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```
%Tyler Matthews 4/15/19
```

```
%System Simulation Problem 05
```

```
close all; clc; clear;%Clear Console and Close Figures
```

```
%Constants
```

```
R1 = 500;
```

```
R2 = 1000;
```

```
R3 = 1000;
```

```
C1 = 4.7e-6;
```

```
C2 = 4.7e-6;
```

```
C3 = 4.7e-6;
```

```
L = 2;
```

```
%Matricies
```

```
A = [-1/(C1*R2), 1/(C1*R2), 0, 1/(C1); 1/(C2*R2), (-1/(C2*R2))+(-1/(C2*R3)), 1/(C2*R3), 0; 0,  
1/(C3*R3), -1/(C3*R3), 0; -1/(L), 0, 0, (-1*R1)/(L)]
```

```
B = [0; 0; 0; 1/(L)]
```

```
C = [0, 0, 1, 0]
```

```
D = [0]
```

A =

1.0e+05 *

| | | | |
|---------|---------|---------|---------|
| -0.0021 | 0.0021 | 0 | 2.1277 |
| 0.0021 | -0.0043 | 0.0021 | 0 |
| 0 | 0.0021 | -0.0021 | 0 |
| -0.0000 | 0 | 0 | -0.0025 |

B =

| |
|--------|
| 0 |
| 0 |
| 0 |
| 0.5000 |

C =

| | | | |
|---|---|---|---|
| 0 | 0 | 1 | 0 |
|---|---|---|---|

D =

0

PART A

