```
clear
syms a1 a2 a3 a4
syms s11 s21 s31 s41 s12 s22 s32 s42 s13 s23 s33 s43 s14 s24 s34 s44
A=[0 1 0 0; 42.51 0 0 0; 0 0 0 1; -2.943 0 0 0]
```

```
A = 4×4
         0    1.0000         0         0
   42.5100         0         0         0
         0         0         0    1.0000
   -2.9430         0         0         0
```

```
B=[0 -3.333 0 1]'
```

```
B = 4×1
         0
   -3.3330
         0
    1.0000
```

```
C=[1 0 0 0;0 0 1 0]
```

```
C = 2×4
     1     0     0     0
     0     0     1     0
```

```
Contr=[B A*B (A^2)*B (A^3)*B]
```

```
Contr = 4×4
         0   -3.3330         0 -141.6858
   -3.3330         0 -141.6858         0
         0    1.0000         0    9.8090
    1.0000         0    9.8090         0
```

```
a=[a1 a2 a3 a4]
```

a = $\begin{pmatrix} a_1 & a_2 & a_3 & a_4 \end{pmatrix}$

```
Ac=[a;1 0 0 0;0 1 0 0;0 0 1 0]
```

Ac =

$$\begin{pmatrix} a_1 & a_2 & a_3 & a_4 \\ 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \end{pmatrix}$$

```
Bc=[1 0 0 0]'
```

```
Bc = 4×1
     1
     0
     0
     0
```

```
Cc=[Bc Ac*Bc (Ac^2)*Bc (Ac^3)*Bc]
```

```
Cc =
```

$$\begin{pmatrix} 1 & a_1 & {a_1}^2 + a_2 & a_3 + a_1 a_2 + a_1 \left({a_1}^2 + a_2\right) \\ 0 & 1 & a_1 & {a_1}^2 + a_2 \\ 0 & 0 & 1 & a_1 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

```
det(Cc)
```

ans = 1

```
T1=[s11 s21 s31 s41;s12 s22 s32 s42;s13 s23 s33 s43;s14 s24 s34 s44]
```

T1 =

$$\begin{pmatrix} s_{11} & s_{21} & s_{31} & s_{41} \\ s_{12} & s_{22} & s_{32} & s_{42} \\ s_{13} & s_{23} & s_{33} & s_{43} \\ s_{14} & s_{24} & s_{34} & s_{44} \end{pmatrix}$$

```
s4=[s14 s24 s34 s44]
```

s4 = $\begin{pmatrix} s_{14} & s_{24} & s_{34} & s_{44} \end{pmatrix}$

```
s3=[s13 s23 s33 s43]
```

s3 = $\begin{pmatrix} s_{13} & s_{23} & s_{33} & s_{43} \end{pmatrix}$

```
s2=[s12 s22 s32 s42]
```

s2 = $\begin{pmatrix} s_{12} & s_{22} & s_{32} & s_{42} \end{pmatrix}$

```
s1=[s11 s21 s31 s41]
```

s1 = $\begin{pmatrix} s_{11} & s_{21} & s_{31} & s_{41} \end{pmatrix}$

```
s4==[0 0 0 1]/(Contr)
```

ans =

$$\left(s_{14} = -\frac{5289001001014353}{576460752303423488} \quad s_{24} = 0 \quad s_{34} = -\frac{88141201681904 19}{288230376151711744} \quad s_{44} = 0\right)$$

```
var = vpa(ans)
```

var = $\left(s_{14} = -0.009174954200924430661179265200 6443 \quad s_{24} = 0.0 \quad s_{34} = -0.030580122351681126441347 3\right.$

```
s3==s4*A
```

ans =

$$\left(s_{13} = \frac{4251\, s_{24}}{100} - \frac{2943\, s_{44}}{1000} \quad s_{23} = s_{14} \quad s_{33} = 0 \quad s_{43} = s_{34}\right)$$

```
var = vpa(ans)
```

var =

$$\left(s_{13} = 42.51\, s_{24} - 2.943\, s_{44} \quad s_{23} = s_{14} \quad s_{33} = 0.0 \quad s_{43} = s_{34}\right)$$

```
s2==s3*A
```

ans =

$$\left(s_{12} = \frac{4251\, s_{23}}{100} - \frac{2943\, s_{43}}{1000} \quad s_{22} = s_{13} \quad s_{32} = 0 \quad s_{42} = s_{33}\right)$$

```
% s14 = -0.0092; s24= 0; s34 = -0.0306;s44=0;
% s13 = 0 ; s23 =s14; s33= 0; s43=s34;
var2 = subs(ans,[s14,s24,s34,s44,s13,s23,s33,s43],[-0.0092,0,-0.0306,0,0,-0.0092,0,-0.0306])
```

var2 =

$$\left(s_{12} = -\frac{1505181}{5000000} \quad s_{22} = 0 \quad s_{32} = 0 \quad s_{42} = 0\right)$$

```
var = vpa(var2)
```

var =

$$\left(s_{12} = -0.3010362 \quad s_{22} = 0.0 \quad s_{32} = 0.0 \quad s_{42} = 0.0\right)$$

```
s1==s2*A
```

ans =

$$\left(s_{11} = \frac{4251\, s_{22}}{100} - \frac{2943\, s_{42}}{1000} \quad s_{21} = s_{12} \quad s_{31} = 0 \quad s_{41} = s_{32}\right)$$

```
var3 = subs(ans,[s12,s22,s32,s42],[-0.3 0 0 0])
```

var3 =

$$\left(s_{11} = 0 \quad s_{21} = -\frac{3}{10} \quad s_{31} = 0 \quad s_{41} = 0\right)$$

```
var4 = vpa(var3)
```

var4 =

$$\left(s_{11} = 0.0 \quad s_{21} = -0.3 \quad s_{31} = 0.0 \quad s_{41} = 0.0\right)$$

```
T1=[s11 s21 s31 s41;s12 s22 s32 s42;s13 s23 s33 s43;s14 s24 s34 s44]
```

