

Universidad Nacional San Agustín de Arequipa

FACULTAD DE INGENIERIAS DE PRODUCCION Y SERVICIOS

ESCUELA PROFESIONAL DE INGENIERIA
DE SISTEMAS

Física Computacional

Alumno:

Fuentes Paredes Nelson Alejandro

Mayo 2020

```
[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

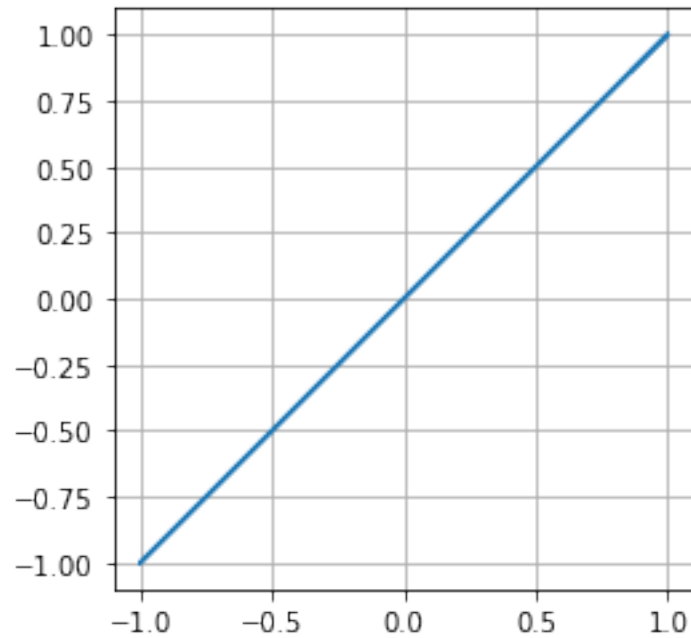
```
[3]: def Lissajous(lnm, m, v, p, h, tf):
      k = m * (lnm**2)
      a = -k * p / m
      ps = [ p ]
      for t in np.arange(0, tf, h):
          a = -k * p / m
          v = v + a*h
          p = p + v*h
          ps.append(p)
      return ps
```

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

(a) $x = 1, v_x = 0, y = +1, v_y = 0$

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

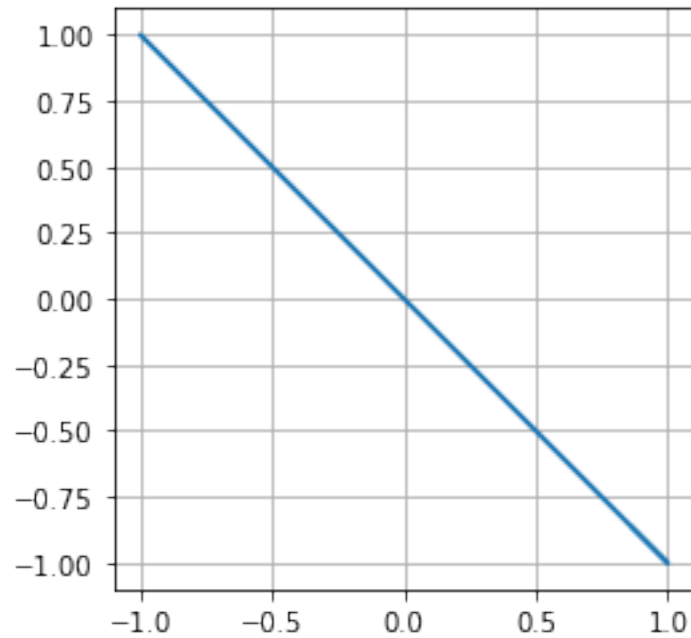
      m = np.array([ 1, 1])
      ln = np.array([ 1 , 1 ])
      h = 0.01
      tf=100
      ps = Lissajous(ln, m,v,p,h, tf)
      fig, ax = pt.subplots()
      ax.plot([p[0] for p in ps], [p[1] for p in ps])
      ax.grid()
      ax.set_aspect('equal')
```



(b) $x = 1, v_x = 0, y = -1, v_y = 0$

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

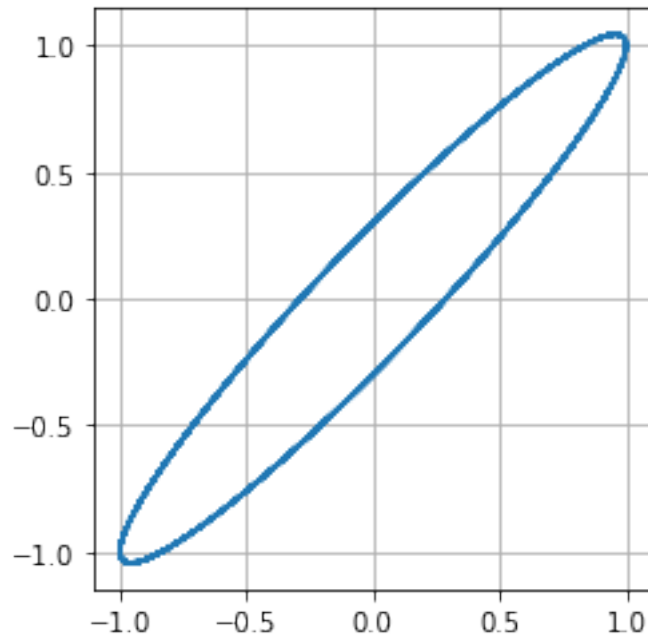
     m = np.array([ 1, 1])
     ln = np.array([ 1 , 1 ])
     h = 0.01
     tfinal=100
     ps = Lissajous(ln, m,v,p,h, tfinal)
     fig, ax = plt.subplots()
     ax.plot([p[0] for p in ps], [p[1] for p in ps])
     ax.grid()
     ax.set_aspect('equal')
```



(c) $x = 1$, $v_x = 0$, $y = +1$, $v_y = 0.3$

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

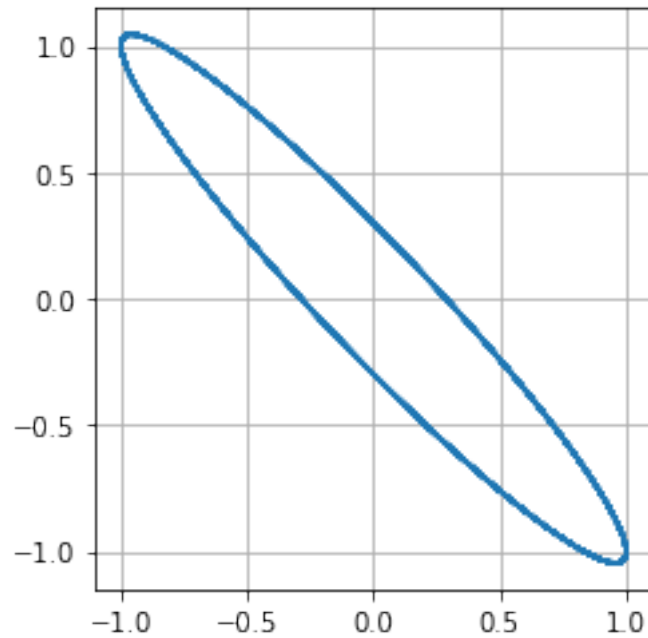
     m = np.array([ 1, 1])
     ln = np.array([ 1 , 1 ])
     h = 0.01
     tfin=100
     ps = Lissajous(ln, m,v,p,h, tfin)
     fig, ax = plt.subplots()
     ax.plot([p[0] for p in ps], [p[1] for p in ps])
     ax.grid()
     ax.set_aspect('equal')
```



(d) $x = 1$, $v_x = 0$, $y = -1$, $v_y = 0.3$

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

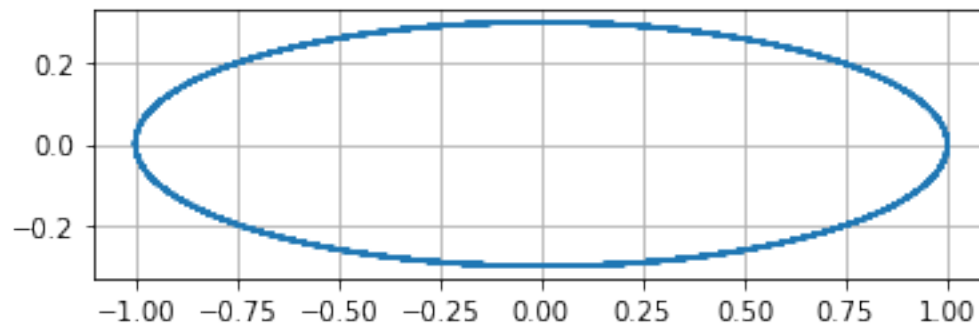
     m = np.array([ 1, 1])
     ln = np.array([ 1 , 1 ])
     h = 0.01
     tfinal=100
     ps = Lissajous(ln, m,v,p,h, tfinal)
     fig, ax = plt.subplots()
     ax.plot([p[0] for p in ps], [p[1] for p in ps])
     ax.grid()
     ax.set_aspect('equal')
```



(e) $x = 1$, $v_x = 0$, $y = 0$, $v_y = 0.3$

```
[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
     tfinal=100
     ps = Lissajous(ln, m,v,p,h, tfinal)
     fig, ax = plt.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

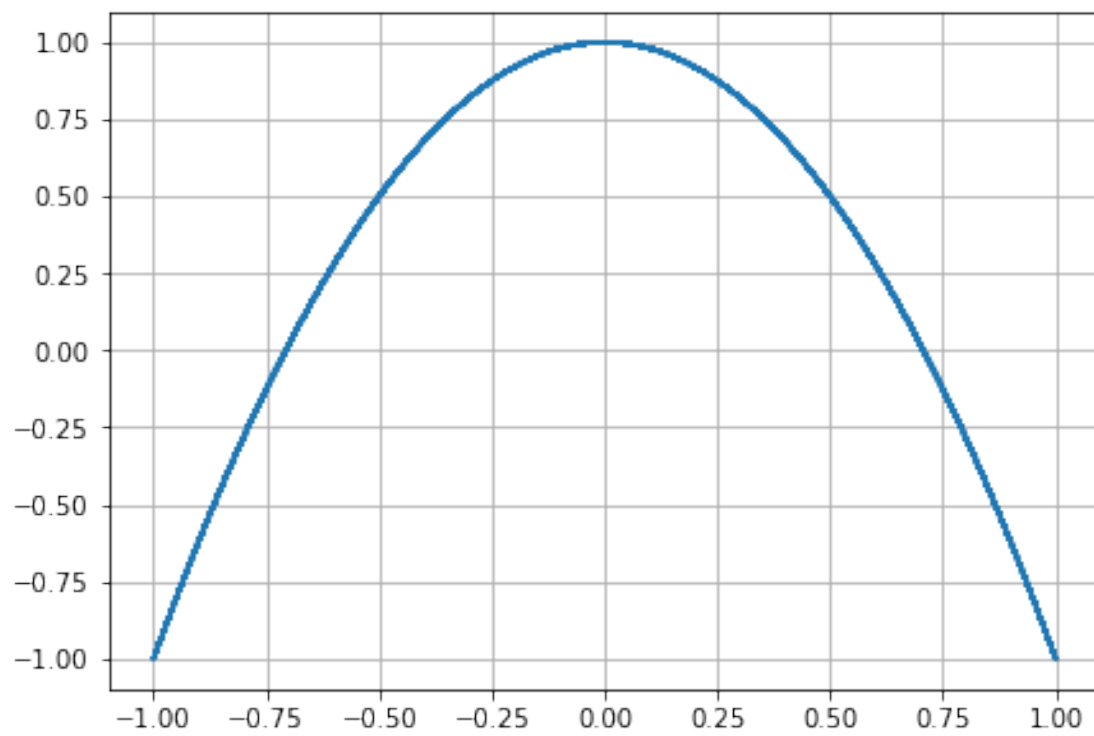
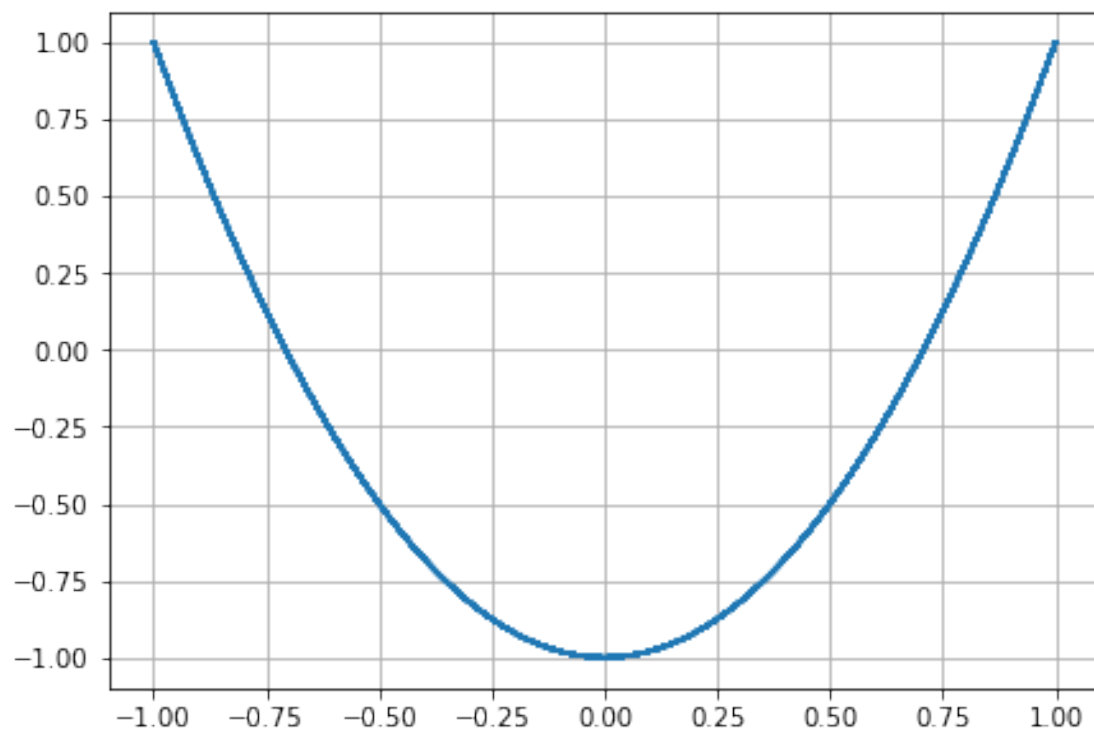
(a) $l = 1, n = 2$

