Universidad Nacional San Agustin de Arequipa

Facultad de Ingenierias de Produccion y Servicios

Escuela Profesional de Ingenieria de Sistemas

Fisica Computacional

Alumno:

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[1]:
```
#%matplotlib notebook
%matplotlib inline
```

1 Importando Librerias

[2]:
```
import numpy as np
from matplotlib import pyplot  as pt

from mpl_toolkits import mplot3d
```

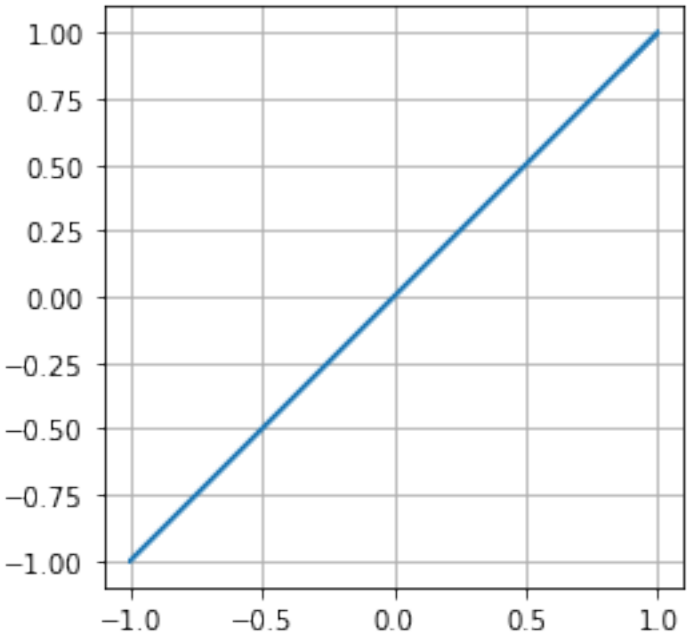
2 Metodo que retorna los puntos de Lissajous

[3]:
```
def Lissajous(lnm, m, v, p, h, tf):
    k = m * (lnm**2)
    a = -k * p / m
    ps = [ p ]
    for t in np.arange(0, tfin, h):
        a = -k * p / m
        v = v + a*h
        p  = p  + v*h
        ps.append(p)
    return ps
```

3 Con estos datos dibujar las figuras de Lissajous con las condiciones iniciales

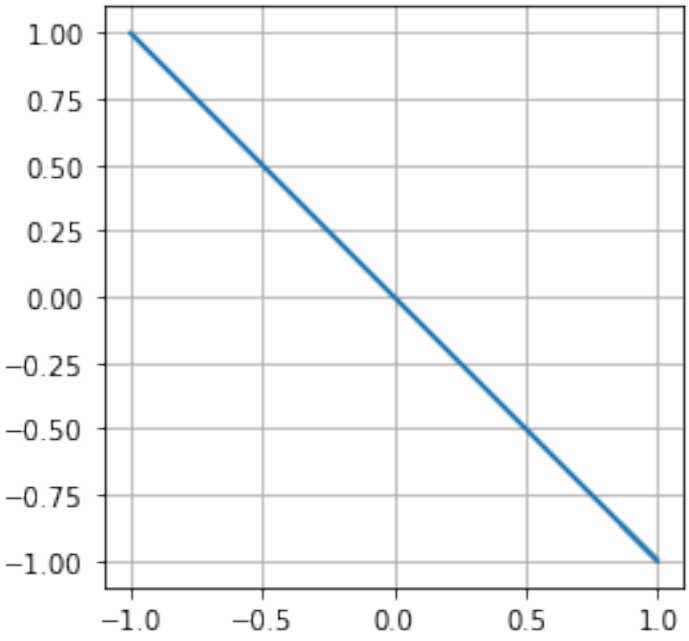
(a) x = 1, vx = 0, y = +1, vy = 0

[4]:
```
p = np.array([ 1, 1 ])
v = np.array([ 0, 0 ])

m = np.array([ 1, 1])
ln = np.array([ 1 , 1 ])
h = 0.01
tfin=100
ps = Lissajous(ln, m,v,p,h, tfin)
fig, ax = pt.subplots()
ax.plot([p[0] for p in ps], [p[1] for p in ps])
ax.grid()
ax.set_aspect('equal')
```



