Contents


```
%Tyler Matthews 4/15/19
%System Simulation Problem 11

 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

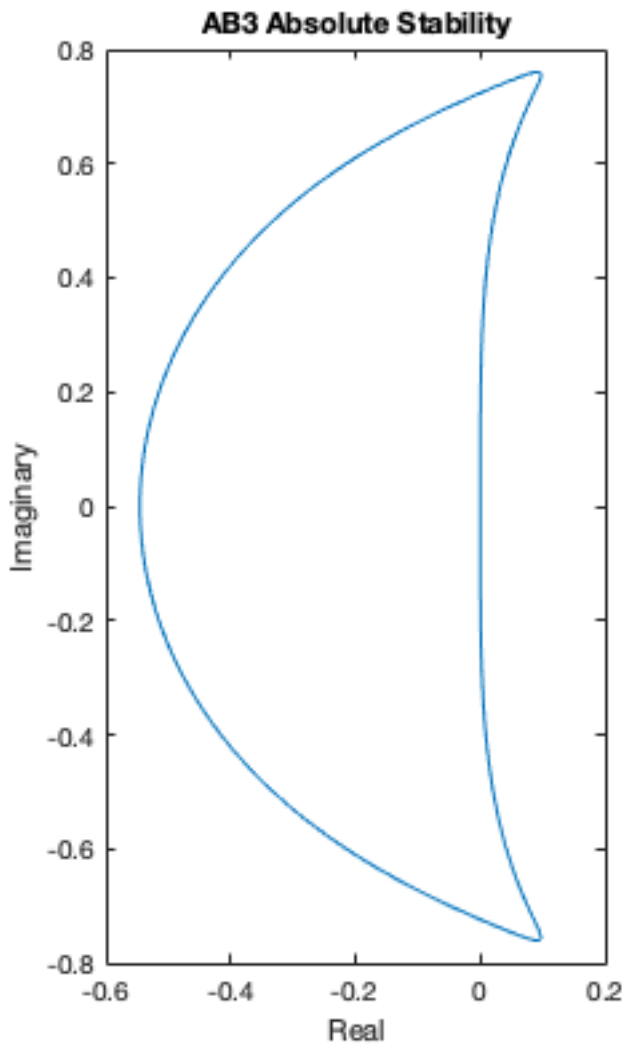
```
lamda = eig(A)
```

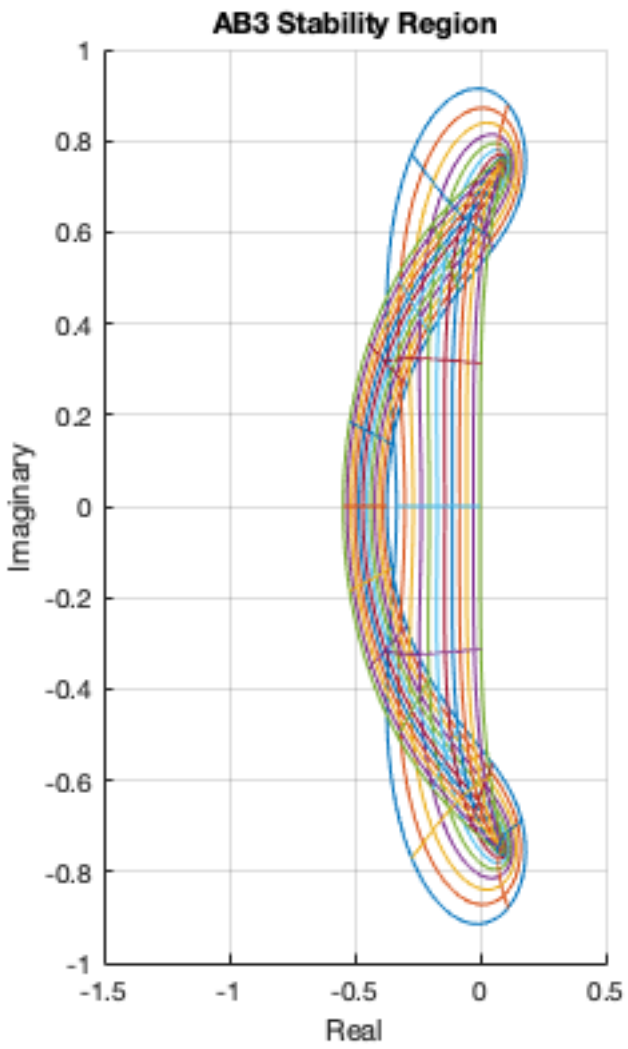
