Table of Contents

Vibrating Spring

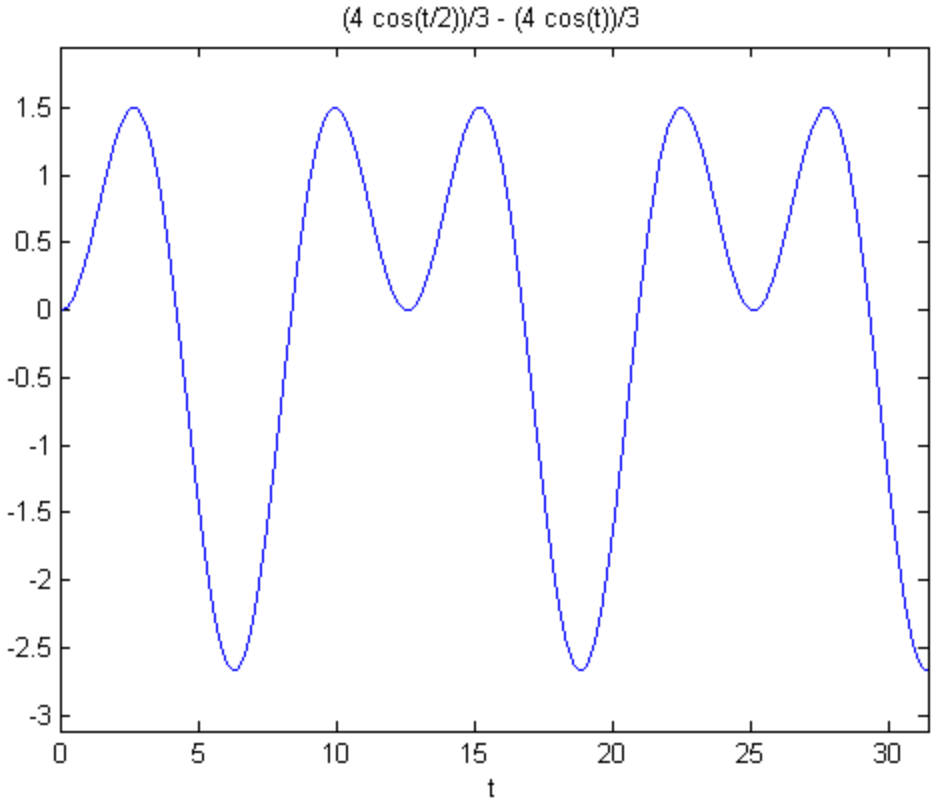
A few examples of vibrating spring motion