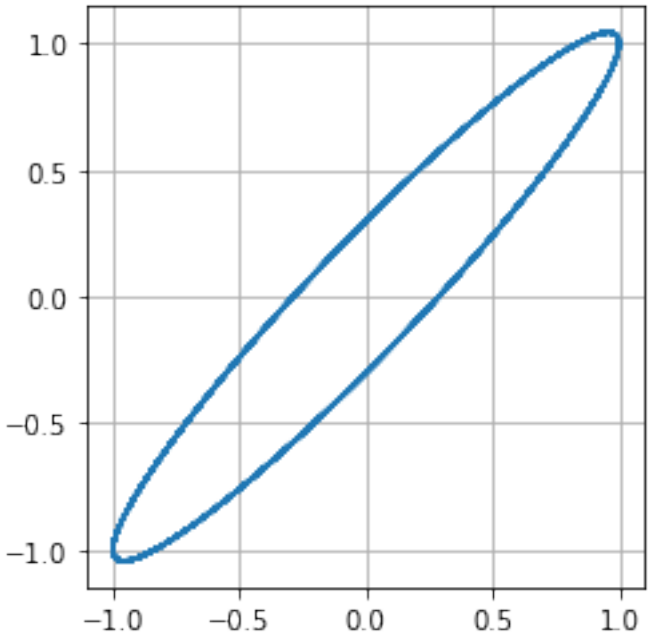
(b) x = 1, vx = 0, y = −1, vy = 0

[5]:
```
p = np.array([ 1, -1 ])
v = np.array([ 0, 0 ])

m = np.array([ 1, 1])
ln = np.array([ 1 , 1 ])
h = 0.01
tfin=100
ps = Lissajous(ln, m,v,p,h, tfin)
fig, ax = pt.subplots()
ax.plot([p[0] for p in ps], [p[1] for p in ps])
ax.grid()
ax.set_aspect('equal')
```



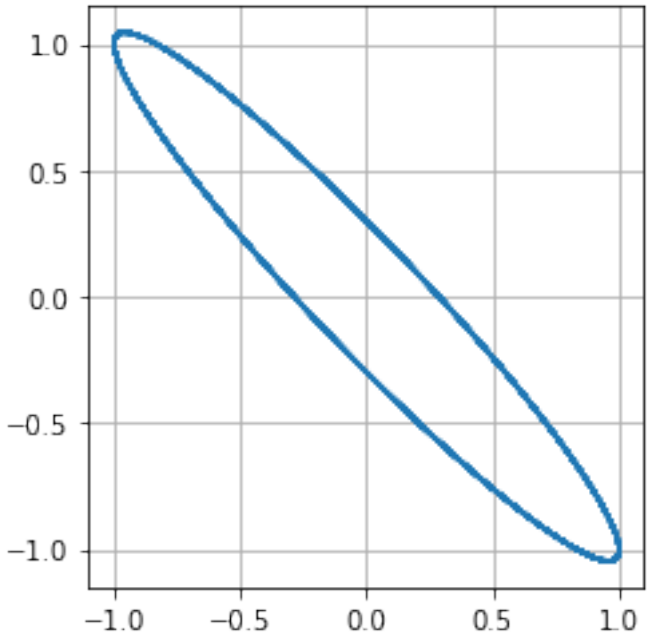
(c) x = 1, vx = 0, y = +1, vy = 0.3

[6]:
```
p = np.array([ 1, 1 ])
v = np.array([ 0, 0.3 ])

m = np.array([ 1, 1])
ln = np.array([ 1 , 1 ])
h = 0.01
tfin=100
ps = Lissajous(ln, m,v,p,h, tfin)
fig, ax = pt.subplots()
ax.plot([p[0] for p in ps], [p[1] for p in ps])
ax.grid()
ax.set_aspect('equal')
```



