Python 7 assignment
The Laplace Transform

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EE15B025

March 13, 2017

Abstract

In this assignment, we will look at how to analyse "Linear Time-invariant Systems" with numerical tools in Python. LTI systems are what Electrical Engineers spend most of their time thinking about - linear circuit analysis or communication channels. The problems will be in "continuous time" and will use Laplace Transforms and Python's Signals toolbox.

Function for Questions 1,2 and 3

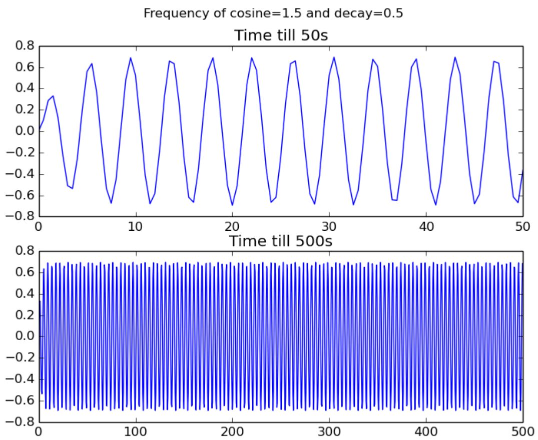
```
def fun(a,b) :
        X=sp.lti(np.polymul([1,a],[1]),np.polymul([1,2*a, (b**2) + (a**2)],[1,0,
        t,x=sp.impulse(X,0,np.linspace(0,50,101))
        t2,x2=sp.impulse(X,0,np.linspace(0,500,1001))

        fig0,ax0=mp.subplots(2)
        fig0.suptitle("Frequency of cosine={} and decay={}".format(b,a))
        ax0[0].plot(t,x)
        ax0[0].set_title("Time till 50s")
        ax0[1].plot(t2,x2)
        ax0[1].set_title("Time till 500s")
        mp.show()
```

Question 1

The programme code is :

```
fun(0.5,1.5)    #Question 1
```

The plot obtained is :

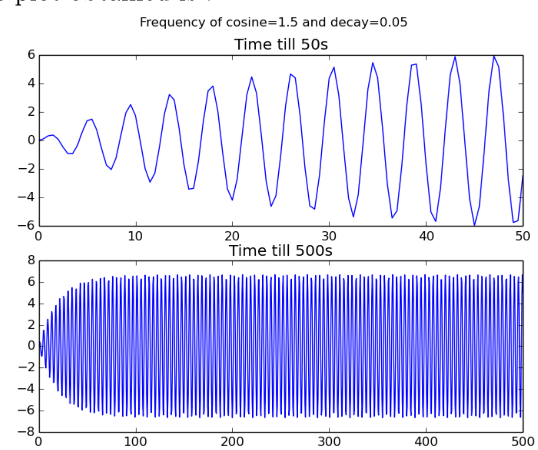


Question 2

The programme code is :

```
fun(0.05,1.5)    #Question 2
```

The plot obtained is :