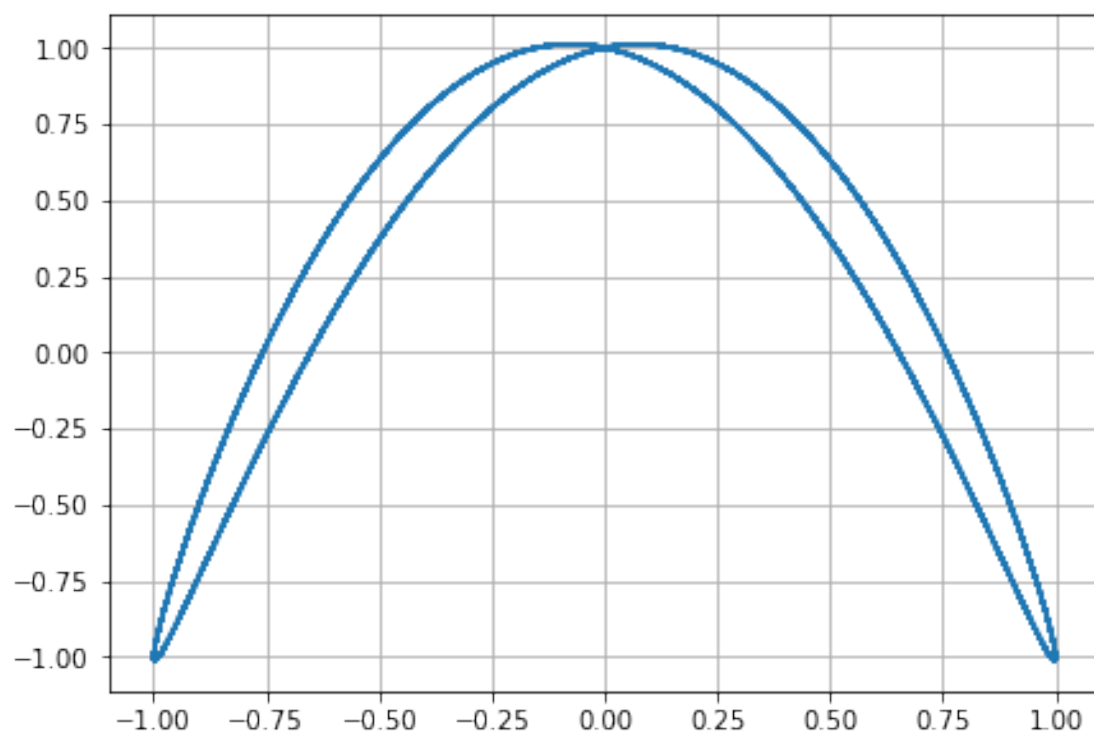
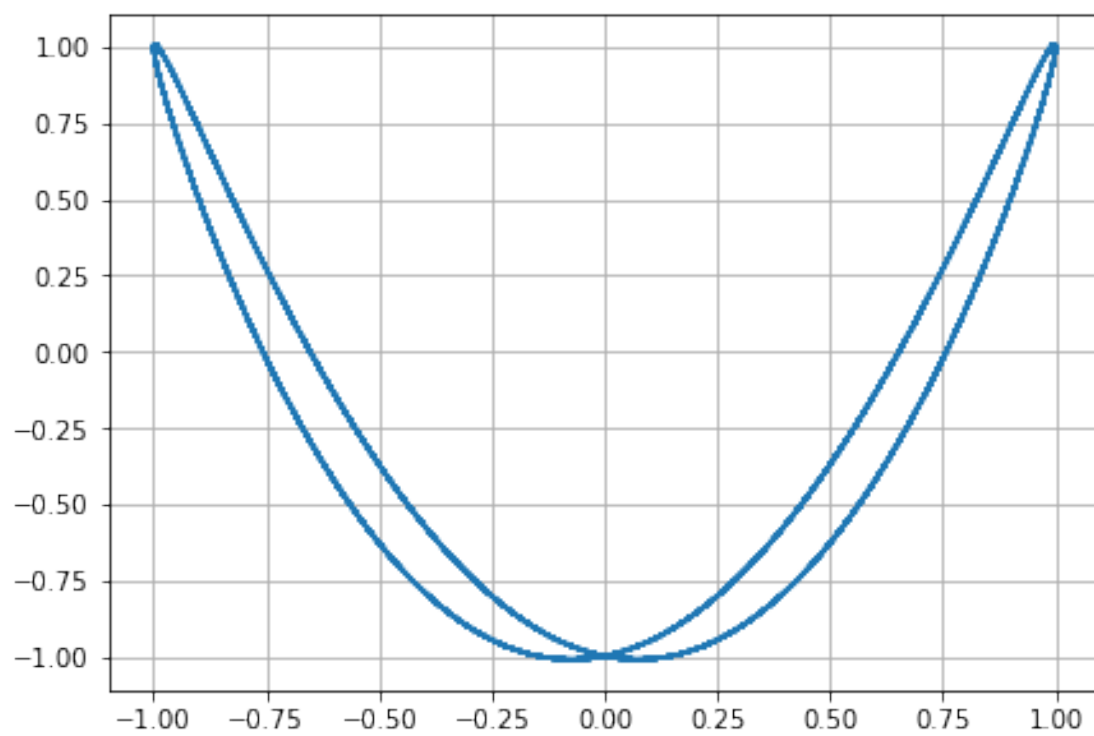
```
[17]: m = np.array([ 1, 1])
      ln = np.array([ 1 , 2 ])

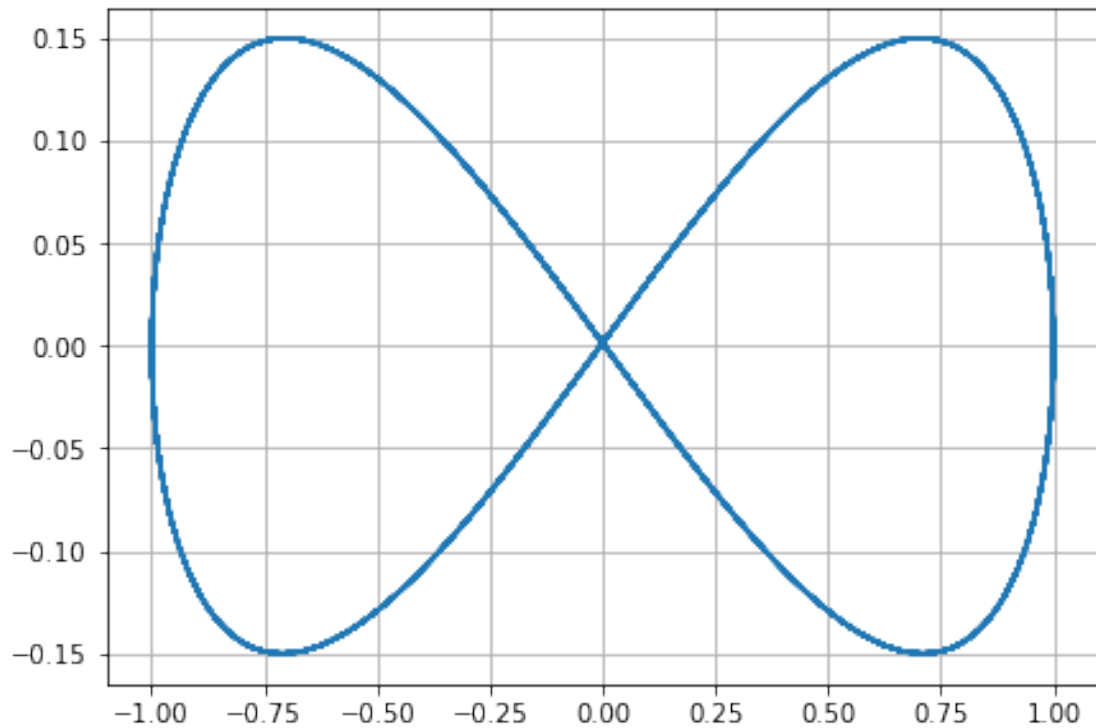
      datos = [
          [ np.array([ 1, 1 ]), np.array([ 0, 0 ]) ],
          [ np.array([ 1, -1 ]), np.array([ 0, 0 ]) ],
          [ np.array([ 1, 1 ]), np.array([ 0, 0.3 ]) ],
          [ np.array([ 1, -1 ]), np.array([ 0, 0.3 ]) ],
          [ np.array([ 1, 0 ]), np.array([ 0, 0.3 ]) ]
      ]

      h = 0.01
      tfin=100

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







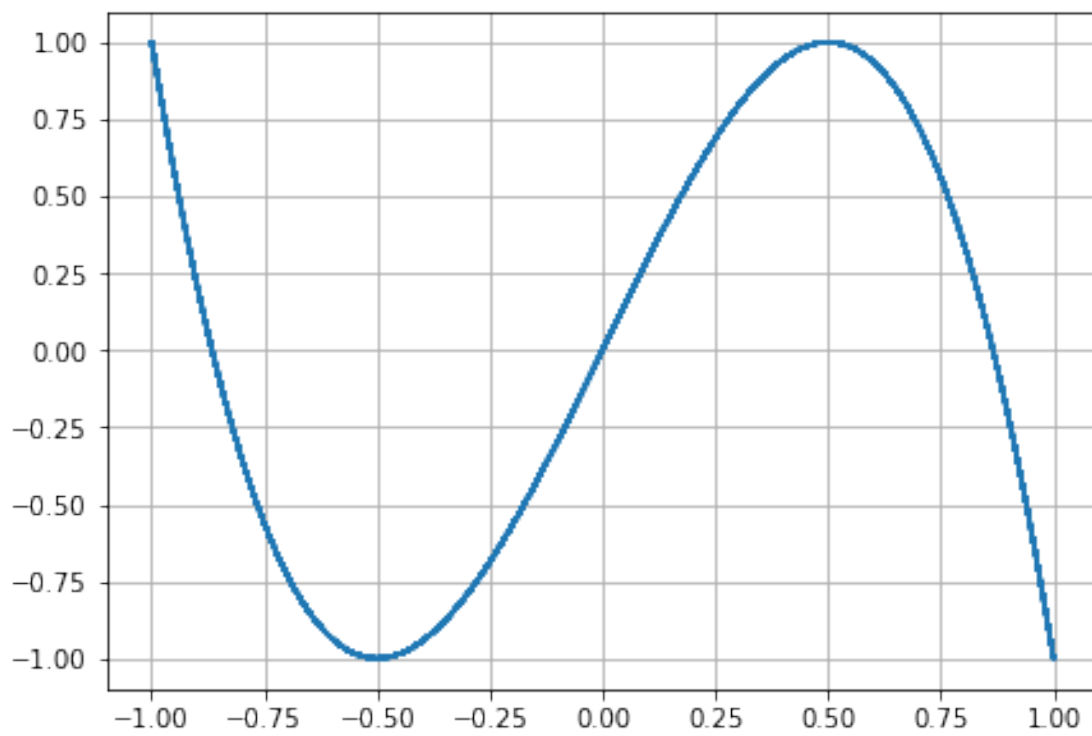
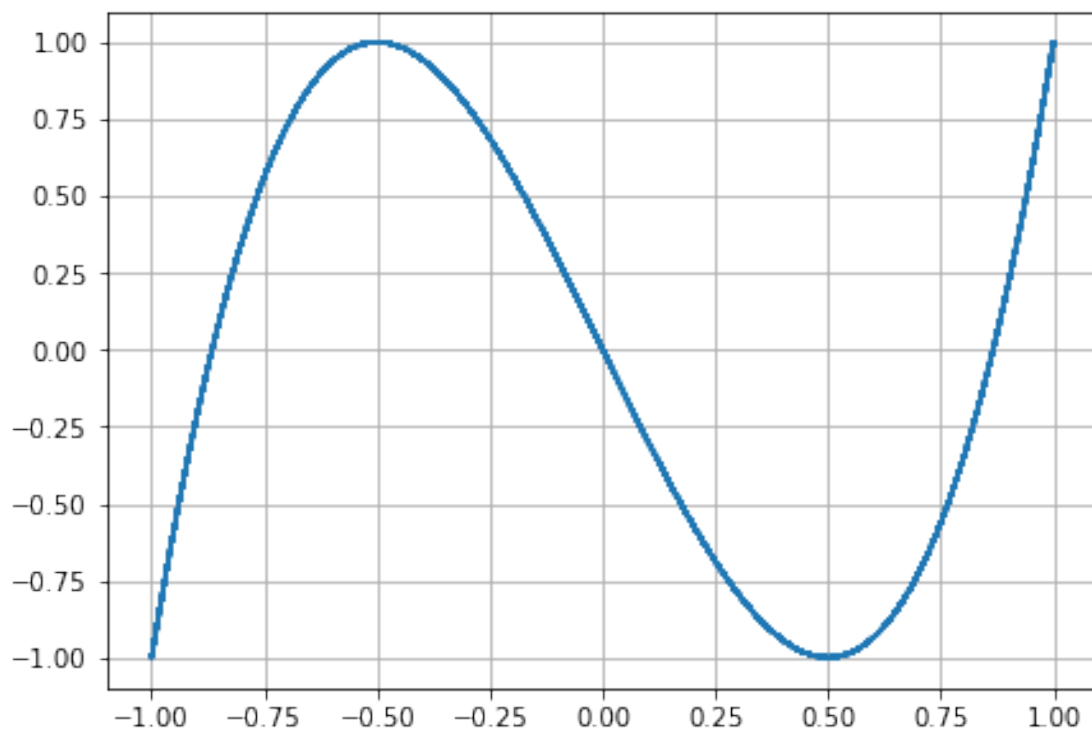
(b) $l = 1, n = 3$

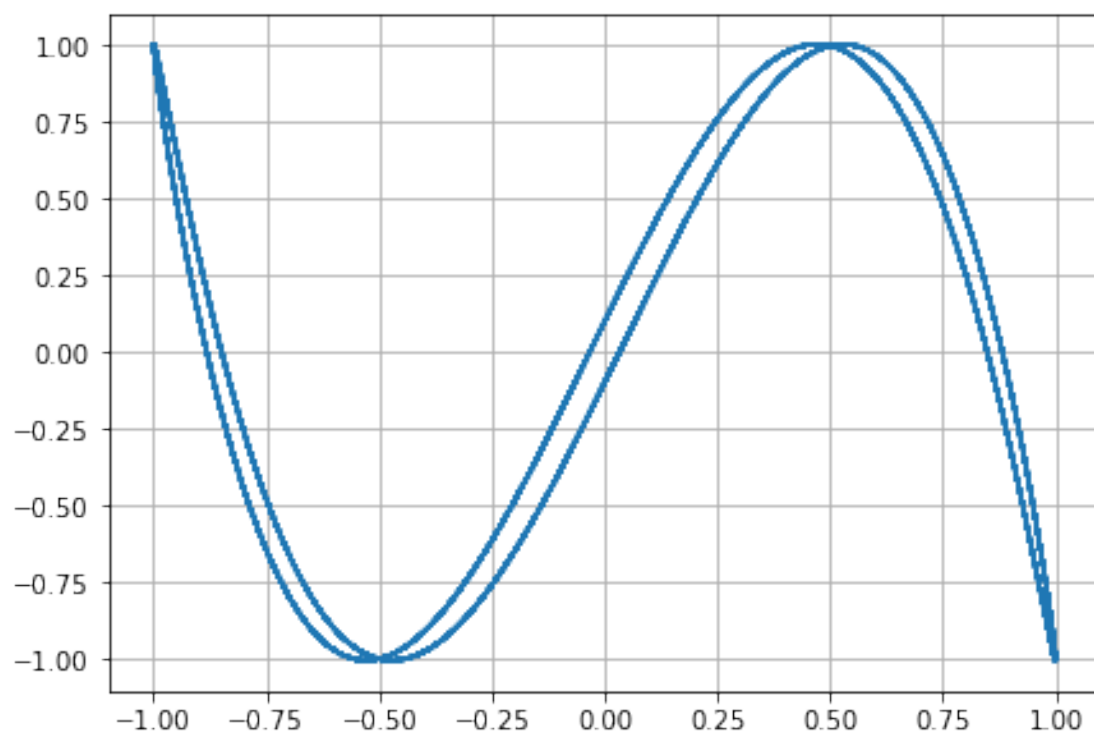
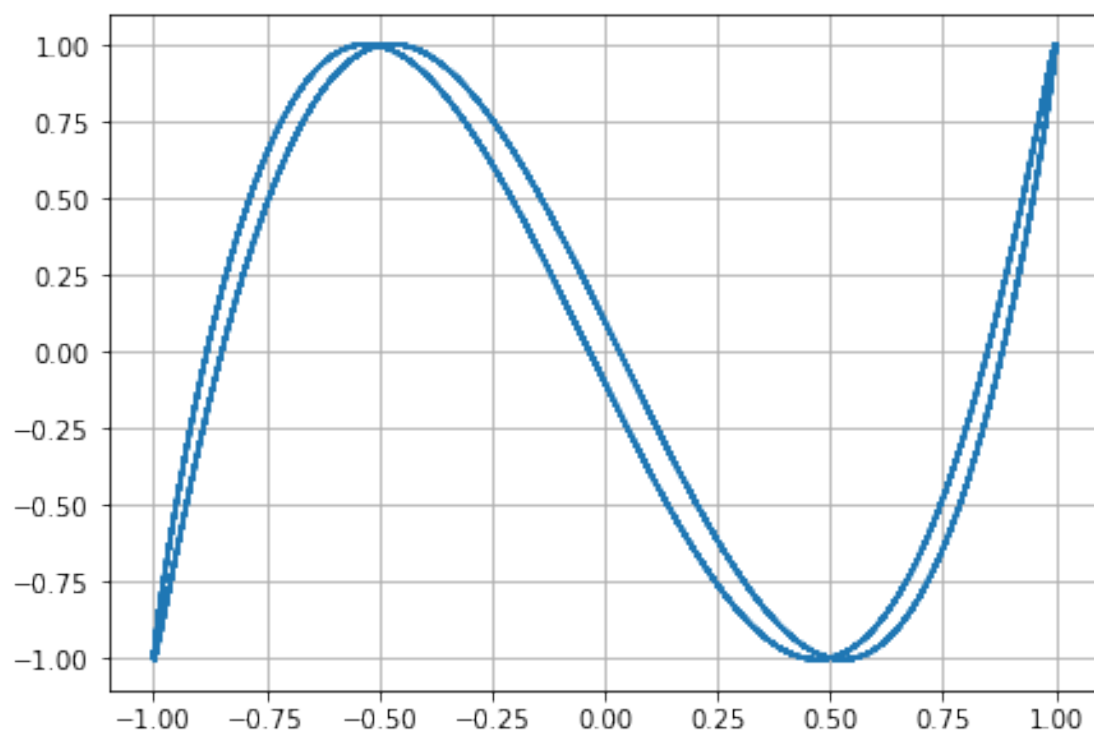
```
[16]: m = np.array([ 1, 1])
      ln = np.array([ 1 , 3 ])