```
lamda =

   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
```



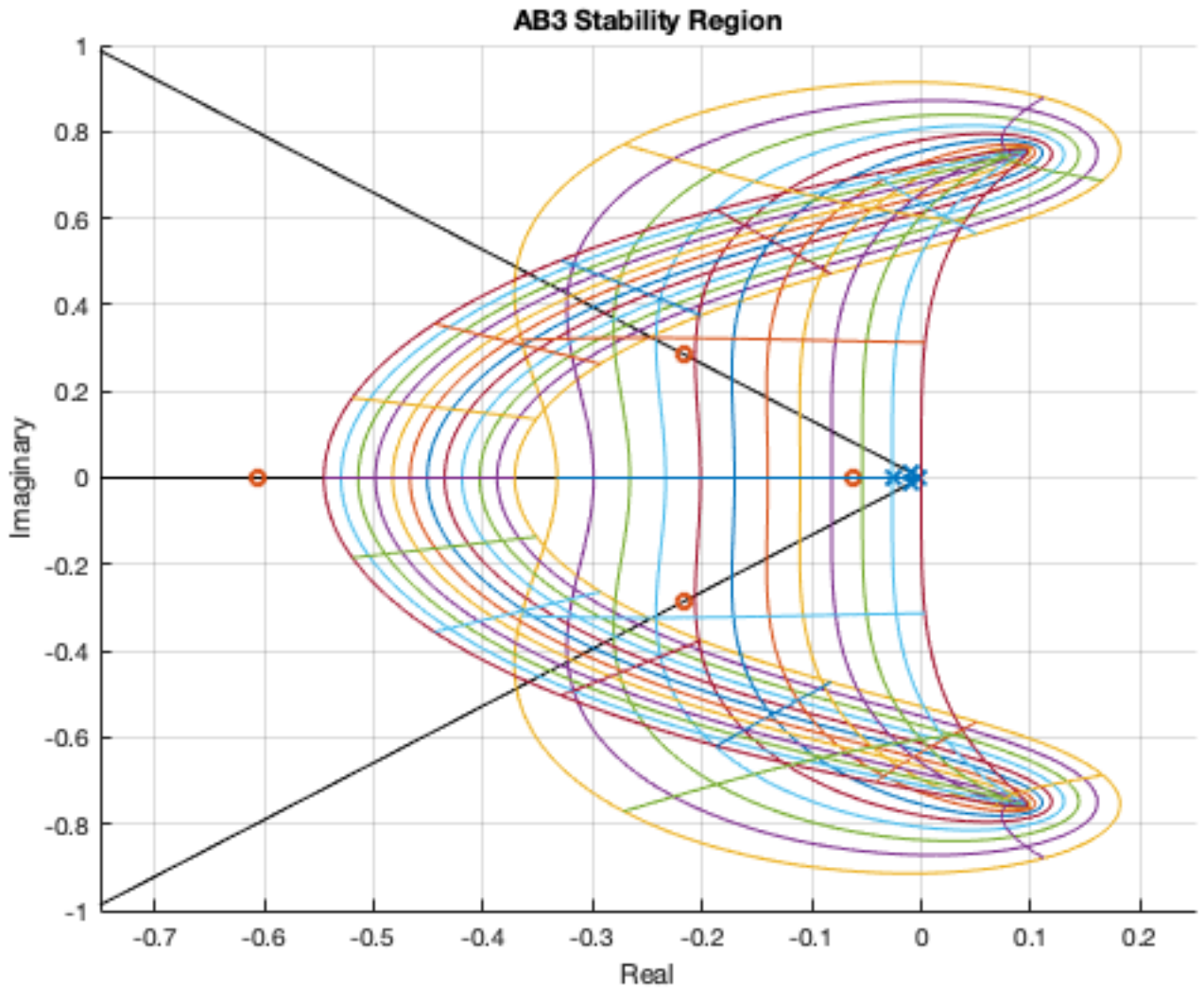


PART C

```
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))
```