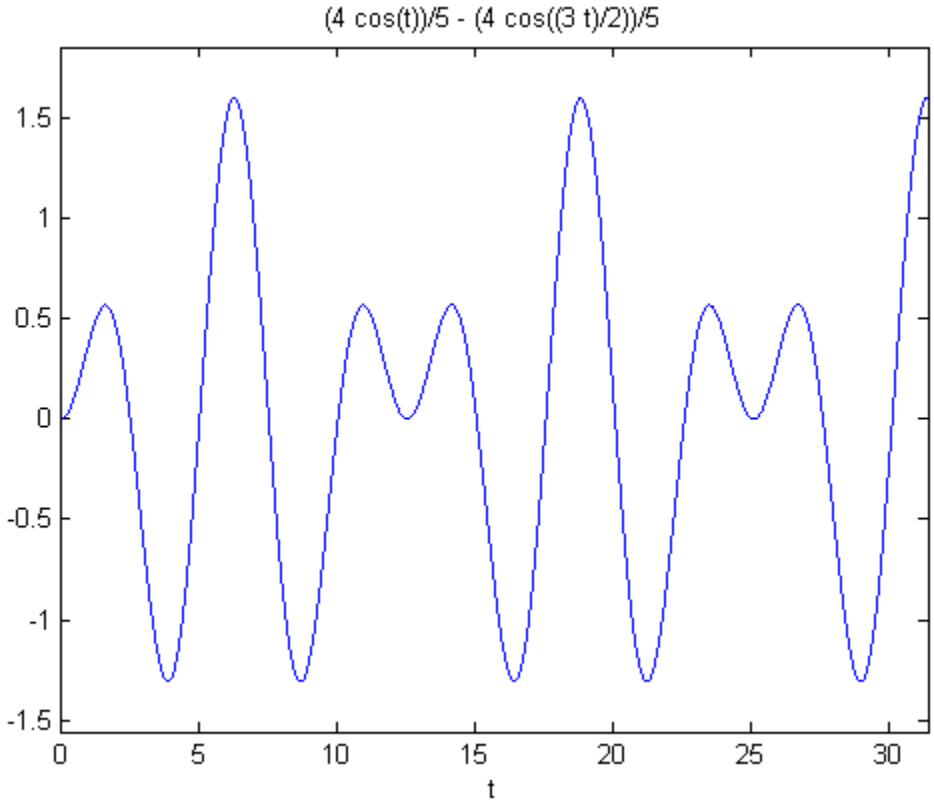
```
clear all
close all
```

Undamped

```
syms omega
ode = 'D2u + u = cos(omega*t)';
undampedsoln = simplify(dsolve(ode,'u(0)=0','Du(0)=0'))
ezplot(subs(undampedsoln, omega, 1/2 ), [0 10*pi])
figure; ezplot(subs(undampedsoln, omega, 3/2 ), [0 10*pi])
```

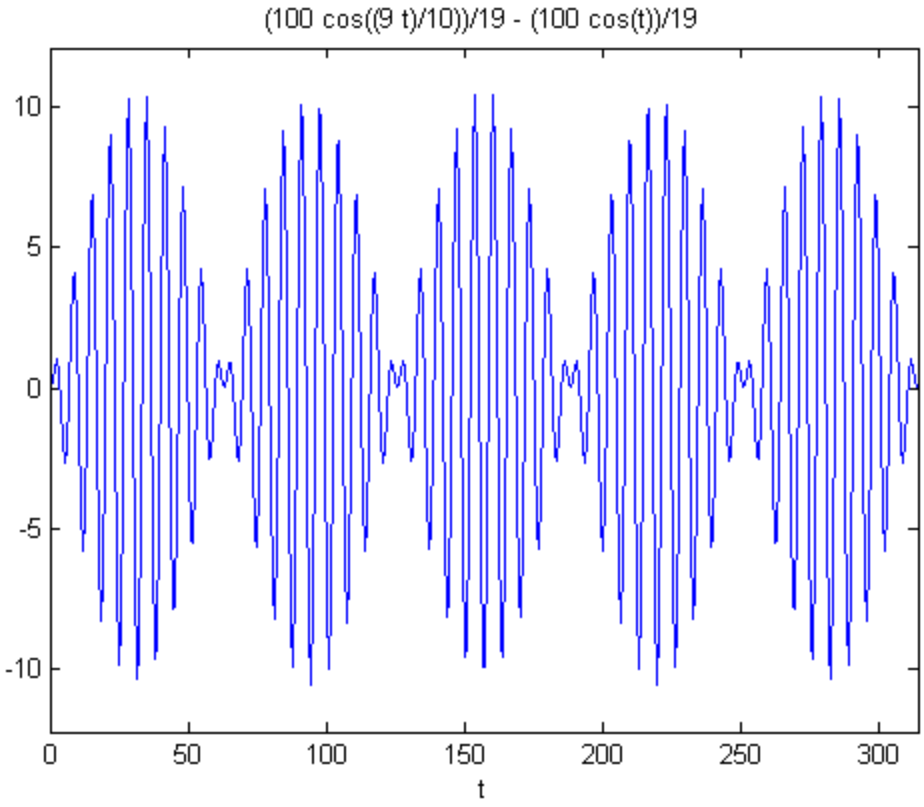
```
undampedsoln =

-(cos(omega*t) - cos(t))/(omega^2 - 1)
```


