EE2703: Assignment 7 (Laplace tranform)

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EE19B130

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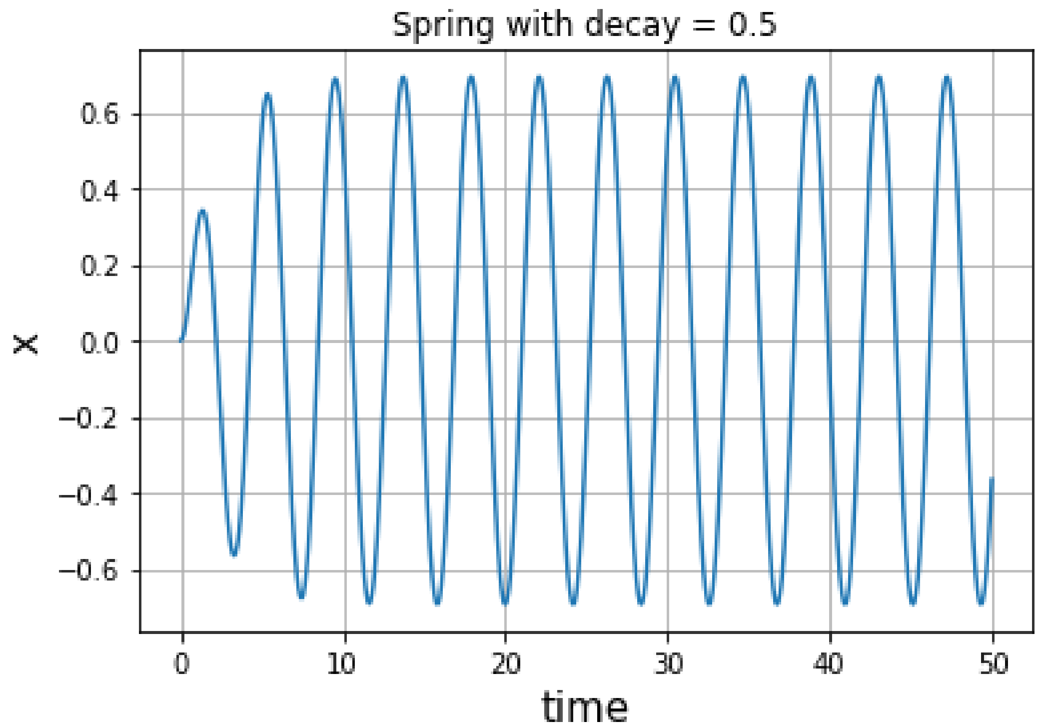
[117]:
```
import numpy as np
import scipy.signal as sp
import pylab
```

[150]:
```
"""
Function to plot graphs
"""
def display_plot(i,x,y,title,xlabel='time',ylabel='x'):
    pylab.figure(i)
    pylab.plot(x,y)
    pylab.title(title)
    pylab.xlabel(r'{}'.format(xlabel),fontsize=15)
    pylab.ylabel(r'{}'.format(ylabel),fontsize=15)
    pylab.grid()
    pylab.show()
```

