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```
%Author: Mario Frakulla
%Lab 4
clear all;
clc;
type difeq
type difeq2
```

```
function [x_dot] = difeq( t, x)
m = 1;
b = 8;
k = 200;
x1 = x(1,1);
x2 = x(2,1);
x_dot(1,1) = x2;
x_dot(2,1) = (-k/m)*x2 - (-b/m)*x1;
end

function [x_dot] = difeq2( t, x)
m = 1;
b = 50;
k = 200;
x1 = x(1,1);
x2 = x(2,1);
x_dot(1,1) = x2;
x_dot(2,1) = (-k/m)*x2 - (-b/m)*x1 ;
end
```

PART A

```
k = 200;
m = 1;
b = 8;
A = [ 0 1; (-k/m) (-b/m)];
B = [0 1];
syms f(t) x(t) dx(t);
dx(t) = A*x(t) + B*f(t)
```

```
dx(t) =

[          0,    f(t) + x(t)]
[ -200*x(t), f(t) - 8*x(t)]
```

PART B

```
%The spring system is in equilibrium when it does not accelerate, i.e
 acceleration =0, and its
%velocity is also zero. By setting these two terms 0, and calculating
 the
%location y, in which equlibrium happens, we would obtain the
 following
%values
% y = 0, when f(t) = 0
% y = 0.25, when f(t) = 50
% y = -0.1 when f(t) = -20
% Physically, a constant force does not produce acceleration to the
 system,
% which means that for
```

PART C (ROOTS OF AUXILIARY EQUATION)

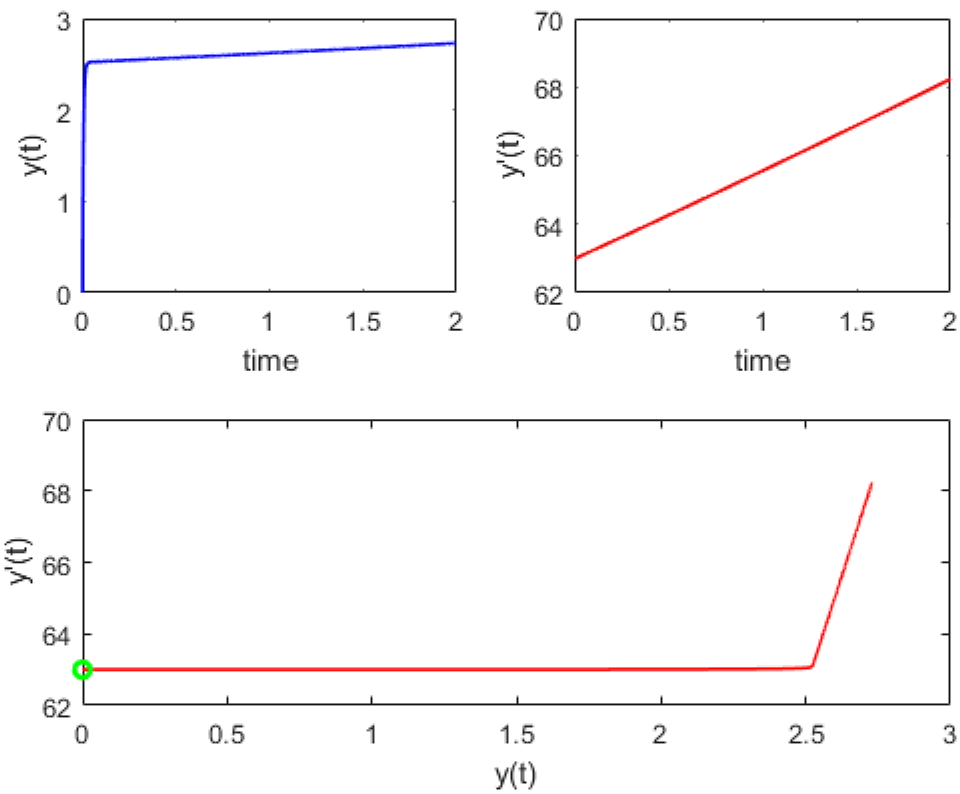
```
rootsAux = roots([1,b/m,k/m])
fprintf('The roots of the Auxiliary equation are complex. We obtain
 complex roots for the Auxiliary Equation, in the case when the
 Discriminant is negative')
```

```
rootsAux =

  -4.0000 +13.5647i
  -4.0000 -13.5647i

The roots of the Auxiliary equation are complex. We obtain complex
 roots for the Auxiliary Equation, in the case when the Discriminant
 is negative
```

PART D

