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# part a

```
%{
y'' + (b/m)y' + (k/m)y = f(t) => y'' = f(t) - (b/m)y' - (k/m)y
y'' = (y')'
x1 = y, x2 = y', y'' = x2'
Ax2' + Bx2 + Cx1 = g(t)
x1' = x2
x2'(t) = (b/m)x2(t) - (k/m)x1 + f(t)
[x1; x2]' = [0 1; -(k/m) (b/m)][x1; x2] + [0; f(t)]
%}
```

# part b

```
type d2ydt2.m
b = 8
y = d2ydt2(0, b)
y = d2ydt2(50, b)
y = d2ydt2(-20, b)
%{
changing f(t) shifts equilibirum poin in that direction
increaseing f(t) shifts right, decreasing f(t) shifts left
%}


function [ y ] = d2ydt2( f, b )
d2y = 0;
dy = 0;
k = 200;
m = 1;
y = (f - d2y - (b/m)*dy) / (k/m);
end


b =

     8
```

```
y =

     0


y =

    0.2500


y =

   -0.1000
```

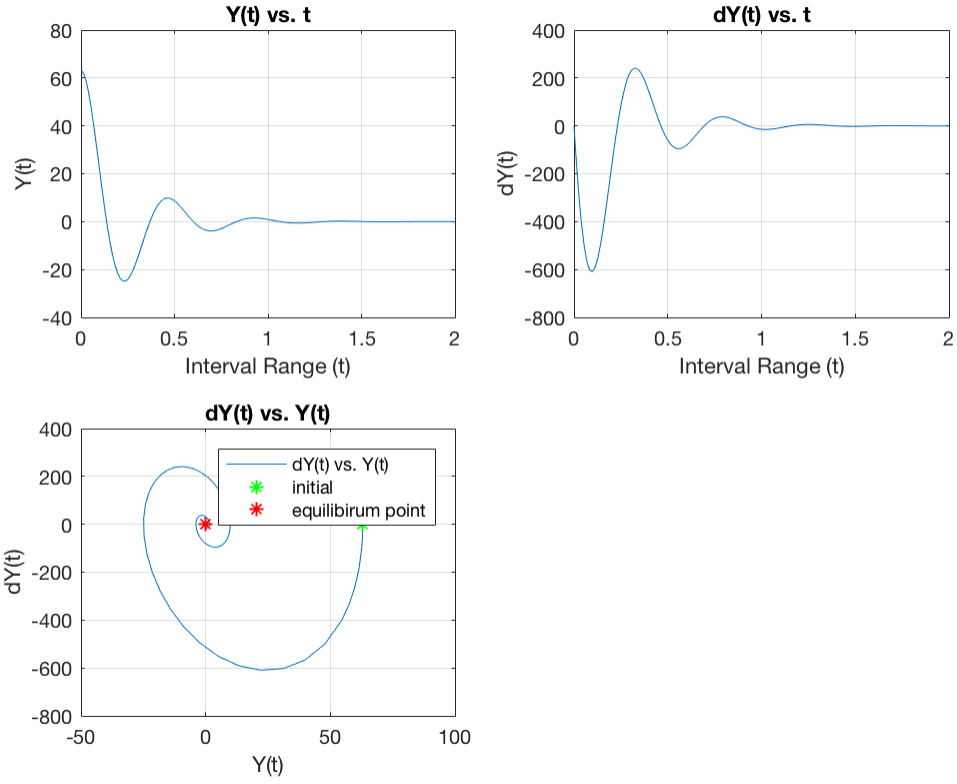
# part c

```
%{
f(t) = y'' + 8y' + 200y
Aux = r^2 + 8r + 200
%}
Aux = [1 8 200];
rootsAux = roots(Aux)
%{
roots are complex b/c determinant (b^2 - 4ac) is less than 0
%}
checkRootsAux = (Aux(2))^2 - 4*(Aux(1))*(Aux(3))


rootsAux =

  -4.0000 +13.5647i
  -4.0000 -13.5647i


checkRootsAux =

  -736
```