(4 cos(t/2))/3 - (4 cos(t))/3
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-2.5
-3
0
5
10
15
20
25
30
t


(4 cos(t))/5 - (4 cos((3 t)/2))/5
1.5
1
0.5
0
-0.5
-1
-1.5
0
5
10
15
20
25
30
t

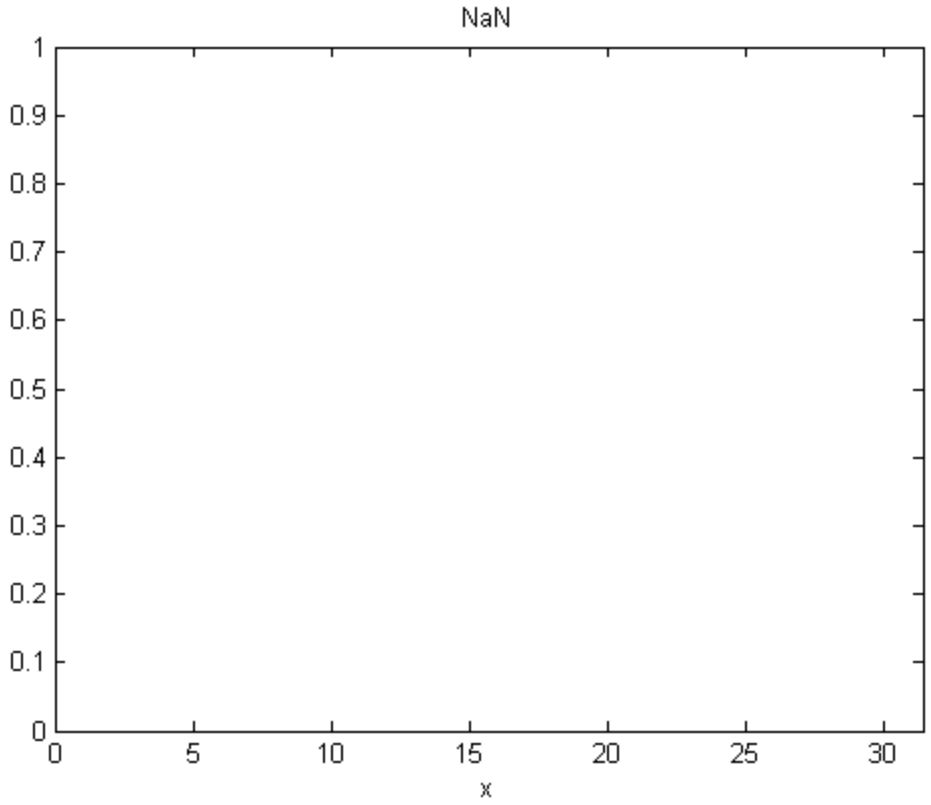
now for omega close to the natural frequency

```
figure; ezplot(subs(undampedsoln, omega, 0.9 ), [0 100*pi])
```



