Contents

D

```
clear; close all;

J = 3e-6;
b = 3e-6;
K = 0.02;
R = 4;
L = 2e-6;
h= 0.0001;

A = [0 1 0 ; 0 -b/J K/J; 0 -K/L -R/L]
B = [0;0;1/L]
C = [1 0 0]
D = 0;

Ad = expm(h*A)
M = expm(h*[A eye(3); zeros(3,6)]);
Bd = M(1:3,4:6)*B
Cd = C
Dd = 0;
```

```
A =

   1.0e+06 *

         0    0.0000         0
         0   -0.0000    0.0067
         0   -0.0100   -2.0000


B =

           0
           0
      500000


C =

     1     0     0


Ad =

    1.0000    0.0001    0.0000
         0    0.9966    0.0033
         0   -0.0050   -0.0000
```

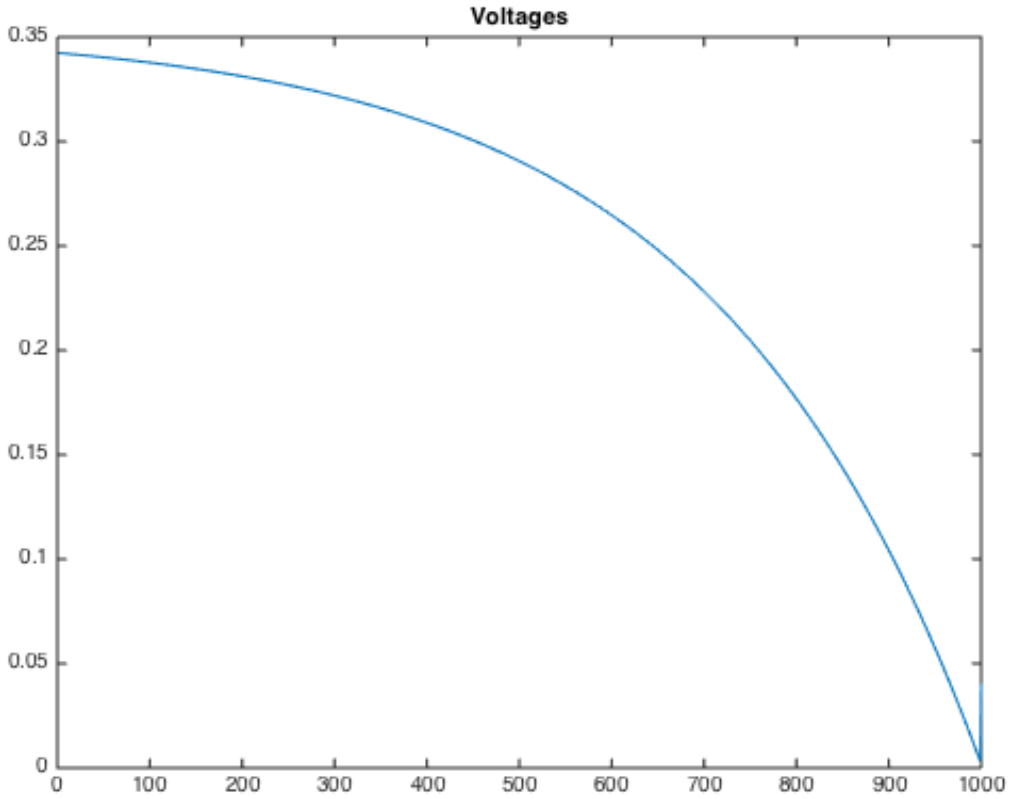
```
Bd =

    0.0000
    0.1656
    0.2492


Cd =

     1     0     0
```

