Due at 1700, Fri. Mar. 20 in homework box under stairs, first floor Cory .
Note: up to 2 students may turn in a single writeup. Reading Nise 10.

1. (20 pts) Nyquist Exercise (Nise 10.5)
Consider a close loop system with unity feedback. For each $G(s)$ below, hand sketch the Nyquist diagram, determine $Z = P - N$, algebraically find the closed-loop pole location, and show that the closed loop pole location is consistent with the Nyquist diagram calculation.

a) $G(s) = \frac{5}{s+1}$

b) $G(s) = \frac{5}{s-1}$

2. (25 pts) Nyquist Plot (Nise 10.5)
Consider a closed loop system with unity feedback. The open loop transfer function is:

$$G(s) = \frac{k(s-2)}{(s+10)(s+2)}$$

a) Hand sketch the asymptotes of the Bode plot magnitude and phase for the open-loop transfer functions.
b) Hand sketch Nyquist diagram.
c) From Nyquist diagram, determine range of k for stability.
d) Verify sketches with MATLAB (`bode()` and `nyquist()`) and hand in.

3. (25 pts) Nyquist Plot (Nise 10.5)
Consider a closed loop system with unity feedback. The open loop transfer function is:

$$G(s) = \frac{k(s+4)^2}{(s+1)^4}$$

a) Hand sketch the asymptotes of the Bode plot magnitude and phase for the open-loop transfer functions.
b) Hand sketch Nyquist diagram.
c) From Nyquist diagram, determine range of k for stability.
d) Verify sketches with MATLAB (`bode()` and `nyquist()`) and hand in.

4. (30 pts) Gain and phase margin (Nise 10.7, 10.10)
A closed loop system with unity gain has open loop transfer function

$$G(s) = \frac{2(s+5)}{s(s^2+2s+8)}$$

a) Plot the Bode magnitude and phase plots for the open loop system (MATLAB ok).
b) Determine the gain and phase margin.
c) Assuming a second order approximation for the closed loop system, estimate the transient response for a step input from the phase margin and gain margin. (That is estimate ξ, overshoot, peak time, and settling time.)
d) Compare the actual closed loop step response from MATLAB with the estimates from c).