MASSACHUSETTS INSTITUTE OF TECHNOLOGY
Department of Electrical Engineering and Computer Science

6.003: Signals and Systems—Spring 2005

PROBLEM SET 10

Issued: April 28, 2005 Due: May 6, 2005

REMINDER: Computer Lab 3 is also due on May 6.

Reading Assignments:

Lectures #20-21 & PS#10:	Chapters 11 (through Subsection 11.3.4) of O&W and Chapter 10 (through Subsection 10.2) of O&W
Lectures #22-23 & PS#11:	Chapter 10 of O&W

Exercise for home study (not to be turned in, although we will provide solutions):

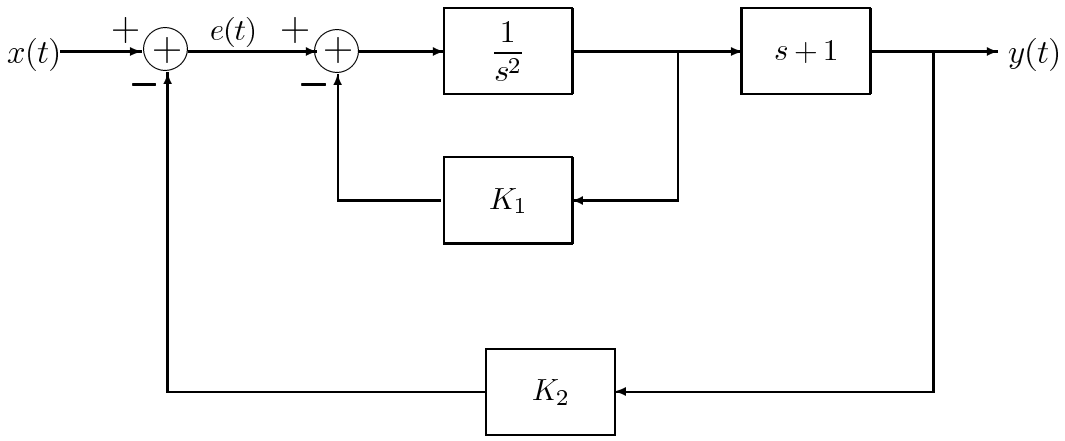
(E1) O&W 11.32 (a) through (d)

Problems to be turned in:

Problem 1 Consider the basic feedback system of Figure 11.3 (a) on p.819 of O&W. Determine the closed-loop system impulse response when

$$H(s) = \frac{1}{s+4}\ , \qquad G(s) = \frac{2s-1}{s+2}$$

Problem 2 Consider the feedback system depicted below:



(a) Find the system functions $H(s) \equiv Y(s)/X(s)$ and $G(s) \equiv E(s)/X(s)$

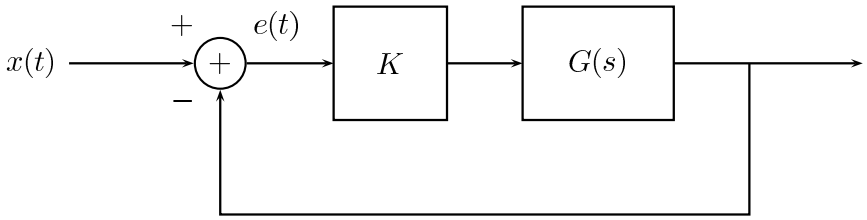
(b) What conditions must be imposed on K_1 and K_2 to ensure that the closed loop system is stable?

(c) Suppose that the input $x(t) = (\sin 4t)u(t)$. We wish to choose values of K_1 and K_2 to satisfy the following requirements:

- The closed loop system from $x(t)$ to $y(t)$ is stable.
- $\lim_{t\to\infty} |y(t) - x(t)| = \lim_{t\to\infty} |e(t)| = 0$.

Find a value of K_1 and K_2 such that the above specifications are satisfied.

Problem 3 Consider the following feedback configuration.



Sketch the root loci for $K > 0$ and $K < 0$ for each of the following:

(a) $G(s) = \dfrac{1}{s-3}$.

(b) $G(s) = \dfrac{1}{(s-2)(s+6)}$

(c) $G(s) = \dfrac{s-2}{(s+2)(s+4)}$.

Problem 4 O&W 11.45 (a) through (d)

Problem 5 O&W 11.57

Problem 6 Determine the z-transform for each of the following sequences. Sketch pole-zero plot and indicate the region of convergence. Indicate whether or not the Fourier transform of the sequence exists.

(a) $x[n] = \left(\dfrac{1}{2}\right)^n u[1-n] - \left(-\dfrac{1}{4}\right)^n u[n-1]$

(b) $x[n] = 3\ \delta[n-4] - 6\ \delta[n+5]$

Reminder: The first 20 problems in each chapter of O&W have answers included at the end of the text. Consider using these for additional practice, either now or as you study for tests.