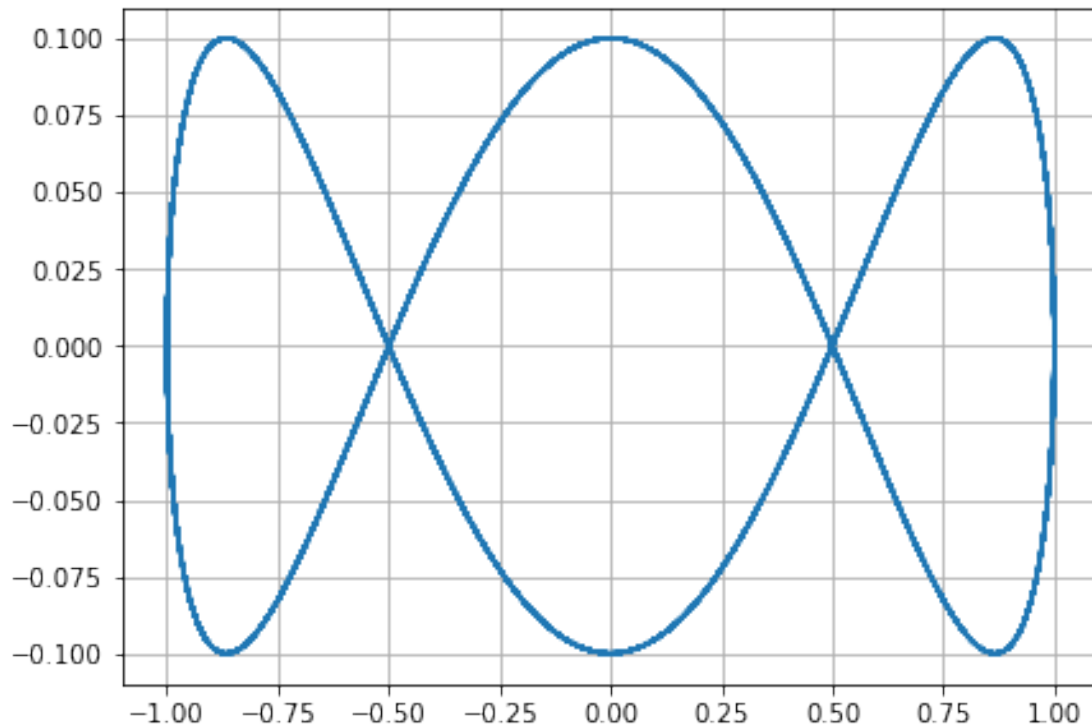
      datos = [
          [ np.array([ 1, 1 ]), np.array([ 0, 0 ]) ],
          [ np.array([ 1, -1 ]), np.array([ 0, 0 ]) ],
          [ np.array([ 1, 1 ]), np.array([ 0, 0.3 ]) ],
          [ np.array([ 1, -1 ]), np.array([ 0, 0.3 ]) ],
          [ np.array([ 1, 0 ]), np.array([ 0, 0.3 ]) ]
      ]

      h = 0.001
      tfin=100

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







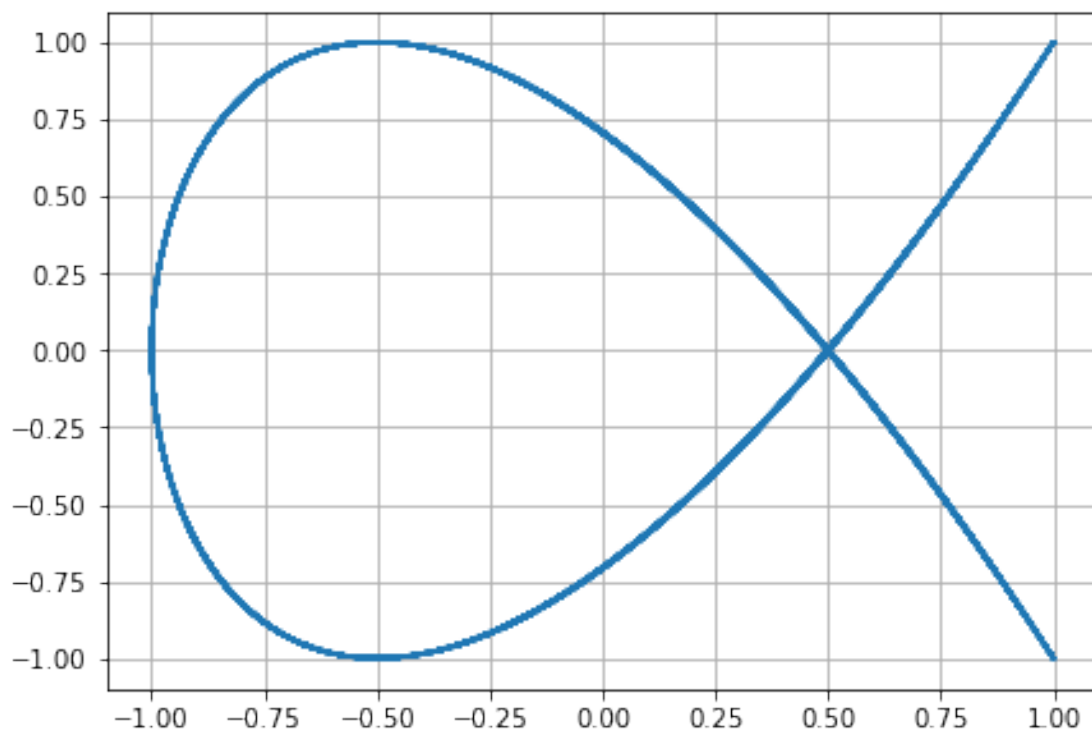
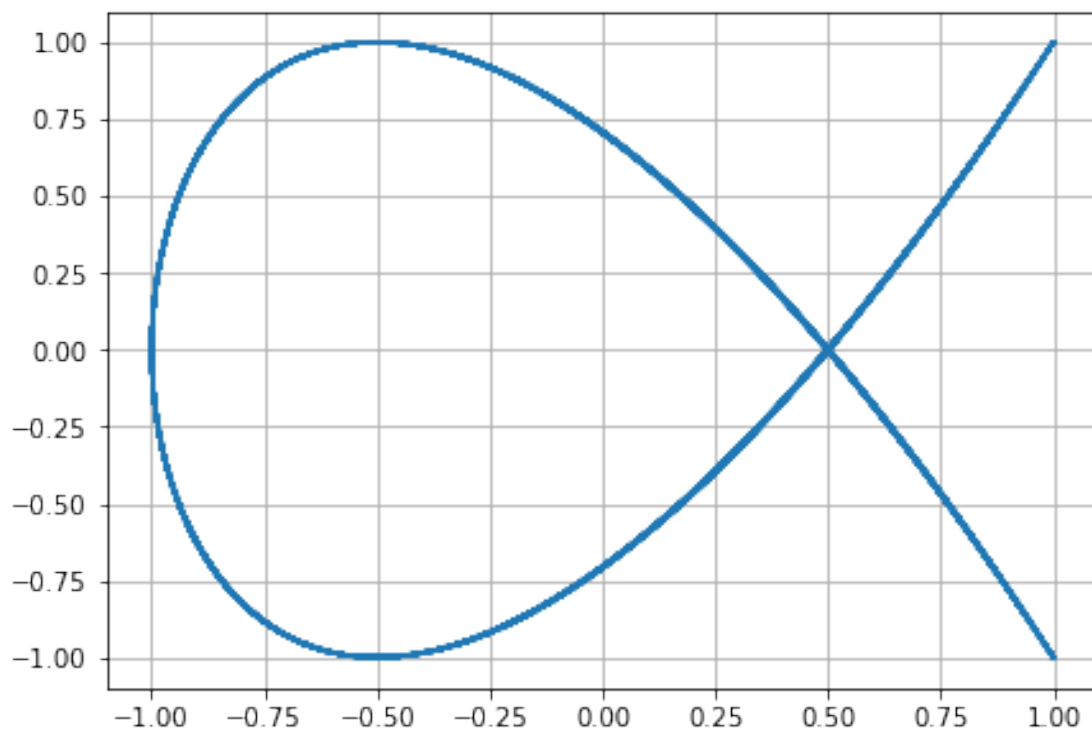
(c) $l = 2, n = 3$

