

# Third Homework

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1. Prove that the root-locus resulting from the combination of two poles and one zero to the left of both of them on the real axis is a circle centered at the zero with radius given by  $\sqrt{|(p_1 - z)||p_2 - z|}$ .
2. Consider the root-locus for the equation

$$1 + \frac{K}{s(s+10)(s+50)} = 0.$$

- (a) Show the real-axis segments clearly.
  - (b) Sketch the asymptotes for  $K \rightarrow \infty$ .
  - (c) For what values of  $K$  are the roots on the imaginary axis?
3. Sketch the complete root-locus (positive and negative gains) for the following systems by hand. Perform all steps indicated in the handout and detail your computations.

(a)

$$KG(s) = \frac{K(s+4)}{s(s-4)(s^2+2s+1)}$$

(b)

$$KG(s) = \frac{K(s+2)}{s(s+1)(s^2+2s+20)}$$

(c)

$$KG(s) = \frac{2K}{s(s^2+5s+10)}$$

(d)

$$KG(s) = \frac{2K(s^2 + s + 1)}{s(s^2 + 2s + 9)(s^2 + s + 2)}$$

(e)

$$KG(s) = \frac{K(s + 0.1)(s + 0.5)}{s(s^2 + 2s + 1)(s + 3)(s + 12)}$$

(f)

$$KG(s) = \frac{K(s + 1)(s - 0.4)}{s(s + 3)(s + 4)(s^2 + 6)}$$