0.1 1. Time Response of a Spring

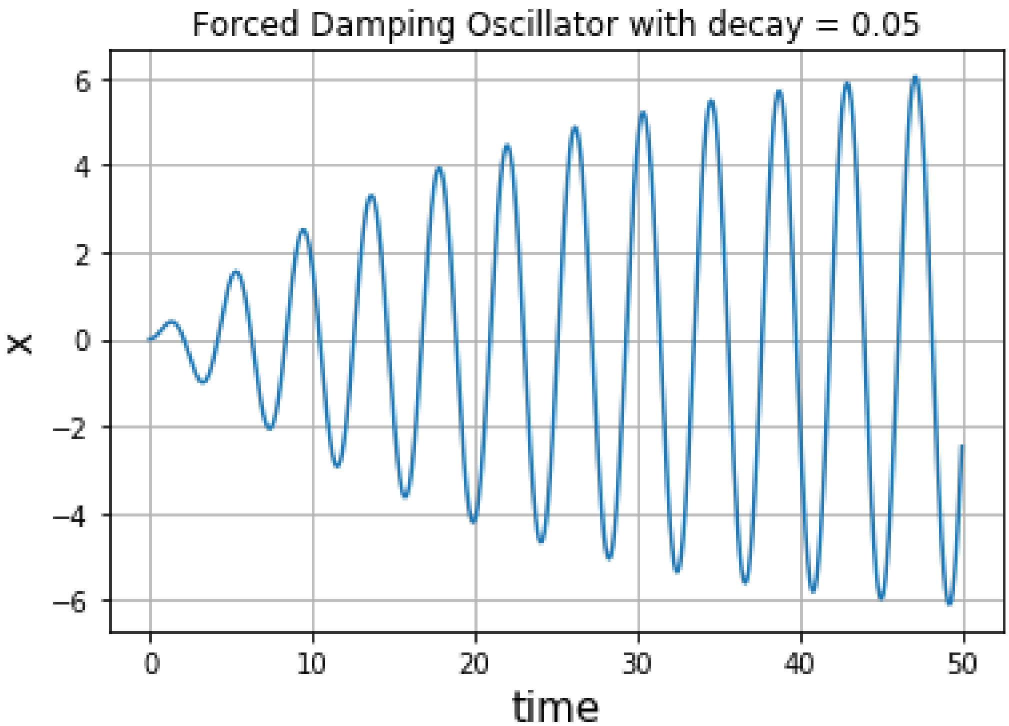
[151]:
```
def func_H(freq,decay):
    num = np.poly1d([1,freq])
    den = np.poly1d([1,(2*freq),((freq*freq)+(decay*decay))])
    return num, den
```

[152]:
```
num,den = func_H(0.5,1.5)
den = np.polymul([1,0,2.25],den)

H1 = sp.lti(num,den)
t = np.linspace(0,50,1000)

t,x = sp.impulse(H1,T=t)
display_plot(0,t,x,"Spring with decay = 0.5", 'time','x')
```



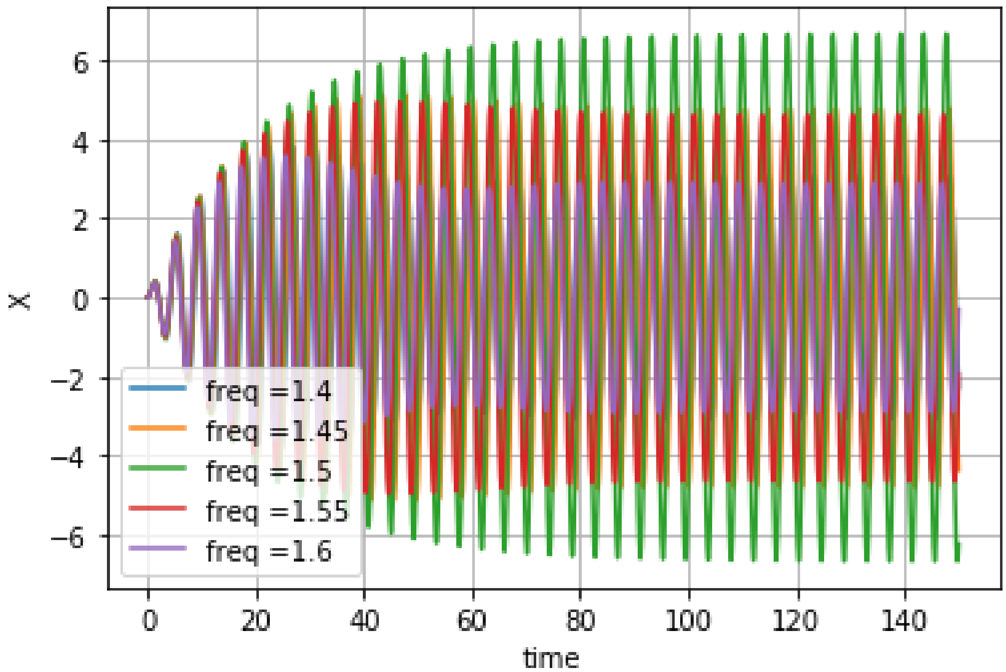
0.2 2. Time Response of a Spring with a much smaller decay

[153]:
```
num,den = func_H(0.05,1.5)
den = np.polymul([1,0,2.25],den)

H2 = sp.lti(num,den)
t = np.linspace(0,50,1000)

t,x = sp.impulse(H2,T=t)
display_plot(0,t,x,"Spring with decay = 0.05", 'time','x')
```



