ECE 3510 Exam 2 Study Guide

The 2nd Exam will be on Wednesday 3/17/21

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.

Open book, notes, & calculator.

1. Effect of initial conditions. Closed-book part, given:

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

   May give H(s), a's & b's and y(0).. and ask for effect of initial conditions

2. The advantages of state space over classical frequency-domain techniques.
   - Multiple input / multiple output systems
   - Can model nonlinear systems
   - Can model time varying systems
   - Can be used to design optimal control systems
   - Can determine controllability and observability

3. **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.

4. Control system characteristics and the objectives of a "good" control system. See p. 60 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 45° 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.

5. Elimination of DC steady-state error, p. 81.
   - 1 Closed-loop system stable
   - AND 2 $\mathbf{C}(s)$ or $\mathbf{P}(s)$ has pole @ 0
   - AND 3 $\mathbf{C}(s)$ and $\mathbf{P}(s)$ No zero @ 0

   Rejection of constant (DC) disturbances, p. 82 - 83.
   - 1 Closed-loop system stable
   - AND 2 $\mathbf{C}(s)$ has pole @ 0
   - OR 3 $\mathbf{P}(s)$ has zero @ 0 But bad for DC response

6. 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.

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7. **Root - Locus method**

   a) **Main rules**

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

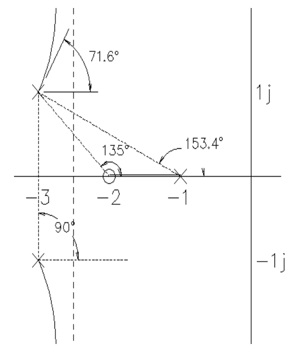
   c) Additional rules. Open-book part only.

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

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

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

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



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

9. Labs 2 - 5a Position control DC motor characteristics PI control

Download old exams from HW page on class web site. But remember, they may cover more than we did in our class.
http://www.ece.utah.edu/~ece3510/

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