UC Berkeley

EE128 Homework #8

Due on 12/12/05

It is helpful to learn the MATLAB function c2d. You can use it for verifying your answers. You should not, however, reply on it to do the problem unless the problem indicates that it is ok to do so.

(1) Textbook problem 8.5. (For part (b), use the following MATLAB commands for plotting the frequency responses).

```
numc=[ 1 1];
denc=[0.1 1];
Hc=tf(numc,denc);
Ht=c2d(Hc,0.25,'tustin');
[Ht_num,Ht_den]=tfdata(Ht,'v');
Hm=c2d(Hc,0.25,'matched');
[Hm_num,Hm_den]=tfdata(Hm,'v');
W=logspace(-1,2,200);
hold on
bode(Hc,W);
dbode(Ht_num,Ht_den,0.25,W);
dbode(Hm_num,Hm_den,0.25,W);
```

Problem (2.a) ~ (2.f) below are all based on the system in textbook problem 8.8

(2.a) Textbook problem 8.8.

Hint: (i) Use textbook Equation 8.33 to find the equivalent

(ii) Use the following MATLAB commands to draw a root locus on the z-plane. Note that the rlocus command is the same for continuous time systems and discrete time systems. The only difference is the grid.

```
hold on
zgrid
rlocus(NUM,DEN)
```

(iii) Find the k that renders the $\xi = 0.7$ closed loop poles. (Hint, k should be very close to 1.)

(2.b) With the k found in (2.a), what is the natural frequency (in rad/sec) of the closed loop poles ?

(2.c) With the k found in (2.a), would the closed loop system remain stable for all T ? If not, what is the range of the sample frequency for a stable closed loop system?

Hint: Use the following MATLAB script to find the closed loop pole for a range of value of T.

```
for T=start:step:end
plant=tf(1,[1 2 0]);
plantd=c2d(plant,T);
cloop=feedback(plantd,K);
cpoles=pole(cloop);
T
cpoles
end
```

(2.d) Express the system in control canonical state variable form and find its discrete time equivalent (in state variable form). Use T=1.

(2.e) Find the discrete time transfer function using the formula $H(z)=c(zI-A)^{-1}b$.

(2.f) Design a discrete time state feedback controller (i.e., find the feedback vector K) such that $\xi = 0.7$ and the natural frequency is about half of the value found in (3.b)

(3) Textbook problem 8.9. You may use MATLAB to the fullest extent for this problem.