1 Root locus - 20 pts

For the open-loop pole-zero given below, sketch the root locus and find the break-in point.

Zeros: $z_1 = -5, z_2 = -3$. Poles: $p_1 = 2 + j2, p_2 = 2 - j2$.

2 Root locus - 20 pts

For the unity feedback system shown below, where

$$G(s) = \frac{K(s^2 - 25)}{s^2 + 3}$$

sketch the root locus and tell for what values of $K$ the system is (marginally) stable and unstable.
3 Root locus - 40 pts

Given the unity feedback system as shown in problem 2, where

\[ G(s) = \frac{K(s + 2)}{s(s + 1)(s + 3)(s + 5)} \]

do the following:

(a) Sketch the root locus.

(b) Find the asymptotes.

(c) Find the value of gain that will make the system marginally stable.

(d) Find the value of gain for which the closed-loop transfer function will have a pole on the real axis at -2.5.

4 Root locus - 20 pts

For the unity feedback system shown in problem 2, where

\[ G(s) = \frac{K(s + 2)}{s(s + 4)(s + 9)} \]

Find \( K \) to yield closed-loop complex poles with a damping ratio of 0.5. Does your solution require a justification of a second-order approximation? Explain.