T1 =

$$\begin{pmatrix} s_{11} & s_{21} & s_{31} & s_{41} \\ s_{12} & s_{22} & s_{32} & s_{42} \\ s_{13} & s_{23} & s_{33} & s_{43} \\ s_{14} & s_{24} & s_{34} & s_{44} \end{pmatrix}$$

```
T1ac = subs(T1,[s14,s24,s34,s44,s13,s23,s33,s43,s12,s22,s32,s42,s11,s21,s31,s41],[-0.0092,0,-0
```

T1ac =

$$\begin{pmatrix} 0 & -\frac{3}{10} & 0 & 0 \\ -\frac{3}{10} & 0 & 0 & 0 \\ 0 & -\frac{23}{2500} & 0 & -\frac{153}{5000} \\ -\frac{23}{2500} & 0 & -\frac{153}{5000} & 0 \end{pmatrix}$$

```
vpa(inv(T1ac))
```

```
ans =
```

$$\begin{pmatrix} 0 & -3.33333333333333333333333333333333 \\ -3.33333333333333333333333333333333 & 0 \\ 0 & 1.00217864923747276688453159041 39 \\ 1.00217864923747276688453159041 39 & 0 & -32.679738562(\end{pmatrix}$$

```
Ac=T1ac*A*inv(T1ac)
```

```
Ac =
```

$$\begin{pmatrix} 0 & \frac{4251}{100} & 0 & 0 \\ 1 & 0 & 0 & 0 \\ 0 & \frac{501727}{500000} & 0 & 0 \\ 0 & 0 & 1 & 0 \end{pmatrix}$$

```
Bc=vpa(T1ac*B)
```

```
Bc =
```

$$\begin{pmatrix} 0.9999 \\ 0 \\ 0.0000636 \\ 0 \end{pmatrix}$$

```
Bc=[1 0 0 0]'
```

```
Bc = 4×1
     1
     0
     0
     0
```

```
Cc=([Bc Ac*Bc (Ac^2)*Bc (Ac^3)*Bc])
```

```
Cc =
```

$$\begin{pmatrix} 1 & 0 & \frac{4251}{100} & 0 \\ 0 & 1 & 0 & \frac{4251}{100} \\ 0 & 0 & \frac{501727}{500000} & 0 \\ 0 & 0 & 0 & \frac{501727}{500000} \end{pmatrix}$$

```
Cc=C*inv(T1ac)
```

Cc =

$$\begin{pmatrix} 0 & -\frac{10}{3} & 0 & 0 \\ 0 & \frac{460}{459} & 0 & -\frac{5000}{153} \end{pmatrix}$$

```
vpa(Cc)
```

ans =

$$\begin{pmatrix} 0 & -3.33333333333333333333333333333333 & 0 & 0 \\ 0 & 1.00217864923747276688453159041 39 & 0 & -32.679738562091503267973856209 15 \end{pmatrix}$$

```
Dc=[0;0]
```

Dc = 2×1

```
     0
     0
```

aa

```
syms lamb f1 f2 f3 f4

Fc=[f1 f2 f3 f4]
```

Fc = $\begin{pmatrix} f_1 & f_2 & f_3 & f_4 \end{pmatrix}$

```
id=eye(4);
l_m=id*lamb
```

l_m =

$$\begin{pmatrix} \text{lamb} & 0 & 0 & 0 \\ 0 & \text{lamb} & 0 & 0 \\ 0 & 0 & \text{lamb} & 0 \\ 0 & 0 & 0 & \text{lamb} \end{pmatrix}$$

```
P=det(l_m-Ac)
```

P =

$$\frac{\text{lamb}^2\,(100\,\text{lamb}^2 - 4251)}{100}$$

```
simplify(P)
```

ans =

$$\text{lamb}^4 - \frac{4251\,\text{lamb}^2}{100}$$

```
a1=0;a2=-42.51;a3=0;a4=0;
acl1=13.52;acl2=56.64;acl3=76.72;acl4=32.6;
Fc=[a1-acl1 a2-acl2 a3-acl3 a4-acl4]
```

```
Fc = 1×4
  -13.5200  -99.1500  -76.7200  -32.6000
```

```
F=Fc*T1ac
```

F =

$$\left(\frac{751123}{25000}\quad \frac{148807}{31250}\quad \frac{24939}{25000}\quad \frac{146727}{62500}\right)$$

```
vpa(F)
```

ans = (30.04492 4.761824 0.99756 2.347632)

```
round(vpa(eig(A+B*F)),4)
```

ans =

$$\begin{pmatrix} -6.5541 \\ -4.9652 \\ -1.0448 \\ -0.9594 \end{pmatrix}$$

```
round(vpa(eig(Ac+Bc*Fc)),4)
```

ans =

$$\begin{pmatrix} -6.5539 \\ -4.951 \\ -1.0912 \\ -0.9239 \end{pmatrix}$$

```
Asf = A+B*F
```