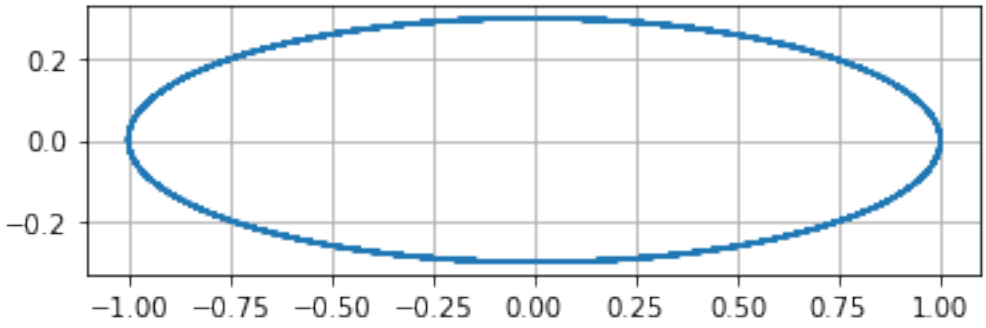
(d) x = 1, vx = 0, y = −1, vy = 0.3

[7]:
```
p = np.array([ 1, -1 ])
v = np.array([ 0, 0.3 ])

m = np.array([ 1, 1])
ln = np.array([ 1 , 1 ])
h = 0.01
tfin=100
ps = Lissajous(ln, m,v,p,h, tfin)
fig, ax = pt.subplots()
ax.plot([p[0] for p in ps], [p[1] for p in ps])
ax.grid()
ax.set_aspect('equal')
```



(e) x = 1, vx = 0, y = 0, vy = 0.3

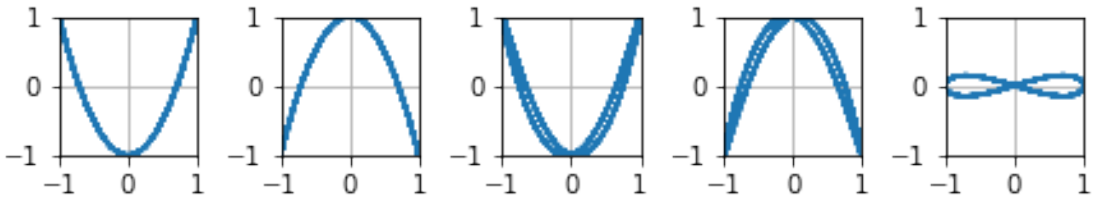
[8]:
```
p = np.array([ 1, 0 ])
v = np.array([ 0, 0.3 ])

m = np.array([ 1, 1])
ln = np.array([ 1 , 1 ])
h = 0.01
tfin=100
ps = Lissajous(ln, m,v,p,h, tfin)
fig, ax = pt.subplots()
ax.plot([p[0] for p in ps], [p[1] for p in ps])
ax.grid()
ax.set_aspect('equal')
```



4 Cada elemento de fila es (a), (b), (c), (d), (e). Fabrique para

(a) l = 1, n = 2

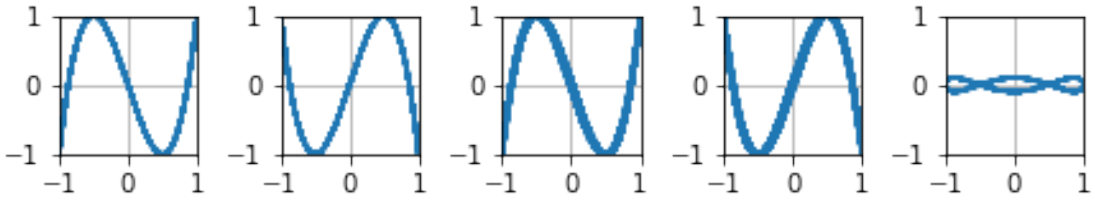
[9]:
```
m = np.array([ 1, 1])
ln = np.array([ 1 , 2 ])

datos = [
    [ np.array([ 1, 1 ]), np.array([ 0, 0 ]) ],
    [ np.array([ 1, -1 ]), np.array([ 0, 0 ]) ],
    [ np.array([ 1, 1 ]), np.array([ 0, 0.3 ]) ],
    [ np.array([ 1, -1 ]), np.array([ 0, 0.3 ]) ],
    [ np.array([ 1, 0 ]), np.array([ 0, 0.3 ]) ]
]


h = 0.01
tfin=100

fig, ax = pt.subplots(1,5, constrained_layout=True)

for i, data in enumerate(datos):
    ps = Lissajous(ln, m,data[1],data[0],h, tfin)
    ax[i].plot([p[0] for p in ps], [p[1] for p in ps])
    ax[i].grid()
    ax[i].set_aspect('equal')
    ax[i].set(xlim=(-1,1), ylim=(-1,1))
```