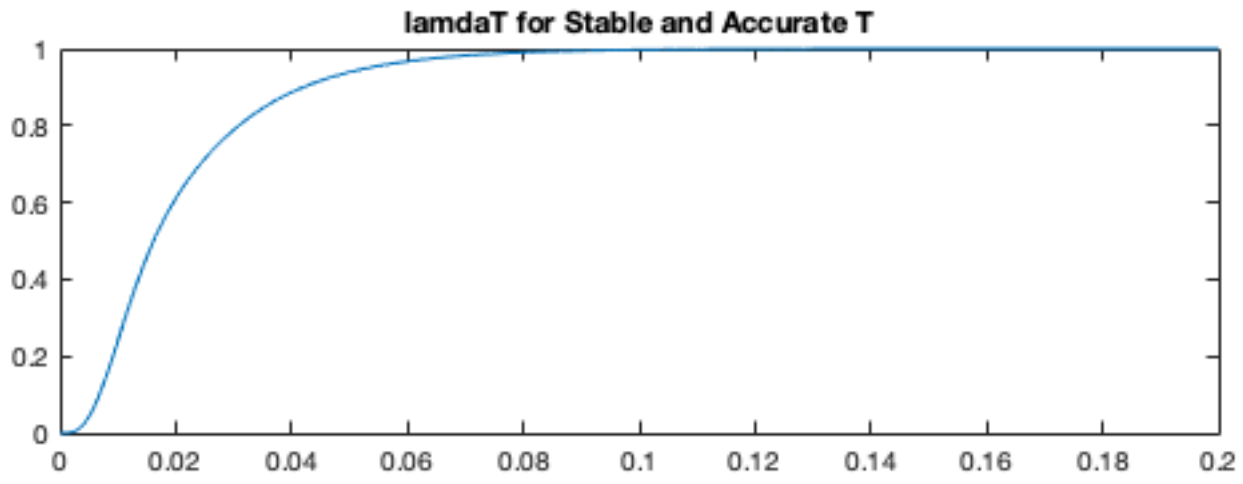
```
stable_accurate_poles =

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

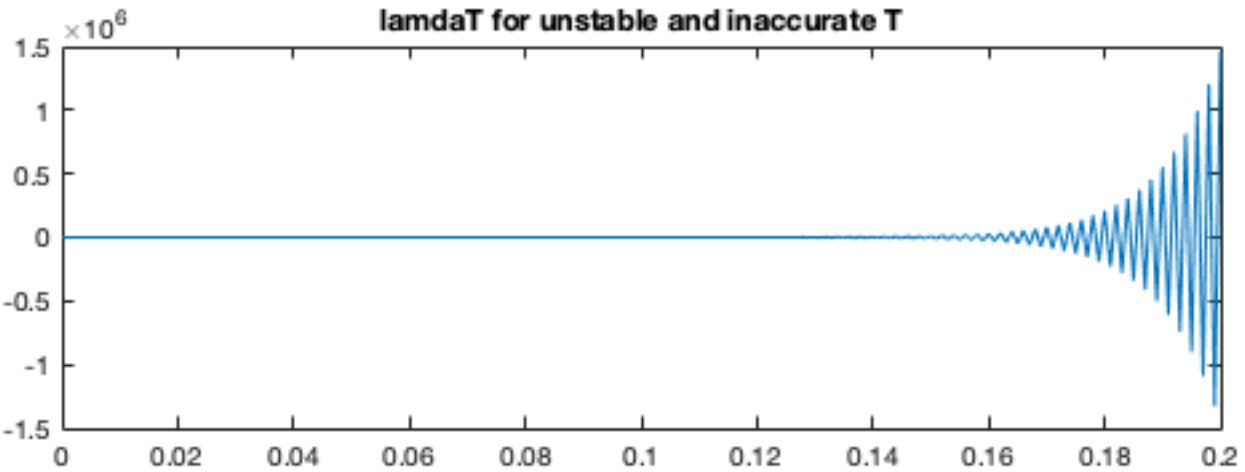
```
unstable_inaccurate_poles =