Asf =

$$\begin{pmatrix} 0 & 1 & 0 & 0 \\ -\frac{1440742959}{25000000} & -\frac{495973731}{31250000} & -\frac{83121687}{25000000} & -\frac{489041091}{62500000} \\ 0 & 0 & 0 & 1 \\ \frac{169387}{6250} & \frac{148807}{31250} & \frac{24939}{25000} & \frac{146727}{62500} \end{pmatrix}$$

```
vpa(Asf)
```

```
ans =
```

$$\begin{pmatrix} 0 & 1.0 & 0 & 0 \\ -57.62971836 & -15.871159392 & -3.32486748 & -7.824657456 \\ 0 & 0 & 0 & 1.0 \\ 27.10192 & 4.761824 & 0.99756 & 2.347632 \end{pmatrix}$$

```
Asf=[0 1 0 0;-57.6297 -15.8712 -3.3249 -7.8247;0 0 0 1;27.1019 4.7618 0.9976 2.3476]
```

```
Asf = 4×4
         0    1.0000         0         0
  -57.6297  -15.8712   -3.3249   -7.8247
         0         0         0    1.0000
   27.1019    4.7618    0.9976    2.3476
```

```
Bsf = B
```

```
Bsf = 4×1
         0
   -3.3330
         0
    1.0000
```

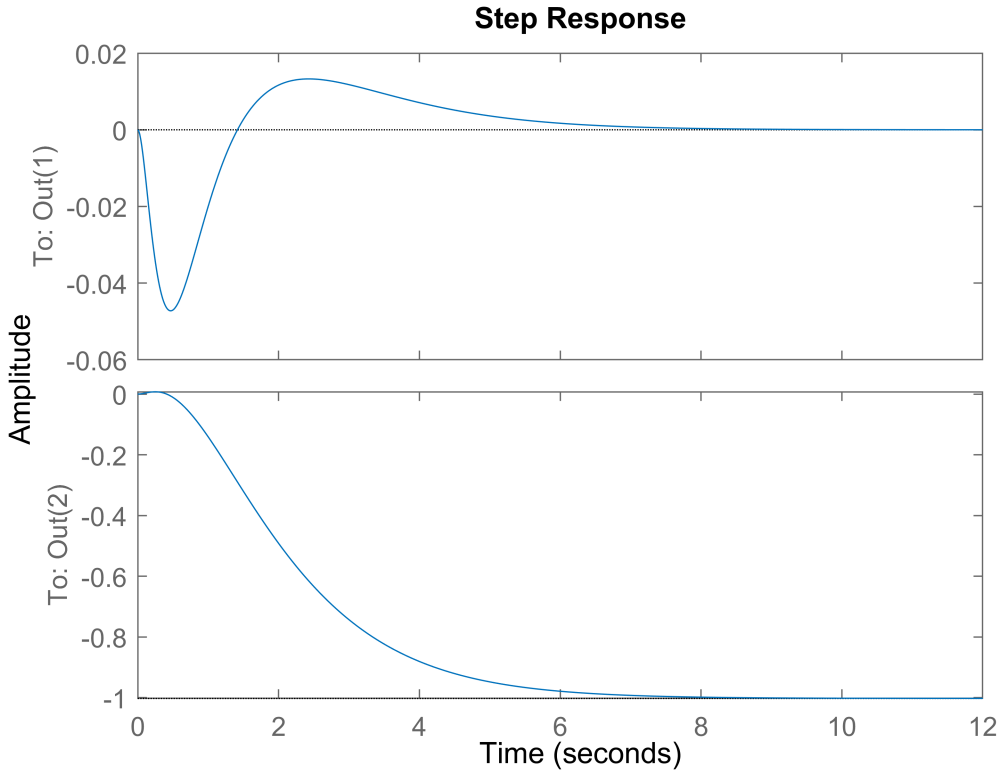
```
Csf = C
```

```
Csf = 2×4
     1     0     0     0
     0     0     1     0
```

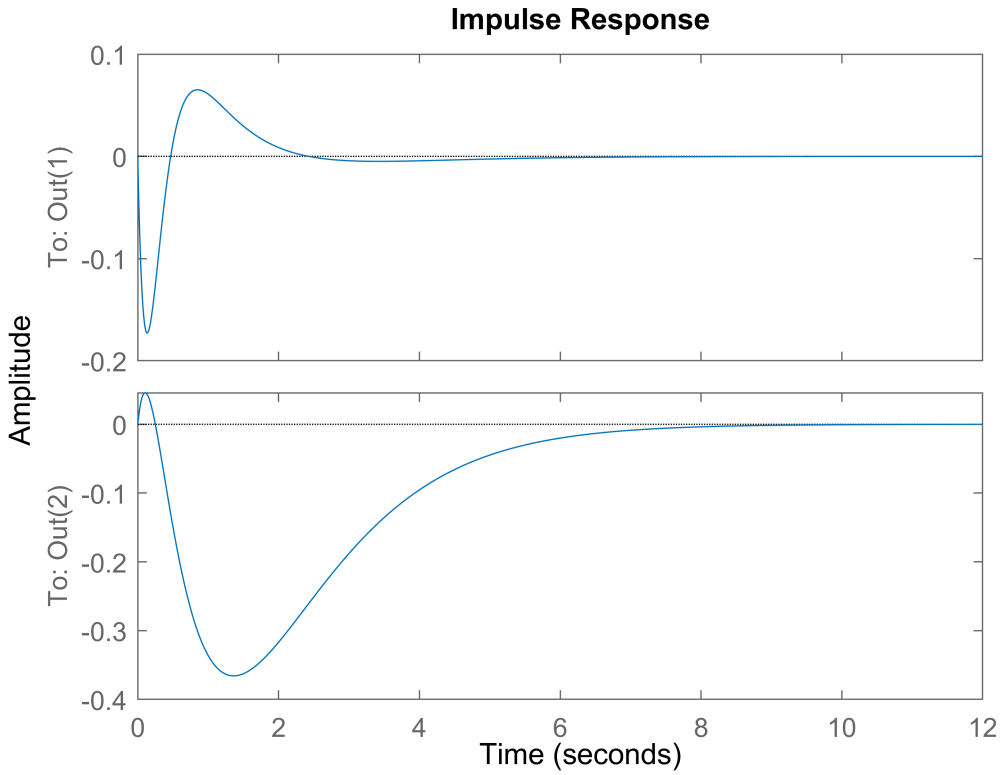
```
Dsf = Dc
```

```
Dsf = 2×1
     0
     0
```

```
sys=ss(Asf,Bsf,Csf,Dsf);
step(sys)
```


