Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

(A constituent unit of MAHE, Manipal)

V SEMESTER B.TECH. (AERONAUTICAL ENGINEERING)

END SEMESTER EXAMINATIONS, NOV/DEC 2018

SUBJECT: FLIGHT DYNAMICS [AAE 3101]

REVISED CREDIT SYSTEM
(21/12/2018)

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

- Answer **ALL** the questions.
- Missing data may be suitable assumed.

1A. The right engine on an aircraft with two 10,000 lbf thrust engines fails. The aircraft is at sea level. **(06)**

$C_{n_\beta} = 0.002$ deg^{-1} $S = 300$ ft^2 $b = 50$ ft

$C_{n_{\delta_R}} = -0.0033$ deg^{-1} $q = 100$ lb/ ft^2 $y_e = 5$ ft

a) If the pilot takes no corrective action, what will the sideslip angle be?
b) How many degrees and which direction should the pilot deflect the rudder to realign the nose with the relative wind?
c) If the max rudder deflection is 15 deg, at what airspeed would the pilot no longer be able to maintain $\beta = 0$ deg?

1B. The wing contribution to cross derivative C_{n_p} is basically in three ways that can be measured qualitatively. Explain any two with suitable diagrammatical representation. **(04)**

2A. Develop an expression for the wing dihedral effect C_{l_β} for a wing planform that uses dihedral only for the outboard portion of the wing (see Figure 1). Clearly state all of your assumptions. **(06)**

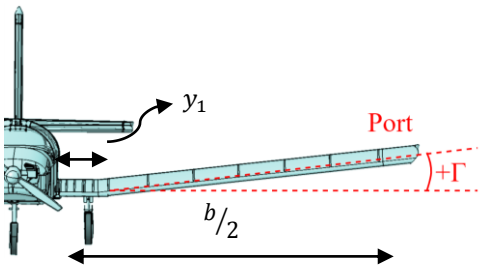


Figure 1

2B. Given the following equation for a mass–spring–damper system **(04)**

$$\ddot{X} + 1.8\dot{X} + 9X = 9$$

What is the solution at $t = 0.3s$?

3A. The Boeing 747-8 is typical of a large classical transport aircraft is typical cruising flight at Mach 0.65 at an altitude of $20{,}000$ ft. The characteristic equation of the aircraft is **(06)**

$$\Delta(s) = s^4 + 1.0999s^3 + 1.3175s^2 + 1.0594s + 0.01129 = 0$$

Identify all the modes, find the frequencies and damping ratio of all the modes and comment on stability.

3B. With suitable diagrammatical representation, write all the small perturbation longitudinal and lateral directional thrust forces and moments at nominal engine operating conditions. **(04)**

4A. What is directional weathervane effect? Explain the typical plot of yawing moment coefficient against yaw attitude for a directionally stable aeroplane shown in Figure 2 below. **(06)**

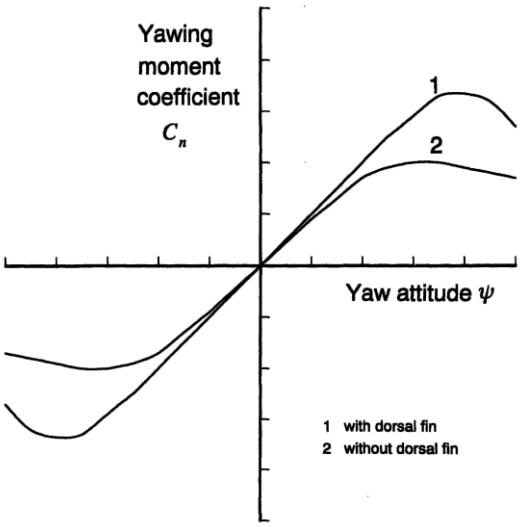


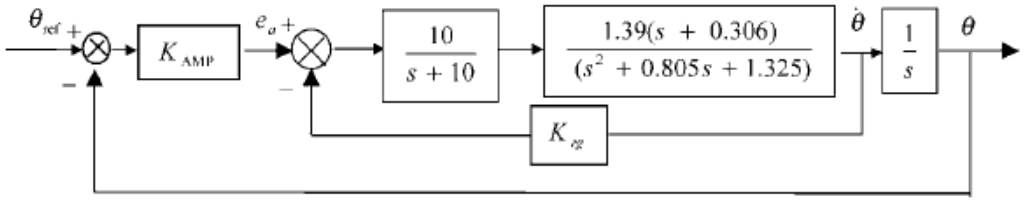
Figure 2

4B. Given that **(04)**

$\dot{\emptyset} = 100$ deg/s	$\emptyset = 45$ deg
$\dot{\psi} = 10$ deg/s	$\psi = 360$ deg
$\dot{\theta} = 10$ deg/s	$\theta = 5$ deg

Find the body axis roll, pitch, and yaw rates using the kinematic equations.

5A. The following is a model of pitch displacement autopilot with rate feedback: **(06)**



Determine the closed loop transfer function $\frac{\theta}{\theta_{ref}}$. Note, you will have to determine the closed loop transfer function for the inner loop first. K_{AMP} and K_{rg} represent the gain of the amplifier and the rate gyro, respectively.

5B. Express all forces (namely, weight, aerodynamic, and thrust forces) for sea-level standard day at military thrust on the T-37 in its most convenient axis system. Assume the thrust lines are parallel to the longitudinal axis and in the plane of the CG. The aircraft weighs 5500 lbf and each engine is delivering 700 lbf of thrust. **(04)**

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