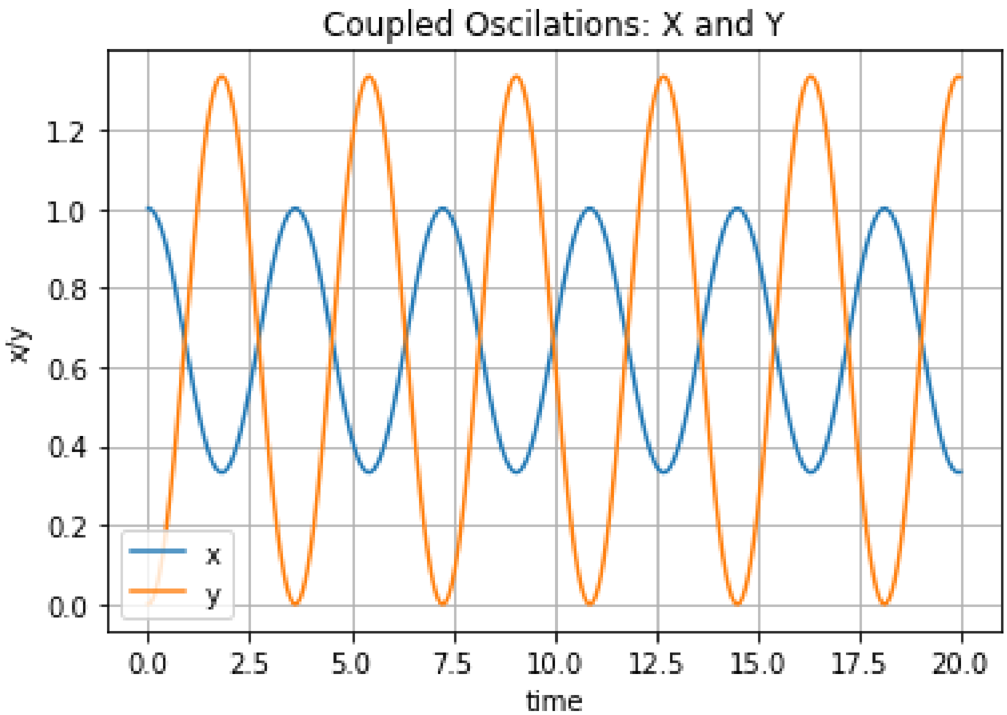
0.3 3. LTI response over different frequencies of applied force

[154]:
```
freqs = np.linspace(1.4,1.6,5)
leg = []
for freq in freqs:
    num = np.poly1d([1])              # Numerator of transfer function
    den = np.poly1d([1,0,2.25])       # Denominator of tranfer functioin
    H = sp.lti(num,den)               # Transfer function
    t = np.linspace(0,150,5001)  # Time range for graph
    f = np.cos(freq*t)*np.exp(-0.05*t)   # Forcing function

    t,y,svec=sp.lsim(H,f,t)           # Output wave found as convolution

    leg.append("freq =" + str(freq))
    pylab.xlabel('time')
    pylab.ylabel('X')
    pylab.plot(t,y)

pylab.grid()
pylab.legend(leg)
pylab.show()
```