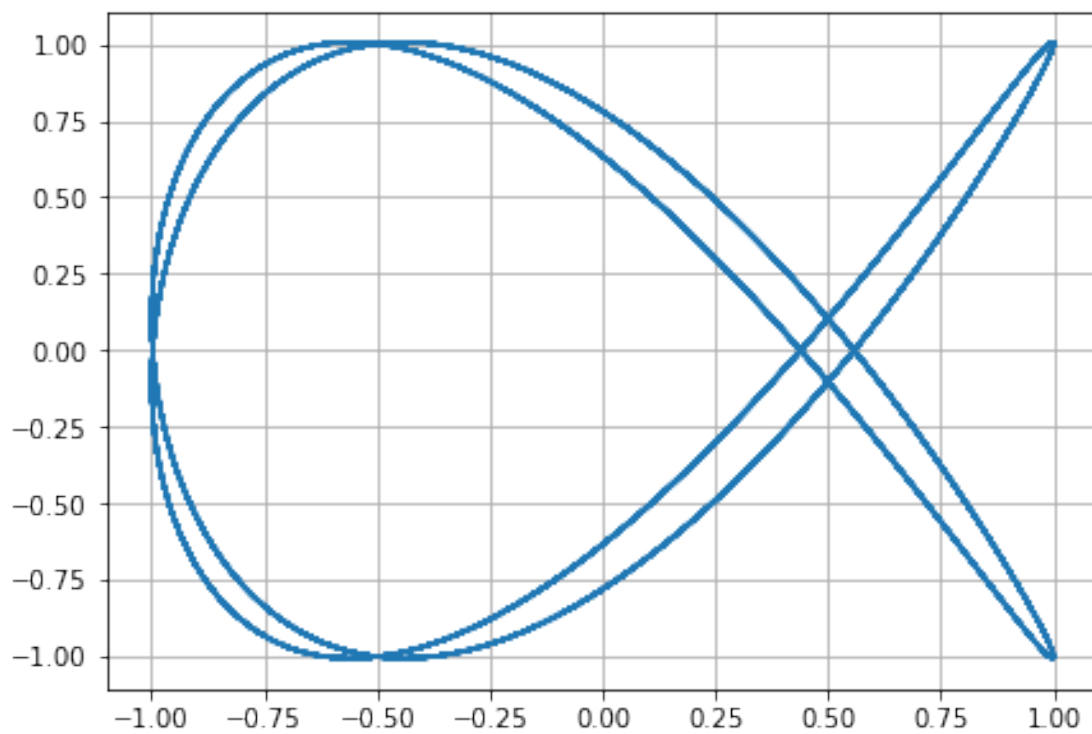
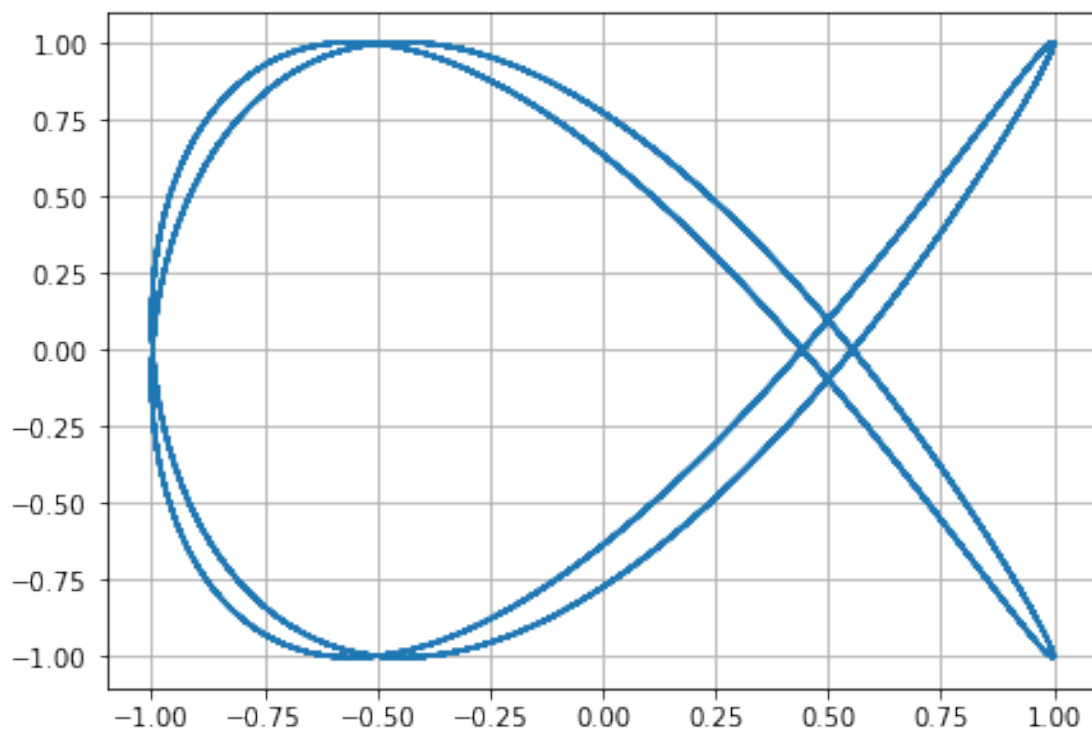
```
[18]: m = np.array([ 1, 1])
      ln = np.array([ 2 , 3 ])

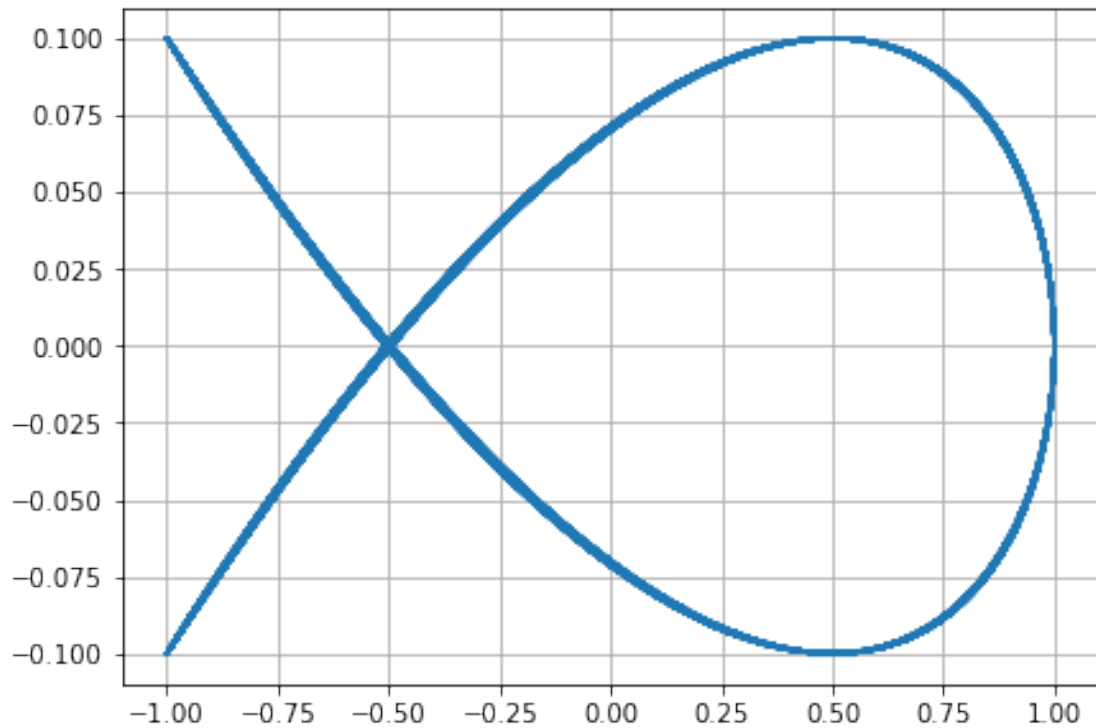
      datos = [
          [ np.array([ 1, 1 ]), np.array([ 0, 0 ]) ],
          [ np.array([ 1, -1 ]), np.array([ 0, 0 ]) ],
          [ np.array([ 1, 1 ]), np.array([ 0, 0.3 ]) ],
          [ np.array([ 1, -1 ]), np.array([ 0, 0.3 ]) ],
          [ np.array([ 1, 0 ]), np.array([ 0, 0.3 ]) ]
      ]

      h = 0.01
      tfin=100

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







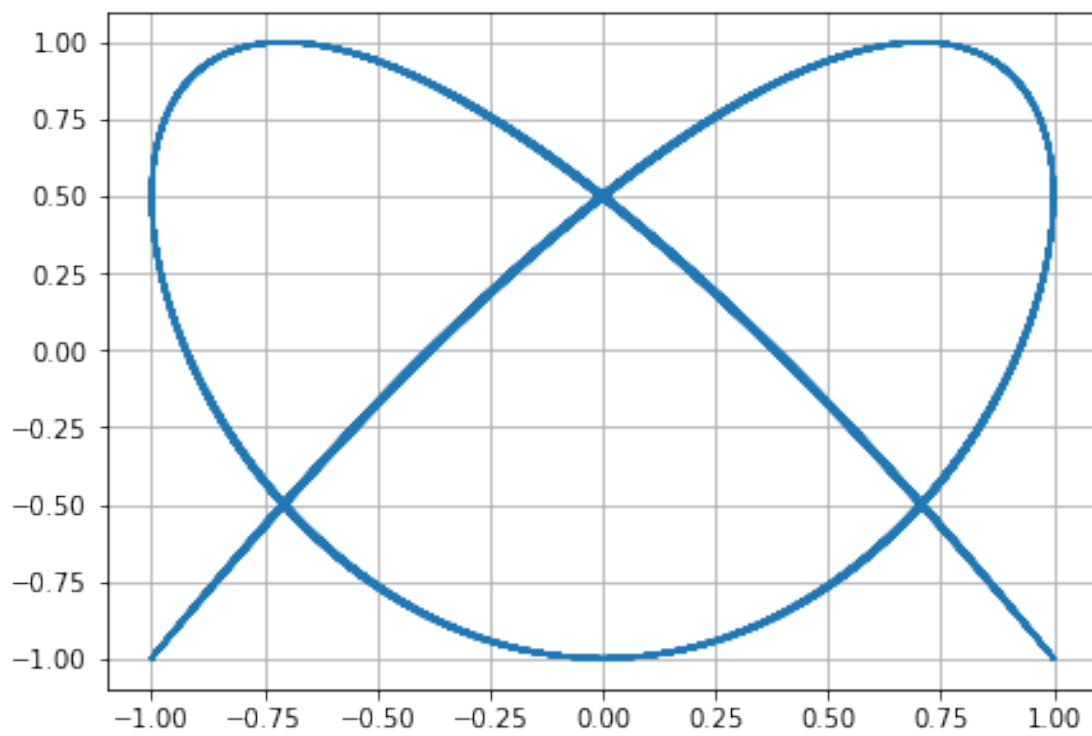
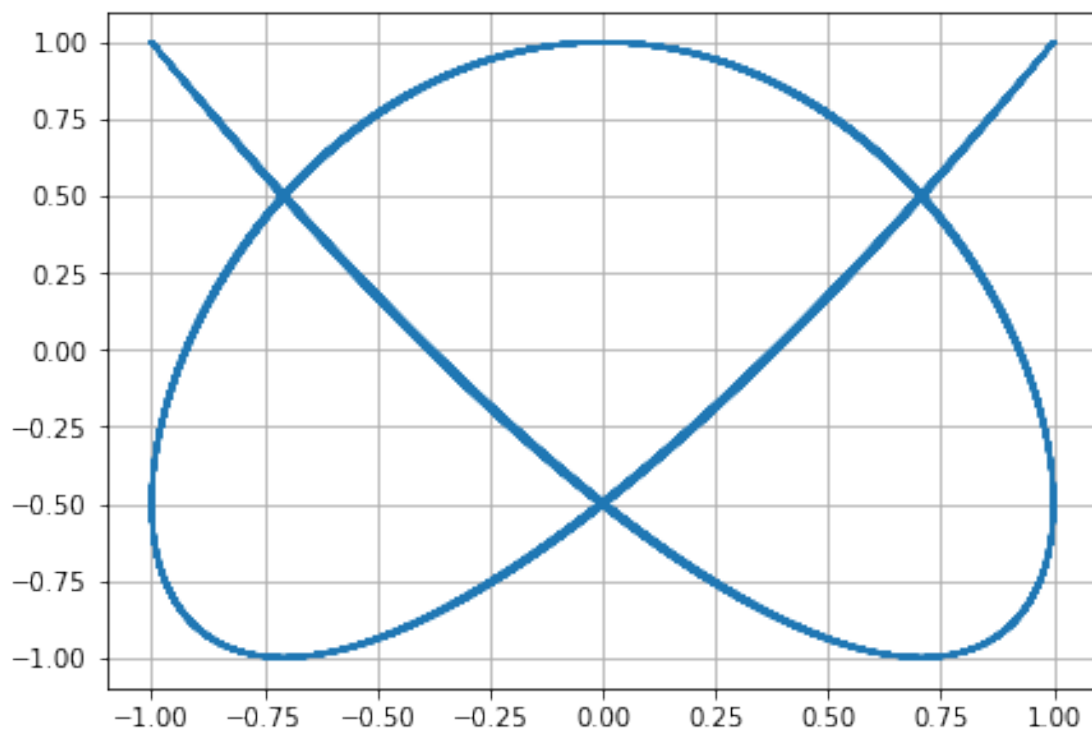
(d) $l = 3, n = 4$

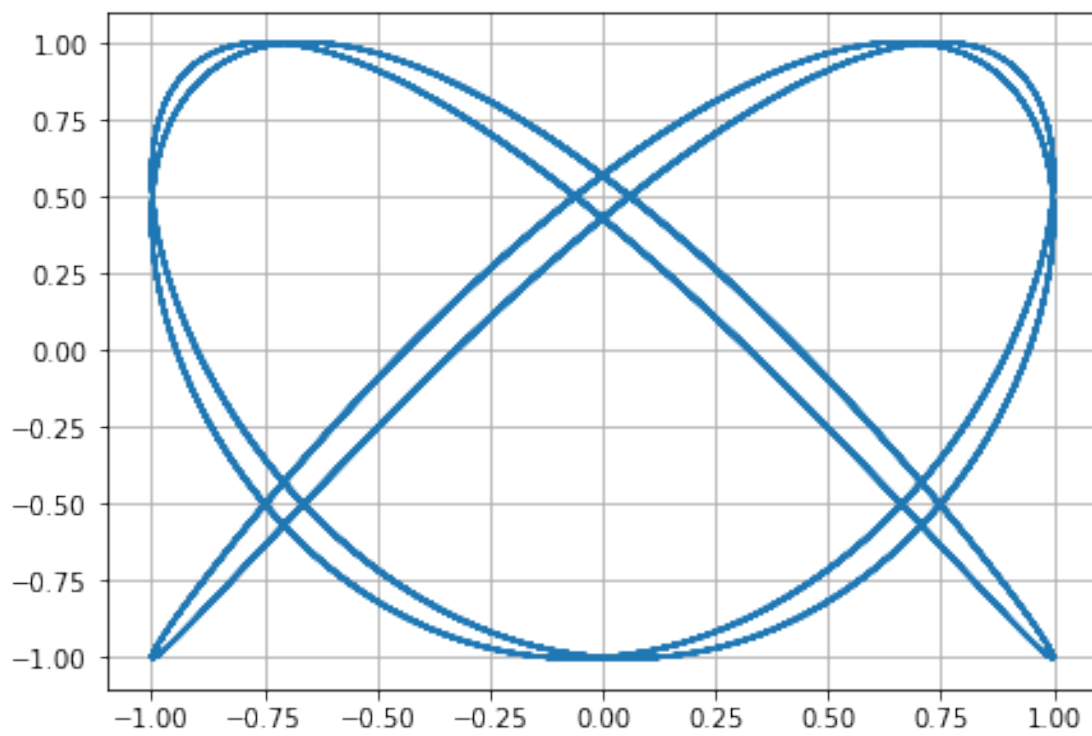
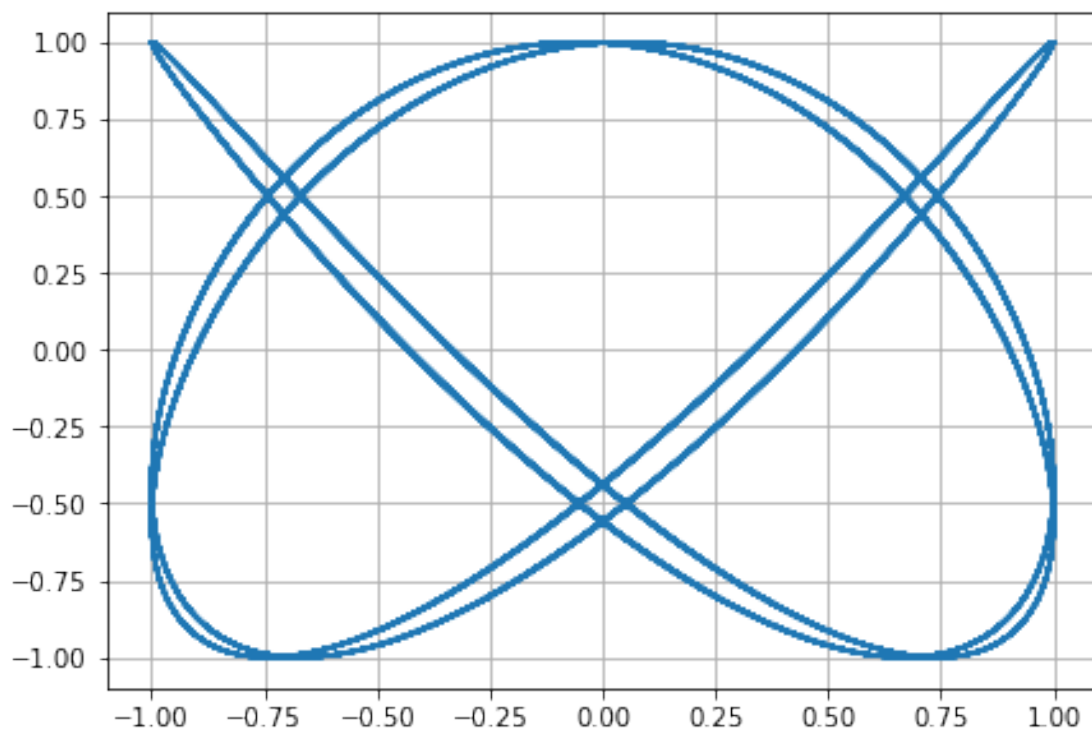
```
[19]: m = np.array([ 1, 1])
      ln = np.array([ 3 , 4 ])

