Indian Institute of Engineering Science and Technology, Shibpur

8th Sem BE Part IV (Aero) Final Examination 2014

Advanced Aircraft Dynamics
Elective II
(AE 7800/04)

Time : 3 hours Full Marks : 70

All questions are of equal value
Answer any Four of the following

1. a) A rocket is flying at an airspeed of 1000 ft/s. The angle of attack is 30 degree and the side slip angle, β_a, is 20 degrees. Determine the axial sideslip, and normal velocity components.
   b) An airplane model is mounted in a wind tunnel with the angle of attack set at 40 degrees and the side slip angle, β_e, set to 30 degrees. By varying β_e slightly to both sides from this orientation, the change in the yawing moment coefficient with respect to β_e is estimated to be 0.250. Find the angle β_a and estimate the change in the yawing moment coefficient with respect to β_a.

2. Derive the linear and angular equations of motion and show that while the longitudinal disturbances affect only the longitudinal velocity components, the lateral disturbances affect both longitudinal and lateral velocity components.

3. Derive the expressions for force and moment derivatives with respect to forward velocity of the aircraft in subsonic flight.

4. a) Explain roll damping derivative.

   b) Derive the expressions for force and moment derivatives with respect to roll rate of the aircraft.

5. A large jet transport is flying at 30,000 ft with a steady level airspeed of 450 mph, which is the minimum drag speed for this altitude. This airplane has the following properties in cruise configuration:

   $\mathbf{S_w = 5500\ ft^2}$ $\mathbf{b_w = 196\ ft}$ $\mathbf{c_w = 28\ ft}$ $\mathbf{x_{bw} = 0}$

   $\mathbf{C_{Lw\alpha} = 4.67}$ $\mathbf{S_h = 1300\ ft^2}$ $\mathbf{x_{bh} = -100\ ft}$

$x_{bwingtip} = -50$ ft $l_{wt} = 55$ ft $C_{Lh\alpha} = 3.50$

$W = 636600$ lb $C_{L\alpha} = 5.50$ $C_{M\alpha} = 5.50$

The maximum lift-to-drag ratio is 14. Assuming constant thrust aligned with the direction and the centre of gravity, estimate all dimensional longitudinal aerodynamic derivatives with respect to the velocity components. Assume speed of sound at the given altitude is 994.85 ft/s.

6. a) Derive the Kinematic equations for an aircraft motion.

b) Derive the gravity equations for an aircraft motion.