

Exam 3 Study Guide

Exam 3 on:

Wed, 4/3/24

circle one

Fri, 4/5/24

The exam will be **closed book**, but you may use the colored sheets from exam 1 and 2 the new one for exam 3 for the second part ONLY..

The exam will cover

1. Root - Locus method

a) Main rules

b) **Gain** at any point on the root locus: $k = \frac{1}{|G(s)|}$

c) Additional rules.

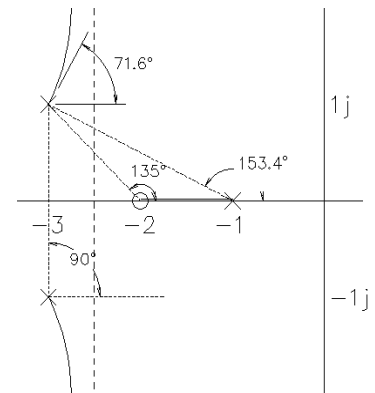
The breakaway/in points are also solutions to:
$$\sum_{\text{all}} \frac{1}{(s + -p_i)} = \sum_{\text{all}} \frac{1}{(s + -z_i)}$$

Complex angle of $G(s)$ at any point on the root locus: $\arg(G(s)) = \arg(N(s)) - \arg(D(s)) = \pm 180^\circ, \pm 540^\circ, \dots$

Or: $\arg\left(\frac{1}{G(s)}\right) = \arg(D(s)) - \arg(N(s)) = \pm 180^\circ, \pm 540^\circ, \dots$

Departure angles from complex poles:

Example. $180 - 90 - 153.4 + 135 = 71.6^\circ$



2. Root - Locus Interpretation and design

Concepts of what a root locus plot is and what it tells you. Movement of poles

Good vs bad, fast response vs slow, OK damping vs bad.

Compensators

Know pole & zero locations of P, PI, lag, PD, lead & PID Compensators.

PI and Lag, purpose and design, ties in with steady-state error

PD and Lead, purpose and design ties in with root locus angle rules

Choose points on the s-plane to achieve given required characteristics based on the 2nd-order assumption (RL Crib)

Know that the 2nd-order assumption may be inaccurate if other CL poles and/or zeros aren't 5x farther from Imaginary axis and are not canceling one another.

Design of a compensator to force the RL point through a given point (like RL7).

3. Unconventional root-locus

4. Compensator circuits & Instrumentation amplifier

5. PID tuning.

6. PLCs and **Ladder logic**. Basic switching logic.

7. Phase-locked loop (PLL)

8. **Bode Plots** (all types, including complex poles and zeros)

Be able to draw both magnitude and phase plots and the smooth curves as well as the asymptotic lines.

Complex poles and zeros $s^2 + 2\zeta\omega_n s + \omega_n^2 = (s + a)^2 + b^2 = s^2 + 2a s + a^2 + b^2$

natural frequency $\omega_n = \sqrt{a^2 + b^2}$ damping factor $\zeta = \frac{a}{\omega_n}$ max at approx ω_n , $\frac{1}{2\zeta}$ $20 \cdot \log\left(\frac{1}{2\zeta}\right)$ dB

9. Concentrate on Homeworks RL5 - BP1

10. Up to Lab 6 (Basic PLL)