MECH 6300 - Homework 4

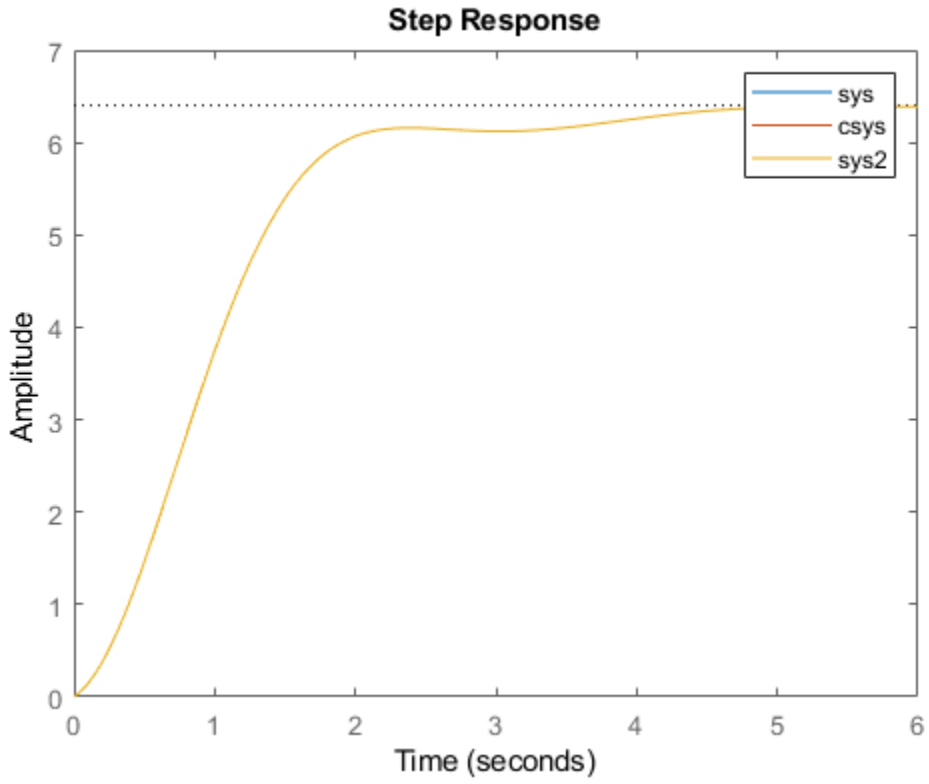
```
close all

% Problem 1

A = [0  1   0
     0  0   1
     -2 -4  -3];
B = [1  0
     0  1
     -1 1];
C = [0  1   -1
     1  2   0];
D = 0;

sys = ss(A,B,C,D)

% Matrix Inversions
syms s
sI_A = (s * eye(3) - A);
poles = factor(det(sI_A),s);
sI_A_inv = sI_A^-1


% Problem 2 and 3
A = [1  0   -1
    -16 -2  7
    0   -1  -2];
B = [1;0;1];
C = [1  -1  0];
D = 0;

sys = ss(A,B,C,D);
[csys,T] = canon(sys)

P_inv = [-1 -3  1
         2   20  0
         -2  -4  8];
P = inv(P_inv);

A_hat = P*A*P_inv;
B_hat = P*B;
C_hat = C*P_inv;
D_hat = D;

sys2 = ss(A_hat,B_hat,C_hat,D_hat)

figure()
step(sys)
hold on
step(csys)
```

```
step(sys2)
legend()
hold off


%Problem 4 Verification
A = [1  0   1   1
    0   1   0   0
    0   0   1   -1
    0   0   0   1];

s*eye(4)-A;
adjoint(s*eye(4)-A);
inv(s*eye(4)-A)
e_At = ilaplace(inv(s*eye(4)-A))
exp(A*t)


%Problem 6
A1 = [2 -1  2
      0 -1  -1
      0 0   1];
B1 = [1; 1; 0];
C1 = [1 -1 0];
D1 = 0;
sys1 = ss(A1,B1,C1,D1);
tf1 = tf(sys1)


A2 = [2 3   2
      0 -1  1
      0 0   -1];
B2 = [1; 1; 0];
C2 = [1 -1  0];
D2 = 0;
sys2 = ss(A2,B2,C2,D2);
tf2 = tf(sys2)


sys =

  A =
       x1  x2  x3
   x1   0   1   0
   x2   0   0   1
   x3  -2  -4  -3

  B =
       u1  u2
   x1   1   0
   x2   0   1
   x3  -1   1

  C =
```

```
       x1  x2  x3
   y1   0   1  -1
   y2   1   2   0

  D =
       u1  u2
   y1   0   0
   y2   0   0

Continuous-time state-space model.


sI_A_inv =

[ (s^2 + 3*s + 4)/(s^3 + 3*s^2 + 4*s + 2),        (s + 3)/(s^3 + 3*s^2
 + 4*s + 2),   1/(s^3 + 3*s^2 + 4*s + 2)]
[              -2/(s^3 + 3*s^2 + 4*s + 2),    (s*(s + 3))/(s^3 + 3*s^2
 + 4*s + 2),   s/(s^3 + 3*s^2 + 4*s + 2)]
[          -(2*s)/(s^3 + 3*s^2 + 4*s + 2), -(2*(2*s + 1))/(s^3 + 3*s^2
 + 4*s + 2), s^2/(s^3 + 3*s^2 + 4*s + 2)]


csys =

  A =
       x1  x2  x3
   x1  -1   0   0
   x2   0  -1   2
   x3   0  -2  -1

  B =
          u1
   x1   5.026
   x2  0.3246
   x3   1.484

  C =
          x1      x2      x3
   y1   1.044   2.617  -3.436

  D =
       u1
   y1   0

Continuous-time state-space model.


T =

    5.7446    0.7181   -0.7181
    0.9561   -0.1534   -0.6315
    2.1836    0.3925   -0.6994
```

```
sys2 =

  A =
       x1  x2  x3
   x1  -1   0   0
   x2   0  -1   2
   x3   0  -2  -1

  B =
          u1
   x1   -1.75
   x2   0.175
   x3  -0.225

  C =
        x1   x2   x3
   y1   -3  -23    1

  D =
       u1
   y1   0

Continuous-time state-space model.


ans =

[ 1/(s - 1),          0, 1/(s - 1)^2, (s - 2)/(s - 1)^3]
[         0, 1/(s - 1),           0,                 0]
[         0,          0,   1/(s - 1),      -1/(s - 1)^2]
[         0,          0,           0,         1/(s - 1)]


e_At =

[ exp(t),       0, t*exp(t), t*exp(t) - (t^2*exp(t))/2]
[      0, exp(t),        0,                        0]
[      0,       0,   exp(t),                -t*exp(t)]
[      0,       0,        0,                   exp(t)]


ans =

[ exp(t),       1, exp(t),  exp(t)]
[      1, exp(t),       1,       1]
[      1,       1, exp(t), exp(-t)]
[      1,       1,       1,  exp(t)]


tf1 =

       2
  -----------
  s^2 - s - 2
```

```
Continuous-time transfer function.


tf2 =

       6
  -----------
  s^2 - s - 2

Continuous-time transfer function.
```



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