Exam 3 Study Guide   Exam 3 is Thur, 4/3/08

1. Root - Locus method

a) Main rules (that you have memorized). This exam will concentrate on the additional rules below.

1. Root-locus plots are symmetric about the real axis.
2. On the real axis, spaces left of an odd number of O-L poles and zeros are always part of the locus. (Essentially, every other space on the real axis (counting leftward) is part of the plot.)
3. Each O-L pole originates ($k = 0$) one branch. (n)

   Each O-L zero terminates ($k = \infty$) one branch. (m)

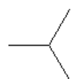
   All remaining branches go to ∞. $(n - m)$

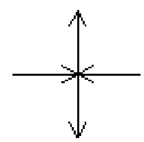
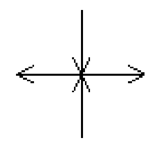
   These remaining branches approach asymptotes as they go to ∞.
4. The origin of the asymptotes is the *centroid*.

$$\text{centroid} = \sigma = \frac{\sum_{all} OLpoles - \sum_{all} OLzeros}{n - m}$$

(# poles - # zeros)

5. The angles of the asymptotes

n - m	angles (degrees)			
2	90	270		
3	60	180	300	
4	45	135	225	315 

6. The angles of departure (and arrival) of the locus are almost always:  OR: 

b) Additional rules. You will be given anything you need in abbreviated form.

Example of material to be included with exam:

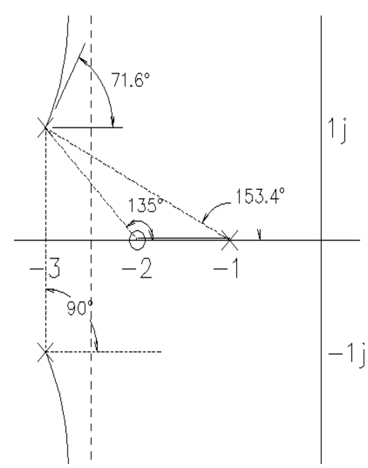
The breakaway points are also solutions to: $\displaystyle\sum_{all} \frac{1}{(s + -p_i)} = \sum_{all} \frac{1}{(s + -z_i)}$

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

Phase angle of G(s) at
any point on the root locus: $\arg(G(s)) = \arg(N(s)) - \arg(D(s)) = \pm 180^o \quad \pm 360^o \ldots$

Or: $\displaystyle\arg\left(\frac{1}{G(s)}\right) = \arg(D(s)) - \arg(N(s)) = \pm 180^o \quad \pm 360^o \ldots$

Departure angles from complex poles: $180 - 90 - 153.4 + 135 = 71.6 \quad \text{deg}$



c) 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.

Effects of adding a compensator

Know pole & zero locations of P, PD, PI, & PID Compensators as well as Lag and Lead

Conclusions, see section 4.4.5, p.84

2. Be able to find a transfer function for a system with multiple multiple feeback paths, like you did in the PID lab and again in lab 8.

3. Phase-locked loops

   How does it work

   The loop block diagram

   Material from labs

4. Bode Plots

   Be able to draw both magnitude and phase plots

   Be able to draw the smoth curves as well as the the asymptotic lines

   I may ask you to start with a circuit

   Basic rules

   Complex poles an zeros

   Bode to transfer function

   GM, PM & DM

   You will be given:

$$(s+a)^2+b^2 = s^2+2\cdot a\cdot s+a^2+b^2$$
$$= s^2+2\cdot\zeta\cdot\omega_n\cdot s+\omega_n^2$$

natural frequency $\omega_n = \sqrt{a^2+b^2}$

damping factor $\zeta = \frac{a}{\omega_n}$

max at approx ω_n , $\frac{1}{2\cdot\zeta}$

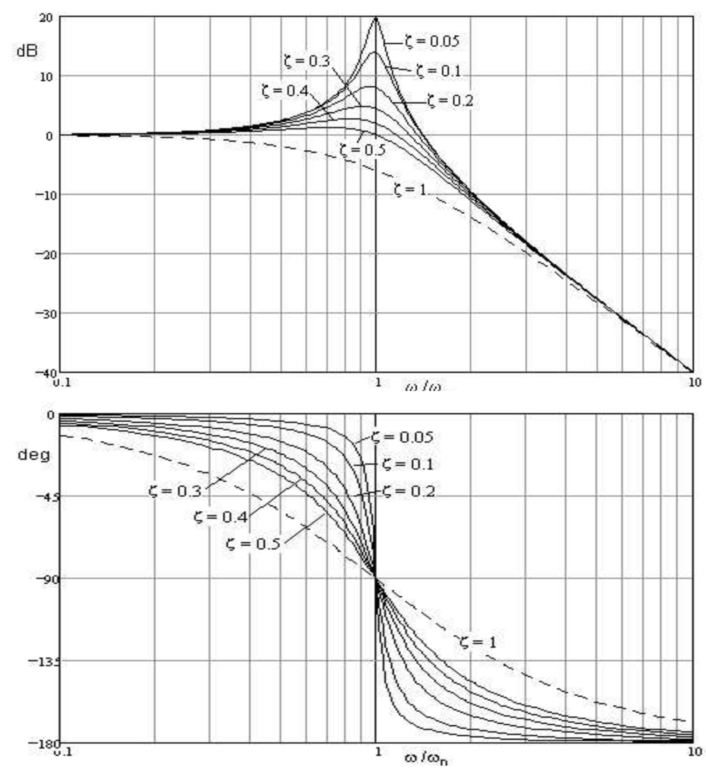
in dB: $20\cdot\log\left(\frac{1}{2\cdot\zeta}\right)$

$2 = 6\cdot dB$ $\quad 10 = 20\cdot dB$

$4 = 12\cdot dB$ $\quad \frac{1}{2} = -6\cdot dB$

$5 = 14\cdot dB$

Add dB to multiply numbers



5. Nyquist plots

   You may be asked to draw a simple one. At minimum you should;

   Be able to find the start point (DC gain ($s = 0 = \omega$)) from the transfer function)

   Find the final value ($\omega = \infty$) and the approach angle to the final value.

   Concepts of what a Nyquist plot is and what it tells you. $Z = N + P$

   Be able to count encirclements, with or without the $\omega < 0$ part of the plot.

   GM & PM

6. Up to HW 18

7. Up to Lab 8