Contents

Marion Anderson ECE 4550 Fall 2018 HW 5

```
clear clc close all

M1 = 1; M2 = 1;

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

5.1: Controllability

```
scriptC = B;  % Initial controllability matrix
for n = 1:length(A)-1  % adding to controllability matrix
    scriptC = [scriptC, (A^n) * B];
end

fprintf('\n'); disp('scriptC ='); fprintf('\n')
disp(scriptC)
fprintf('\n'); disp('det(scriptC) ='); fprintf('\n')
disp(det(scriptC))


% The controllability matrix has non-zero determinant, and so must be
% full rank. This system is controllable.
```

```
scriptC =

     0     1     0    -2
     0     0     0     2
     1     0    -2     0
     0     0     2     0


det(scriptC) =

    -4
```

5.2: Regulator Gains

```
% regulator gain matrix
syms K1 K2 K3 K4
```

```
K = [K1 K2 K3 K4];

sR = -10;  % desired pole location

K = acker(A, B, sR*ones(1, length(A)))
eig(A - B*K)
```

```
K =

         596        4404          40        1960


ans =

 -10.0022 + 0.0000i
 -10.0000 + 0.0022i
 -10.0000 - 0.0022i
  -9.9978 + 0.0000i
```

5.3: Observability

```
scriptO = C;  % Initial observability matrix
for n = 1:length(A)-1  % adding to observability matrix
    scriptO = [scriptO; C * (A^n)];
end

fprintf('\n'); disp('scriptO ='); fprintf('\n')
disp(scriptO)
fprintf('\n'); disp('det(scriptO) ='); fprintf('\n')
disp(det(scriptO))


% The observability matrix has non-zero determinant, and so must be
% full rank. This system is observabile.
```

```
scriptO =

     0     1     0     0
     0     0     0     1
     2    -2     0     0
     0     0     2    -2


det(scriptO) =

    -4
```

5.4: Estimator Gains

```
% estimator gain matrix
syms L1 L2 L3 L4
L = [L1; L2; L3; L4];
```

```
sL = -10;  % desired pole location
AL = A - L*C  % estimator system matrix

% solving for gains
L = acker(A', C', sL*ones(1, length(A)))'
eig(A - L*C)
```

```
AL =

[  0,      -L1, 1, 0]
[  0,      -L2, 0, 1]
[ -2,   2 - L3, 0, 0]
[  2, - L4 - 2, 0, 0]


L =

        1960
          40
        4404
         596


ans =

 -10.0022 + 0.0000i
 -10.0000 + 0.0022i
 -10.0000 - 0.0022i
  -9.9978 + 0.0000i
```

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