# Department of Mechanical Engineering

2.14 Analysis and Design of feedback Control Systems

Fall Term 2005

Problem Set 5

**Assigned:** Oct. 1, 2003 **Due:** Oct. 8, 2003

**Reading:** Nise, Chapter 6
Nise, Chapter 8
Nise, Appendix B (Matlab Tutorial) – if you need it.

**Getting Started:** Use Matlab wherever you can in solving the following problems. Hand in plots and either a printout of your Matlab workings, or a written summary of the steps you took and the intermediate results. Open the help in Matlab and read the sections on the Control Toolbox. Make sure you are working at a graphic terminal (not a telnet connection) to be able to use the GUI and plotting functions

**Problem 1:** Nise, Ch. 6, Problem 2 (p. 354 4th Ed., p. 354 3rd Ed.)
Use Matlab's function `roots` to verify your answer.

**Problem 2:** Nise, Ch. 6, Problem 28 (p. 358 4th Ed., p. 358 3rd Ed.)

**Problem 3:** Nise, Ch. 6, Problem 52 (p. 491 4th Ed., p. 489 3rd Ed.)

**Problem 4:** Nise, Ch. 8, Problem 49 (p. 491 4th Ed., p. 489 3rd Ed.)
Use `rlocus()` to plot and analyze the root-locus plots. You may estimate the gains interactively with the mouse and cursor.
Also, use the `step()` function to make a plot of the step response of your final system using the values of $K_1$ found in part (e) and $K_2$ found in part (c).

**Problem 5:** Nise, Ch. 8, Problem 52 (p. 493 4th Ed., p. 491 3rd Ed.)
Use Matlab. Here is a procedure you might follow:

1. Note that the transfer function given is only for the drive-train, and is not a closed-loop system. You can however use root-locus methods to find the dependence of the open-loop drive-train poles upon $N$ provided the characteristic equation is in the appropriate form.

2. Rearrange the characteristic equation into a form suitable for root locus analysis, that is
$$1 + N^2 \frac{N(s)}{D(s)} = 0$$

3. Use `rlocus()` to plot the root locus with $N^2$ as the parameter equivalent to "gain". "Hold" the Matlab plot (command is `hold`) and superimpose a line representing the locus of points with a damping ratio $\zeta = 0.5$ using the `plot()` function.

4. Use the mouse/cursor to estimate the "gain" at the point of intersection.

Just a comment: I would think that a transmission system such as the drive-train shown in Fig. P8.22c, with a damping ratio of 0.5, was pretty poor. What do you think?