Step Response
Amplitude
To: Out(1)
To: Out(2)
Time (seconds)

```
impulse(sys)
```


Impulse Response
Amplitude
To: Out(1)
To: Out(2)
Time (seconds)

Is different due to rounding error? Perhaps?

Task4

```
syms a1 a2 a3 a4
Ao=[a1 1 0 0;a2 0 1 0;a3 0 0 1; a4 0 0 0]
```

Ao =

$$\begin{pmatrix} a_1 & 1 & 0 & 0 \\ a_2 & 0 & 1 & 0 \\ a_3 & 0 & 0 & 1 \\ a_4 & 0 & 0 & 0 \end{pmatrix}$$

```
Co=[1 0 0 0]
```

```
Co = 1×4
     1     0     0     0
```

```
Ooa=[C(2,:);(C(2,:)*A);(C(2,:)*A^2);(C(2,:)*A^3)]
```

```
Ooa = 4×4
         0         0    1.0000         0
         0         0         0    1.0000
   -2.9430         0         0         0
         0   -2.9430         0         0
```

Is it correct to use Ooa (with substituted values from A and C) intead of Oo (that has symbolic values)

```
Oo=[Co;(Co*Ao);(Co*Ao^2);(Co*Ao^3)]
```

Oo =

$$\begin{pmatrix} 1 & 0 & 0 & 0 \\ a_1 & 1 & 0 & 0 \\ {a_1}^2 + a_2 & a_1 & 1 & 0 \\ a_3 + a_1 a_2 + a_1 \left({a_1}^2 + a_2\right) & {a_1}^2 + a_2 & a_1 & 1 \end{pmatrix}$$

```
det(Oo)
```

ans = 1

```
syms t4

eq1=t4==inv(Ooa)*[0;0;0;1]
```

eq1 =

$$\begin{pmatrix} t_4 = 0 \\ t_4 = -\frac{1000}{2943} \\ t_4 = 0 \\ t_4 = 0 \end{pmatrix}$$

```
vpa(eq1)
```

```
ans =
```

$$\begin{pmatrix} t_4 = 0.0 \\ t_4 = -0.33978933061501868841318382602786 \\ t_4 = 0.0 \\ t_4 = 0.0 \end{pmatrix}$$

```
t4=[0 -0.3398 0 0]'
```

```
t4 = 4×1
         0
   -0.3398
         0
         0
```

```
t3=A*t4
```

```
t3 = 4×1
   -0.3398
         0
         0
         0
```

```
t2=A*t3
```

```
t2 = 4×1
         0
  -14.4449
         0
    1.0000
```

```
t1=A*t2
```

```
t1 = 4×1
  -14.4449
         0
    1.0000
         0
```

```
S=[t1 t2 t3 t4]
```

```
S = 4×4
  -14.4449         0   -0.3398         0
         0  -14.4449         0   -0.3398
    1.0000         0         0         0
         0    1.0000         0         0
```

```
Ao=inv(S)*A*S
```

```
Ao = 4×4
         0    1.0000         0         0
   42.5100         0    1.0000         0
         0         0         0    1.0000
         0         0         0         0
```

```
Bo=inv(S)*B
```

```
Bo = 4×1
         0
    1.0000
         0
  -32.7000
```

```
Co=C*S
```

```
Co = 2×4
  -14.4449         0   -0.3398         0
    1.0000         0         0         0
```

```
Do=[0;0];
syso=ss(Ao,Bo,Co,Do);
round(vpa(eig(A)),4)
```

```
ans =
```

$$\begin{pmatrix} 0 \\ 0 \\ 6.52 \\ -6.52 \end{pmatrix}$$

```
round(vpa(eig(Ac)),4)
```

```
ans =
```

$$\begin{pmatrix} 0 \\ 0 \\ -6.52 \\ 6.52 \end{pmatrix}$$

```
round(vpa(eig(Ao)),4)
```

```
ans =
```

$$\begin{pmatrix} 6.52 \\ -6.52 \\ 0 \\ 0 \end{pmatrix}$$

Why inverted?

```
syms lamb
det(lamb*eye(4)-Ao)
```

```
ans =
```

$$\frac{\text{lamb}^2\ (100\,\text{lamb}^2 - 4251)}{100}$$

```
expand(ans)
```

```
ans =
```

$$\text{lamb}^4 - \frac{4251\,\text{lamb}^2}{100}$$

```
a1=0;a2=-42.51;a3=0;a4=0;
acl1=135.2;acl2=5664;acl3=76720;acl4=326000;
Lo=[a1-acl1 a2-acl2 a3-acl3 a4-acl4]'
```

```
Lo = 4×1
10^5 ×
   -0.0014
   -0.0571
   -0.7672
   -3.2600
```

```
L=S*Lo
```

```
L = 4×1
10^5 ×
    0.2802
    1.9320
   -0.0014
   -0.0571
```