(b) l = 1, n = 3

[10]:
```
m = np.array([ 1, 1])
ln = np.array([ 1 , 3 ])

datos = [
    [ np.array([ 1, 1 ]), np.array([ 0, 0 ]) ],
    [ np.array([ 1, -1 ]), np.array([ 0, 0 ]) ],
```

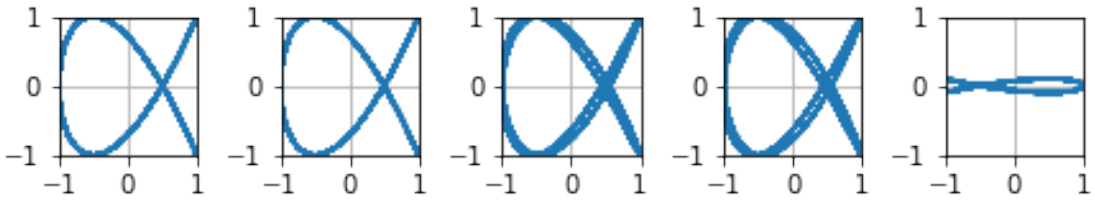
```
    [ np.array([ 1, 1 ]), np.array([ 0, 0.3 ]) ],
    [ np.array([ 1, -1 ]), np.array([ 0, 0.3 ]) ],
    [ np.array([ 1, 0 ]), np.array([ 0, 0.3 ]) ]
]


h = 0.01
tfin=100

fig, ax = pt.subplots(1,5, constrained_layout=True)

for i, data in enumerate(datos):
    ps = Lissajous(ln, m,data[1],data[0],h, tfin)
    ax[i].plot([p[0] for p in ps], [p[1] for p in ps])
    ax[i].grid()
    ax[i].set_aspect('equal')
    ax[i].set(xlim=(-1,1), ylim=(-1,1))
```



(c) $l = 2, n = 3$

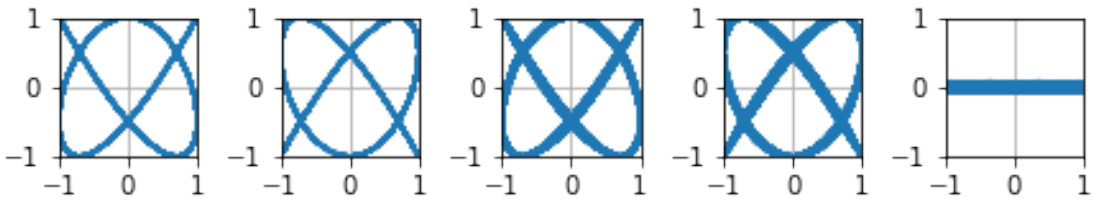
[11]:
```
m = np.array([ 1, 1])
ln = np.array([ 2 , 3 ])

datos = [
    [ np.array([ 1, 1 ]), np.array([ 0, 0 ]) ],
    [ np.array([ 1, -1 ]), np.array([ 0, 0 ]) ],
    [ np.array([ 1, 1 ]), np.array([ 0, 0.3 ]) ],
    [ np.array([ 1, -1 ]), np.array([ 0, 0.3 ]) ],
    [ np.array([ 1, 0 ]), np.array([ 0, 0.3 ]) ]
]


h = 0.01
tfin=100

fig, ax = pt.subplots(1,5, constrained_layout=True)

for i, data in enumerate(datos):
```

```
    ps = Lissajous(ln, m,data[1],data[0],h, tfin)
    ax[i].plot([p[0] for p in ps], [p[1] for p in ps])
    ax[i].grid()
    ax[i].set_aspect('equal')
    ax[i].set(xlim=(-1,1), ylim=(-1,1))
```



