
(a) \( G(s) = \frac{10(s + 1)}{(s + 5)(s + 0.2)} \) (simple example)

(b) \( G(s) = \frac{10}{s(s + 1)(s + 10)} \) (A/C roll att / aileron)

(c) \( G(s) = \frac{250(s + 1)}{(s - 1)(s - 0.1)(s^2 + 2s + 16)} \) (conditionally stable system)

(d) \( G(s) = \frac{(100s + 1)(s + 1)}{(100s^2 + 2s + 1)(.04s^2 + 0.2s + 1)} \) (A/C pitch att./elev.)

(e) \( G(s) = \frac{1}{s^2(s^2 + s + 400)} \) (S/C attitude w/ underdamped structure)

(f) \( G(s) = \frac{s + 1}{s^2(s^2 + 3s + 9)} \) (A/C u/elev.)

2. Assuming the transfer function given in part (c) of Problem 1 is the “loop gain function” \( KG(s) \) of a feedback system, approximate the values of the two gain margins and the phase margin for the system. Explain why there are two gain margins.

3. JVV Problem 7.2 (do not use Matlab for this problem)

4. JVV Problem 7.24 (do not use Matlab for this problem)

5. JVV Problem 8.3
6. Estimate the transfer functions associated with the following Bode plots. You should determine pole and zero locations, as well as the transfer function gain. (you should print out these Bode plots and estimate based on the asymptotes).

Problem 6(a)

Problem 6(b)
7. Consider the following loop gain function:

\[ KG(s) = \frac{K(s + 0.05)}{s^2(s^2 + 5s + 25)} \]

(a) Using Matlab (sisotool is a good approach), determine the values of \( K \) that result in the following phase margin:

(i) 75 deg, (ii) 60 deg, (iii) 45 deg.

(b) For each of the values of gain given above, record the damping ratio of the dominant pole, and the peak overshoot of the time response. Make a table that compares your results to Table 8.4.1 on page 230 of JVV.

8. At what frequency does a time delay of 20 milliseconds introduce 90 degrees of phase lag? At what frequency does it introduce 180 degrees of phase lag? What are these values if the time delay is doubled?

9. Introduce a time delay into the loop gain function used in Problem 7 i.e. let

\[ KG(s) = \frac{Ke^{-Td}s(s + 0.05)}{s^2(s^2 + 5s + 25)} \]

Find the maximum time delay for which 45 degrees phase margin can be maintained. For this value of time delay, determine the closed loop pole locations and plot the loop gain Bode diagram and closed loop unit step response. Compare your results for damping ratio and peak overshoot with those in Table 8.4.1.