation due to change the forward speed. (10 Marks)
b. Derive an expression due to the yawing rate 'r'. (10 Marks)

Module-5

9 Write a short note on :
a. Wind shear.
b. Roll control Reversal.
c. Cooper – Harper scale.
d. Flying qualities. (20 Marks)

OR

10 a. Elaborate how Dutch Roll and Spiral instability affect the Aircraft stability. (10 Marks)
b. With a neat sketch describe how the dynamic lateral stability considering rudder free case. (10 Marks)

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