   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
```

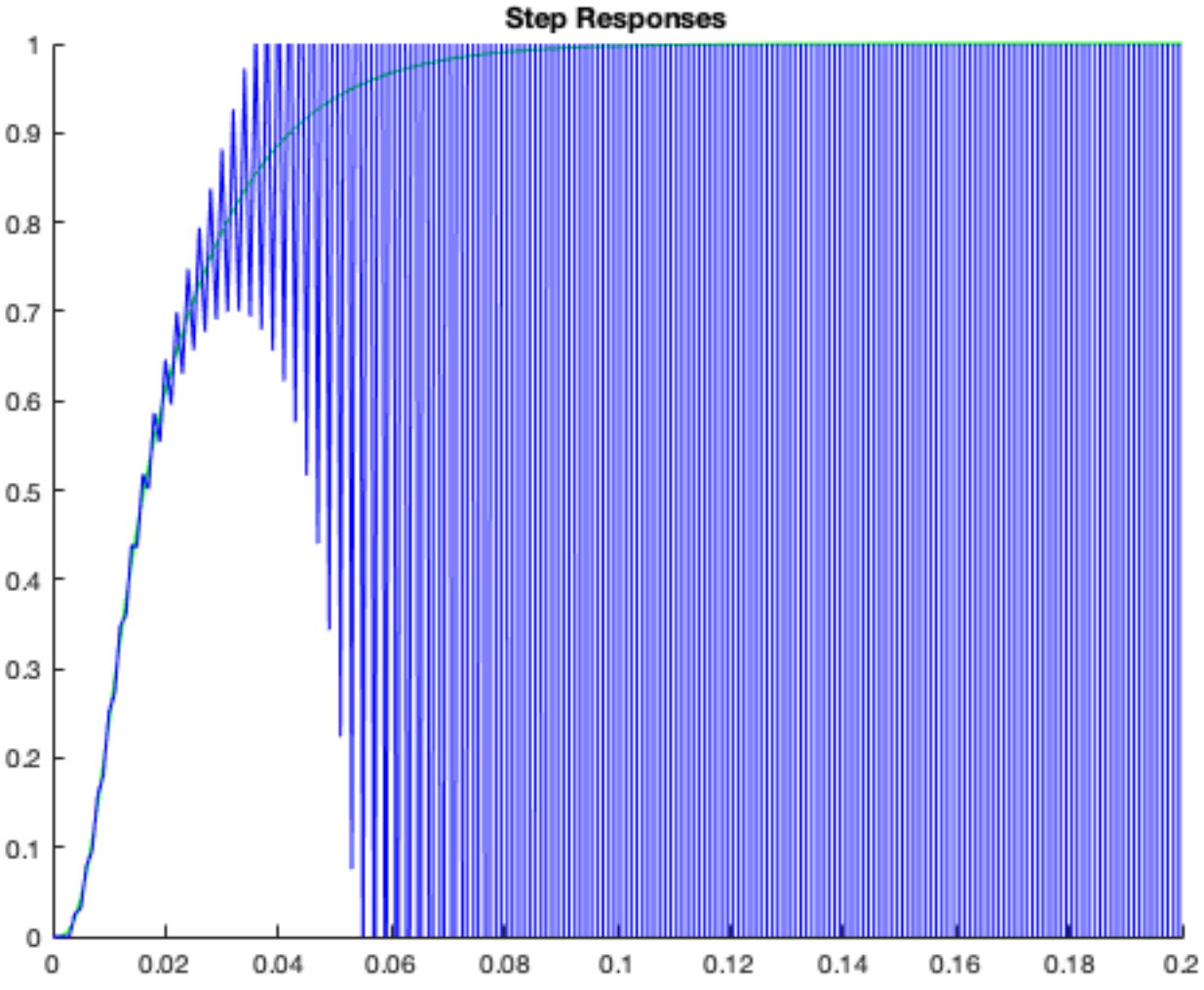
PART E

```
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')
```







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