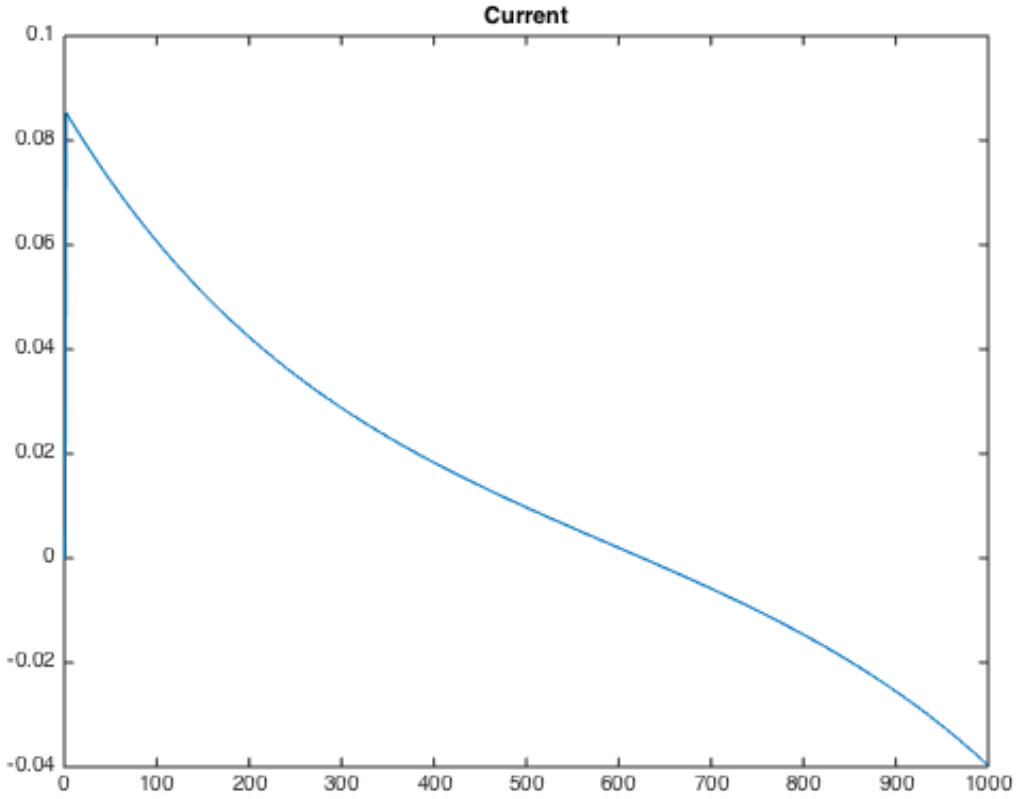
E

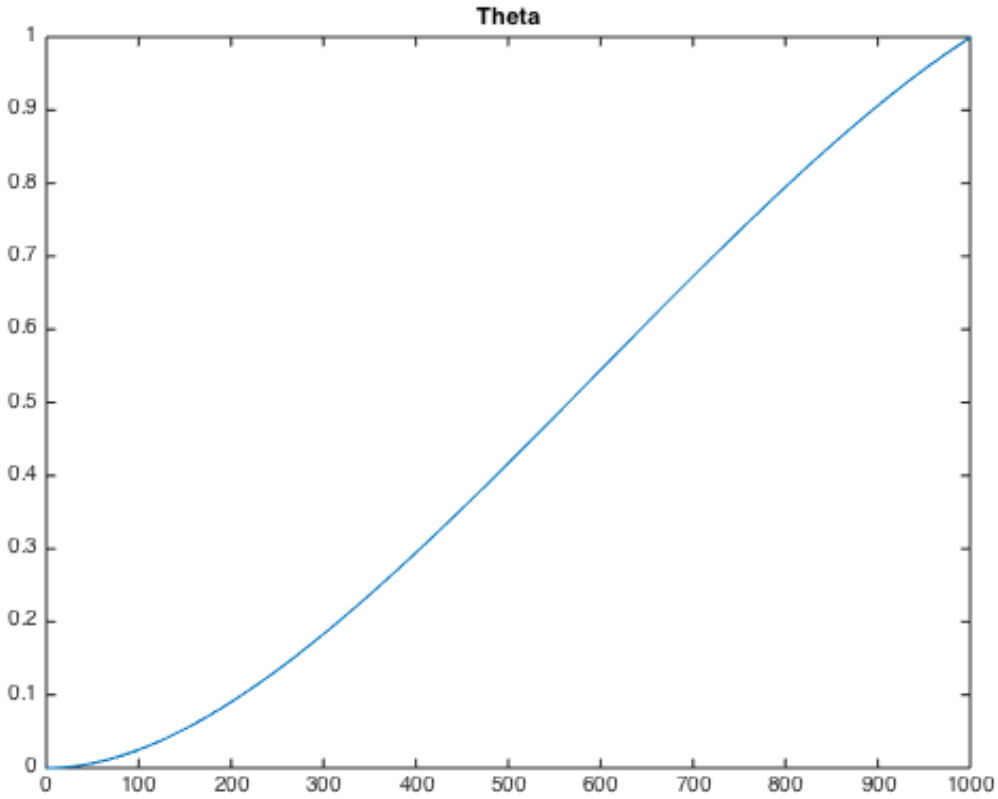
xdes(1) = 1 is obvious because we need to reach point theta=1. The velocity at which to approach the point and the current at which to approach the point were a result of some experimentation. Because the problem did not specify the complete parameters for xdes I found the velocity and current which would result in the smallest input.

```
xdes = [1;8.0808; -0.0303];

% Create controlability matrix
Ctrl = zeros(3,1000);
for i = 1:1000
   Ctrl(:,i) = Ad^(i-1)*Bd;
end

% Least norms
inputReversed = Ctrl'*inv(Ctrl*Ctrl')*xdes;
input = flipud(inputReversed);

Js = norm(input)^2;

% Computation of the currents and theta's
x = zeros(3,1000);
for i = 2:1000
    x(:,i) = Ad*x(:,i-1)+Bd*input(i-1);
end

figure; plot(input);
title('Voltages');

figure; plot(x(3,:));
title('Current');

figure; plot(x(1,:));
title('Theta');

disp(['The minimum norm of the input voltages is: ' num2str(Js)]);
```

```
The minimum norm of the input voltages is: 72.946
```


Voltages
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
0
100
200
300
400
500
600
700
800
900
1000


Current
0.1
0.08
0.06
0.04
0.02
0
-0.02
-0.04
0
100
200
300
400
500
600
700
800
900
1000



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