```
lamda = eig(A)
```

```
lamda =
```

```
1.0e+02 *
```

```
-6.0605 + 0.0000i
```

```
-2.1649 + 2.8500i
```

```
-2.1649 - 2.8500i
```

```
-0.6204 + 0.0000i
```

PART B

```
Nt=21;
```

```
Nr=12;
```

```
theta=linspace(0,2*pi,1001);
```

```
rho=linspace(0.712,1,1001);
```

```
tvec=linspace(0,2*pi,Nt);
```

```
rvec=linspace(0.712, 1,Nr);
```

```
figure;
```

```
subplot(1,2,1)
```

```
z=exp(i*theta);
```

```
w=(12*z.^3-12*z.^2)./(23*z.^2-16*z+5);
```

```
plot(real(w), imag(w))
```

```
xlabel('Real')
```

```
ylabel('Imaginary')
```

```
title('AB3 Absolute Stability')
```

```
subplot(1,2,2)
```

```
for k=1:length(rvec)
```

```
    z=rvec(k)*exp(i*theta);
```

```
    w=(12*z.^3-12*z.^2)./(23*z.^2-16*z+5);
```

```
    hold on
```

```
    plot(real(w), imag(w))
```

```
    hold off
```

```
end
```

```
for k=1:length(tvec)-1
```

```
    z=rho*exp(i*tvec(k));
```

```
    w=(12*z.^3-12*z.^2)./(23*z.^2-16*z+5);
```

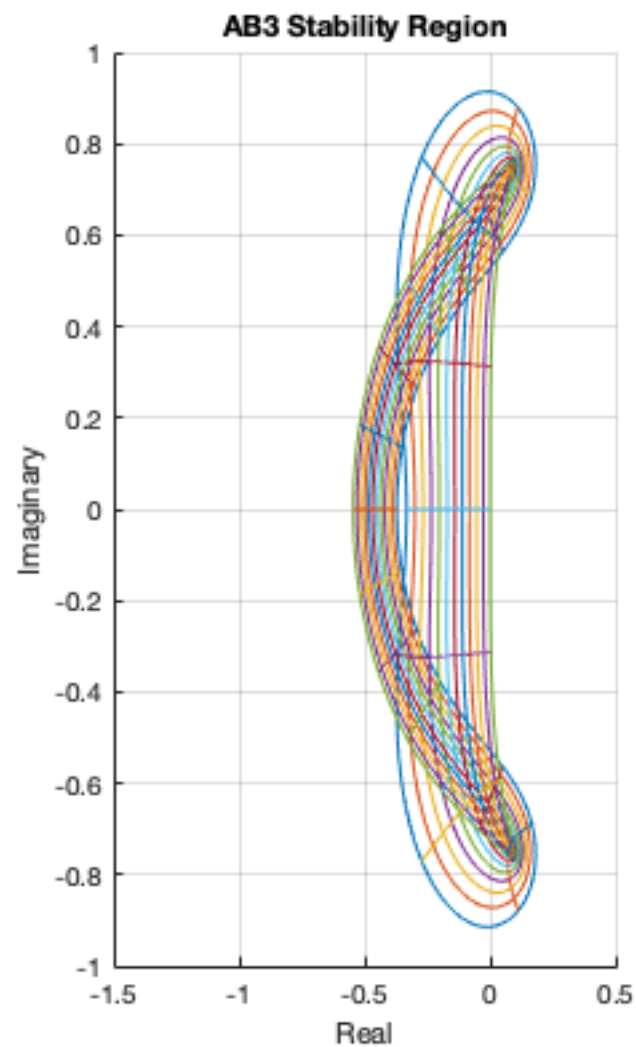
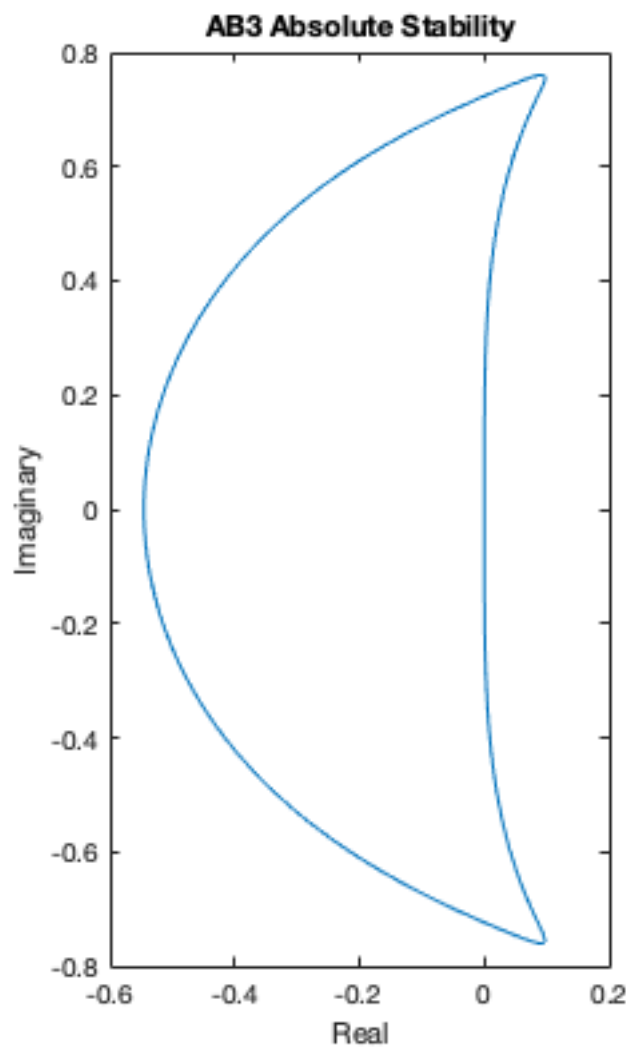
```
    hold on
```

```

plot(real(w), imag(w))
hold off
end

title('AB3 Stability Region')
axis([-1.5 0.5 -1 1])
xlabel('Real')
ylabel('Imaginary')
grid on

```



PART C

```

figure;

T = linspace(0,1,1001);

hold on
plot(real(lamda(1)*T), imag(lamda(1)*T), 'black')
plot(real(lamda(2)*T), imag(lamda(2)*T), 'black')
plot(real(lamda(3)*T), imag(lamda(3)*T), 'black')
plot(real(lamda(4)*T), imag(lamda(4)*T), 'black')
hold off

stable = 4e-5
unstable = 10e-4

hold on
plot(real(lamda*stable),imag(lamda*stable ), 'x') %Stable and accurate

```