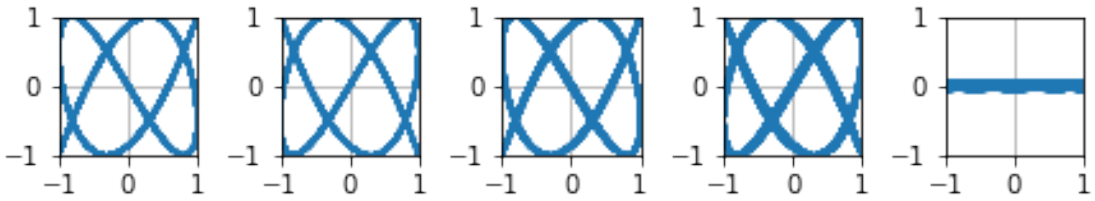
(d) l = 3, n = 4

[12]:
```
m = np.array([ 1, 1])
ln = np.array([ 3 , 4 ])

datos = [
    [ np.array([ 1, 1 ]), np.array([ 0, 0 ]) ],
    [ np.array([ 1, -1 ]), np.array([ 0, 0 ]) ],
    [ np.array([ 1, 1 ]), np.array([ 0, 0.3 ]) ],
    [ np.array([ 1, -1 ]), np.array([ 0, 0.3 ]) ],
    [ np.array([ 1, 0 ]), np.array([ 0, 0.3 ]) ]
]


h = 0.01
tfin=100

fig, ax = pt.subplots(1,5, constrained_layout=True)

for i, data in enumerate(datos):
    ps = Lissajous(ln, m,data[1],data[0],h, tfin)
    ax[i].plot([p[0] for p in ps], [p[1] for p in ps])
    ax[i].grid()
    ax[i].set_aspect('equal')
    ax[i].set(xlim=(-1,1), ylim=(-1,1))
```



(e) l = 3, n = 5

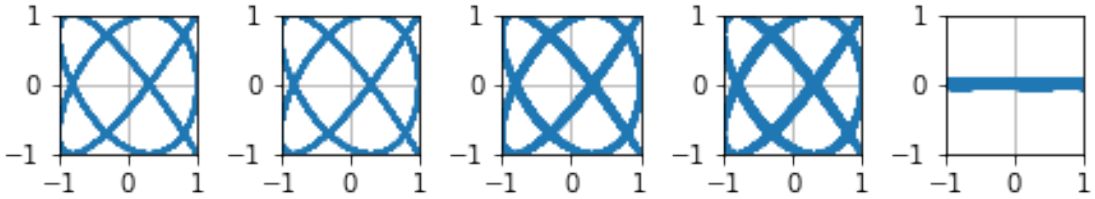
[13]:
```
m = np.array([ 1, 1])
ln = np.array([ 3 , 5 ])

datos = [
    [ np.array([ 1, 1 ]), np.array([ 0, 0 ]) ],
    [ np.array([ 1, -1 ]), np.array([ 0, 0 ]) ],
    [ np.array([ 1, 1 ]), np.array([ 0, 0.3 ]) ],
    [ np.array([ 1, -1 ]), np.array([ 0, 0.3 ]) ],
    [ np.array([ 1, 0 ]), np.array([ 0, 0.3 ]) ]
]


h = 0.01
tfin=100

fig, ax = pt.subplots(1,5, constrained_layout=True)

for i, data in enumerate(datos):
    ps = Lissajous(ln, m,data[1],data[0],h, tfin)
    ax[i].plot([p[0] for p in ps], [p[1] for p in ps])
    ax[i].grid()
    ax[i].set_aspect('equal')
    ax[i].set(xlim=(-1,1), ylim=(-1,1))
```



(f) l = 4, n = 5

[14]:
```
m = np.array([ 1, 1])
ln = np.array([ 4 , 5 ])

datos = [
    [ np.array([ 1, 1 ]), np.array([ 0, 0 ]) ],
    [ np.array([ 1, -1 ]), np.array([ 0, 0 ]) ],
    [ np.array([ 1, 1 ]), np.array([ 0, 0.3 ]) ],
    [ np.array([ 1, -1 ]), np.array([ 0, 0.3 ]) ],
```

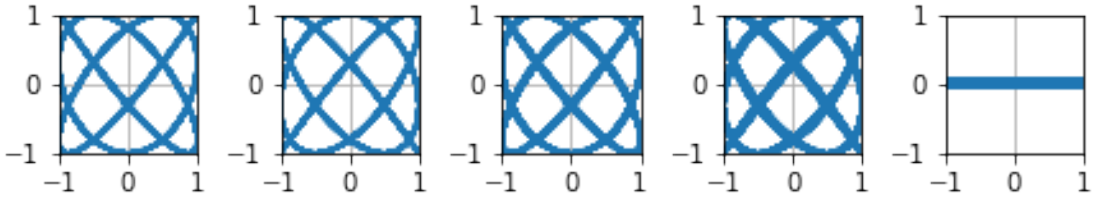
```
    [ np.array([ 1, 0 ]), np.array([ 0, 0.3 ]) ]
]


h = 0.01
tfin=100

fig, ax = pt.subplots(1,5, constrained_layout=True)

for i, data in enumerate(datos):
    ps = Lissajous(ln, m,data[1],data[0],h, tfin)
    ax[i].plot([p[0] for p in ps], [p[1] for p in ps])
    ax[i].grid()
    ax[i].set_aspect('equal')
    ax[i].set(xlim=(-1,1), ylim=(-1,1))
```