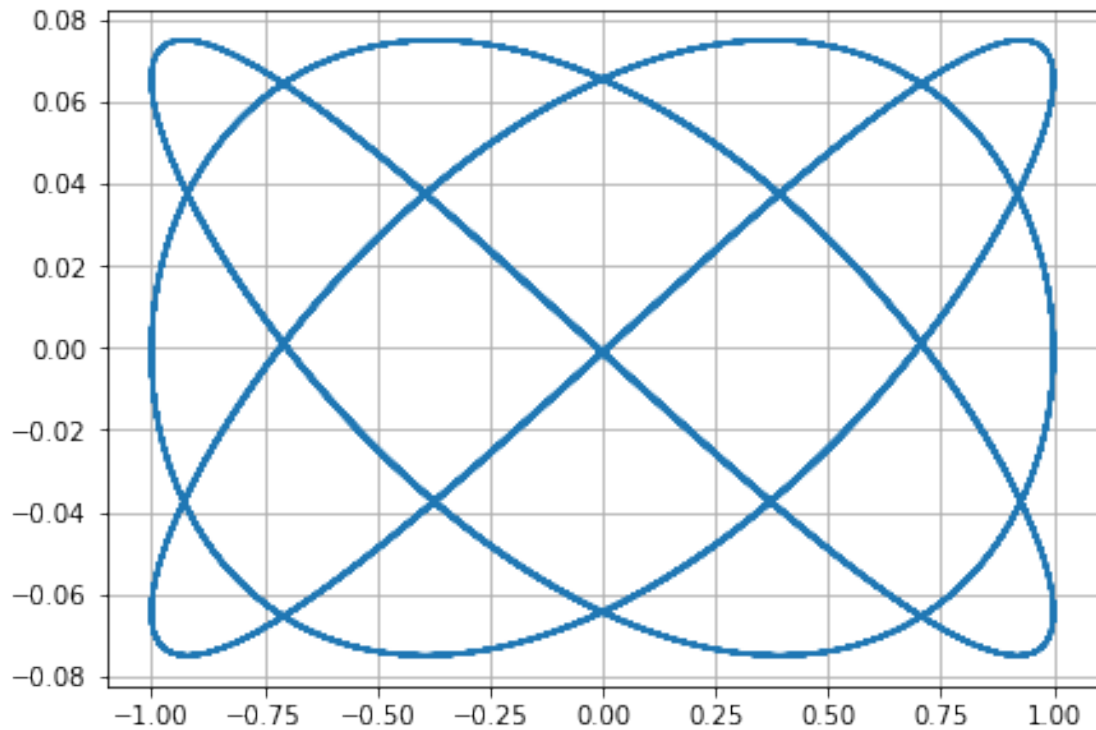
      datos = [
          [ np.array([ 1, 1 ]), np.array([ 0, 0 ]) ],
          [ np.array([ 1, -1 ]), np.array([ 0, 0 ]) ],
          [ np.array([ 1, 1 ]), np.array([ 0, 0.3 ]) ],
          [ np.array([ 1, -1 ]), np.array([ 0, 0.3 ]) ],
          [ np.array([ 1, 0 ]), np.array([ 0, 0.3 ]) ]
      ]

      h = 0.01
      tfin=100

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





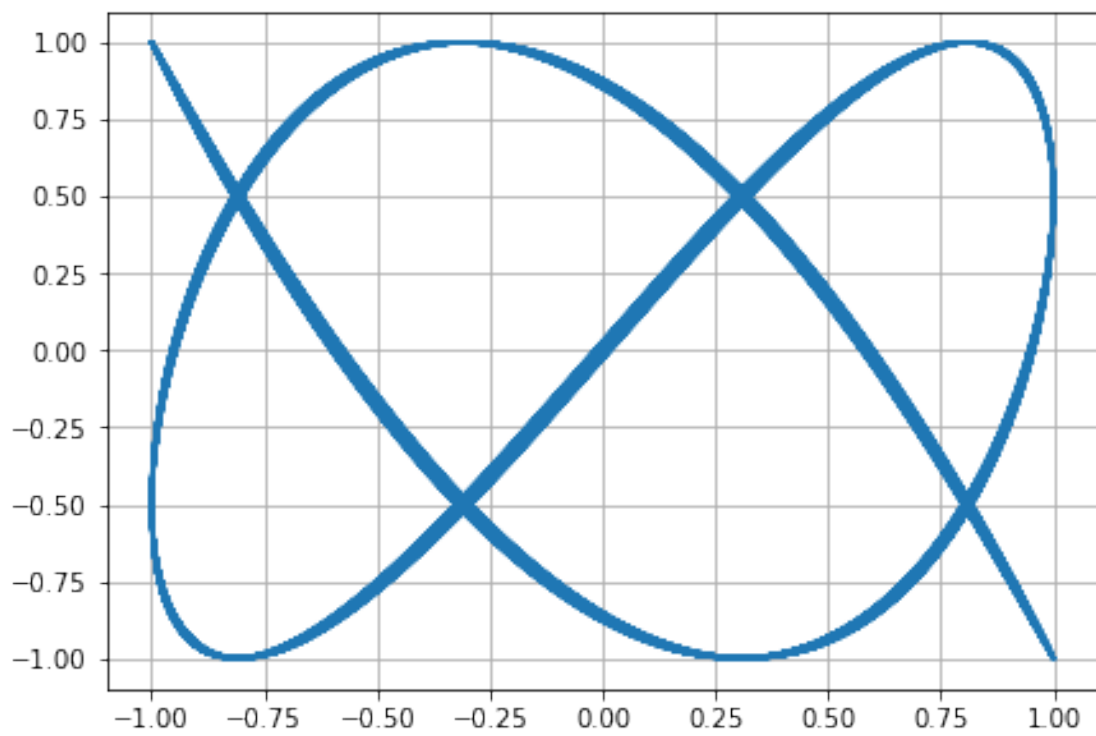
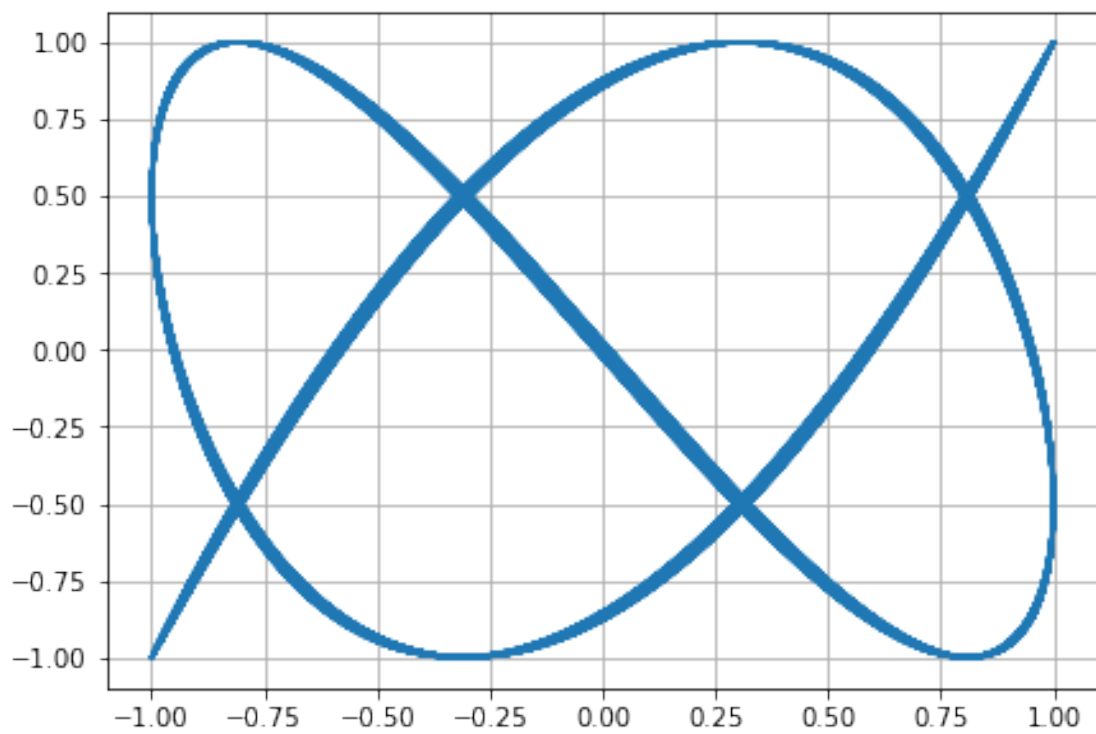
(e) $l = 3, n = 5$