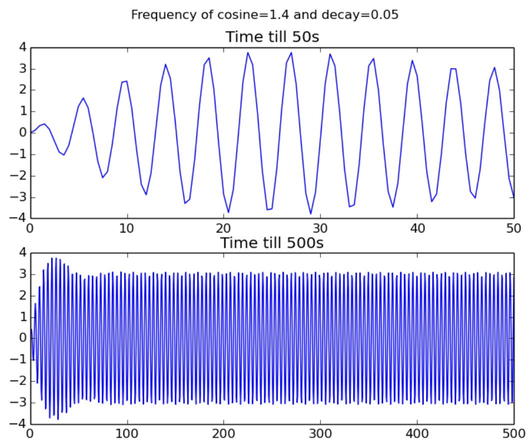


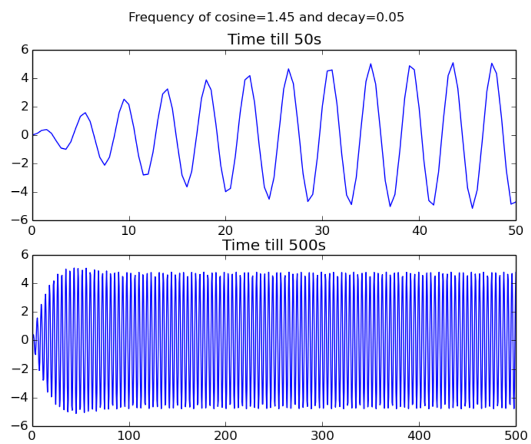
Question 3

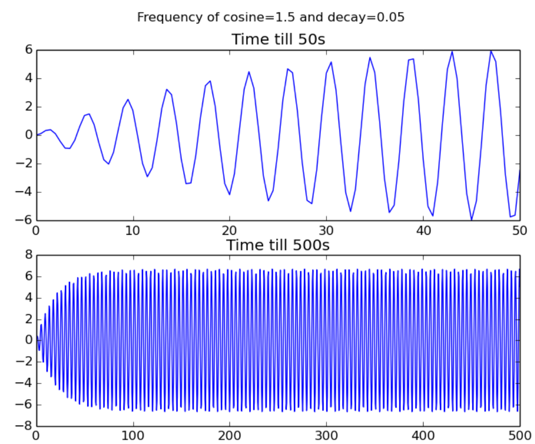
The programme code is :

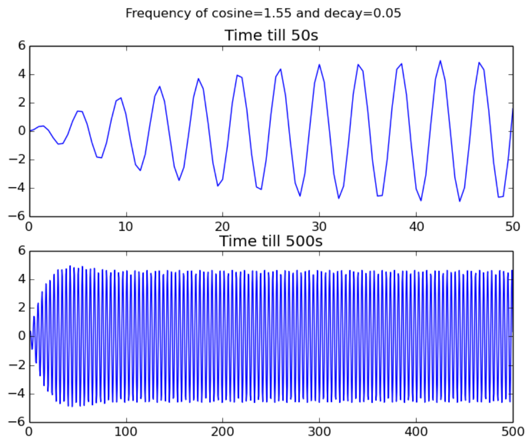
```
#Question 3
b=1.4
for i in range(5) :
        fun(0.05,b)
        b+=0.05
```

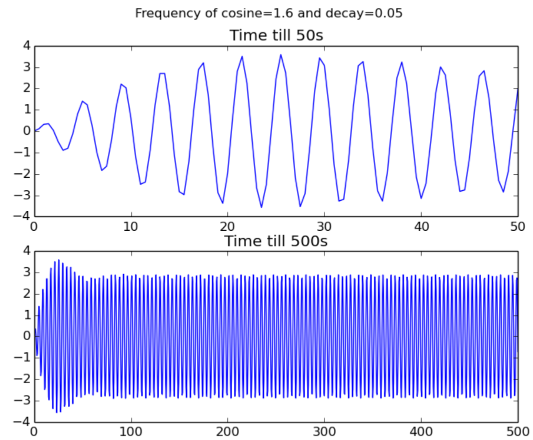
The plots obtained are :











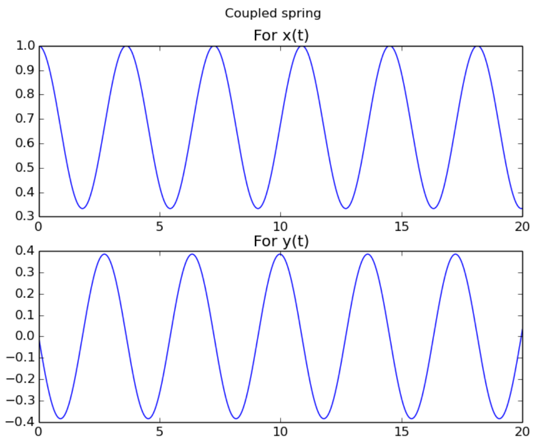
As the frequency of the cosine curve is varied, the initial jump or peak amplitude in the resultant plot changes. ie, we get a different initial curve before reaching steady state.