```

plot(real(lamda*unstable),imag(lamda*unstable ), 'o') %Unstable and inaccurate
hold off

for k=1:length(rvec)
    z=rvec(k)*exp(i*theta);
    w=(12*z.^3-12*z.^2)./(23*z.^2-16*z+5);

    hold on
    plot(real(w), imag(w))
    hold off
end

for k=1:length(tvec)-1
    z=rho*exp(i*tvec(k));
    w=(12*z.^3-12*z.^2)./(23*z.^2-16*z+5);

    hold on
    plot(real(w), imag(w))
    hold off
end

title('AB3 Stability Region')
axis([-0.75 0.25 -1 1])
xlabel('Real')
ylabel('Imaginary')
grid on

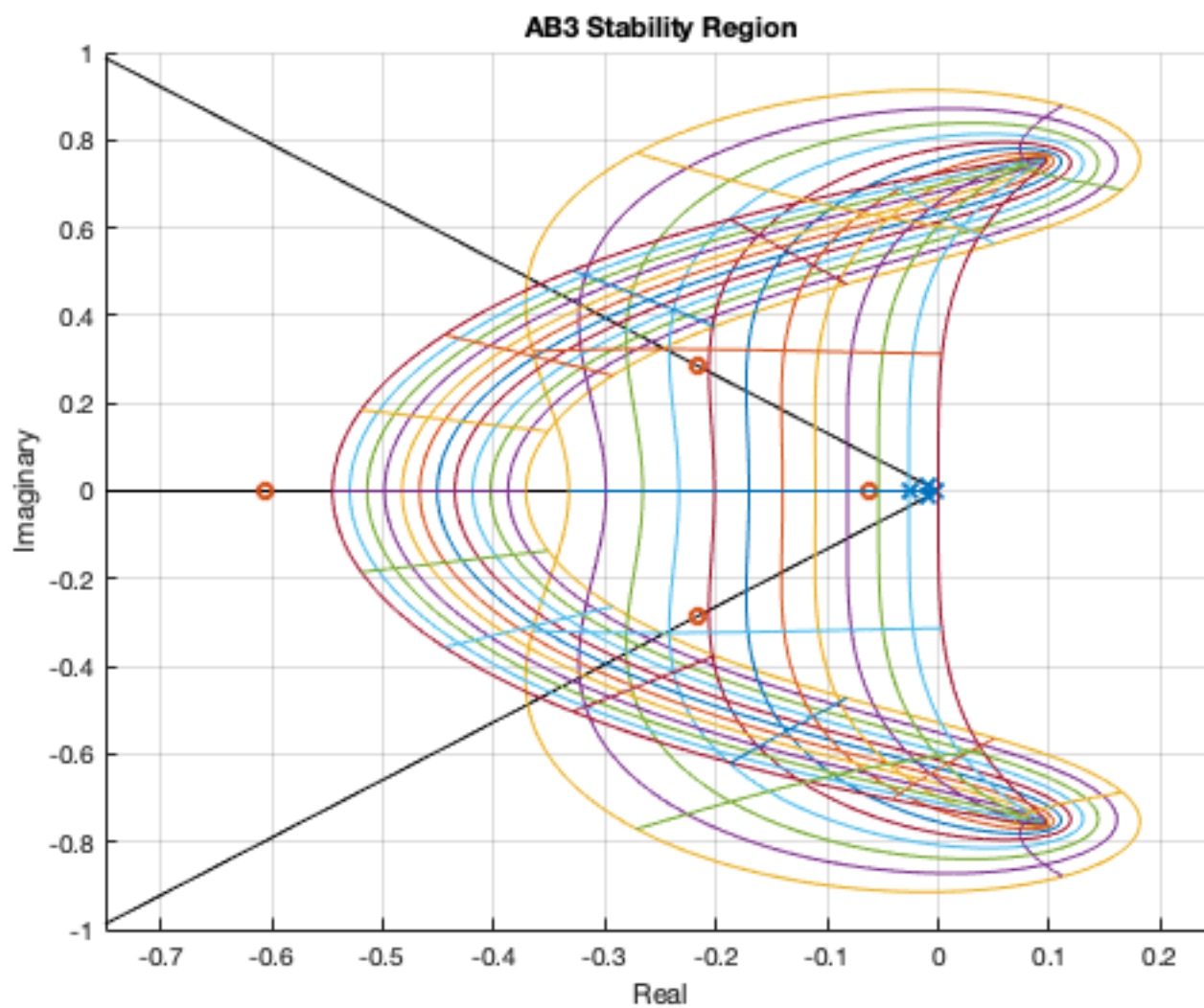
```

stable =

4.0000e-05

unstable =

1.0000e-03



PART D