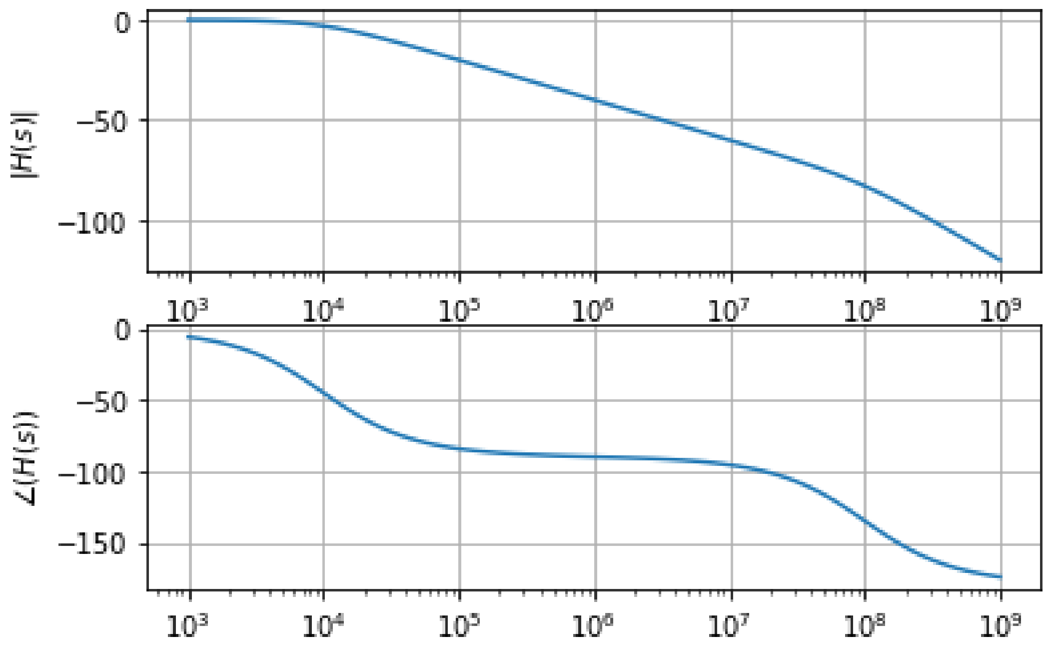
0.4 4. Coupled Spring System

[155]:
```
Hx = sp.lti(np.poly1d([1,0,2]),np.poly1d([1,0,3,0]))
t = np.linspace(0,20,1000)
t1,x = sp.impulse(Hx,T=t)

Hy = sp.lti(np.poly1d([2]),np.poly1d([1,0,3,0]))
t = np.linspace(0,20,1000)
t2,y = sp.impulse(Hy,T=t)


pylab.title("Coupled Oscilations")
pylab.plot(t1,x)
pylab.plot(t2,y)
pylab.xlabel('time')
pylab.ylabel('x/y')
pylab.legend(['x','y'])
pylab.grid()
pylab.show()
```



0.5 5. Magnitude and Phase response of Two port network

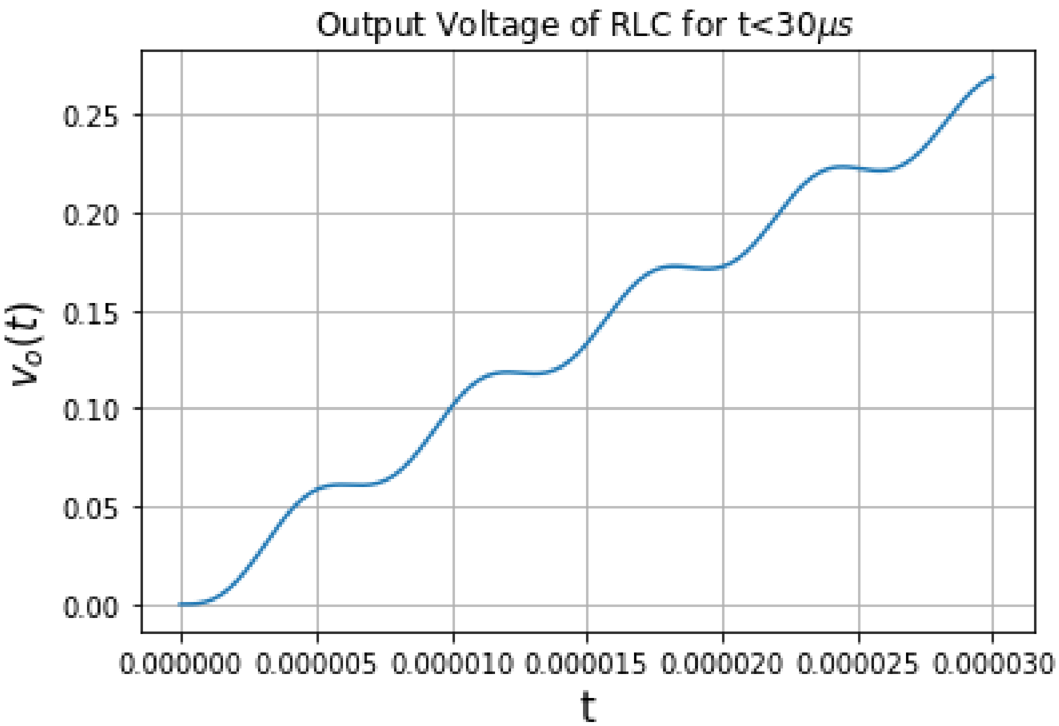
[156]:
```
H = sp.lti(np.poly1d([1000000]),np.poly1d([0.000001,100,1000000]))
w,S,phi=H.bode()

"""
Magnitude response
"""
pylab.subplot(2,1,1)
pylab.semilogx(w,S)
pylab.ylabel(r'$|H(s)|$')
pylab.grid()

"""
Phase response
"""
pylab.subplot(2,1,2)
pylab.semilogx(w,phi)
pylab.ylabel(r'$\angle(H(s))$')
pylab.grid()
pylab.show()
```



