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```
%Tyler Matthews
%P18

clc; close all; clear all; %Clear console, clear workspace, close figures

A = [-244*10^-6 -1668 1.667 -8.332; 0 -321 320 -1679; 0 79 -80 -79; 0 -320 320 -1680];
B = [8;3;7;2];
x0 = [1;1;1;1];
```

Part A

```
eigen = eig(A)
disp('Stiffness Ratio = 2000')
```

```
eigen =
```

```
1.0e+03 *
```

```
-0.0000
```

```
-2.0000
```

```
-0.0010
```

```
-0.0800
```

```
Stiffness Ratio = 2000
```

Part B

```
T = 0.02;
tfinal = 5;
t = [0:T:tfinal];
N = length(t);

LT = eigen(2)*T;
Am = [0 1 0 -LT; 1 0 -LT 0; 1 1 0 0; 0 1 -1 -1];
Bm = [-exp(LT);0;-1;-2];
Xm = inv(Am)*Bm;
a0 = Xm(1)
a1 = Xm(2)
b0 = Xm(3)
```

```
b1 = Xm(4)
srpstr=['SRP-2-',num2str(abs(LT))];
tstr=['Simulation using ',srpstr,' and T=',num2str(T)];
```

```
a0 =

    0.9750
```

```
a1 =

   -1.9750
```

```
b0 =

   -0.0244
```

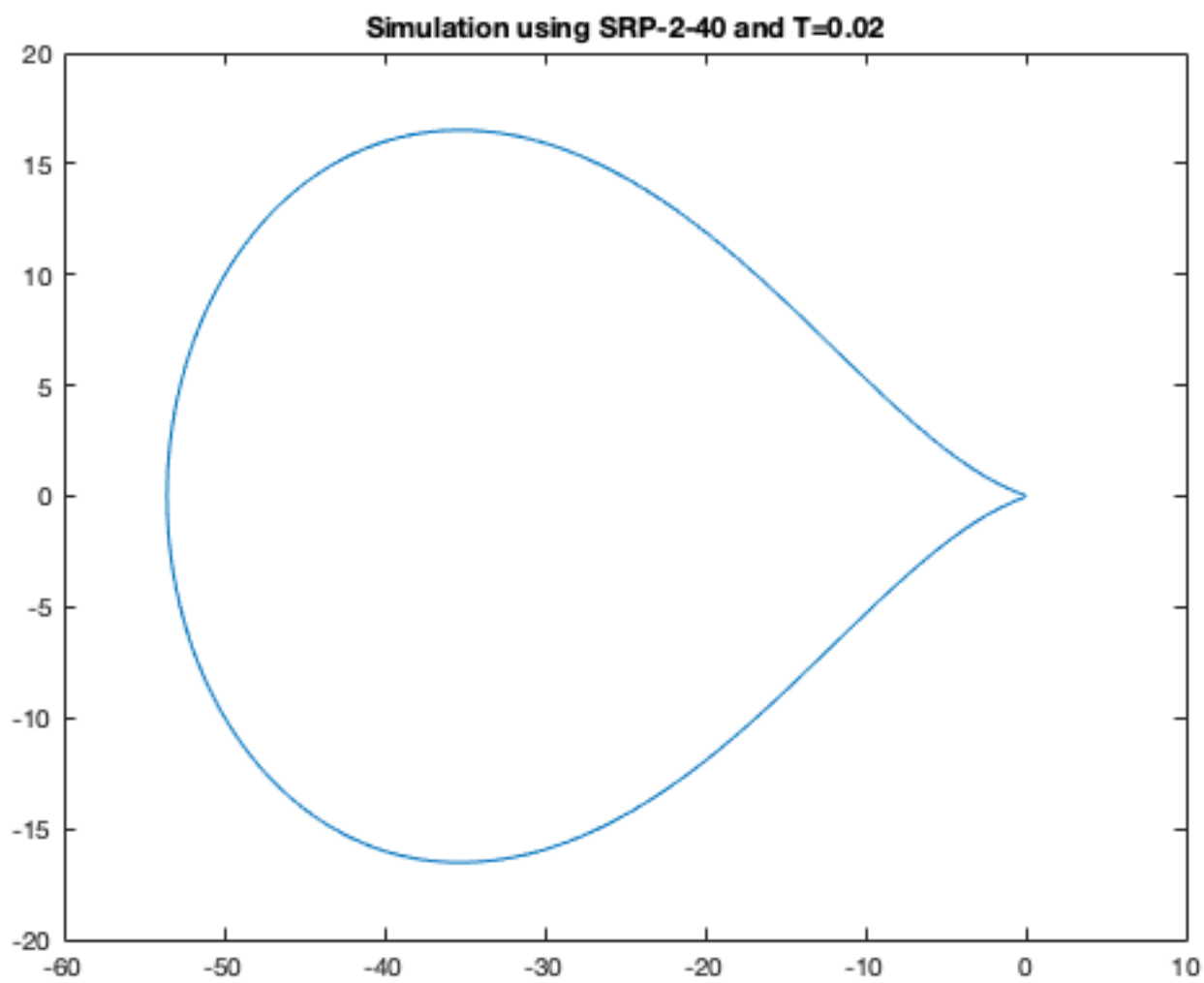
```
b1 =

    0.0494
```

Part C

```
theta=linspace(0,2*pi,1001);
z = 1*exp(theta*i);
w = (z.^2 + a1*z +a0)./(b1*z + b0);

