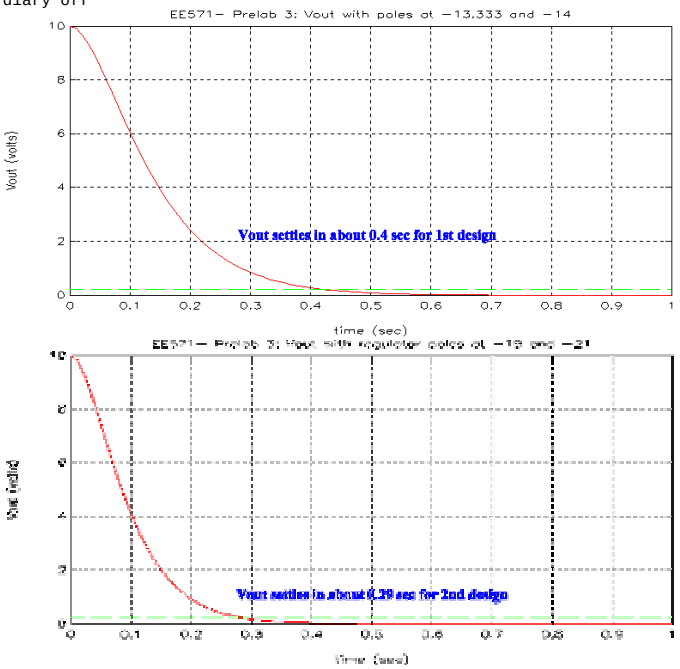
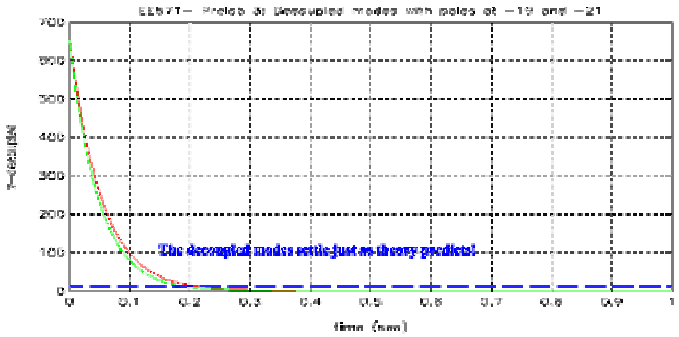
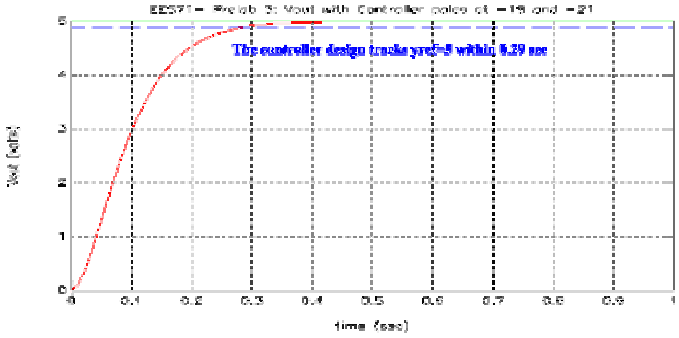
EE571 - Solution to Prelab#3 (PLEASE use my numbers on the Web Lab)

```
a=[0 3.1;0 -5.27]
a =
         0    3.1000
         0   -5.2700

b=[0;68.0164]
b =
         0
   68.0164

%Check if controllable
M=[b a*b]
M =
         0  210.8508
   68.0164 -358.4464

rank(M)
ans =
     2

%Good!  System is controllable! Now put in P.V. form:
poly(a)
ans =
    1.0000    5.2700         0

Apv=[0 1;0 -5.27]
Apv =
         0    1.0000
         0   -5.2700

bpv=[0;1]
bpv =
     0
     1

Mpv=[bpv Apv*bpv]
Mpv =
         0    1.0000
    1.0000   -5.2700

Tpv=M*inv(Mpv)
Tpv =
  210.8508         0
    0.0000   68.0164

Repartofs=-4/.3
Repartofs =
  -13.3333

%Real part of s must be to the left
%or on sigma=-13.3333
%For first attempt, put eigenvalues
%on sigma=-13.333
S_desired=[-4/.3 -14]
S_desired =
  -13.3333  -14.0000

%Find desired char. polynomial:
poly(S_desired)
ans =
    1.0000   27.3333  186.6667

kpv=[ans(3)+0 ans(2)-5.27]
kpv =
  186.6667   22.0633

eig(Apv-bpv*kpv)
ans =
  -13.3333
  -14.0000

%Now put into original coordinates
K=kpv*inv(Tpv)
K =
    0.8853    0.3244

%Check eigenvalues:
eig(a-b*K)
ans =
  -13.3333
  -14.0000

%Good! Now simulate using lsim
x0=[10;0]
x0 =
    10
     0

t=[0:.01:1];
u=zeros(1,101);
[y,x]=lsim(a-b*K,b,[1 0],[0],u,t,x0);
plot(t,y,[0 1],[.2 .2],'--')
grid;title('EE571- Prelab 3: Vout with poles at -13.333 and -14')
ylabel('Vout (volts)');xlabel('time (sec)')
meta plab3a
%Settling time is about 0.4 seconds (not 0.3)!
%Redesign using eigenvalues at -19 and -21
S_desired=[-19 -21]
S_desired =
   -19   -21

poly(S_desired)
ans =