Is this error due to rounding acceptable?

```
eig(A+L*C(2,:))
```

```
ans = 4×1
  -65.2121
  -49.9921
  -10.0091
   -9.9910
```

```
eig(Ao+Lo*Co(2,:))
```

```
ans = 4×1
  -65.2121
  -49.9921
  -10.0091
   -9.9910
```

```
Aso = A+L*C(2,:); Bso = B; Cso = C; Dso = Do;
sysso=ss(Aso,Bso,Cso,Dso)
```

```
sysso =

  A =
             x1         x2          x3         x4
   x1         0          1  2.802e+04          0
   x2     42.51          0  1.932e+05          0
   x3         0          0     -135.2          1
```

```
   x4     -2.943          0      -5707          0

  B =
           u1
   x1       0
   x2  -3.333
   x3       0
   x4       1

  C =
       x1  x2  x3  x4
   y1   1   0   0   0
   y2   0   0   1   0

  D =
       u1
   y1   0
   y2   0

Continuous-time state-space model.
```

```
eig(Aso)
```

```
ans = 4×1
  -65.2121
  -49.9921
  -10.0091
   -9.9910
```

Task5

closed loop state feedback system

```
Asf=A+B*F
```

```
Asf =
```

$$\begin{pmatrix} 0 & 1 & 0 & 0 \\ -\frac{1440742959}{25000000} & -\frac{495973731}{31250000} & -\frac{83121687}{25000000} & -\frac{489041091}{62500000} \\ 0 & 0 & 0 & 1 \\ \frac{169387}{6250} & \frac{148807}{31250} & \frac{24939}{25000} & \frac{146727}{62500} \end{pmatrix}$$

```
vpa(Asf)
```

```
ans =
```

$$\begin{pmatrix} 0 & 1.0 & 0 & 0 \\ -57.62971836 & -15.871159392 & -3.32486748 & -7.824657456 \\ 0 & 0 & 0 & 1.0 \\ 27.10192 & 4.761824 & 0.99756 & 2.347632 \end{pmatrix}$$

```
Asf=[0 1 0 0;-57.6297 -15.871 -3.3248 -7.824657;0 0 0 1;27.10192 4.7618 1 2.3476]
```

```
Asf = 4×4
         0    1.0000         0         0
```

```
  -57.6297  -15.8710   -3.3248   -7.8247
         0         0         0    1.0000
   27.1019    4.7618    1.0000    2.3476
```

```
Bsf=B;
Csf=C;
Dsf=Do;
```

Observer base state feedback system

```
Areg = [ (A+B*F) B*F; zeros(size(A)) (A+L*C(2,:)) ]
```

Areg =

$$\begin{pmatrix} 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ -\frac{1440742959}{25000000} & -\frac{495973731}{31250000} & -\frac{83121687}{25000000} & -\frac{489041091}{62500000} & -\frac{2503492959}{25000000} & -\frac{495973731}{31250000} & -\frac{8312}{2500} \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ \frac{169387}{6250} & \frac{148807}{31250} & \frac{24939}{25000} & \frac{146727}{62500} & \frac{751123}{25000} & \frac{148807}{31250} & \frac{249}{250} \\ 0 & 0 & 0 & 0 & 0 & 1 & \frac{19256850}{687194} \\ 0 & 0 & 0 & 0 & \frac{4251}{100} & 0 & \frac{331923241}{171798} \\ 0 & 0 & 0 & 0 & 0 & 0 & -\frac{4757076}{3518437} \\ 0 & 0 & 0 & 0 & -\frac{2943}{1000} & 0 & -\frac{62745711}{109951} \end{pmatrix}$$

```
vpa(Areg)
```

