ECE 3510 Exam 2 Study Guide

The 2nd Exam will be on Wednesday 3/13/24

The first part will be **closed book, closed notes, no-calculator,** not even your exam note sheets.

When you hand in the first part you will get the second part, which will be **open note sheets only, with calculator**.

<u>The exam will cover</u> **Download old exams from HW page on class web site.**

1. Sinusoidal responses, effects of poles & zeros, etc.

   Steady-state AC analysis to get $y_{ss}(t)$

2. Transient response to sinusoidal inputs

3. Effect of initial conditions

$$\mathbf{Y}(s) = \overbrace{\frac{b_2 \cdot s^2 + b_1 \cdot s + b_0}{s^2 + a_1 \cdot s + a_0}}^{\mathbf{H}(s)} \cdot \mathbf{X}(s) + \frac{s \cdot y(0-) + \frac{d}{dt}y(0-) + a_1 \cdot y(0-) - b_2 \cdot s \cdot x(0-) - b_2 \cdot \frac{d}{dt}x(0-) - b_1 \cdot x(0-)}{s^2 + a_1 \cdot s + a_0}$$

4. Know the advantages of the state-space method

   Easily handles multiple inputs, multiple outputs and initial conditions
   Can be used with nonlinear systems
   Can be used with time-varying systems
   Reveals unstable systems that have stable transfer functions (pole-zero cancellations). You can determine:
      Controllability: State variables can all be affected by the input
      Observability: State variables are all "observeable" from the output
   Basis of Optimal and Adaptive control methods

5. **Electrical analogies of mechanical systems**, particularly translational and rotational systems, but could include fluids, just no pistons or turbines (gyrators). Expect a transformer and expect to move the impedance to the primary side. Memorize basic analogies. Actual full problem would be in open note-sheet part

6. Control system characteristics and the objectives of a "good" control system. See p. 64 of Bodson or my handout.
   Stable
   Tracking fast smooth minimum error (often measured in steady state)
   Reject disturbances
   Insensitive to plant variations
   Tolerant of noise

   Be able to relate these to poles and zeros on the real and Imaginary axis (where possible). Know how time constant relates to pole location. Know characteristics of the 45º line (% overshoot & ζ). Know regions where $\zeta >$ or < 0.7071.
   Know what is necessary to completely eliminate the steady-state error for a DC input.

   Know what is necessary to completely eliminate the effect of a DC disturbance. Know what a disturbance is

   Much of this material could be in the closed note sheet part.

Elimination of DC steady-state error, p. 67.	Rejection of constant (DC) disturbances, p. 69.
1 Closed-loop system stable	1 Closed-loop system stable
AND 2 $\mathbf{C}(s)$ or $\mathbf{P}(s)$ has pole @ 0	AND 2 $\mathbf{C}(s)$ has pole @ 0
AND 3 $\mathbf{C}(s)$ and $\mathbf{P}(s)$ No zero @ 0	OR 3 $\mathbf{P}(s)$ has zero @ 0 But bad for DC response

7. The Routh-Hurwitz method is not a part of this exam, with the following exceptions:

   Know that for all the roots of a polynomial to be in the LHP, all of the coefficients must be greater than 0.
   (This is sufficient for a second-order polynomial.)

   Know how this is applied to what we care about, the poles of the closed-loop system.

   This could be in the closed note sheet part.

8. **Root - Locus method** (memorize a) & b), they could be in closed note sheet part)

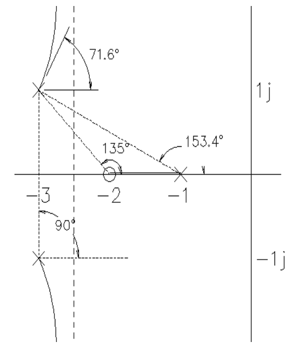
   a) **Main rules**

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

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

   d) **Departure angles** from complex poles: Example. $180 - 90 - 153.4 + 135 = 71.6$ deg
   (And arrival angles to complex zeroes)



9. **PI** To eliminate steady-state error (for constant inputs) & perfect rejection of constant disturbances
   Add pole at 0 and zero at close by

10. Concentrate on Homeworks 7 - RL4 I'll scan through for problems

11. Labs 2 - 4 Position control DC motor characteristics

12. Download old exams from HW page on class web site. But remember, they may cover more than we did in our class.