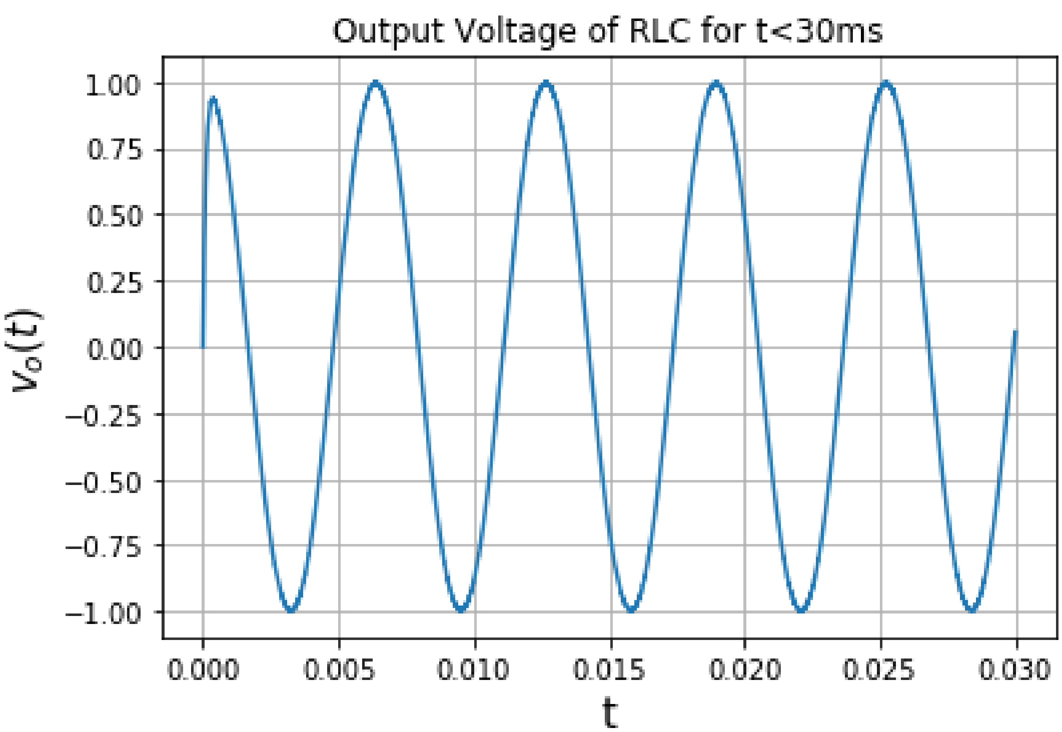
0.6 6. Output Voltage

[157]:
```
"""
This function returns Low pass filter response for given input and time period
"""
def RLC(t, R=100, L=1e-6, C=1e-6):
    H = sp.lti([1],[L*C,R*C,1])
    vi = np.multiply(np.cos(1000*t)-np.cos(1000000*t),np.heaviside(t,0.5))

    return sp.lsim(H,vi,t)
```

[158]:
```
t = np.linspace(0,30*0.000001,10000)
_,y1,svec = RLC(t)
display_plot(5,t,y1,"Output Voltage for t<30$\mu s$", 't',r'$v_{o}(t)$')


t = np.linspace(0,30*0.001,10000)
_,y2,svec = RLC(t)
display_plot(6,t,y2,"Output Voltage for t<30ms",'t',r'$v_{o}(t)$')
```



Output Voltage of RLC for t<30μs
0.25
0.20
0.15
0.10
0.05
0.00
$v_o(t)$
0.000000
0.000005
0.000010
0.000015
0.000020
0.000025
0.000030
t



Output Voltage of RLC for t<30ms
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
$v_o(t)$
0.000
0.005
0.010
0.015
0.020
0.025
0.030
t