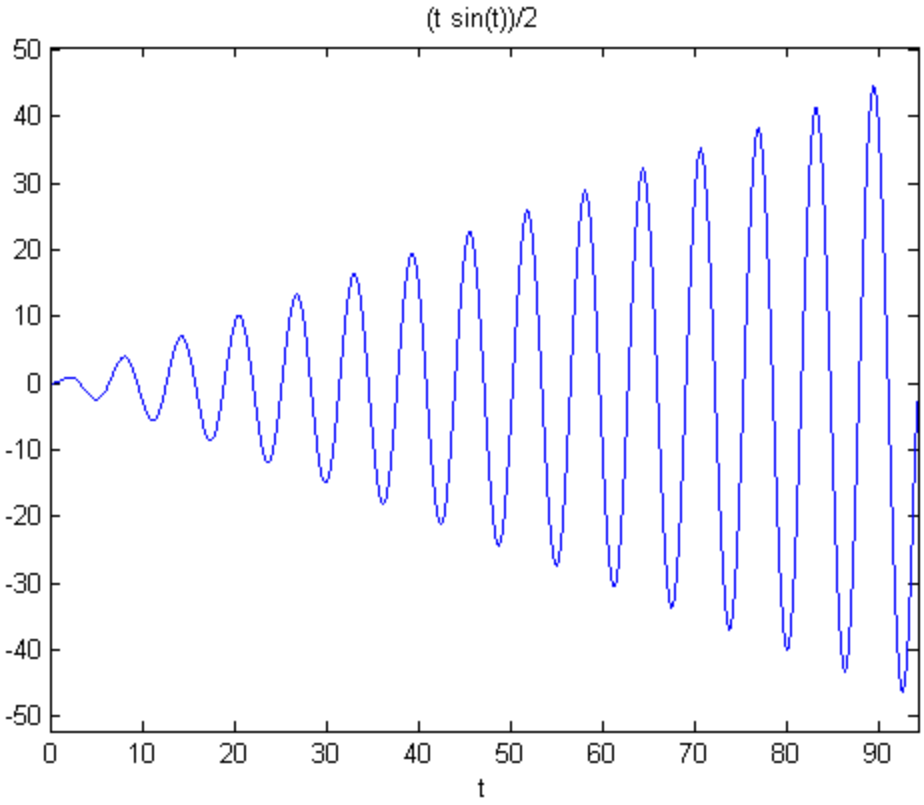
there's the beats; now let's try for resonance

```
figure; ezplot(subs(undampedsoln, omega, 1 ), [0 10*pi])
```



Arghh! Need to convince Mathematica to evaluate correctly at omega = 1.

```
figure; ezplot(limit(undampedsoln, omega, 1), [0 30*pi])
```



