Indian Institute of Technology Kanpur
AE 322: Aircraft Control Systems
Even Semester: 2019-20
Assignments 3 and 4 (Lock-down assignments)

Due on canvas on 15/06/20 **Answer all the questions**

Q1. Sketch the asymptotic Bode plot of the following transfer functions:

(1) $G(s) = \dfrac{1}{0.1s+1},$

(2) $G(s) = \dfrac{1}{s+10},$

(3) $G(s) = \dfrac{(s+1)}{(0.1s+1)},$

(4) $G(s) = \dfrac{(0.1s+1)}{(s+1)},$

(5) $G(s) = \dfrac{1}{(s+1)(0.1s+1)}$

15 Marks

Q2. See the attached code for attitude stabilization and tracking using a PD control. The objective is to track attitude trajectory of appropriate frequency by choosing suitable gains (kp and kd) (a sample code is given however the code is not tracking pitch attitude). Find the maximum frequency that can be tracked using suitable gains. Support your results with (Bode) plot analysis. **25 Marks**

Q3 Explain the Dutch-roll mode. **5 Marks**

Q4. Assume that an aircraft exchange kinematic and potential energy in the phugoid mode, derive the expression of natural frequency of this mode. **10 Marks**

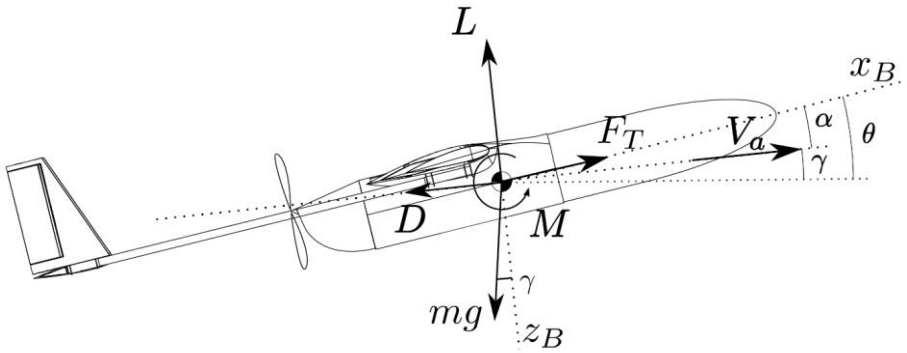
Q5. Consider an aircraft in wind tunnel which is restricted to move in x-y plane.

(i) Derive the equations of motion **10 Marks**
(ii) Comment on static stability. **5 Marks**
(iii) Derive the expressions for damping and control derivatives. **10 Marks**

Q6. Write short notes on any four **20 Marks**

(i) Dorsal fin
(ii) Roll stability due to high and low wing configurations
(iii) Significance of swept wing
(iv) T-tail design
(v) Attitude controller

Q7. Consider motion of an aircraft in a longitudinal plane as shown below



(I) Derive the equations of motion (Hint: find the rate of change in airspeed, flight path angle, pitch angle, and pitch rate, respectively). **10 Marks**

(II) Assuming that one can independently control airspeed using thrust force, F_T, design a controller to follow the given airspeed, V_r. **15 Marks**