(g) $l = 5, n = 6$

[15]:
```
m = np.array([ 1, 1])
ln = np.array([ 5 , 6 ])

datos = [
    [ np.array([ 1, 1 ]), np.array([ 0, 0 ]) ],
    [ np.array([ 1, -1 ]), np.array([ 0, 0 ]) ],
    [ np.array([ 1, 1 ]), np.array([ 0, 0.3 ]) ],
    [ np.array([ 1, -1 ]), np.array([ 0, 0.3 ]) ],
    [ np.array([ 1, 0 ]), np.array([ 0, 0.3 ]) ]
]


h = 0.01
tfin=100

fig, ax = pt.subplots(1,5, constrained_layout=True)

for i, data in enumerate(datos):
    ps = Lissajous(ln, m,data[1],data[0],h, tfin)
    ax[i].plot([p[0] for p in ps], [p[1] for p in ps])
```

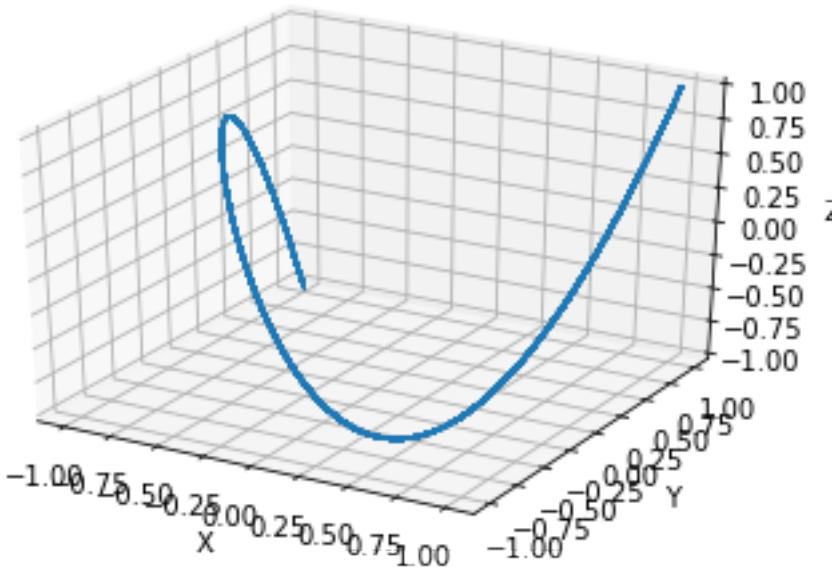
```
    ax[i].grid()
    ax[i].set_aspect('equal')
    ax[i].set(xlim=(-1,1), ylim=(-1,1))
```



5 Con estos datos dibujar una figura de Lissajous con las condiciones iniciales en 3D como referencia.

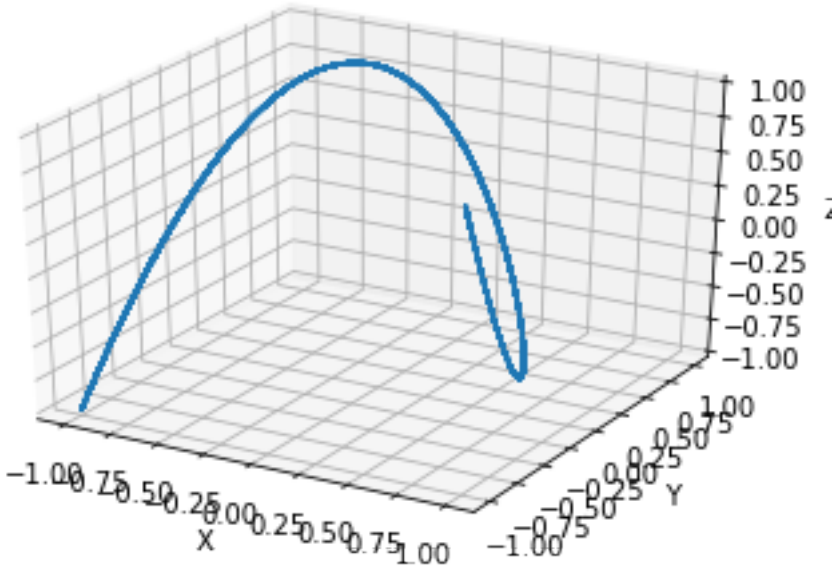
(a) x = 1, vx = 0, z = 1, vz = 0, y = +1, vy = 0

