Homework 10
Due: Thursday, April 28, 2005, at 5pm

Reading OWN Chapters 9,10,11.

Please write your section day and time on the upper left of the front page of your homework. This will help us return your homeworks.

You may work in (small) groups to do the homework, but each person must write up their own answers. Note that working together does not mean dividing up the problems and sharing answers later.

For any Matlab problems, submit computer generated plots only. **No code is required!**

Problem 1 *(One Last Laplace Transform Problem.)*

OWN 9.35

Problem 2 *(Z-Transform.)*

OWN 10.21 a,g

Problem 3 *(Z-Transform.)*

OWN 10.22 b,d

Problem 4 *(Inverse Z-Transform.)*

OWN 10.23, first two transforms. Don't worry about the Taylor series method.

Problem 5 *(Root Locus.)*

OWN 11.24 a, b

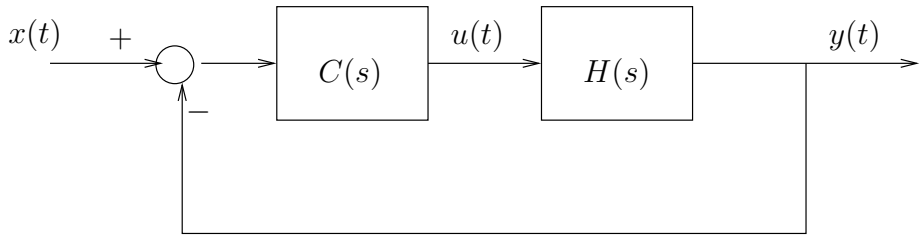
Problem 6 *(MATLAB - Control of an Unstable System.)*

Suppose we are given a causal LTI system $H(s)$ with poles at 1 and 2.

$$H(s) = \frac{1}{s^2 - 3s + 2}$$

(a) Is this system stable or unstable? Does your answer depend on the causality of the system?

(b) We want to stabilize this system using feedback control. As shown in the diagram, a compensator $C(s)$ is place before the system, and both blocks are placed into a negative feedback loop.



SISOTOOL is a GUI in MATLAB that allows you to play with feedback systems. In particular, one of the plots it shows is the root locus of the 'plant', $H(s)$. Type in the following:

```
H = tf(1, [1 -3 2]);
sisotool(H);
```

The main window in the GUI is the root locus of the system. The variable gain K is in the forward path of the closed loop feedback system.

The purple squares are the poles of the closed loop system for the gain chosen. You can drag one of the squares along the curves of the root locus and the other pole will move as well. Is it possible to stabilize the closed loop system with a controller (compensator) that only has a (positive or negative) gain and no poles or zeros? Use Matlab to answer this!

(HINT: What is the restriction on the poles of the closed loop system for the causal LTI system to be stable?)

(c) Suppose that the compensator is now allowed to have one real pole and one real zero, both in the left half plane. Of course, it is also allowed a gain. You can place a pole by clicking on the 'x' next to the arrow in the toolbar and clicking on the place on the Real axis of the root locus where you want the pole. Similarly for the zero, click on the zero next to the 'x' and place it on the root locus. Note that you can drag both of these around the s-plane as well once they are placed.

Can you now stablize the system? If so, what is your compensator, C(s), and the closed loop transfer function, $\frac{Y(s)}{X(s)}$? If not, how can you see this from the root locus?