# Devon Quaternik

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# Problem 1

```
%desired s=-1+-2j;
%s^2+2s+5=0;

a=[0 0 -2; 1 0 -5; 0 1 -4];
b=[1;1;0];
P=ctrb(a,b)
rnk=rank(P);
if rnk==length(a)
    disp('Controllable');
else
    disp('Not Controllable');
    rnk
end

%assuming
c=[0 0 1];

[num,den]=ss2tf(a,b,c,0)

syms s
frac=(s+1)/(s^3+4*s^2+5*s+2)
frac1=simplifyFraction(frac)
if frac1==frac
    disp('Minimal form')
else
    disp('non-minimal')
end

num1=[0 0 1];
den1=[1 3 2];

[a1,b1,c1,d1]=tf2ss(num1,den1)

p1=ctrb(a1,b1);
if rank(p1)==length(a1)
    disp('Controllable');
else
    disp('Not Controllable');
end
```

```
de=[-1+2*j -1-2*j];
K=place(a1,b1,de)

abk=a1-b1*K
bk=b1
ck=c1
dk=d1


P =

     1     0    -2
     1     1    -5
     0     1    -3

Not Controllable

rnk =

     2


num =

         0         0    1.0000    1.0000


den =

    1.0000    4.0000    5.0000    2.0000


frac =

(s + 1)/(s^3 + 4*s^2 + 5*s + 2)


frac1 =

1/(s^2 + 3*s + 2)

non-minimal

a1 =

    -3    -2
     1     0


b1 =

     1
     0
```

```
c1 =

     0     1


d1 =

     0

Controllable

K =

   -1.0000    3.0000


abk =

   -2.0000   -5.0000
    1.0000         0


bk =

     1
     0


ck =

     0     1


dk =

     0
```

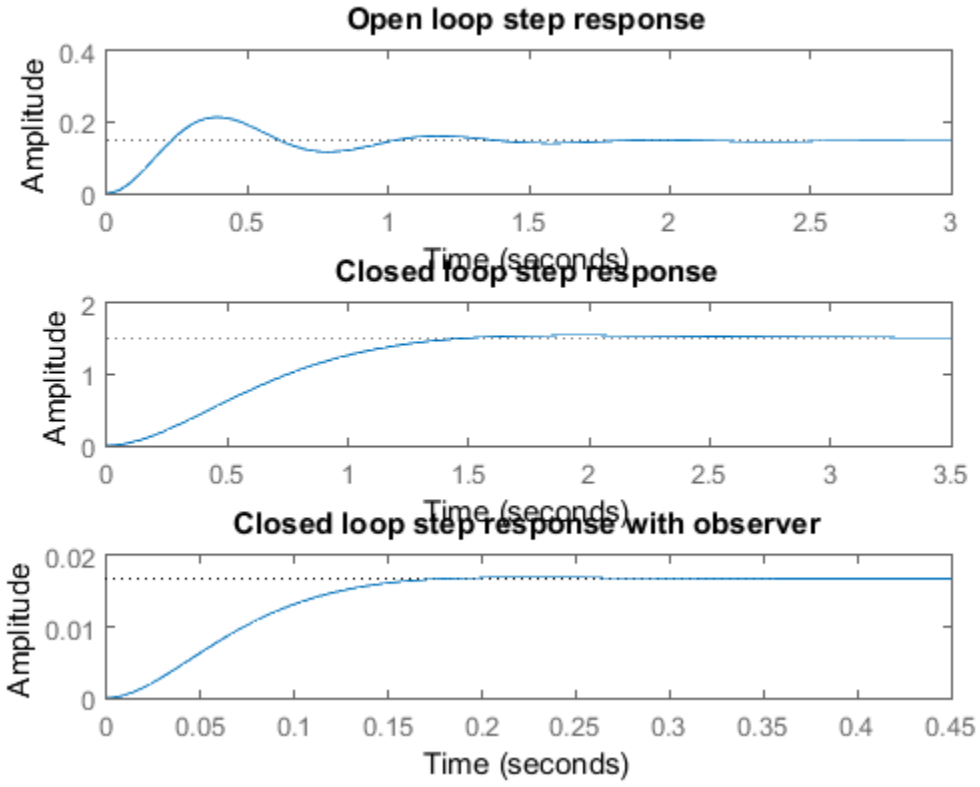
# Problem 5/CME 8.4a

```
%Uses minimal realization from CME 5.4
%Uses minimal realization from CME 5.4
num1=[0 0 10]
den1=[1 4 68]

%minimal form state-space realization
[a,b,c,d]=tf2ss(num1,den1)

sys=ss(a,b,c,d);
ts=2;
PO=2/100;
```

```
z=sqrt((log(PO))^2/(pi^2+(log(PO))^2));
wn=4/(z*ts);

eq=[1 2*z*wn wn^2];

%desired eigenvalues
ev=roots(eq)
ev1=ev';
ev2=10*ev1

L=place(a',c',ev2)'

K=acker(a,b,ev1)

a1=a-b*K;
b1=b;
c1=c;
d1=d;

sys2=ss(a1,b1,c1,d1);

a2=a1-L*c
b2=b;
c2=c;
d2=d;

sys3=ss(a2,b2,c2,d2);


sys1=ss(a,b,c,d);
subplot(3,1,1),stepplot(sys1);
title('Open loop step response');
subplot(3,1,2),stepplot(sys2);
title('Closed loop step response');
subplot(3,1,3),stepplot(sys3);
title('Closed loop step response with observer');

stepinfo(sys2)
stepinfo(sys3)

%You can see from the stepinfo, the observer improves results further
 than
%just a controller. It reduces overshoot and, more noticibly,  the
 times it
%takes to reach steady state


num1 =

     0     0    10


den1 =
```

```
     1     4    68


a =

    -4   -68
     1     0


b =

     1
     0


c =

     0    10


d =

     0


ev =

  -2.0000 + 1.6061i
  -2.0000 - 1.6061i


ev2 =

 -20.0000 -16.0612i -20.0000 +16.0612i


L =

   44.5963
    3.6000


K =

         0  -61.4204


a2 =

   -4.0000 -452.5423
    1.0000  -36.0000


ans =
```

```
          RiseTime: 0.9328
      SettlingTime: 1.4044
       SettlingMin: 1.3796
       SettlingMax: 1.5502
         Overshoot: 2.0000
        Undershoot: 0
              Peak: 1.5502
          PeakTime: 1.9572


ans =

          RiseTime: 0.1040
      SettlingTime: 0.1601
       SettlingMin: 0.0152
       SettlingMax: 0.0170
         Overshoot: 1.1311
        Undershoot: 0
              Peak: 0.0170
          PeakTime: 0.2234
```

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