figure;
plot(real(w),imag(w))
title(tstr)
```



Part D

```
x = zeros(4,N);
u = x;
f = x;
x(:,1) = [1 1 1 1];

k=1;
f(1,k) = -244*10^-6*x(1,k) - 1668*x(2,k) + 1.667*x(3,k) - 8.332*x(4,k);
f(2,k) = -321*x(2,k) + 320*x(3,k) - 1679*x(4,k);
f(3,k) = 79*x(2,k) - 80*x(3,k) - 79*x(4,k);
f(4,k) = -320*x(2,k) + 320*x(3,k) - 1680*x(4,k);

x(:,2)=x(:,1)+T*f(:,1);

for k=2:N-1
    f(1,k) = -244*10^-6*x(1,k) - 1668*x(2,k) + 1.667*x(3,k) - 8.332*x(4,k);
    f(2,k) = -321*x(2,k) + 320*x(3,k) - 1679*x(4,k);
    f(3,k) = 79*x(2,k) - 80*x(3,k) - 79*x(4,k);
    f(4,k) = -320*x(2,k) + 320*x(3,k) - 1680*x(4,k);

    x(:,k+1) = T*b1*f(:,k) + T*b0*f(:,k-1) - a1*x(:,k) - a0*x(:,k-1);

end

figure;
subplot(4,1,1)
plot(t,x(1,:))
xlabel('t')
```

```

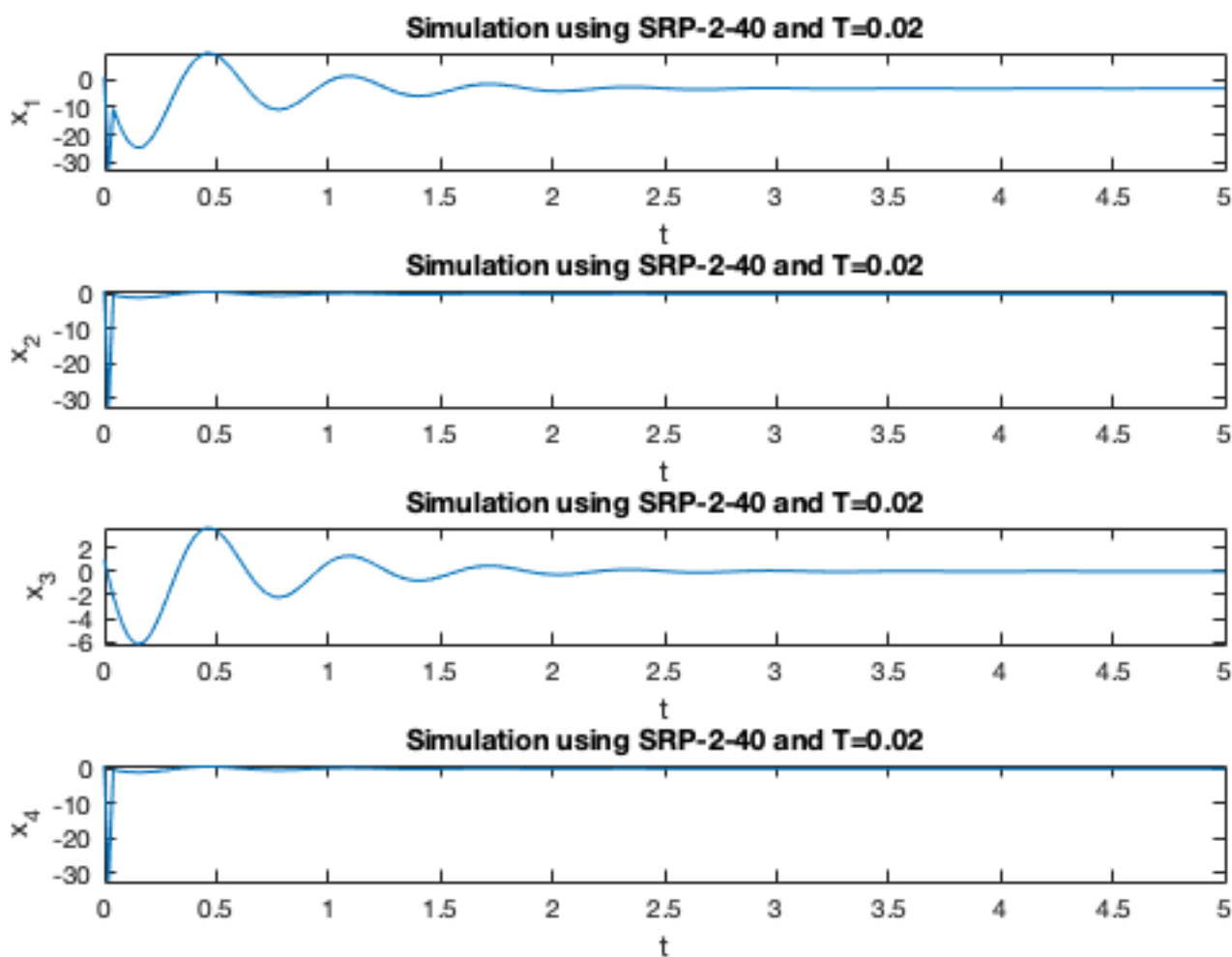
ylabel('x_1')
title(tstr)

