Hall Ticket No | | | | | | | | | | | Question Paper Code: AAE014

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

B.Tech VI Semester End Examinations (Regular) - May, 2019

Regulation: IARE – R16

AIRCRAFT STABILITY AND CONTROL

Time: 3 Hours **(AE)** **Max Marks: 70**

Answer ONE Question from each Unit
All Questions Carry Equal Marks
All parts of the question must be answered in one place only

UNIT – I

1. (a) What is the criterion for static longitudinal stability? Explain about power effects on longitudinal static stability **[7M]**

   (b) A wing section being tested in a wind tunnel is hinged at its leading edge, with freedom to rotate about the hinge axis. Calculate the equilibrium floating angle of the wing at a tunnel speed of 100 kmph, given that: wing weight is 250 N/m^2, c.g. location at 0.4c, A.C. location at 0.24c, C_{mac}= 0.04, α_o= -3^0, $\frac{d_{c_l}}{d_\alpha} = 0.105\ deg^{-1}$. Assume standard sea level conditions. Is the equilibrium statically stable? **[7M]**

2. (a) Deduce the expression for the tail contribution to the pitching moment of an aircraft. **[7M]**

   (b) Explain the effect of wing and fuselige to get static longitudional stability. **[7M]**

UNIT – II

3. (a) How lateral and directional stability of an aircraft achived? Explain the effect dihedral on lateral stability. **[7M]**

   (b) During flight, the left aileron found stuck to neutral condition. Pilot wanted to roll left. What are the controls needed to do this attitude? **[7M]**

4. (a) Explain is the criterion for directional stability. What is “Rudder lock” and the use of “Dorsal fin”. **[7M]**

   (b) The static lateral stability should not be too small, Give reason and explain. **[7M]**

UNIT – III

5. (a) What are the moments of Inertia that are applied when deriving the aircrafts equation of motion? Give the numerical expression for all the moment of Inertia. **[7M]**

   (b) Express all forces (weight, aerodynamic, and thrust) for sea level at military thrust in most convenient axis system. Assume the thrust lines are parallel to the longitudinal axis and in plane of CG. The aircraft weighs 24.5 kN and each engine is delivering 3.11kN thrust **[7M]**

6. (a) Highlight the position and orientation of an aircraft relative to earth and describe it in terms of Euler's angle **[7M]**

   (b) Derive a six step procedure that used to build up the response side of the three moment equations. **[7M]**

UNIT – IV

7. (a) With the first-order approximation of applied aero forces, get the equations for longitudinal perturbed forces. **[7M]**

   (b) Estimate the pitch damping derivative, Cm_q, for an aircraft with following characteristics: $C_{L_{\alpha h}}$ = 0.075/deg, η_h =0.98, V_h= 0.375, x_h/c = 3.0. Where c is mean chord length. **[7M]**

8. (a) Describe the derivatives of yawing moment of an aircraft with respect to the side slip, rate of side slip, roll rate, yaw rate , aileron , rudder deflections. **[7M]**

   (b) Find the β derivative for an aircraft at 1km altitude and Mach 0.9 (U1= 267 m/s, q= 1383 kg/m^2 , S=50m^2, b = 12m) C_l = -0.08. If β is perturbed to 1 deg, find perturbed rolling moment. **[7M]**

UNIT – V

9. (a) Discuss the dynamics stability aspects of an aircraft, considering its linearized longitudinal equations of motion being analyzed under three degree and two degree of freedom assumptions. **[7M]**

   (b) The roots of a longitudinal stability quartic are: 2.57 ± 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? **[7M]**

10. (a) Bring out the relationship between yaw and roll of an airplane in the following cases:
    i.Rolling moment with yaw rate
    ii. Yawing moment with roll rate. **[7M]**

    (b) The lateral stability quadratic for an airplane is :
    $\lambda^4+16\lambda^3+13.1\lambda^2+9.8\lambda+0.73 = 0$
    Extract the roots of this quadratic. Obtain the time to double or halve the amplitude and the period of the oscillatory mode. **[7M]**

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