Homework 13

Colt Bradley

1 Small Oscillations for a Spring System

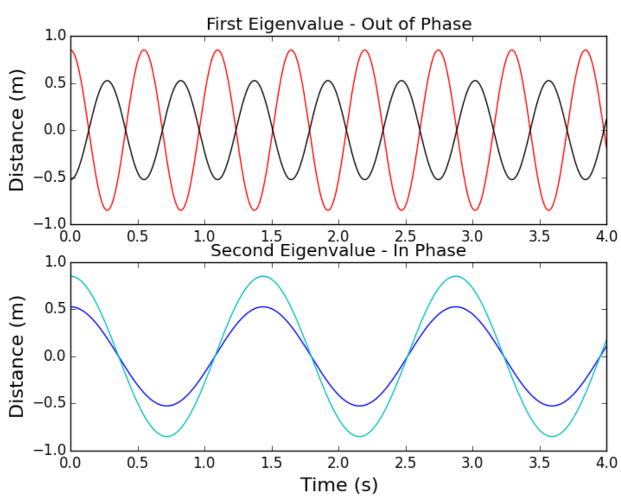
Here, we use linear algebra tools to solve a systems of springs for small oscillations. For the first normal mode, we find:

$$\eta_1 = (0.851)\cos 11.44t \quad (1a)$$
$$\eta_2 = -(0.526)\cos 11.44t \quad (1b)$$

And for the second mode, we have:

$$\eta_3 = (0.526)\cos 11.44t \quad (2a)$$
$$\eta_4 = (0.851)\cos 11.44t \quad (2b)$$

The first normal mode is out of phase, which is evident from the minus sign in front of η_2. The second normal mode is in phase. This is especially evident in the graph below.



2 Code

```
#Colt Bradley
#3.1.16
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#import modules
import numpy as n
import pylab as p

#define values
k = 15.
m = .3

#define matrix, solve
mat = n.matrix([[2*k,-k],[-k,k]])
eval, evec = n.linalg.eig(mat)

#redefine eigenvalues as omega
omeg = n.sqrt(eval/m)

#create times, build lists of function values for each time
t = n.linspace(0,4,500)
eig1_1 = evec[0,0]*n.cos(omeg[0]*t)
eig1_2 = evec[1,0]*n.cos(omeg[0]*t)
eig2_1 = evec[0,1]*n.cos(omeg[1]*t)
eig2_2 = evec[1,1]*n.cos(omeg[1]*t)

#plot on the same plot using subplots and appropriate labeling.
p.subplot(211)
p.title("First Eigenvalue - Out of Phase")
p.ylabel("Distance (m)",fontsize = 16)
p.plot(t,eig1_1,"r",label = "Eig1_1")
p.plot(t,eig1_2,"k",label = "Eig1_2")

p.subplot(212)
p.title("Second Eigenvalue - In Phase")
p.plot(t,eig2_1,"b", label = "Eig2_1")
p.plot(t,eig2_2,"c",label = "Eig2_2")
p.ylabel("Distance (m)",fontsize = 16)
```

```
p.xlabel("Time (s)",fontsize = 16)
p.show()
p.savefig("fig.png")
```