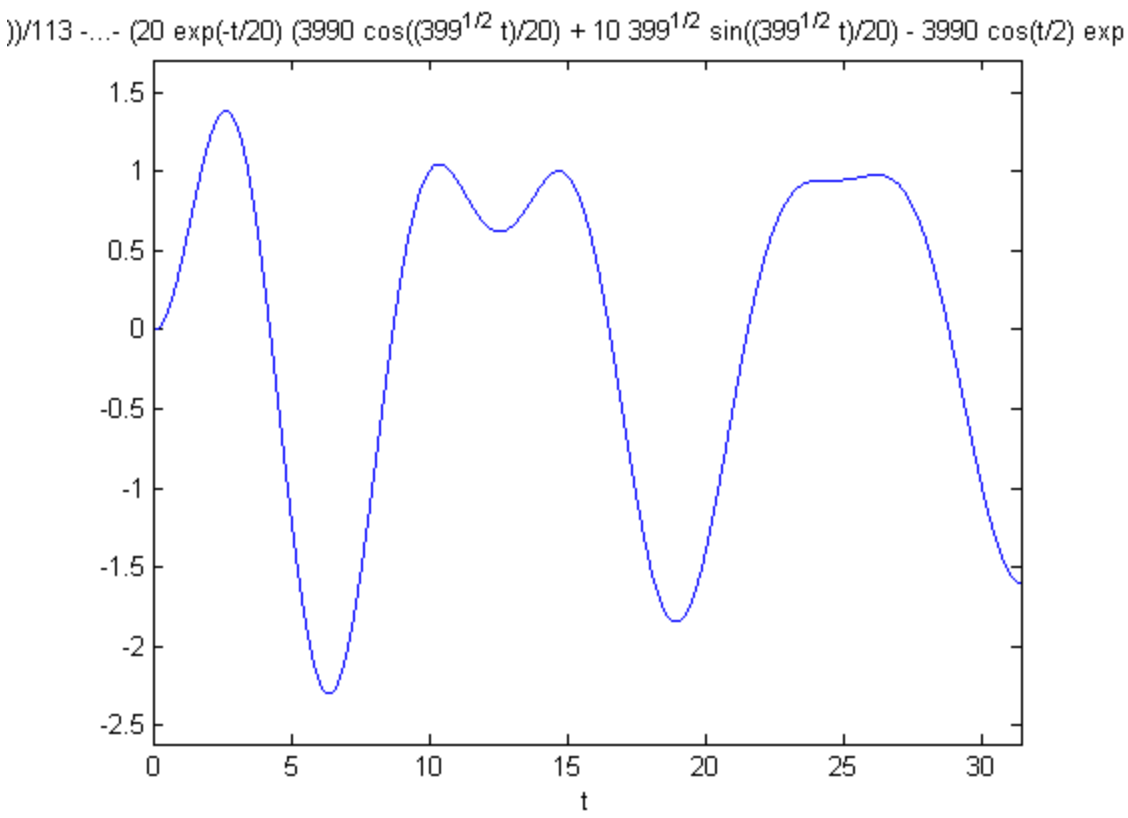
Damped

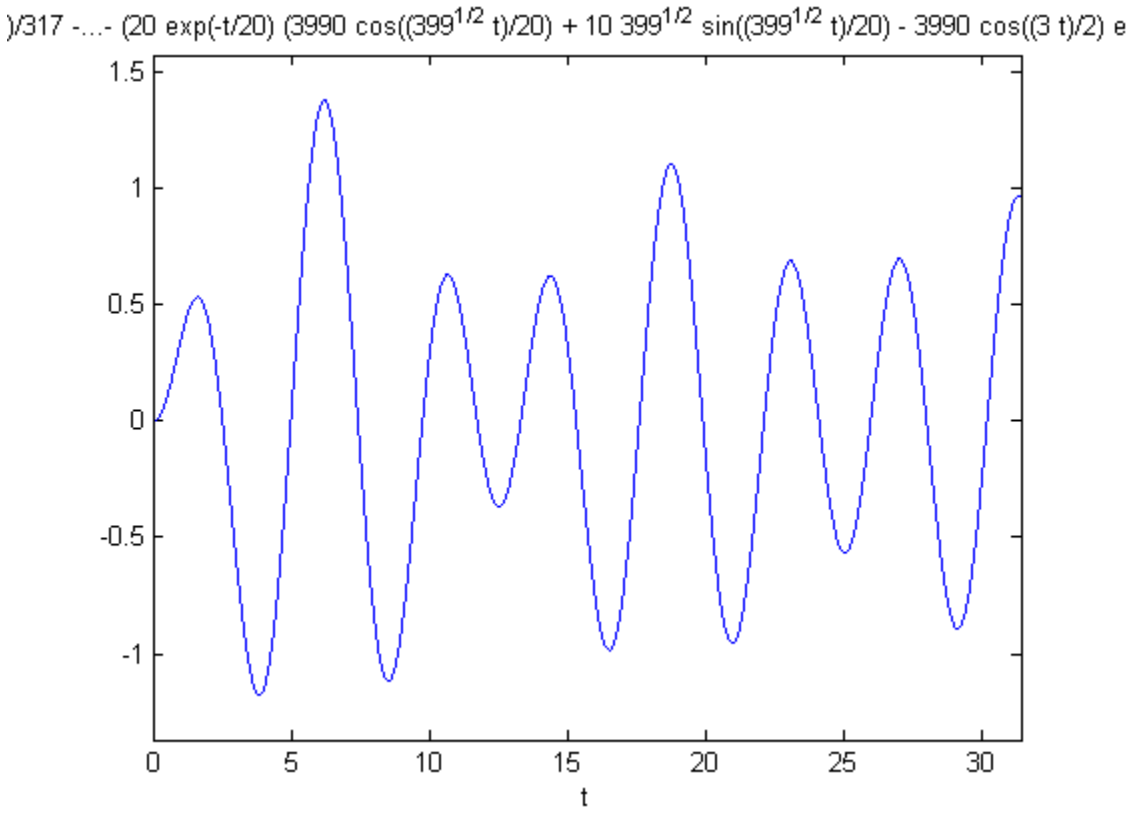
```
clear all
close all
syms omega
ode2 = 'D2u + Du/10 + u = cos(omega*t)';
dsolve(ode2,'u(0)=0','Du(0)=0')
```

```
ans =

exp(-t/20)*cos((399^(1/2)*t)/20)*((10*399^(1/2)*exp(t/20)*(sin(t*(omega -
```