```
x10 = 63;
x20 = 0;
x_0 = [x10; x20];
tSpan = [0 2];
[t_OUT, y_OUT] = ode45(@difeq,tSpan,x_0);
subplot(2,2,1)
plot(t_OUT, y_OUT(:,2), 'Color', 'Blue', 'LineWidth', 1.25)
xlabel('time')
ylabel('y(t)')
subplot(2,2,2)
plot(t_OUT, y_OUT(:,1), 'Color', 'Red', 'LineWidth', 1.25)
```

```
xlabel('time')
ylabel('y''(t)')
subplot(2,2,3:4)
plot(y_OUT(:,2), y_OUT(:,1), 'Color', 'Red', 'LineWidth', 1.25)
hold on
plot(y_OUT(1 , 2),  y_OUT(1,1), 'go', 'LineWidth', 2)
xlabel('y(t)')
ylabel('y''(t)')
```



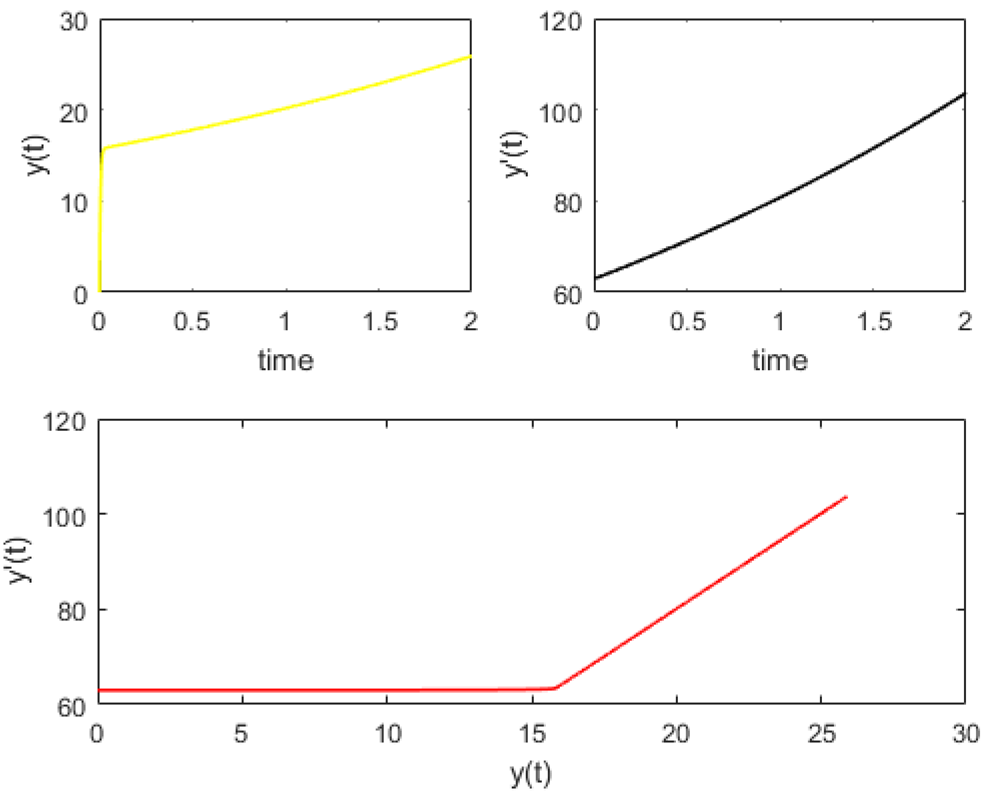
PART E

```
%No, the system should not change for us to obtain real, or repeated
 roots.
%However, the coefficients of the Auxiliary equations should change
%For b = sqrt(800), we would obtain two negative, real,  repeated
 roots ,
%as the Discriminat is going to be equal to 0, and the root is going
 to
%equal (sqrt(800))/2
```

PART F

```
hold off
figure(3)
[t_OUT, y_OUT] = ode45(@difeq2,tSpan,x_0);
```

```
subplot(2,2,1)
plot(t_OUT, y_OUT(:,2), 'Color', 'Yellow', 'LineWidth', 1.25)
xlabel('time')
ylabel('y(t)')
subplot(2,2,2)
plot(t_OUT, y_OUT(:,1), 'Color', 'Black', 'LineWidth', 1.25)
xlabel('time')
ylabel('y''(t)')
subplot(2,2,3:4)
plot(y_OUT(:,2), y_OUT(:,1), 'Color', 'Red', 'LineWidth', 1.25)
xlabel('y(t)')
ylabel('y''(t)')
%as b increases (the friction coefficient), we can expect equilibrium
 to be
%acheived faster, as the force of friction is greater. Thus, the
 result in
%part F is smaller than in part D
```



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