[16]:
```
p = np.array([ 1, 1, 1 ])
v = np.array([ 0, 0, 0 ])


m = np.array([ 1, 1 , 1])
ln = np.array([  1, 2 , 3  ])


h = 0.01
tfin=100
ps = Lissajous(ln, m,v,p,h, tfin)
fig, ax = pt.subplots()
ax = pt.axes(projection='3d')
ax.plot([p[0] for p in ps], [p[1] for p in ps] ,[p[2] for p in ps])
ax.set(xlabel='X', ylabel='Y', zlabel='Z')
ax.grid()
```



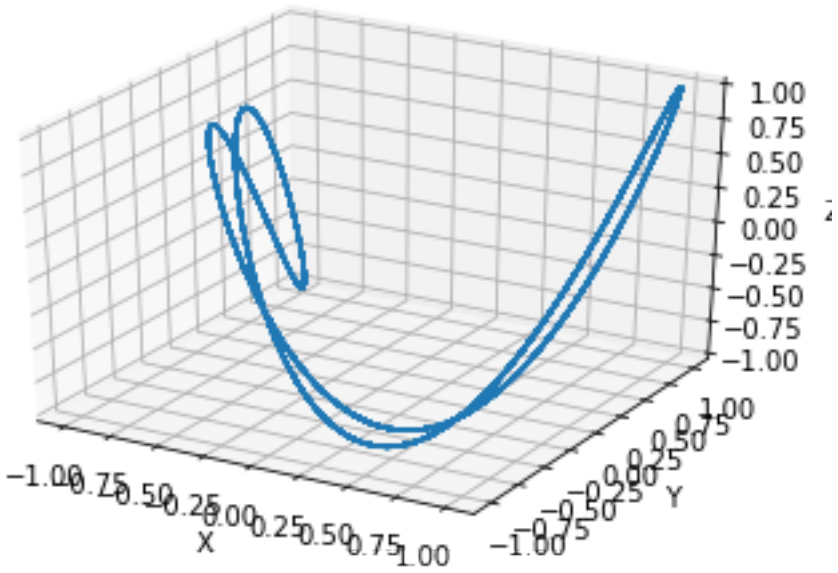
(b) x = 1, vx = 0, z = 1, vz = 0, y = −1, vy = 0

[17]:
```
p = np.array([ 1, -1, 1 ])
v = np.array([ 0, 0, 0 ])


m = np.array([ 1, 1 , 1])
ln = np.array([  1, 2 , 3  ])


h = 0.01
tfin=100
ps = Lissajous(ln, m,v,p,h, tfin)
fig, ax = pt.subplots()
ax = pt.axes(projection='3d')
ax.plot([p[0] for p in ps], [p[1] for p in ps] ,[p[2] for p in ps])
ax.set(xlabel='X', ylabel='Y', zlabel='Z')
ax.grid()
```



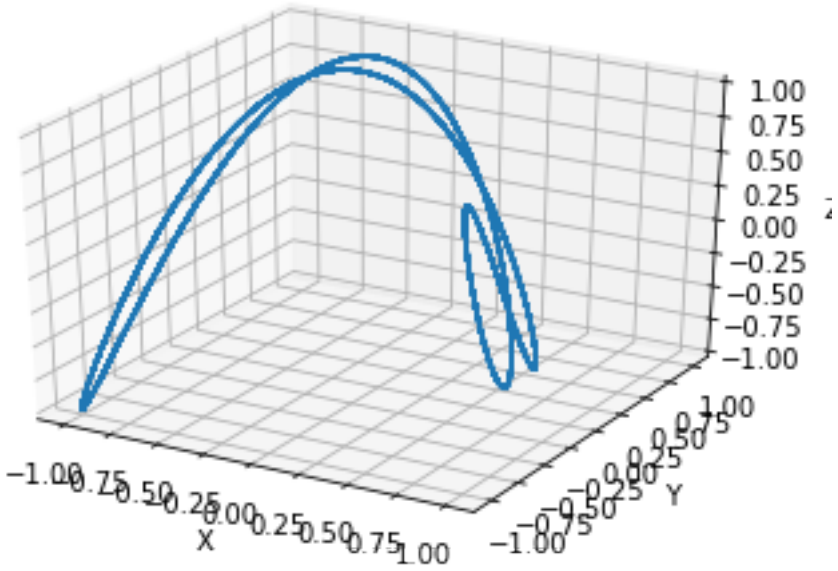
(c) x = 1, vx = 0, z = 1, vz = 0, y = +1, vy = 0.3