I guess we'll suppress the algebriac output and concentrate on the graphs from here on.

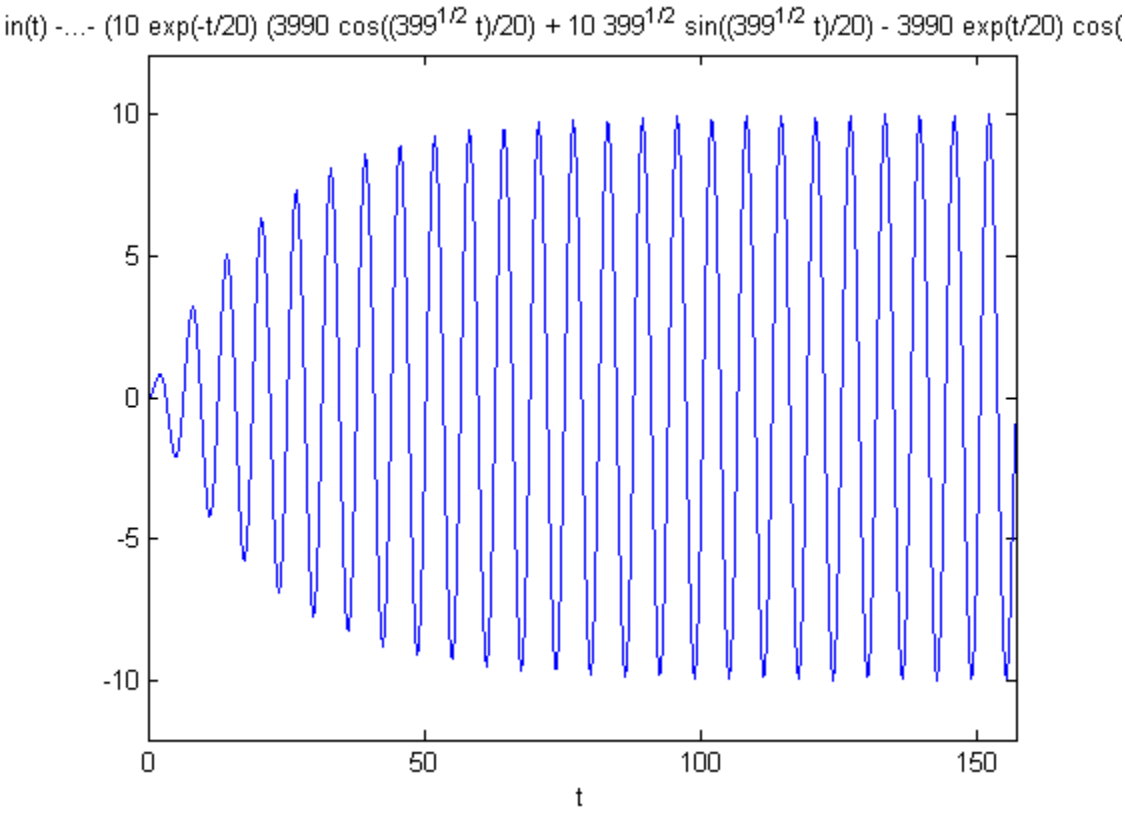
```
dampedsoln = simplify(dsolve(ode2,'u(0)=0','Du(0)=0'));
ezplot(subs(dampedsoln, omega, 1/2 ), [0 10*pi])
figure; ezplot(subs(dampedsoln, omega, 3/2 ), [0 10*pi])
```

