ELE 504 HW #7

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Noah Johnson 4/2/19

Setup

```
run prob1_model.m
```

Question 1a

```
eig(A)

% 2 peaks exist at f1 = 21.3 rads/sec and f2 = 1.57 rads/sec
% The peak at f2 has a higher peak magnitude value and is thus
% considered the "bad resonance


ans =

  -0.7100 +21.3001i
  -0.7100 -21.3001i
  -0.1220 + 1.5700i
  -0.1220 - 1.5700i
  -0.0068 + 0.0000i
  -0.0000 + 0.0000i
```

Question 1b

```
Q1 = C'*C; % according to the given eqn

R1 = 0.2; % SAA
```

Question 1c

```
K1 = lqr(A,B,Q1,R1);

eig(A-B*K1)

% The new poles result in a 29% attenuation of the peak at f2
```

```
ans =

  -1.4875 +21.3405i
  -1.4875 -21.3405i
  -0.1712 + 1.5614i
  -0.1712 - 1.5614i
  -0.1087 + 0.0000i
  -0.0000 + 0.0000i
```

Question 1d

```
plant = ss(A,B,C,zeros(2,1));
[plant_mode, Tc] = canon(plant,'modal');
[A_,B_,C_,D_] = ssdata(plant_mode);

Q2 = diag([0,0,4,4,0,0]);

Q = Q1 + Q2;

R2 = 1;

K2 = lqr(A_,B_,Q,R2);

eig(A_-B_*K2)

% The new poles result in a 55% attenuation of the peak at f2
```

```
ans =

  -0.7129 +21.3002i
  -0.7129 -21.3002i
  -0.2708 + 1.5677i
  -0.2708 - 1.5677i
  -0.0190 + 0.0000i
  -0.0000 + 0.0000i
```

Question 2a

```
A = [-5 -2 0; 2 0 0; 0 .5 0];
B = [2; 0; 0];
```

```
C = [0 0 2];

%This system has all zeros at negative infinity

Q = C'*C;
R = eye();

rho = 2.72e4;

K = lqr(A,B,Q*rho,R);

eig(A-B*K)

[d1,d2] = rb_regsf(A,B,K,0)
```

```
ans =

  -9.0453 + 0.0000i
  -4.5013 + 7.2575i
  -4.5013 - 7.2575i


d1 =

    0.7263


d2 =

     1
```

Question 2b

```
rho2 = 4e8;

Q0 = rho2*B*B';

L = lqr(A',C',Q0,1)';

eig(A-L*C)

[dO1,dO2] = rb_regob(A,B,C,K,L,0)
```

```
ans =

 -43.1546 + 0.0000i
 -21.5771 +37.2590i
 -21.5771 -37.2590i


dO1 =
```

```
    0.5855


dO2 =

    0.6088
```

Question 3a

```
load sroots;

A = [-5 -2 0; 2 0 0; 0 0.5 0];
B = [2; 0; 0];
C = [0 0.25 1];

tzero(A,B,C,0);

%zero at s= -2 confirmed.

Ts = 1;

Tss = Ts/1.5;

dzeros = s2/Tss;

d = poly(dzeros)';

M = diag([2 4 2]);
```

Problem 3b

```
C1 =(inv(M)*d)';

rho = 100;

Q = rho*C1'*C1;

R = 1;

K = lqr(A,B,Q,R);

clp = eig(A-B*K)

[d1,d2] = rb_regsf(A,B,K,0)


clp =

  -9.5893 + 0.0000i
  -5.6530 + 4.4084i
  -5.6530 - 4.4084i
```

```
d1 =

    0.8344


d2 =

     1
```

Question 3c

```
rho = 90;

Qo = rho*B*B';

L = lqr(A',C',Qo,1)';

clop = eig(A-L*C)

[d1,d2] = rb_regob(A,B,C,K,L,0)

% The Observer poles are not fast enough to maintain the 1 second
 settling
% time.


clop =

  -3.1623 + 0.0000i
  -2.1794 + 1.1180i
  -2.1794 - 1.1180i


d1 =

    0.8862


d2 =

    0.7004
```

Question 4a

```
A = [-5 -2 0; 2 0 0; 0 .5 0];
B = [ 2; 0; 0];
C = [0 0.25 -1];

rho = 7.5;
```

```
Q = rho*C'*C;

K = lqr(A,B,Q,1);

clp = eig(A-B*K)

[d1,d2] = rb_regsf(A,B,K,0)


clp =

  -3.9520 + 0.0000i
  -1.0190 + 0.5895i
  -1.0190 - 0.5895i


d1 =

    1.0000


d2 =

     1
```

Question 4b

```
rho = 2000;

Qo = rho*B*B';

L = lqr(A',C',Qo,1)';

clop = eig(A-L*C)

[d1,d2] = rb_regob(A,B,C,K,L,0)


clop =

  -5.0385 + 4.3501i
  -5.0385 - 4.3501i
  -2.0186 + 0.0000i


d1 =

    1.0000


d2 =
```

```
    0.6003
```

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