subplot(4,1,2)
plot(t,x(2,:))
xlabel('t')
ylabel('x_2')
title(tstr)

subplot(4,1,3)
plot(t,x(3,:))
xlabel('t')
ylabel('x_3')
title(tstr)

subplot(4,1,4)
plot(t,x(4,:))
xlabel('t')
ylabel('x_4')
title(tstr)

```



Part E

```

J = [-244*10^-6 -1668 1.667 -8.332; 0 -321 320 -1679; 0 79 -80 -79; 0 -320 320 -1680];
x0 = [1;1;1;1];

tfinal = 0.15;
T = 0.02;

```

```

Teul=0.00002;
t = [0:T:tfinal];
te=[0:Teul:tfinal];
N = length(t);
Ne=length(te);

exJ = expm(J*T)
[junk,nn] = size(J);

A1 = (exJ-eye(nn))*inv(J*T)-2*eye(nn)
A0 = -eye(nn)-A1
B1 = (A1+exJ)*inv(J*T)
B0 = (A0)*inv(J*T)

```

exJ =

1.0000	-30.3646	-2.6309	29.5264
0	0.9465	0.0336	-0.9465
0	0.7783	0.2019	-0.7783
0	-0.0336	0.0336	0.0336

A1 =

-1.0000	-14.9491	-1.6037	14.1319
0	-1.0889	0.0790	-0.8861
0	0.4913	-1.5012	-0.4913
0	-0.0790	0.0790	-1.8960

A0 =

0.0000	14.9491	1.6037	-14.1319
0	0.0889	-0.0790	0.8861
0	-0.4913	0.5012	0.4913
0	0.0790	-0.0790	0.8960

B1 =

1.5000	-19.8768	-2.1855	18.6610
0	1.3596	0.1271	-1.3103
0	0.6747	0.8121	-0.6747
0	-0.1271	0.1271	0.1765

B0 =

-0.5000	4.9277	0.5819	-4.5291
0	-0.4485	-0.0481	0.4242
0	-0.1834	-0.3132	0.1834
0	0.0481	-0.0481	-0.0725

Part F

```
x = zeros(nn,N);
f = x;
xe=zeros(nn,Ne);
fe=xe;
x(:,1) = x0;
xe(:,1)=x(:,1);

for k=1:Ne-1
    fe(:,k)=J*xe(:,k);
    xe(:,k+1)=xe(:,k)+Teul*fe(:,k);
end

f(:,1) = J*x(:,1);
x(:,2) = x(:,1)+T*f(:,1);
for k=1:N-2
    f(:,k+1) = J*x(:,k+1);
    x(:,k+2) = -A1*x(:,k+1)-A0*x(:,k)+T*B1*f(:,k+1)+T*B0*f(:,k);
end

figure;
subplot(4,1,1)
plot(te,xe(1,:), 'b')
hold on
stairs(t,x(1,:), 'r')
hold off
xlabel('t')
ylabel('x_1')

subplot(4,1,2);
plot(te,xe(2,:), 'b')
hold on
stairs(t,x(2,:), 'r')
hold off
xlabel('t')
ylabel('x_2')

subplot(4,1,3);
plot(te,xe(3,:), 'b')
hold on
stairs(t,x(3,:), 'r')
hold off
xlabel('t')
ylabel('x_3')

subplot(4,1,4);
plot(te,xe(4,:), 'b')
hold on
stairs(t,x(4,:), 'r')
hold off
xlabel('t')
ylabel('x_4')
```

