Code No: 07A62101 **R07** **Set No. 2**

III B.Tech II Semester Examinations,December 2010
FLIGHT MECHANICS - II
Aeronautical Engineering

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. Explain the phenomenon of releasing the elevator and its effect on longitudinal stability of an airplane. [16]

2. (a) Explain the term mechanical gearing in the case of directional stability
   (b) Derive the expression for the rate of change of pedal force with yaw angle in terms of Rudder power. [6+10]

3. Write a typical Transfer Function for an aircraft and explain. How is it useful in explaining the behaviour of the aircraft for a disturbance? [16]

4. (a) Write short notes on
      i. Elevons
      ii. Differential ailerons
      iii. Frise ailerons.
   (b) Explain different modes of making the airplane depart from a stable condition and then return to the cruise condition. Make use of sketches and plots. [8+8]

5. (a) Explain the significance of the elevator float angle.
   (b) Explain the origin of the longitudinal stick force. [8+8]

6. (a) Describe three dynamic modes of lateral motion of an aircraft. Explain them in detail.
   (b) Explain the orientation and position of an airplane in terms of a fixed frame of reference. Illustrate with sketch. [8+8]

7. Compute the gradient of elevator angle per g at constant air speed $(d\delta_e/dn)_{Turns}$ in terms of speed of the aircraft, assuming 10 % increase in tail damping requirement. [16]

8. For an unaccelerated flight, derive an expression for the stick-force required to trim an aircraft at a speed of V. [16]

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Code No: 07A62101 **R07** **Set No. 4**

III B.Tech II Semester Examinations,December 2010
FLIGHT MECHANICS - II
Aeronautical Engineering

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. The aerodynamic forces and moments on the body are due to only two basic sources as given below. Explain them with sketches
   (a) Pressure distribution over the body surface
   (b) Shear stress distribution over the body surface. [8+8]
2. (a) Explain with appropriate sketches, the following:
      i. Phugoid motion
      ii. Spiral instability
      iii. Dutch Roll motion.
   (b) What is the significance of the derivative $C_{l\beta}$ arising from the dihedral of the wing Γ, of an aircraft in terms of the lateral stability of the aircraft? Explain briefly. [9+7]
3. Explain the aerodynamic forces on elevator - stabilizer configuration in the stick free condition of an airplane. [16]
4. What are the two broad categories of aircraft flight controls fall? Explain them in detail with figures. [16]
5. (a) What is the critical centre of gravity (cg) position for longitudinal stability? Explain why.
   (b) Can the aircraft be flown with the centre of gravity behind this point? If so, under what restrictions? What is the effect on the handling of the aircraft? [8+8]
6. (a) Describe briefly about the spoilers and speed brakes.
   (b) And their use in aircraft. [8+8]
7. Calculate and show in tabular form, the airplane angular velocities (pitch and yaw turns) in radians per second versus true air speed in kmph for the following airplane normal accelerations obtained in steady level turns:
   n = 1.0, 1.5, 2.0, 3.0, 4.0, 6.0, 8.0.
   The speeds should range from 150 kmph to 650 kmph.Compute for 10 speeds. [16]
8. Derive the equations of motion of an airplane constrained to the plane of symmetry at constant speed and also derive the characteristic equation of an airplane dynamics. Discuss the solutions. [16]

Code No: 07A62101 **R07** **Set No. 4**

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Code No: 07A62101 **R07** **Set No. 1**

III B.Tech II Semester Examinations,December 2010
FLIGHT MECHANICS - II
Aeronautical Engineering

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. Derive an expression for the angular velocity of an aircraft about its pitch axis in terms of the forward velocity and load factor of the airplane 'n' for pull up from level flight. [16]

2. (a) Explain the coupling between stability and control.
   (b) Explain the effect of engine power on the stability of an aircraft. [8+8]

3. Explain the aerodynamic forces on a stabilator configuration in stick free condition of an airplane. [16]

4. The oscillatory mode from the lateral-directional stability quartic is given by $\lambda^2 +$ B λ + C = 0, where B = 1.102 and C = 4.71. Obtain the characteristics of the oscillation. [16]

5. Derive the expression for rate of change of yawing moment coefficient with rudder deflection
   $dC_n / d\delta_r = [-a_v \tau (S_v / S_w) (l_v / b) \eta_v]$
   using standard notation. Explain all the symbols used in the derivation. [8+8]

6. (a) Show with a sketch the axes system associated with an airplane.
   (b) Explain the equilibrium forces and moments acting on the airplane, illustrating with sketches and plots. How are these forces and moments controlled? [8+8]

7. A rectangular wing of AR = 6.5 has the plan form Area S = 57 sq.m. The airfoil section has its aerodynamic centre at 0.24c and $C_{m\,ac}$ = -0.088. The wing is balanced so that the cg lies on the chord but 0.15 m ahead of the a.c. Calculate the C_L of the wing for equilibrium. Comment on the result. The section of the wing was later modified to be a reflexed airfoil with $C_{m\,ac}$ = + 0.2. Calculate the position of the cg for equilibrium at C_L = 0.4 in both the cases. Comment on the results thus obtained. [16]

8. A rocket is flying at an airspeed of 300 m/s. The angle of attack is 30 degrees and the sideslip angle, β_e, is 20 degrees, with bank angle of 40 degrees and elevation angle of 20 degrees and an azimuth angle of 70 degrees. Assuming no wind, what is its velocity in earth - fixed coordinates? [16]

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Code No: 07A62101 **R07** **Set No. 3**

III B.Tech II Semester Examinations,December 2010
FLIGHT MECHANICS - II
Aeronautical Engineering

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. Explain pure convergence and pure divergence and damped and negatively damped oscillations in the case of an airplane. [16]
2. Explain the effect of tab on the pressure distribution of an elevator, when it is a leading tab and when it is a lagging tab. [16]
3. Explain the following of an aircraft in detail with required sketches
   (a) Bulkhead
   (b) Rib
   (c) Span and
   (d) Empennage. [4+4+4+4]
4. (a) Give the advantages and disadvantages of canard wing configuration with respect to stability.
   (b) What are the advantages and disadvantages of swept wing configuration? Explain with respect to stability. [8+8]
5. Discuss why the products of inertia I_{yz} and I_{xy} are usually zero for an airplane configuration. Use simple sketches to support your arguments. The products of inertia I_{yz}, I_{xy}, I_{xz} are defined as follows :

   $I_{yz} = \iiint yz\ dm$ $I_{xy} = \iiint xy\ dm$ $I_{xz} = \iiint xz\ dm$
   Why is I_{xz} usually not zero? [16]
6. Calculate and show in a tabular form, the airplane angular velocities (pitch rate) in radians per second versus true air speed in kmph for the following airplane normal accelerations obtained in steady systematic pull-ups from level flight:
   n = 1.0, 1.5, 2.0, 3.0, 4.0, 6.0, 8.0.
   The speeds should range from 150 kmph to 650 kmph. [16]
7. Derive the expression for the derivative of pedal force for the rudder of an airplane with yaw angle of the airplane. [16]
8. The elevator hinge moment parameters of an airplane are the following:
   $C_{H\alpha,t}$ = - 0.006 ; $C_{H\delta,e}$ = - 0.010, $C_{H,0} = 0$. Calculate and tabulate the elevator hinge moment coefficient, $C_{H,e}$ versus elevator deflection δ_e, for the following values of tail angles of attack:
   - 15, - 10, - 5, zero, 5, 10 and 15 degrees. [16]

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