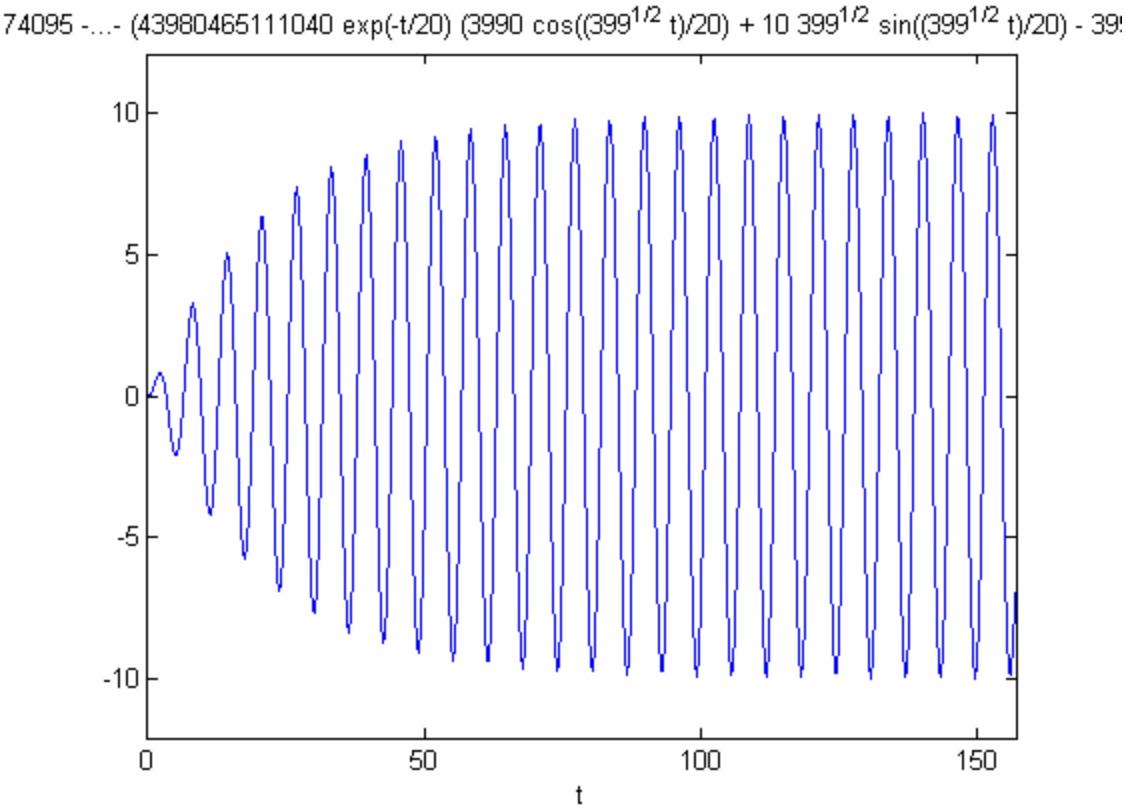

))/113 -...- (20 exp(-t/20) (3990 cos((399^1/2 t)/20) + 10 399^1/2 sin((399^1/2 t)/20) - 3990 cos(t/2) exp
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-2.5
0
5
10
15
20
25
30
t


)/317 -...- (20 exp(-t/20) (3990 cos((399^1/2 t)/20) + 10 399^1/2 sin((399^1/2 t)/20) - 3990 cos((3 t)/2) e
1.5
1
0.5
0
-0.5
-1
0
5
10
15
20
25
30
t

now for resonance

```
figure; ezplot(subs(dampedsoln, omega, 1 ), [0 50*pi])
figure; ezplot(subs(dampedsoln, omega, 0.995 ), [0 50*pi])
```





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