MASSACHUSETTS INSTITUTE OF TECHNOLOGY
Department of Electrical Engineering and Computer Science

6.003: Signals and Systems—Fall 2003

COMPUTER LAB 3

Issued: November 6, 2003 Due: December 5, 2003

Problems to be handed in: In this lab, you will complete the Basic and Intermediate Problems for the Stabilization of Unstable Systems considered in Section 11.2 on pages 194–197 of Buck, Daniel, and Singer (BDS). For all of the exercises, please include your MATLAB code with your name in it to your report. As stated in the General Information Sheet, we do not expect a formal lab report, but it is still important that you present your results clearly and in an organized manner. Included below are items to be turned in, along with more specific instructions:

Basic Problems

(a) Note that the unstable system characterized by the differential equation (11.5) is representing the input-output behavior of the system $H(s)$ in Figure 11.2.

(b) Follow the question in BDS.

(c) For the rest of the lab, create a system object using `tf` command as follows:

```
b = [bm ··· b1 b0];
a = [an ··· a1 a0];
sys = tf(b,a);
```

where `a` and `b` are arrays of coefficients of the polynomials in the system function $H(s)$:

$$H(s) = \frac{\texttt{bm}s^m + \cdots + \texttt{b1}s + \texttt{b0}}{\texttt{an}s^n + \cdots + \texttt{a1}s + \texttt{a0}}.$$

Using this notation, `rlocus(sys)` plots the locus of Eq. (11.6) for $K \geq 0$. Note that `rlocus`$(-$`sys`$)$ will plot the roots for $K \leq 0$. In order to determine the value of K which leads to a given set of pole locations, either you supply the array of gains K as a vector to `rlocus`, i.e., `r = rlocus(sys,K)` or output arguments to be applied, i.e., `[r,k]=rlocus(sys)` where the values of `k` are chosen automatically by MATLAB.

Submit two plots, one for the case of $K \geq 0$ and the other for $K \leq 0$ on the same page using `subplot`.

(d) Submit two plots, one for the case of $K \geq 0$ and the other for $K \leq 0$ on the same page using `subplot`.

(e) Follow the question in BDS.

Intermediate Problems

(f) Follow the question in BDS and submit two plots, one for the case of $K \geq 0$ and the other for $K \leq 0$ on the same page using `subplot`.

(g-h) Follow the questions in BDS.

(i-k) Follow the questions in BDS and submit both step responses, one from Part (i) and the other from Part (k) on the same plot. You may want to use `hold` command and different line types. See `help plot`.

(l-m) Follow the questions in BDS.

(n) Follow the question in BDS and overlay the two step responses, one for Part (n) and the other for Part (i) in one plot.

(o) Follow the question in BDS and overlay the two step responses, one for Part (o) and the other for Part (k) in one plot.

(p) Follow the question in BDS.

Useful MATLAB Functions:

`help`: All of the functions listed below have help pages within MATLAB that can be viewed by typing `help <function>` from the MATLAB command prompt.

`subplot`: SUBPLOT Create axes in tiled positions. `H = SUBPLOT(m,n,p)`, or `SUBPLOT(mnp)`, breaks the Figure window into an m-by-n matrix of small axes, selects the p-th axes for for the current plot, and returns the axis handle. The axes are counted along the top row of the Figure window, then the second row, etc. See more detailed information and examples by typing `subplot`.

`ltiview`: LTIVIEW Opens the LTI Viewer GUI. The LTI Viewer is an interactive graphical user interface (GUI) for analyzing the time and frequency responses of linear systems and comparing such systems. You may want to use this interface to check your answers or codes.