Reg.No.										

Manipal Institute of Technology, Manipal

(A Constituent Institute of Manipal University)

V SEMESTER B.TECH (AERONAUTICAL ENGINEERING)

END SEMESTER EXAMINATIONS, JUNE/JULY 2016

SUBJECT: FLIGHT DYNAMICS [AAE 306]

REVISED CREDIT SYSTEM

Time: 3 Hours. MAX.MARKS: 50

Instructions to Candidates:

- Answer **ANY FIVE FULL** questions.
- Missing data may be suitably assumed.

1A. Lateral perturbation equation of motion for Boeing 747 in horizontal flight at $40{,}000\ ft$ height, forward speed of $774\ ft/sec$, mach no. 0.8 with rudder chosen as actuator is given as: **(06)**

$$\begin{bmatrix}\dot{\beta}\\ \dot{\gamma}\\ \dot{\rho}\\ \dot{\emptyset}\end{bmatrix}=\begin{bmatrix}-0.0558 & -0.9968 & 0.0802 & 0.0415\\ 0.598 & -0.115 & -0.0318 & 0\\ -3.05 & 0.388 & -0.4650 & 0\\ 0 & 0.0805 & 1 & 0\end{bmatrix}\begin{bmatrix}\beta\\ \gamma\\ \rho\\ \emptyset\end{bmatrix}+\begin{bmatrix}0.00729\\ -0.475\\ 0.153\\ 0\end{bmatrix}\begin{bmatrix}\delta_a\\ \delta_r\end{bmatrix}$$

Find the open loop poles. Identify all the modes of the aircraft and calculate the time constants, damped frequencies, damping ratios and discuss stability.

1B. Explain the terms : Roll Helix Angle and Mach Tuck Derivative **(04)**

2A. Explain in detail all the yaw rate $rb/2U_1$ derivatives and show that the side force and change in angle of attack at the vertical tail results from positive yaw rate. **(06)**

2B. What is the first order approximation of applied aero forces and moments? How do we non-dimensionalize the perturbed values. **(04)**

3A. The transfer function for the un-augmented McDonnell F-4C Phantom describing the pitch attitude response to elevator when flying at Mach 1.2 at an altitude of $35{,}000\ ft$ is given by **(06)**

$$\frac{\theta(s)}{\gamma(s)}=\frac{-20.6(s+0.013)(s+0.16)}{(s^2+0.017s+0.002)(s^2+1.74s+29.49)}$$

Write down the longitudinal characteristic equation and state whether the aircraft is stable, or not. Reduce to state space and what are the numerical parameters describing the longitudinal stability modes of the McDonnell F-4C Phantom?

3B. Find the time response for the following system: $\ddot{x} + 10\dot{x} + 16x = 32; x(0) = 0;\ \dot{x}(0) = 0$ **(04)**

4A. Describe all the roll rate $pb/2U_1$ derivatives and the role of three aircraft component which have primary influence on the value of roll damping derivative. **(06)**

4B. What is Spiral mode, Roll mode and Dutch roll modes of lateral directional stability analysis? **(04)**

5A. Describe all the kinematic equations of the aircraft in motion. How many degrees of freedom does an aircraft have? How many are translational and how many are rotational? **(06)**

5B. Describe the coordinate transformation System which includes both Earth Axis to Body axis and Stability Axis to Body Axis transformations. **(04)**

6A. Yaw rate feedback and side slip feedback have been added to an aircraft for turn coordination. The transfer function of resulting aircraft and aileron servo are respectively **(06)**

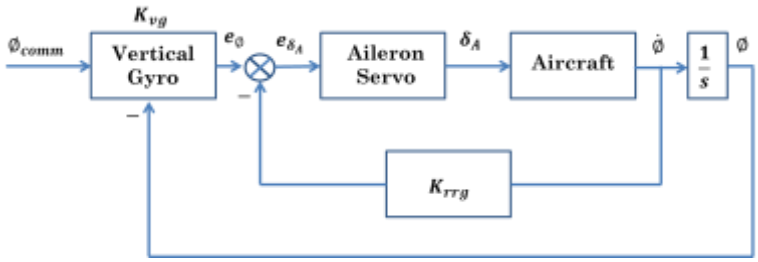
$$\frac{\emptyset(s)}{\delta_A(s)} = \frac{15}{s+15} \; and \; \frac{\delta_A(s)}{e_{\delta_A}(s)} = \frac{20}{s+20}$$

For the bank angle control system shown in figure design a suitable system by drawing a root locus plot on which your design is based.

a) $\xi = 0.8,$ for the inner loop. Find K_{rrg} .

b) $\xi = 0.6,$ for the inner loop. Find K_{vg} .

c) Find $\frac{\emptyset(s)}{\emptyset_{comm(s)}}$



6B. Discuss the short period mode and phugoid period mode of longitudinal stability analysis of an aircraft. **(04)**