# Exam 3 Study Guide  Exam 3 is Mon, 4/12/21, starting at 10:30am

I will set up 2 or 3 zoom sessions and assign each of you to a zoom session for the exam.
Watch for an an announcement on Canvas or a class email.

You will set up a camera and microphone which can observe your activities during the exam and can connect to zoom.

At exam time, you will sign on to your assigned zoom session and connect the camera to observe your activities.
Audio must be on.

The exam will be **open book**, and will be in pdf form. It will be available at about 10:20, A password needed to open the exam will announced at about 10:30. Scan and return exam by 12:30. If you text pictures at 12:30 and then send better-quality scans as pdf files later.

**The exam will cover**

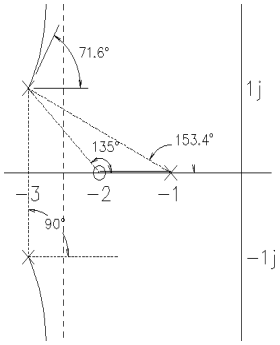
1. Root - Locus method
   a) Main rules
   b) Gain at any point on the root locus: $k = \frac{1}{|G(s)|}$
   c) Additional rules.

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

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

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

   Departure angles from complex poles: Example. $180 - 90 - 153.4 + 135 = 71.6$ deg




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 accurate if other CL poles and/or zeros aren't 5x farther from Imag. axis.

   **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. **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 the asymptotic lines.

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

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

   Bode to transfer function
   GM, PM & DM
   Design

8. Concentrate on Homeworks RL5 - BP3
9. Up to Lab 6 (PLL)