ans =

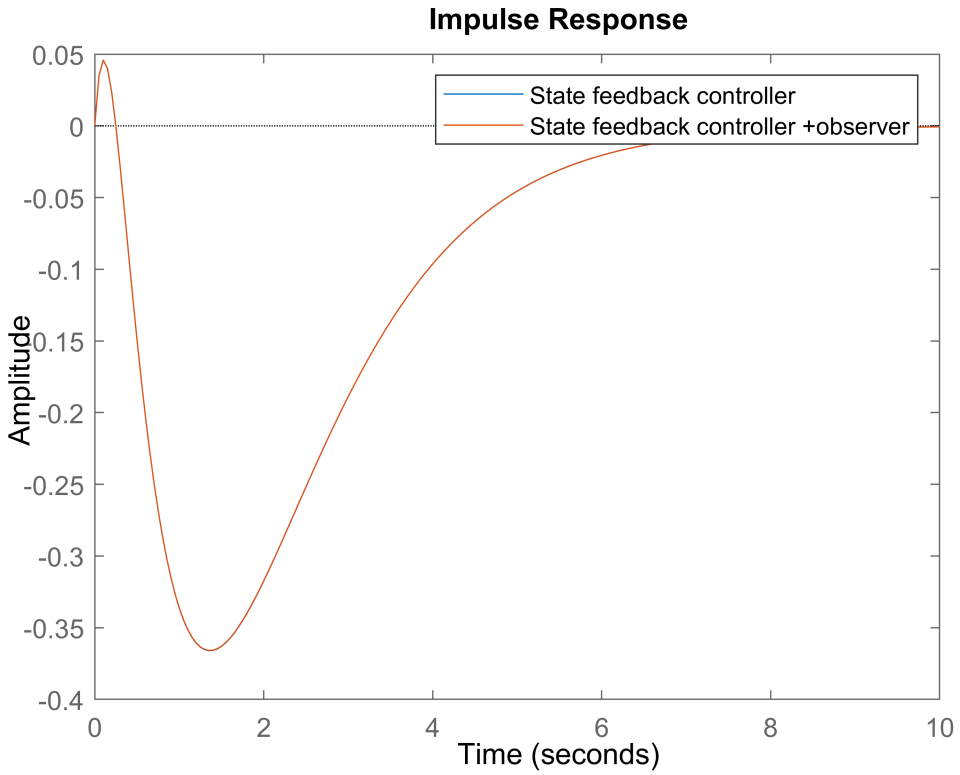
$$\begin{pmatrix} 0 & 1.0 & 0 & 0 & 0 & 0 & \\ -57.62971836 & -15.871159392 & -3.32486748 & -7.824657456 & -100.13971836 & -15.871159392 & \\ 0 & 0 & 0 & 1.0 & 0 & 0 & \\ 27.10192 & 4.761824 & 0.99756 & 2.347632 & 30.04492 & 4.761824 & \\ 0 & 0 & 0 & 0 & 0 & 1.0 & 2 \\ 0 & 0 & 0 & 0 & 42.51 & 0 & 1 \\ 0 & 0 & 0 & 0 & 0 & 0 & - \\ 0 & 0 & 0 & 0 & -2.943 & 0 & - \end{pmatrix}$$

```
Areg=[0 1 0 0 0 0 0 0;-57.6297 -15.871 -3.3248 -7.8246 -100.139 -15.871 -3.3248 -7.8246;0 0 0 1
    0 0 0 0 42.51 0 193204.7548 0; 0 0 0 0 0 0 -135.204 1;0 0 0 0 -2.943 0 -5706.69 0]
```

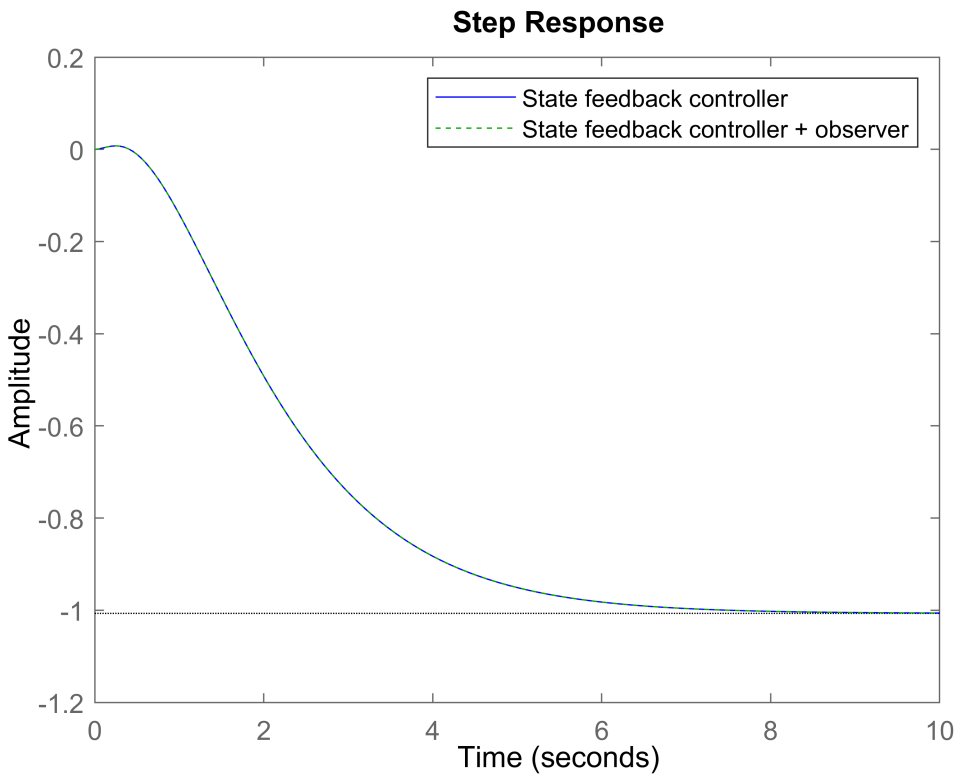
```
Areg = 8×8
10^5 ×
         0    0.0000         0         0         0         0         0         0
   -0.0006   -0.0002   -0.0000   -0.0001   -0.0010   -0.0002   -0.0000   -0.0001
         0         0         0    0.0000         0         0         0         0
    0.0003    0.0000    0.0000    0.0000    0.0003    0.0000    0.0000    0.0000
         0         0         0         0         0    0.0000    0.2802         0
```

```
         0         0         0         0    0.0004         0    1.9320         0
         0         0         0         0         0         0   -0.0014    0.0000
         0         0         0         0   -0.0000         0   -0.0571         0
```

```
Breg = [ B; zeros(size(B)) ];
Creg = [ C(2,:) zeros(size(C(2,:))) ];
Dreg = 0;
sys_sf=ss(Asf,Bsf,Csf(2,:),Dsf(2,:));
sys_reg=ss(Areg,Breg,Creg,Dreg);
figure
impulse(sys_sf);hold on
impulse(sys_reg);hold off
legend('State feedback controller','State feedback controller +observer');
xlim([0 10]);
```




```
figure
step(sys_sf,'b');
hold on
step(sys_reg,'g--');legend('State feedback controller','State feedback controller + observer');
xlim([0 10]);
```




```
A = [0, 1, 0, 0; 42.51, 0, 0, 0; 0, 0, 0, 1; -(2.943), 0, 0, 0];
B = [0; -(3.333); 0; 1];
C = [1, 0, 0, 0; 0, 0, 1, 0];
D = [0; 0];
system_order = length(A)
```

```
system_order = 4
```

```
M = ctrb(A,B);
rank(M)
```

```
ans = 4
```

```
N = obsv(A,C);
rank(N)
```