[18]:
```
p = np.array([ 1, 1, 1 ])
v = np.array([ 0, 0.3, 0 ])


m = np.array([ 1, 1 , 1])
ln = np.array([ 1, 2 , 3 ])


h = 0.01
tfin=100
ps = Lissajous(ln, m,v,p,h, tfin)
fig, ax = pt.subplots()
ax = pt.axes(projection='3d')
ax.plot([p[0] for p in ps], [p[1] for p in ps] ,[p[2] for p in ps])
ax.set(xlabel='X', ylabel='Y', zlabel='Z')
ax.grid()
```



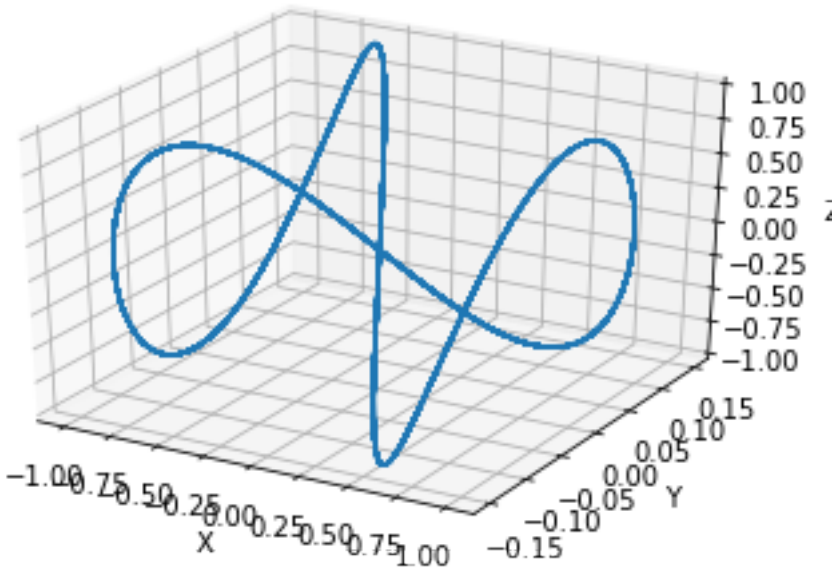
(d) x = 1, vx = 0, z = 1, vz = 0, y = −1, vy = 0.3

[19]:
```
p = np.array([ 1, -1, 1 ])
v = np.array([ 0, 0.3, 0 ])


m = np.array([ 1, 1 , 1])
ln = np.array([  1, 2 , 3  ])


h = 0.01
tfin=100
ps = Lissajous(ln, m,v,p,h, tfin)
fig, ax = pt.subplots()
ax = pt.axes(projection='3d')
ax.plot([p[0] for p in ps], [p[1] for p in ps] ,[p[2] for p in ps])
ax.set(xlabel='X', ylabel='Y', zlabel='Z')
ax.grid()
```



(e) x = 1, vx = 0, z = 1, vz = 0, y = 0, vy = 0.3

[20]:
```
p = np.array([ 1, 0, 1 ])
v = np.array([ 0, 0.3, 0 ])


m = np.array([ 1, 1 , 1])
ln = np.array([  1, 2 , 3  ])


h = 0.01
tfin=100
ps = Lissajous(ln, m,v,p,h, tfin)
fig, ax = pt.subplots()
ax = pt.axes(projection='3d')
ax.plot([p[0] for p in ps], [p[1] for p in ps] ,[p[2] for p in ps])
ax.set(xlabel='X', ylabel='Y', zlabel='Z')
ax.grid()
```


1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
0.15
0.10
0.05
0.00
−0.05
−0.10
−0.15
Y
X