

Summary: Root Locus sketching rules

Negative Feedback

- **Rule 1:** # branches = # poles
- **Rule 2:** symmetrical about the real axis
- **Rule 3:** real-axis segments are to the left of an *odd* number of real-axis finite poles/zeros
- **Rule 4:** RL begins at poles, ends at zeros
- **Rule 5:** Asymptotes: real-axis intercept σ_a , angles θ_a

$$\sigma_a = \frac{\sum \text{finite poles} - \sum \text{finite zeros}}{\#\text{finite poles} - \#\text{finite zeros}} \quad \theta_a = \frac{(2m + 1)\pi}{\#\text{finite poles} - \#\text{finite zeros}} \quad m = 0, \pm 1, \pm 2, \dots$$

- **Rule 6:** Real-axis break-in and breakaway points

Found by setting $K(\sigma) = -\frac{1}{G(\sigma)H(\sigma)}$ (σ real) and solving $\frac{dK(\sigma)}{d\sigma} = 0$ for real σ .

- **Rule 7:** Imaginary axis crossings (*transition to instability*)

Found by setting $KG(j\omega)H(j\omega) = -1$ and solving
$$\begin{cases} \operatorname{Re} [KG(j\omega)H(j\omega)] = -1, \\ \operatorname{Im} [KG(j\omega)H(j\omega)] = 0. \end{cases}$$

Sketch the Root Locus

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Please see: Problem 8.2 in Nise, Norman S. *Control Systems Engineering*. 4th ed. Hoboken, NJ: John Wiley, 2004.

Are these Root Loci valid? If not, correct them

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