     1    40   399

kpv=[ans(3)+0 ans(2)-5.27]
kpv =
  399.0000   34.7300

K=kpv*inv(Tpv)
K =
    1.8923    0.5106

eig(a-b*K)
ans =

  -19.0000
  -21.0000

%Now run lsim again with new regulator:
[y,x]=lsim(a-b*K,b,[1 0],[0],u,t,x0);
plot(t,y,[0 1],[.2 .2],'--')
ylabel('Vout (volts)');xlabel('time (sec)')
grid;title('EE571- Prelab 3: Vout with regulator poles at -19 and
-21')
meta plab3b
%Settling time is now less than 0.3 seconds!
%Let's plot the decoupled modes:
ts_theoretical=-4/(-19)
ts_theoretical =

    0.2105

%The theoretical ts is 0.21 seconds
[P,S]=eig(a-b*K)
P =

    0.1610   -0.1460
   -0.9869    0.9893


S =

  -19.0000         0
         0  -21.0000

z_decoupled=inv(P)*x';
plot(t,z_decoupled,[0 1],0.02*z_decoupled(1,1)*[1 1],'--')
grid;title('EE571- Prelab 3: Decoupled modes with poles at -19 and
-21')
ylabel('z_decoupled');xlabel('time (sec)')
meta plab3c
%Problem 2:  Let's design the controller architecture, Nx and Nu:
y_ref=5
y_ref =

     5

c=[1 0]
c =

     1     0

inv([c 0;a b])*[1;[0;0]]
ans =

     1
     0
     0

Nx=[1;0]
Nx =

     1
     0

Nu=0
Nu =

     0

%Caluclate the constant part of the input
u_fixed=(K*Nx+Nu)*y_ref*ones(1,101);
%Now use lsim to simulate controller
[y,x]=lsim(a-b*K,b,c,[0],u_fixed,t);
plot(t,y,[0 1],y_ref*[1 1],[0 1],.98*y_ref*[1 1],'--')
grid;title('EE571- Prelab 3: Vout with Controller poles at -19 and
-21')
ylabel('Vout (volts)');xlabel('time (sec)')
diary off
```




EE571 – Modes of Uncoupled Models with poles at −19 and −21
The decoupled modes settle just as theory predicts!
time (sec)


EE571 – Prob 5: Vout with Controller poles at −19 and −21
The controller design tracks yref=5 within 0.29 sec
Vout (volts)
time (sec)