ASEN 3128 Assignment 7

Due: Thursday, March 12 at 11:59 PM on Canvas

1) Use the dimensional stability derivatives from table E.3 in Appendix E, for case II of the B747-100 airplane in table E.1, to construct the SI version of table E.3 (longitudinal derivatives only).
2) Since Appendix E is for the case of the body frame shown in Figure E.1, to obtain corresponding derivatives for the case of the stability frame, where θ_0 = 0 for horizontal flight, the stability frame must be rotated by the ξ angle about the body $\hat{y}$ axis from initial alignment with the body frame (-6.8 deg in this case). Convert the derivative table from part 1) into the stability frame using the coordinate rotations in eqn. (B.12,6).
3) Use the dimensional table from part 2) to construct the 4x4 A matrix for the linearized longitudinal dynamics (Eq. (4.9,18)) in SI units.
4) Find the eigenvectors and eigenvalues of A. Identify the Short Period and Phugoid modes. What are the corresponding modal damping ratios and modal natural frequencies?
5) Compare the eigenvalues above of the Short Period mode to the approximation developed in class. Compare the oscillation period of the Phugoid mode above to the Lanchester approximation in the textbook.
6) Simulate the linearized longitudinal dynamics from eqn. (4.9,18) using ODE45.
    a. Verify that the trim state is an equilibrium.
    b. Perturb initial states, one at a time, as follows, and plot the responses. Discuss the results in reference to the modal behavior found above.
        i. Initial Δu^E = 10 m/s.
        ii. Initial Δw^E = 10 m/s.
        iii. Initial Δq = 0.1 rad/s.
        iv. Initial $\Delta\theta$ = 0.1 rad.
    c. Which initial deviations are good at exciting the Short Period mode? The Phugoid mode?