Question 4

The programme code is :

```
#Question 4
Y=sp.lti([2],[1,0,3,0,0])
X=sp.lti([1,0,2,0],[1,0,3,0,0])

t,y=sp.impulse(Y,np.array([[0],[0],[0],[0]]),np.linspace(0,20,1001))
t,x=sp.impulse(X,np.array([[0],[0],[0],[1]]),np.linspace(0,20,1001))

fig1,ax1=mp.subplots(2)
fig1.suptitle("Coupled spring")
ax1[0].plot(t,x)
ax1[0].set_title('For x(t)')
ax1[1].plot(t,y)
ax1[1].set_title("For y(t)")
```

The plot obtained is :

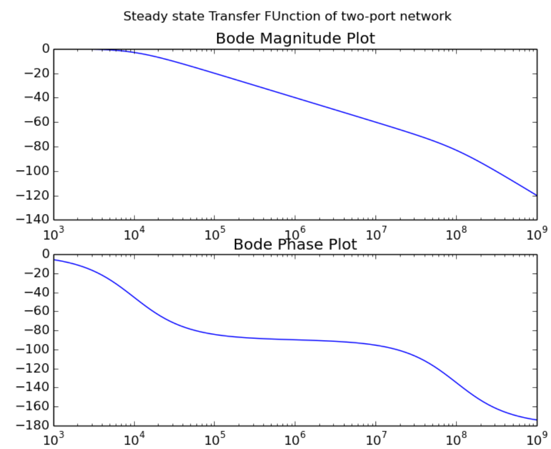


Question 5

The programme code is :

```
#Question 5
L=1/1000000.0
C=1/1000000.0
R=100.0
H=sp.lti([1],[L*C,R*C,1])
w,S,phi=H.bode()
fig2,ax2=mp.subplots(2)
fig2.suptitle("Steady state Transfer FUnction of two-port network")
ax2[0].semilogx(w,S)
ax2[0].set_title('Bode Magnitude Plot')
ax2[1].semilogx(w,phi)
ax2[1].set_title("Bode Phase Plot")
```

The plot obtained is :

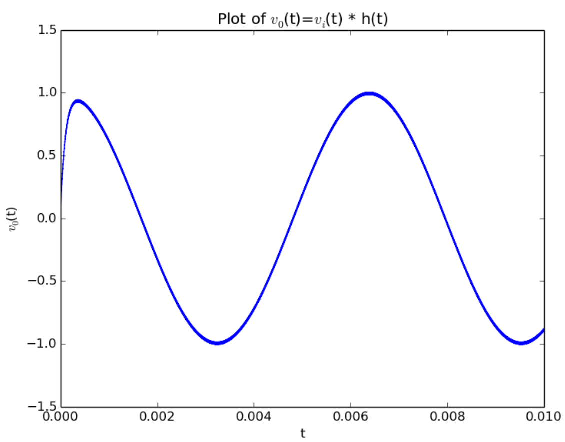


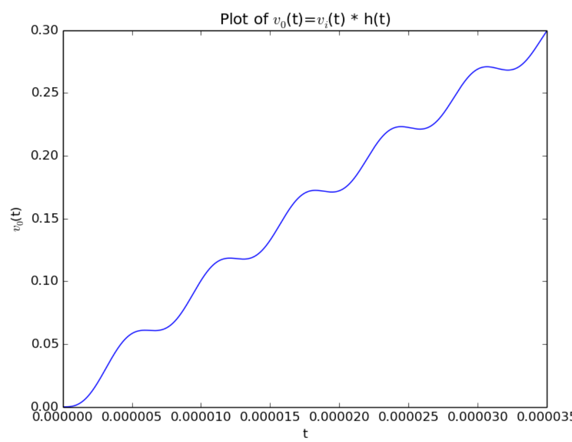
Question 6

The programme code :

```
#Question 6
t=np.linspace(0,0.0001,num=10005)
vi=np.cos(1000*t)-np.cos(1000000*t)
t,y,svec=sp.lsim(H,vi,t)
mp.figure(3)
mp.plot(t,y)
mp.title(r'Plot of $v_{0}$(t)=$v_{i}$(t) * h(t)')
mp.xlabel("t")
mp.ylabel(r'$v_{0}$(t)')
mp.show()
```

The plot obtained is :





The signal rises steeply in the interval 0<t<30μs. That is, The slope value is very high compared to the rest of the curve. This could be due to the contribution of the transient response (due to the sudden input impulse at t=0) which is prominent in the initial stages and dies down as time progresses. As a result, the rest of the graph seems uniform and periodic.