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Lab 4 – Analysis with Root Locus

XMUT315 Control Systems Engineering

Laboratory 4 - Analysis with Root Locus

1. Root locus analysis.
2. Design of control systems.

1. You are given three control systems as listed below:

$$G_1(s) = \frac{s^2 - 12s + 27}{s^2 + 10s + 24}$$

$$G_2(s) = \frac{s + 2}{0.9s^3 + 3s^2 + 5s + 2}$$

$$G_3(s) = \frac{s^2 + 3s + 2}{s^2 - 8s + 15}$$

- a. Determine the poles and zeros of the systems and predict the characteristics of the plots based on these poles and zeros (e.g. asymptotes, break-away/break-in, or angle of departure).

[15 marks]

- b. Calculate the break-away/in points for the root locus and the imaginary axis intercepts for Systems 1 and 3. In class we discussed two techniques to calculate the break-away/in points, attempt both methods to compare the complexity of the systems given above. [30 marks]
- c. For System 2, calculate the angle of departure for complex root (instead of the break-away/in points). [10 marks]
- d. Sketch the root locus diagrams of the systems given above. [15 marks]
- e. Simulate the systems in Matlab (hint: use `rlocus()` function in Matlab). [7.5 marks]
- f. Discover any three differences that you observed between your sketch and calculation results with the simulation results and give reasons behind these differences. [7.5 marks]

2. Given the following control systems as described with transfer functions below

$$G_1(s) = \frac{10}{s(s^2 + 4s + 20)}$$

(System 1)

$$G_2(s) = \frac{50(s + 3)}{s(s - 2)(s + 4)}$$

(System 2)

- a. Simulate Nyquist diagram in Matlab and briefly describe the stability of the control systems (hint: use `nyquist()` function in Matlab): [10 marks]
- b. Describe at least two differences between Nyquist diagram with Bode plots for determining the stability of the control systems. [5 marks]