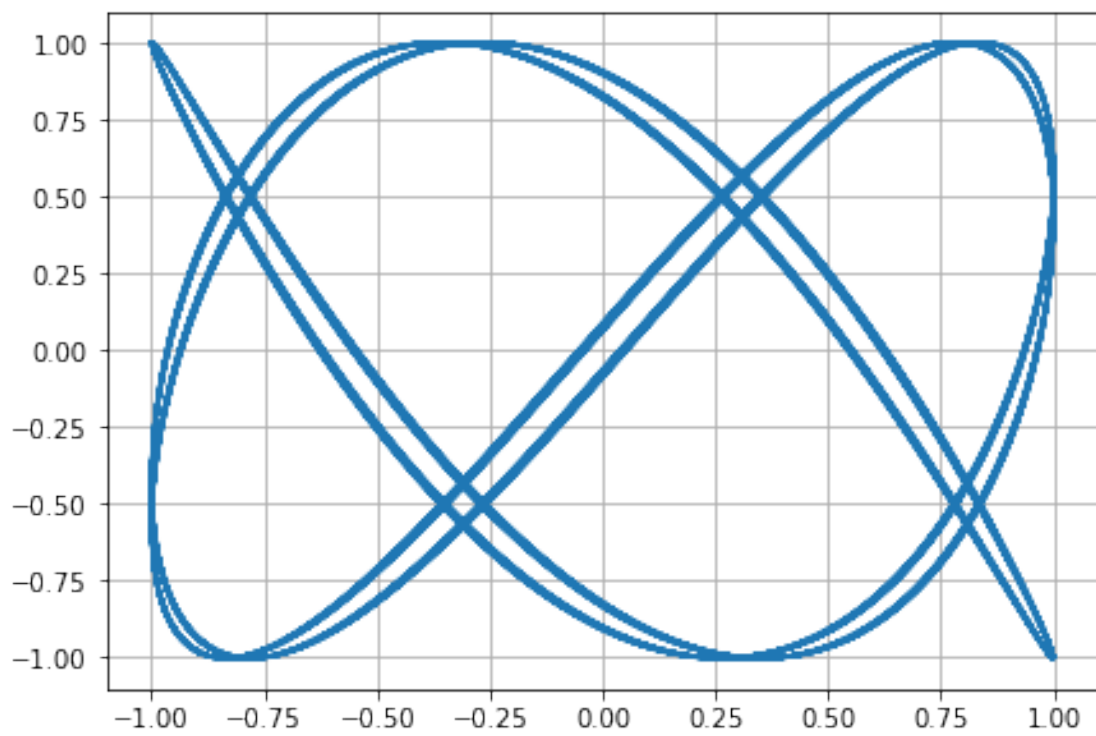
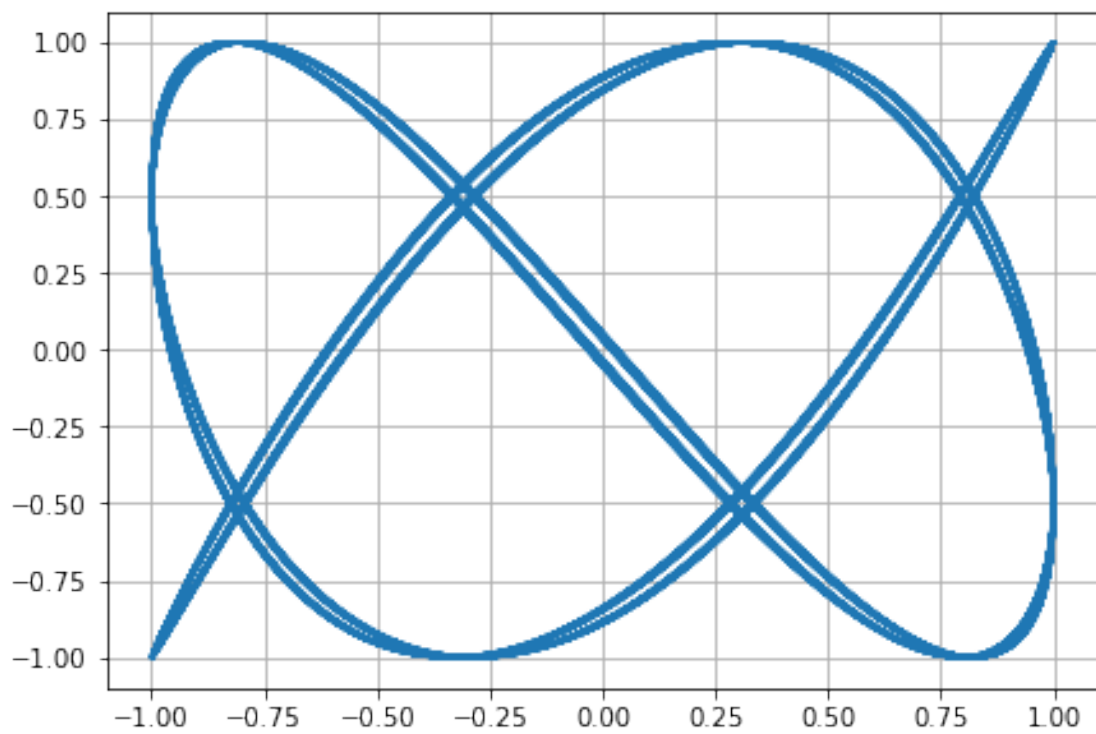
```
[20]: m = np.array([ 1, 1])
      ln = np.array([ 3 , 5 ])

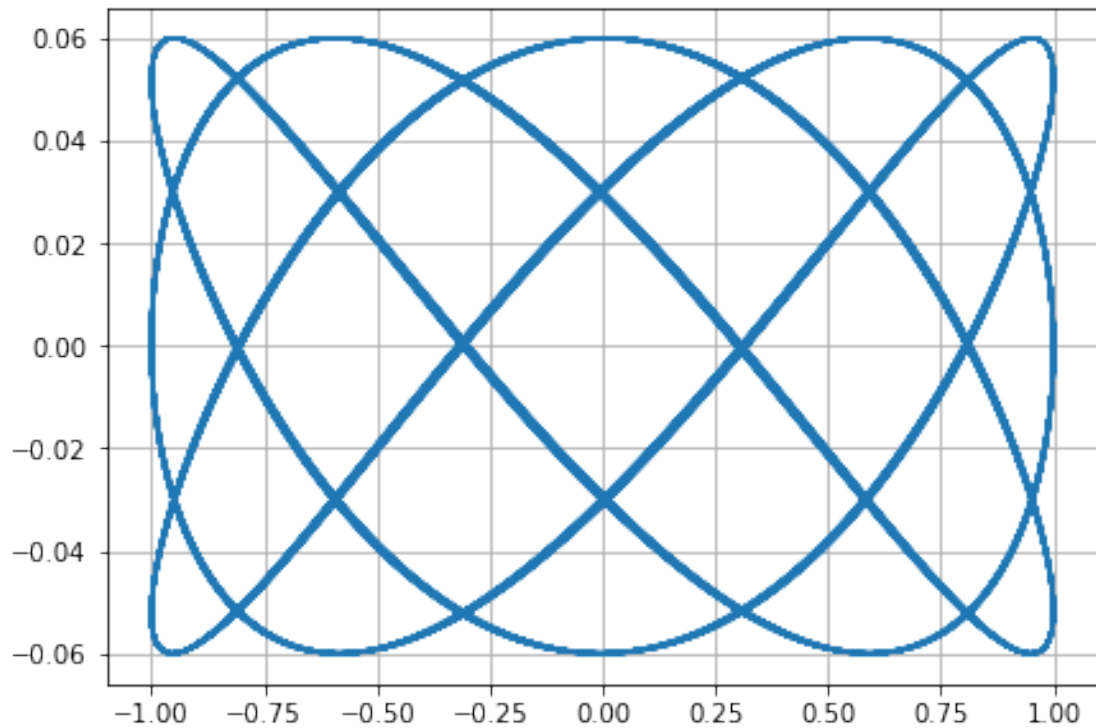
      datos = [
          [ np.array([ 1, 1 ]), np.array([ 0, 0 ]) ],
          [ np.array([ 1, -1 ]), np.array([ 0, 0 ]) ],
          [ np.array([ 1, 1 ]), np.array([ 0, 0.3 ]) ],
          [ np.array([ 1, -1 ]), np.array([ 0, 0.3 ]) ],
          [ np.array([ 1, 0 ]), np.array([ 0, 0.3 ]) ]
      ]

      h = 0.01
      tfin=100

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







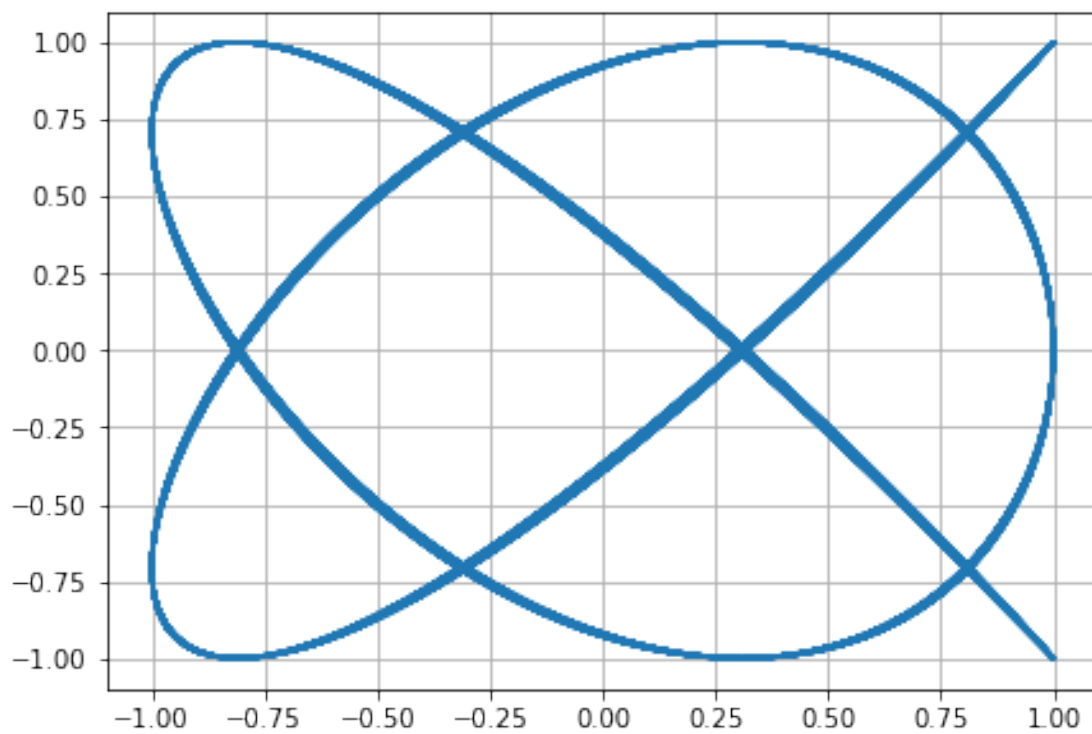
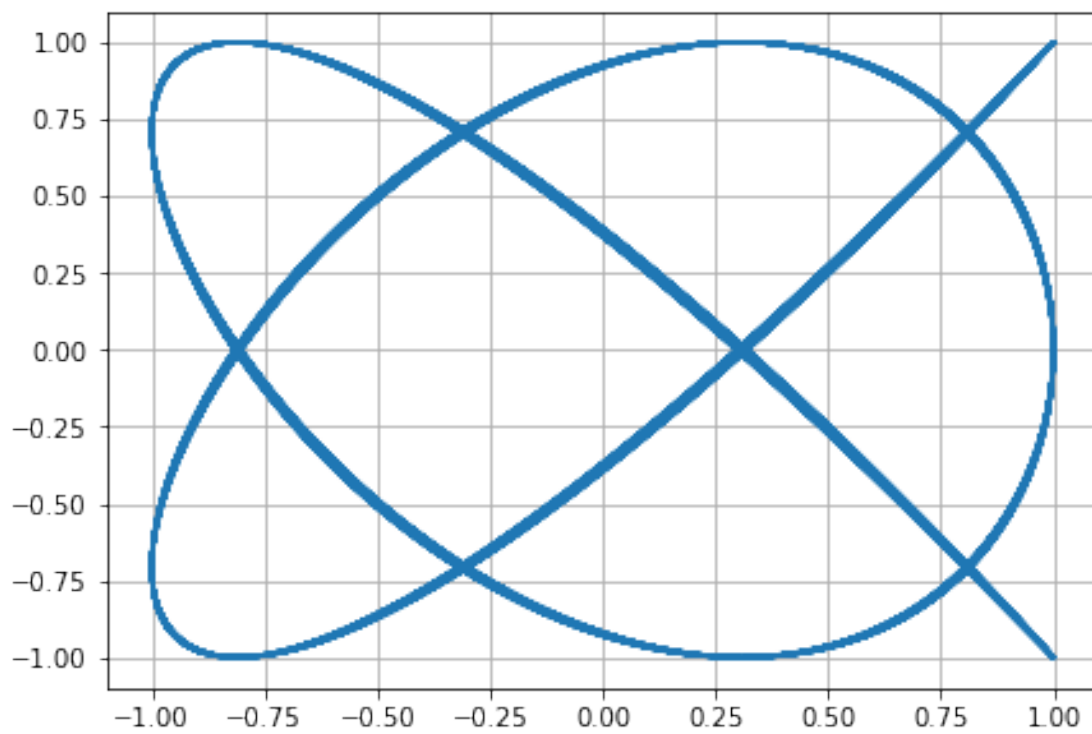
(f) $l = 4, n = 5$

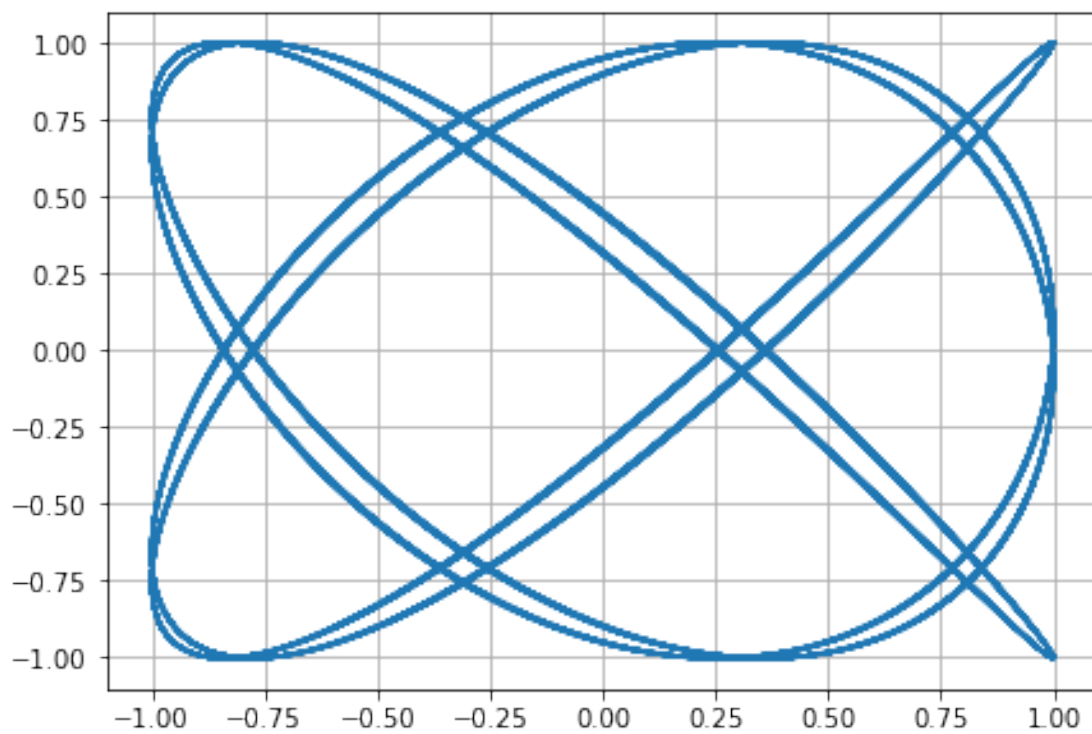
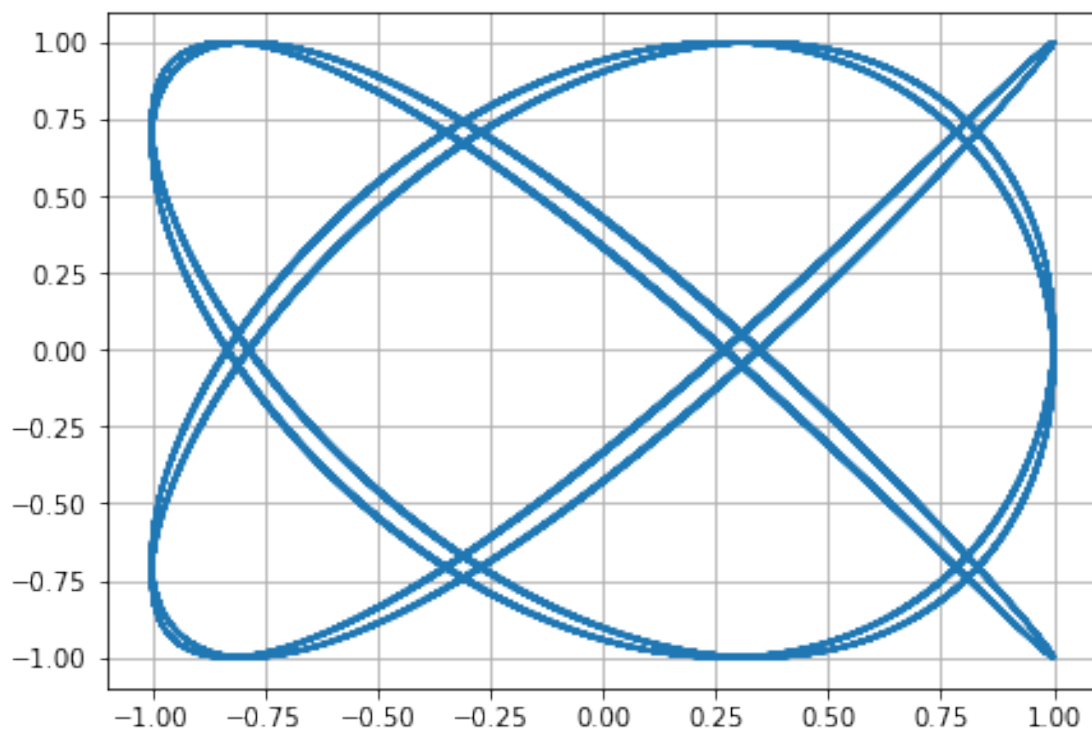
```
[21]: m = np.array([ 1, 1])
      ln = np.array([ 4 , 5 ])

