LAB 6

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March 12, 2019

Displacement in spring for different forces applied

for

$$f(t) = \cos(\omega t)e^{-at}u_0(t)$$

$$F(s) = \frac{s+a}{(s+a)^2 + (\omega)^2}$$

for $x'(0) = 0, x(0) = 0$

$$X(s) = \frac{s+a}{((s+a)^2 + w^2)(s^2 + 2.25)}$$

response to the spring mass system for different decay rates(a=0.5,a=0.05) and is as shown in the below figure.

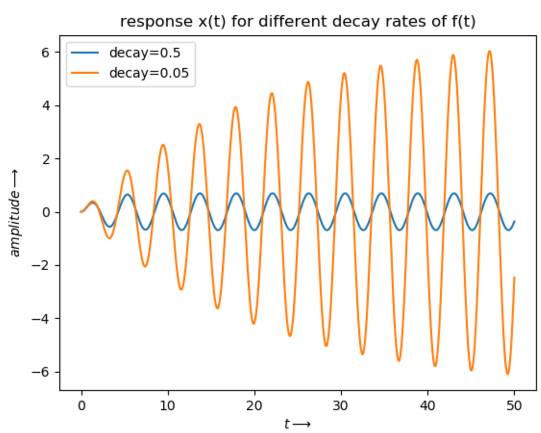
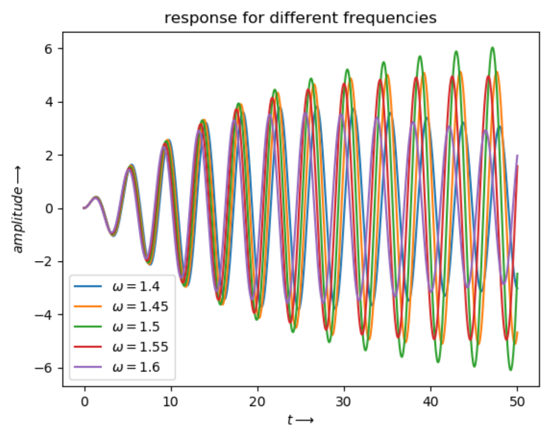


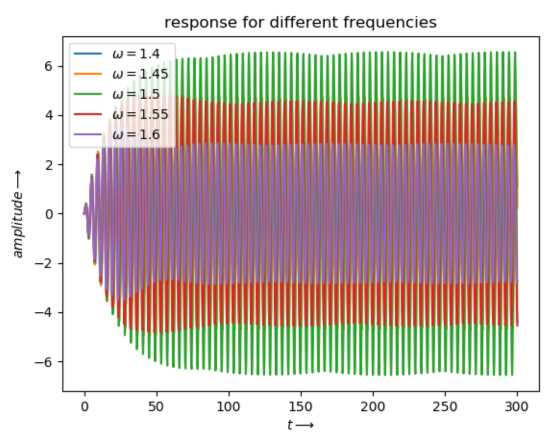
Figure 1: plot1

The displacement x(t) reaches its steady amplitude for decay =0.5, while for decay=0.05 amplitude increases for around 80s and then reaches a constant value.

response for varying frequency of f(t) from 1.4 to 1.6 in steps of 0.05 but keeping the decay(=0.05) constant.



The amplitude of f(t) which is in resonance with the system dominates the rest at (almost)every instant. The response for resonant frequency reaches steady max amplitude without decreasing, while the other frequencies increases and decreases before reaching its steady max amplitude.



solving the time evolution of x and y using the given initial conditions.we get

$$X(s) = \frac{s^3 + 2s}{s^4 + 3s^2}$$

$$Y(s) = \frac{2s}{s^4 + 3s^2}$$

plugging these in sp.impulse will give us the time evolution of x and y.

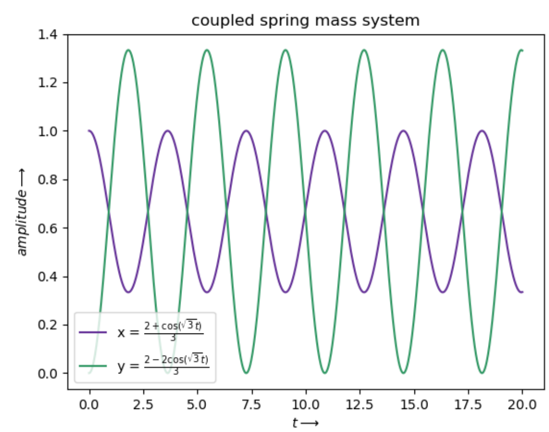
```
t = np.linspace(0,20,1000)
t,x = sp.impulse(sp.lti([1,0,2,0],[1,0,3,0,0]),None,t)
t,y = sp.impulse(sp.lti([2,0],[1,0,3,0,0]),None,t)
```

