(1) Textbook problem 5.6 (g)

Multiple poles at the origin Sketch the root locus with respect to $K$ for the equation $1 + KL(s) = 0$ and the following choices for $L(s)$. Be sure to give the asymptotes, arrival and departure angles at any complex zero or pole, and the frequency of any imaginary-axis crossing. After completing each hand sketch verify your results using MATLAB. Turn in your hand sketches and the MATLAB results on the same scales.

$$(g) \quad L(s) = \frac{(s + 1)^2}{s^3(s + 10)^2}$$

(2) Textbook problem 5.10

A simplified model of the longitudinal motion of a certain helicopter near hover has the transfer function

$$G(s) = \frac{9.8(s^2 - 0.5s + 6.3)}{(s + 0.66)(s^2 - 0.24s + 0.15)},$$

and the characteristic equation $1 + D(s)G(s) = 0$. Let $D(s) = k_p$ at first.

(a) Compute the departure and arrival angles at the complex poles and zeros.

(b) Sketch the root locus for this system for parameter $K = 9.8k_p$. Use axes $-4 \leq x \leq 4$. $-3 \leq y \leq 3$;

(c) Verify your answer using MATLAB. Use the command `axes([-4 4 -3 3])` to get the right scales.

(d) Suggest a practical (at least as many poles as zeros) alternative compensation $D(s)$ which will at least result in a stable system.
(3) Textbook problem 5.22

22. For the system in Fig. 5.55:

(a) Find the locus of closed-loop roots with respect to $K$.
(b) Is there a value of $K$ that will cause all roots to have a damping ratio greater than 0.5?
(c) Find the values of $K$ that yield closed-loop poles with the damping ratio $\zeta = 0.707$.
(d) Use MATLAB to plot the response of the resulting design to a reference step.

(4) Textbook problem 5.33

Consider the rocket-positioning system shown in Fig. 
(a) Show that if the sensor that measures \( x \) has a unity transfer function, the lead compensator

\[
H(s) = K \frac{s + 2}{s + 4}
\]

stabilizes the system.

(b) Assume that the sensor transfer function is modeled by a single pole with a 0.1 sec time constant and unity DC gain. Using the root-locus procedure, find a value for the gain \( K \) that will provide the maximum damping ratio.

(5) Textbook problem 6.3 (c)

3. Sketch the asymptotes of the Bode plot magnitude and phase for each of the following open-loop transfer functions. After completing the hand sketches verify your result using MATLAB. Turn in your hand sketches and the MATLAB results on the same scales.

\[
(c) \quad L(s) = \frac{1}{s(s + 1)(0.02s + 1)}
\]

(6) Textbook problem 6.6 (a)

6. Multiple poles at the origin Sketch the asymptotes of the Bode plot magnitude and phase for each of the following open-loop transfer functions. After completing the hand sketches verify your result using MATLAB. Turn in your hand sketches and the MATLAB results on the same scales.

\[
(a) \quad L(s) = \frac{1}{s^2(s + 8)}
\]