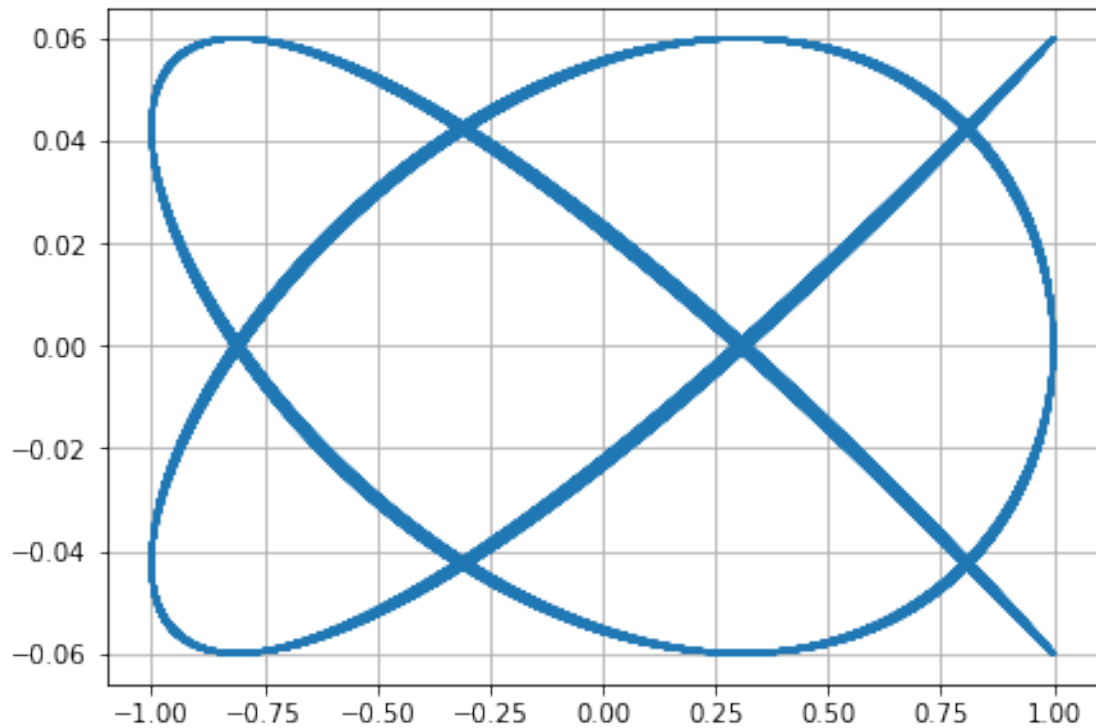
      datos = [
          [ np.array([ 1, 1 ]), np.array([ 0, 0 ]) ],
          [ np.array([ 1, -1 ]), np.array([ 0, 0 ]) ],
          [ np.array([ 1, 1 ]), np.array([ 0, 0.3 ]) ],
          [ np.array([ 1, -1 ]), np.array([ 0, 0.3 ]) ],
          [ np.array([ 1, 0 ]), np.array([ 0, 0.3 ]) ]
      ]

      h = 0.01
      tfin=100

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







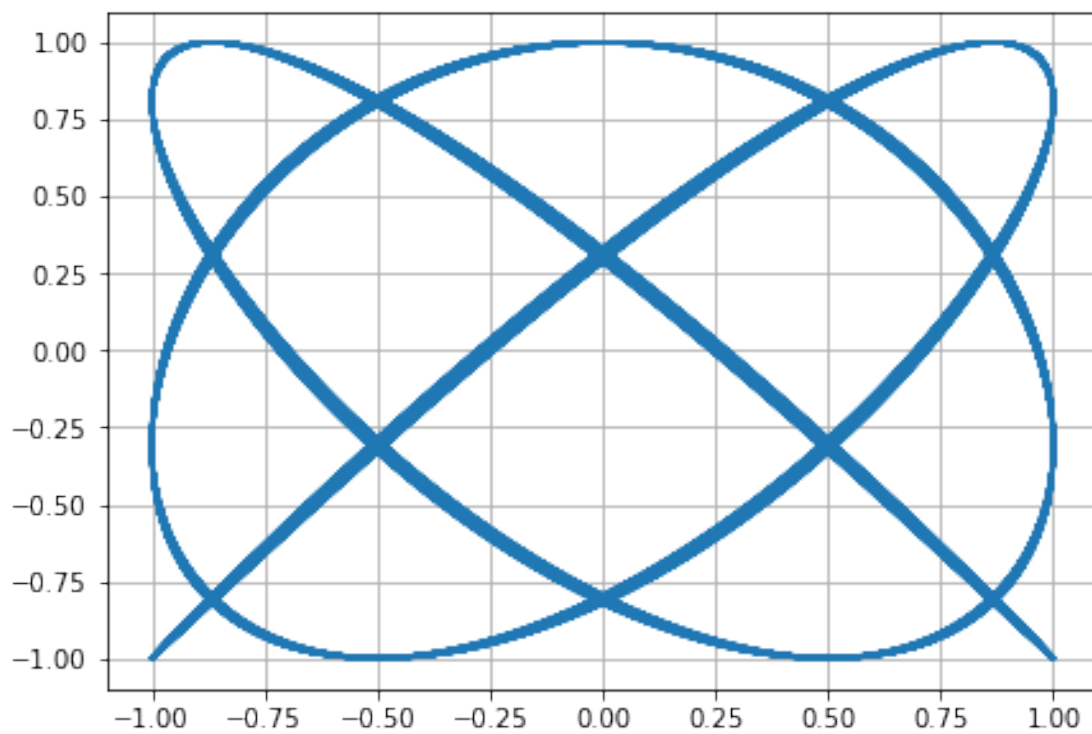
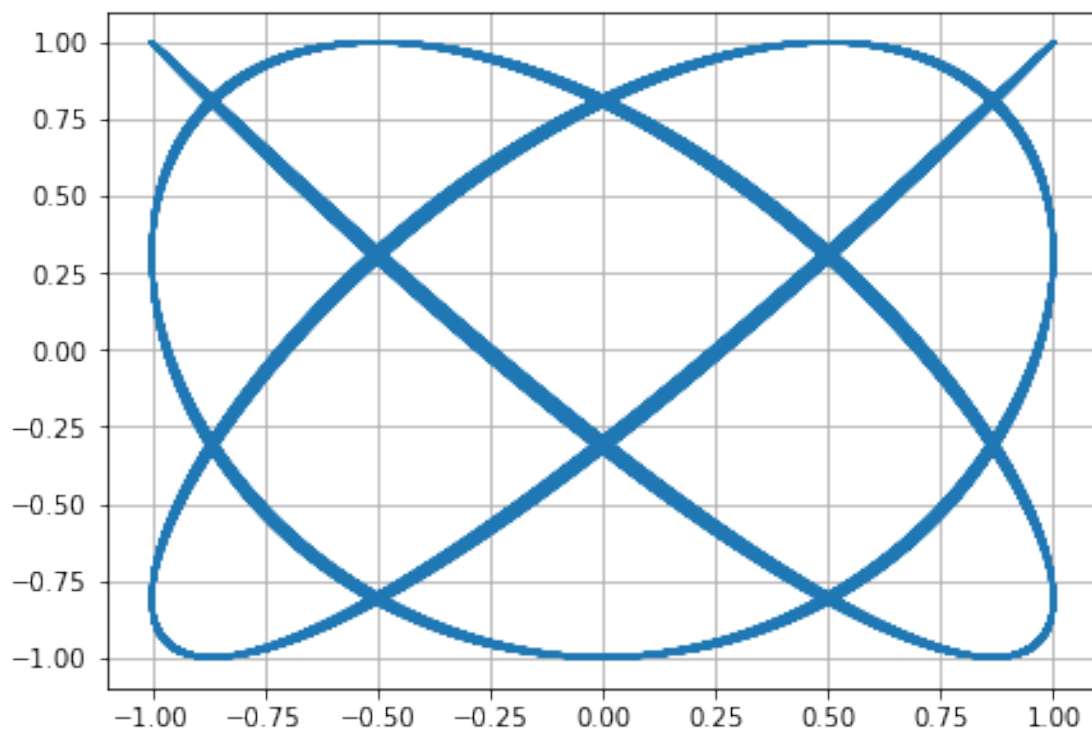
(g) $l = 5, n = 6$