or we can plot the response using the x(t) and y(t) functions obtained by solving the given differential equations without converting them into laplace domain.

```
t = np.linspace(0,20,1000)
x = (2+np.cos(sqrt(3)*t))/3
y = 2*(1-np.cos(sqrt(3)*t))/3
```

$$x(t) = \frac{2 + \cos(\sqrt{3}t)}{3}$$

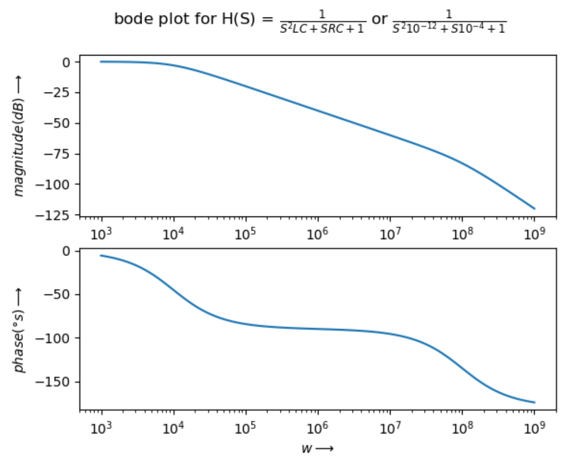
$$y(t) = \frac{2 - 2\cos(\sqrt{3}t)}{3}$$



transfer function for given RLC circuit is

$$H(s) = \frac{1}{s^2LC + sRC + 1}$$

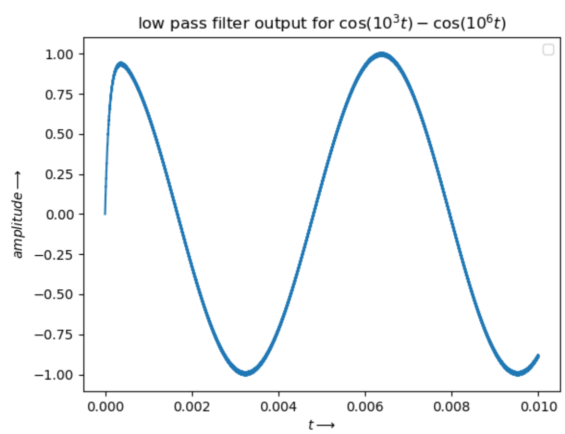
$$H(s) = \frac{1}{10^{-12}s^2 + 10^{-4}s + 1}$$

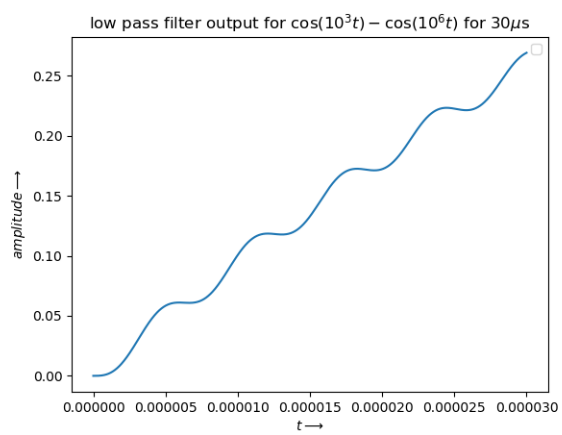


output of the filter for $\cos(10^3 t)u(t) - \cos(10^6 t)u(t)$.

The response on long term is $cos(10^3 t)u(t) - k * cos(10^6 t)u(t)$ where k is a very small value.

for an ideal filter the response at t=0 should be 1 but since the capacitor doesn't allow sudden changes in voltage across it,the voltage takes some time to increase from 0 to 1.(i/e, that is time required for the transients to die out.)




low pass filter output for $\cos(10^3 t) - \cos(10^6 t)$ for $30\mu s$
0.25
0.20
0.15
0.10
0.05
0.00
amplitude ⟶
0.000000
0.000005
0.000010
0.000015
0.000020
0.000025
0.000030
t ⟶