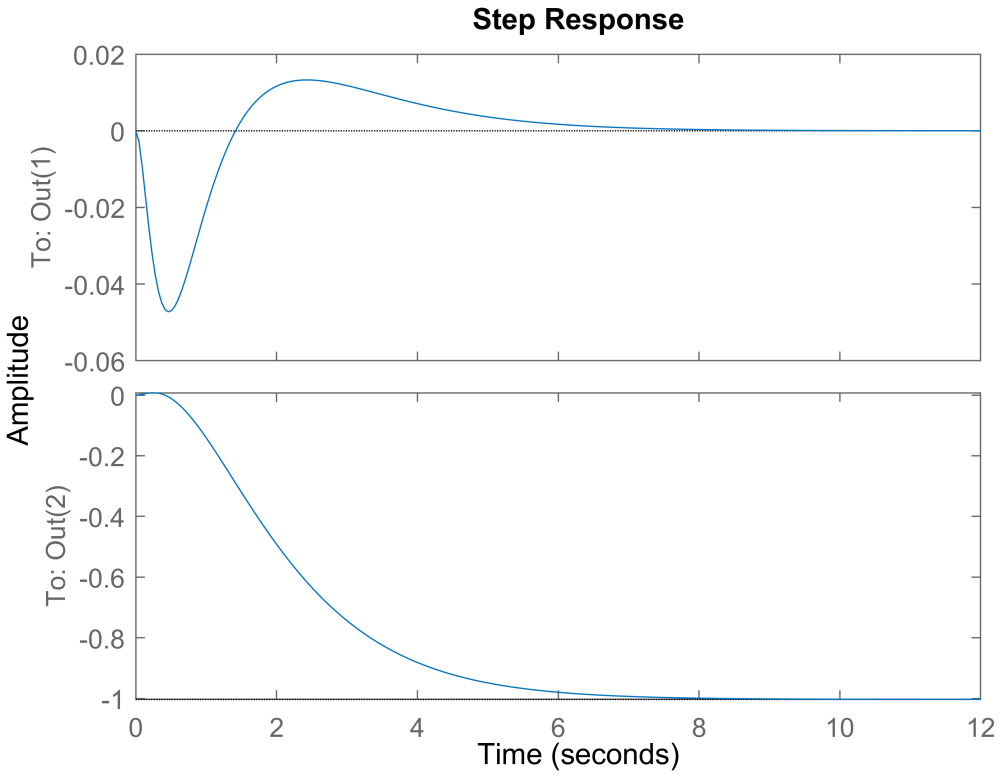
```
ans = 4
```

```
desiredPoles = [-1 -1 -5 -6.52];
K = acker(A,B,desiredPoles);
```

```
Warning: Pole locations are more than 10% in error.
```

```
% K = place(A,B,desiredPoles);
% closed-loop system
Ac = A-B*K; Bc = B; Cc = C; Dc = D;
sys_closed = ss(Ac,Bc,Cc,Dc);
```

```
tf_closed = tf(sys_closed);
figure
step(sys_closed);
```




```
stepinfo(sys_closed)
```

```
ans = 2×1 struct
```

...

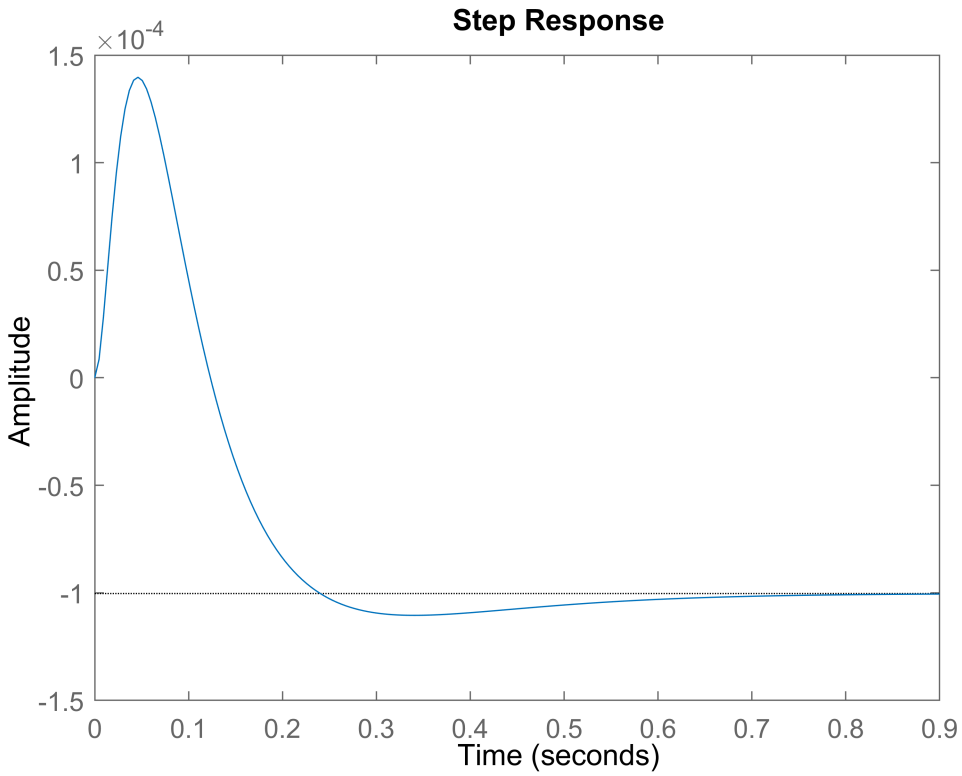
Fields	RiseTime	TransientTime	SettlingTime	SettlingMin	SettlingMax
1	9.0206e-17	6.7445	NaN	-0.0472	0.0133
2	3.3709	6.1824	6.1911	-1.003	-0.9057

```
eig(sys_closed)
```

```
ans = 4×1 complex
  -6.5200 + 0.0000i
  -5.0000 + 0.0000i
  -1.0000 + 0.0000i
  -1.0000 - 0.0000i
```

```
observerPoles = 10 * desiredPoles;
L = acker(A',C(2,:)',observerPoles);
% L = place(A',C(2,:)',observerPoles);
Ao = A - L'*C(2,:); Bo = B; Co = C(2,:); Do = D(2,:);
sys_observer = ss(Ao,Bo,Co,Do);
tf_observer = tf(sys_observer);
figure
```

```
step(sys_observer);
```




```
stepinfo(sys_observer)
```

```
ans = struct with fields:
          RiseTime: 0.0835
    TransientTime: 0.5168
     SettlingTime: 0.6412
      SettlingMin: -1.1045e-04
      SettlingMax: -9.2001e-05
        Overshoot: 10.1105
       Undershoot: 139.2860
             Peak: 1.3972e-04
         PeakTime: 0.0461
```

```
eig(sys_observer)
```