# part d

```
figure
tI = 0;
tEnd = 2;
tSpan = [tI tEnd];
yI = 63;
dyI = 0;
ySpan = [yI; dyI];
type dyode.m
```

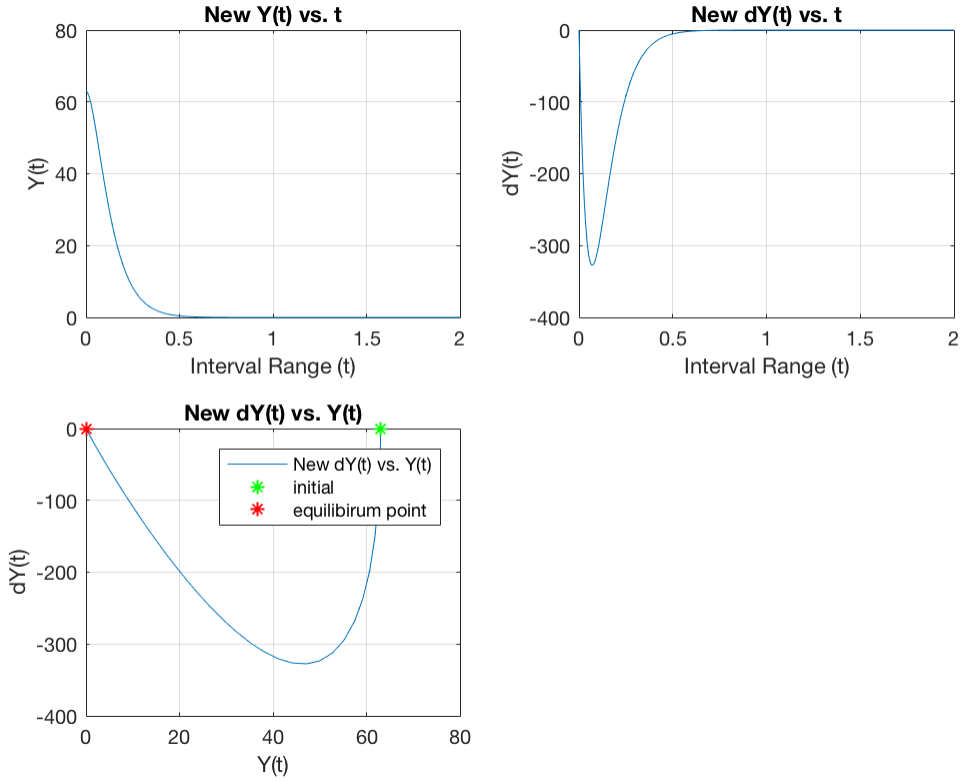
```
[tode, yode] = ode45(@dyode, tSpan, ySpan);
subplot(2,2,1)
plot(tode,yode(:,1))
grid on
hold on
xlabel('Interval Range (t)')
ylabel('Y(t)')
title('Y(t) vs. t')

subplot(2,2,2)
plot(tode,yode(:,2))
grid on
hold on
xlabel('Interval Range (t)')
ylabel('dY(t)')
title('dY(t) vs. t')

subplot(2,2,3)
plot(yode(:,1),yode(:,2))
grid on
hold on
xlabel('Y(t)')
ylabel('dY(t)')
title('dY(t) vs. Y(t)')

points = [yode(1,1) yode(1,2); yode(164,1) yode(164,2)];
plot(63,0, 'g*' )
plot(0, d2ydt2(0, b), 'r*' )
legend('dY(t) vs. Y(t)','initial','equilibirum point')


function [ yode ] = dyode( tSpan, ySpan )
b = 8;
k = 200;
m = 1;
f = 0;
yode = [0 1; -(k/m) -(b/m)]*ySpan + [0; f];

end
```




# part e

```
%{
b^2 - 4ac = 0
b^2 = 4(1)(200)
%}
b = sqrt(4*200);
Aux = [1 b 200];
rootsAux = roots(Aux)

figure
tI = 0;
tEnd = 2;
tSpan = [tI tEnd];
yI = 63;
dyI = 0;
ySpan = [yI; dyI];
type dyode.m
[tode, yode] = ode45(@dyodeNew, tSpan, ySpan);
subplot(2,2,1)
plot(tode,yode(:,1))
grid on
hold on
xlabel('Interval Range (t)')
ylabel('Y(t)')
```

```
title('New Y(t) vs. t')

subplot(2,2,2)
plot(tode,yode(:,2))
grid on
hold on
xlabel('Interval Range (t)')
ylabel('dY(t)')
title('New dY(t) vs. t')

subplot(2,2,3)
plot(yode(:,1),yode(:,2))
grid on
hold on
xlabel('Y(t)')
ylabel('dY(t)')
title('New dY(t) vs. Y(t)')

points = [yode(1,1) yode(1,2); yode(145,1) yode(145,2)];
plot(63, 0, 'g*' )
plot(0, d2ydt2(0, b), 'r*' )
legend('New dY(t) vs. Y(t)','initial','equilibirum point')
%{
Time is faster to get to get to equilibirum with the new B value
%}


rootsAux =

  -14.1421
  -14.1421


function [ yode ] = dyode( tSpan, ySpan )
b = 8;
k = 200;
m = 1;
f = 0;
yode = [0 1; -(k/m) -(b/m)]*ySpan + [0; f];

end
```

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