Problem 1

Note: Show all hand calculations for angle and magnitude criteria. You may verify in Matlab.

Given:
\[ G(s) = \frac{1}{s(s+1)(s+2)} , \quad H(s) = 1 \]

1. Sketch the root locus
2. Find the break-away point
3. Find the jω-axis crossing point and gain using Routh Hurwitz.
4. Find the jω-axis crossing point and gain using the angle and magnitude criteria.
5. Assuming a second order dominant system, find the location and gain where the second order poles have a %OS=4.32% (\( \zeta = 0.707 \)) using the magnitude and angle criteria.
6. Assuming a second order dominant system, find the location and gain where the system has a settling time of 16 seconds using the magnitude and angle criteria.
7. What is the steady state error to a unit step input?

Problem 2

Show all hand calculations for angle and magnitude criteria. You may verify in Matlab.

Given:
\[ G(s) = \frac{1}{(s+4)(s+2)} , \quad H(s) = s + 20 \]

1. Sketch the root locus
2. Assuming a second order dominant system, find the location and gain where the system has a settling time of 0.25 seconds using the magnitude and angle criteria.
3. Assuming a second order dominant system, find the two locations and gains where the system has a time to peak of 0.5 seconds using the magnitude and angle criteria.
4. What difference in the system performance would you expect from the two different closed loop pole locations found in part 3. Simulate both systems in Matlab. What major problem do both of them have?
Problem 3
Given:
\[ G(s) = \frac{1}{s(s^2 + 2s + 2)}, \quad H(s) = \frac{1}{s + 3} \]

1. Plot the root locus in Matlab.
2. Find the break-away point
3. Find the \( \omega \)-axis crossing point and gain.
4. Find the pole locations (all 4) and gain when the dominant second order poles have a damping ratio of 0.5. Is the second order dominant assumption valid?
5. Find the pole locations (all 4) and gain for a settling time of 1 second. Will the system be able to achieve this?

Problem 4
Given:
\[ G(s) = \frac{(s+1)}{s^2(s + 9)}, \quad H(s) = 1 \]

1. Sketch by hand. See if you can come up with two possibilities for the root locus.
2. Plot the root locus in Matlab and compare to your sketch(es). The rest of the problem is to be done in Matlab.
3. Find the break-away point.
4. Assuming a second order dominant system, find the location and gain where the system has a time to peak of 0.5 seconds. Find the location of the third pole.
5. Find the gain for a critically damped system. Find all 3 pole locations. Simulate the system at this gain. Does the system perform like a critically damped system? If not, why not.
6. What is the steady state error to a unit step input?