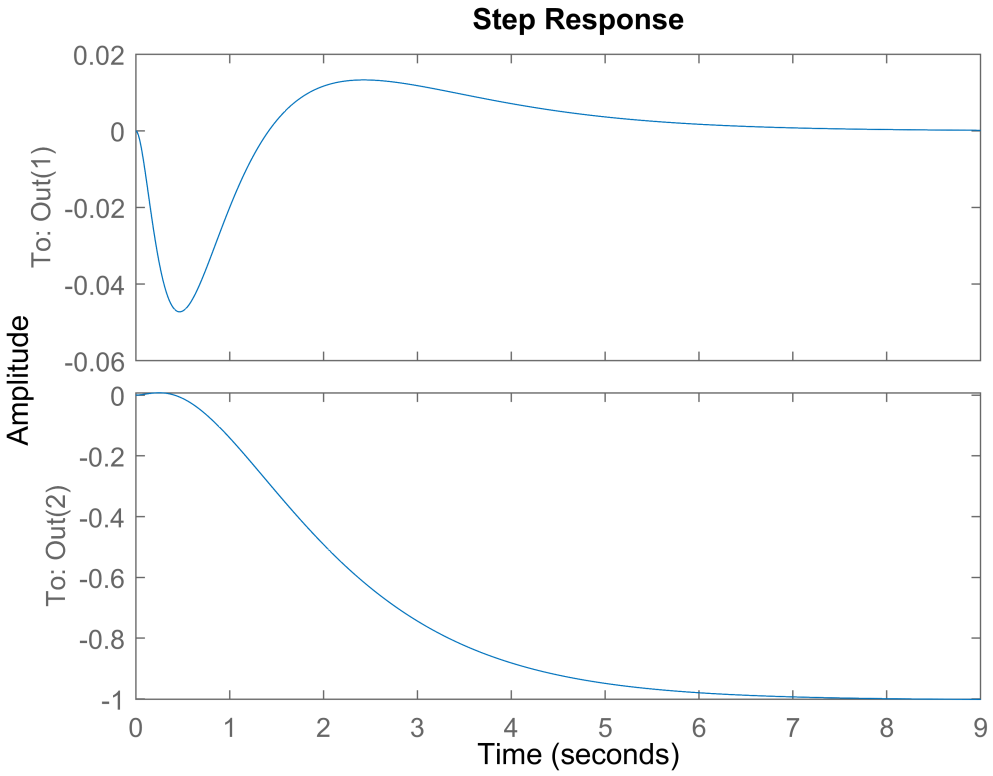
```
ans = 4×1 complex
 -65.2000 + 0.0000i
 -50.0000 + 0.0000i
 -10.0000 + 0.0000i
 -10.0000 - 0.0000i
```

```
Areg = [(A-B*K) B*K;zeros(size(A)) (A+L'*C(2,:))];
Breg = [B; zeros(size(B))];
Creg = [C zeros(size(C))];
Dreg = 0;

sys_reg = ss(Areg,Breg,Creg,Dreg);
tf_reg = tf(sys_reg);
result_eig = eig(sys_reg)
```

```
result_eig = 8×1 complex
10^2 ×
  -0.0652 + 0.0000i
  -0.0500 + 0.0000i
  -0.0100 + 0.0000i
  -0.0100 - 0.0000i
   1.7141 + 0.0000i
  -0.1381 + 0.0553i
  -0.1381 - 0.0553i
  -0.0859 + 0.0000i
```

```
figure
step(sys_reg);
```




```
stepinfo(sys_reg)
```

```
ans = 2×1 struct
```

...

Fields	RiseTime	TransientTime	SettlingTime	SettlingMin	SettlingMax
1	3.4584e-15	6.744	NaN	-0.0472	0.0133
2	3.3708	6.1821	6.1909	-1.0026	-0.9029