```
l1 = lamda * stable;
l2 = lamda * unstable;

num = [0 23 -16 5];
den = [12-12 0 0];

stable_accurate_poles = exp(l1)
unstable_inaccurate_poles = exp(l2)

disp("Stable Principle Poles @ " +stable_accurate_poles(2) + " & " + stable_accurate_poles(3))
disp("Stable Spurious Poles @ " +stable_accurate_poles(1) + " & " + stable_accurate_poles(3))

disp("Unstable Principle Poles @ " +unstable_inaccurate_poles(2) + " & " + unstable_inaccurate_poles(3))
disp("Unstable Spurious Poles @ " +unstable_inaccurate_poles(1) + " & " + unstable_inaccurate_poles(3))
```

```
stable_accurate_poles =
```

```
0.9760 + 0.0000i
0.9913 + 0.0113i
0.9913 - 0.0113i
0.9975 + 0.0000i
```

```
unstable_inaccurate_poles =
```

```
0.5455 + 0.0000i  
0.7729 + 0.2264i  
0.7729 - 0.2264i  
0.9398 + 0.0000i
```

```
Stable Principle Poles @ 0.99131+0.011302i & 0.99131-0.011302i  
Stable Spurious Poles @ 0.97605 & 0.99131-0.011302i  
Unstable Principle Poles @ 0.77285+0.22643i & 0.77285-0.22643i  
Unstable Spurious Poles @ 0.5455 & 0.77285-0.22643i
```

PART E

```
T = (stable);  
t1 = 0:T:0.2;  
N = length(t1);  
  
u = ones(4,N);  
x = zeros(4,N);  
Fx = zeros(4,N);  
y = ones(1,N);  
  
Fx(:,1) = A*x(:,1) + B*u(1);  
x(:,2) = x(:,1) + (T*Fx(:,1));  
  
Fx(:,2) = A*x(:,2) + B*u(2);  
x(:,3) = x(:,2) + ((3/2)*T*Fx(:,2)) - ((1/2)*T*Fx(:,1));  
  
for k=1:N-3  
    Fx(:,k+2) = A*x(:,k+2) + B*u(k+2);  
    x(:,k+3) = x(:,k+2) + ((23/12)*T*Fx(:,k+2)) - ((16/12)*T*Fx(:,k+1)) + ((5/12)*T*Fx(:,k));  
    y1(k+3) = C*x(:,k+3);  
end  
  
figure()  
subplot(2,1,1)  
plot(t1,y1)  
title('lamdaT for Stable and Accurate T')  
  
T = (unstable);  
t2 = 0:T:0.2;  
N = length(t2);  
  
u = ones(4,N);  
x = zeros(4,N);  
Fx = zeros(4,N);  
y = ones(1,N);  
  
Fx(:,1) = A*x(:,1) + B*u(1);  
x(:,2) = x(:,1) + (T*Fx(:,1));  
  
Fx(:,2) = A*x(:,2) + B*u(2);  
x(:,3) = x(:,2) + ((3/2)*T*Fx(:,2)) - ((1/2)*T*Fx(:,1));  
  
for k=1:N-3
```

```

Fx(:,k+2) = A*x(:,k+2) + B*u(k+2);
x(:,k+3) = x(:,k+2) + ((23/12)*T*Fx(:,k+2)) - ((16/12)*T*Fx(:,k+1)) + ((5/12)*T*Fx(:,k));
y2(k+3) = C*x(:,k+3);
end

subplot(2,1,2)
plot(t2,y2)
title('lamdaT for unstable and inaccurate T')

figure;
hold on
    plot(t1,y1,'g')
    plot(t2,y2,'b')
hold off
ylim([0 1])
title('Step Responses')

```