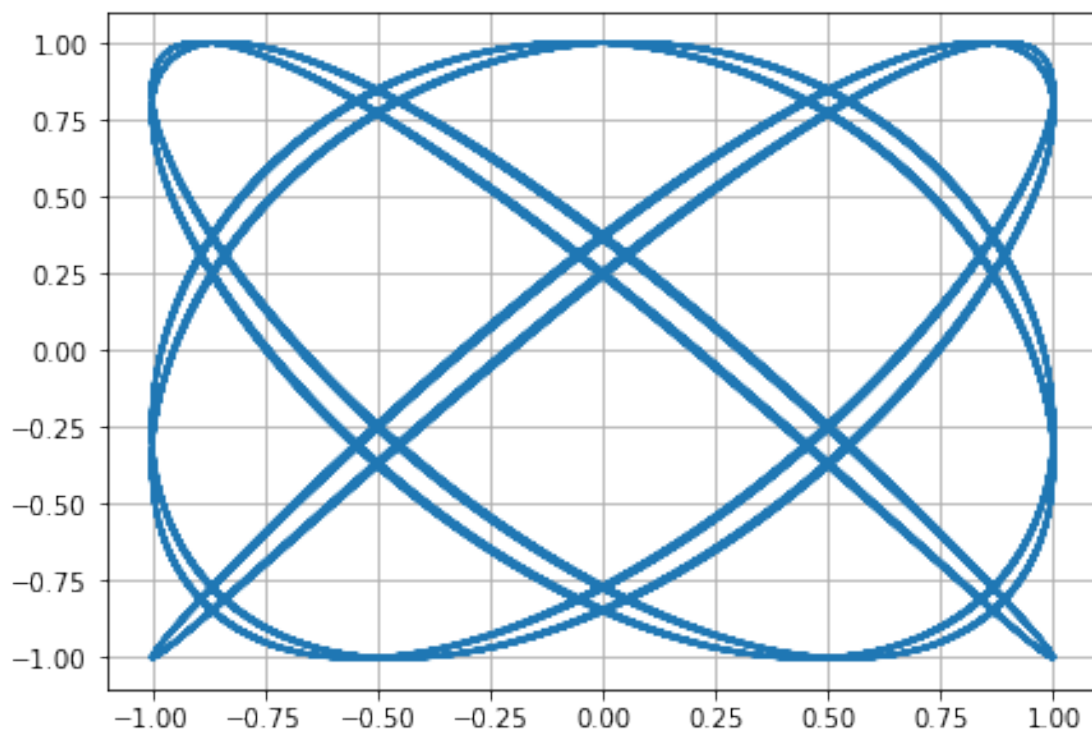
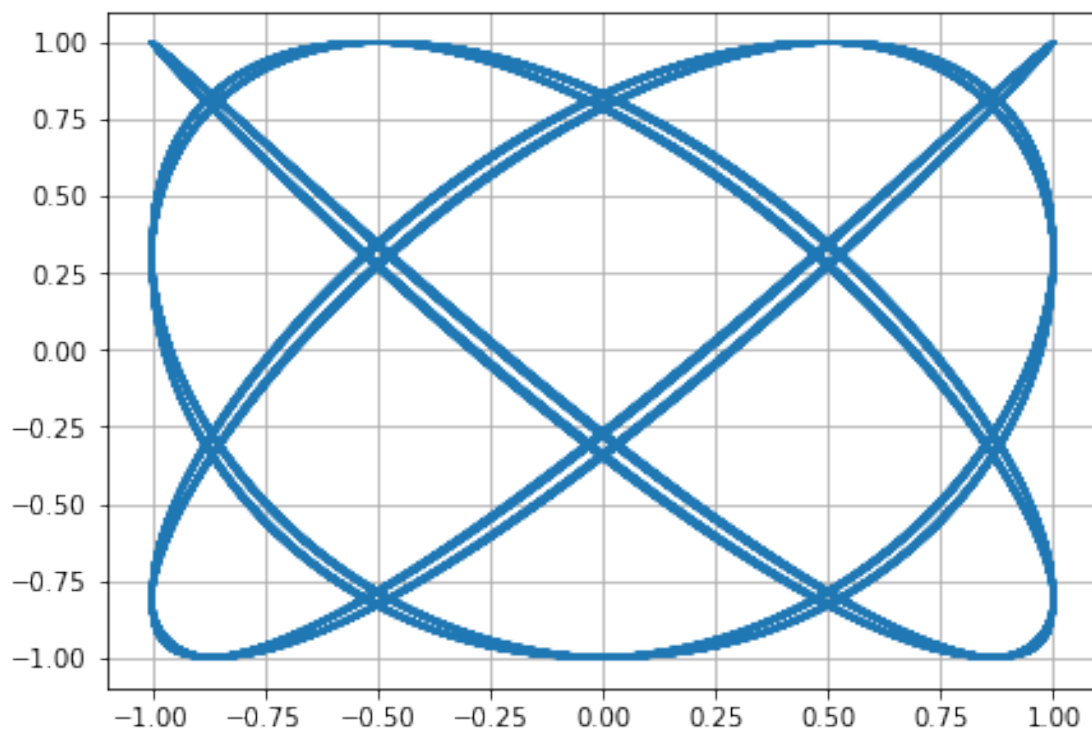
```
[22]: m = np.array([ 1, 1])
      ln = np.array([ 5 , 6 ])

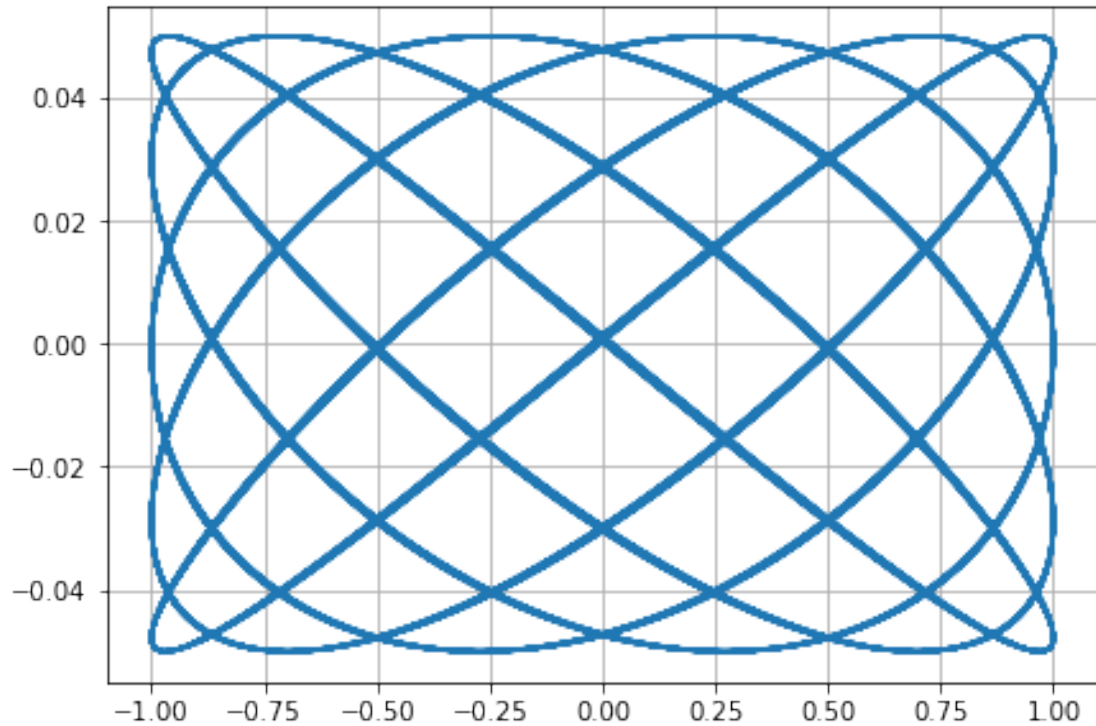
      datos = [
          [ np.array([ 1, 1 ]), np.array([ 0, 0 ]) ],
          [ np.array([ 1, -1 ]), np.array([ 0, 0 ]) ],
          [ np.array([ 1, 1 ]), np.array([ 0, 0.3 ]) ],
          [ np.array([ 1, -1 ]), np.array([ 0, 0.3 ]) ],
          [ np.array([ 1, 0 ]), np.array([ 0, 0.3 ]) ]
      ]

      h = 0.01
      tfin=100

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







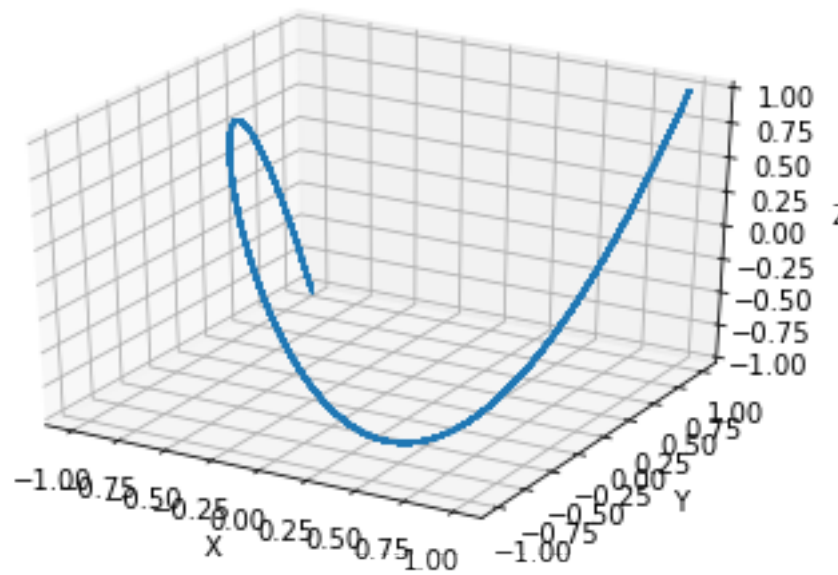
5 Con estos datos dibujar una figura de Lissajous con las condiciones iniciales en 3D como referencia.

(a) $x = 1, v_x = 0, z = 1, v_z = 0, y = +1, v_y = 0$

```
[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 = plt.subplots()
      ax = plt.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()
```

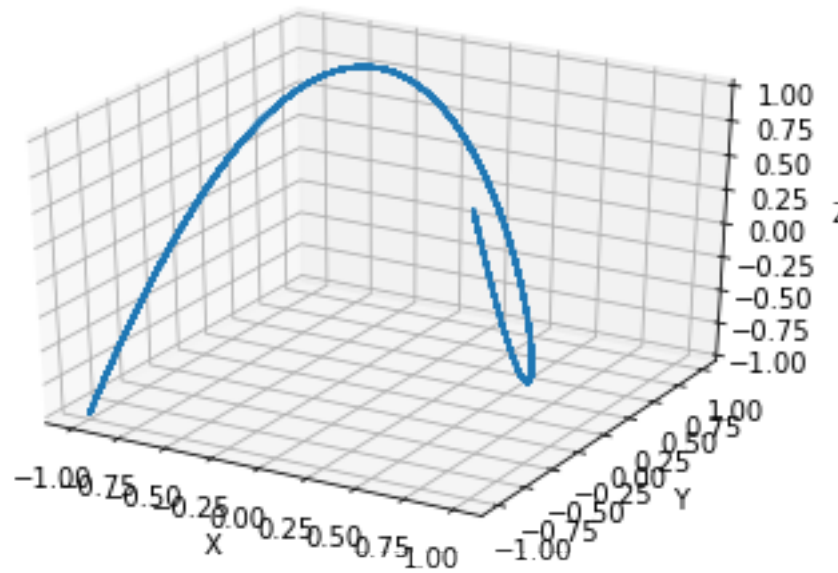


(b) $x = 1, v_x = 0, z = 1, v_z = 0, y = -1, v_y = 0$

```
[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
      tfinal=100
      ps = Lissajous(ln, m,v,p,h, tfinal)
      fig, ax = plt.subplots()
      ax = plt.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()
```

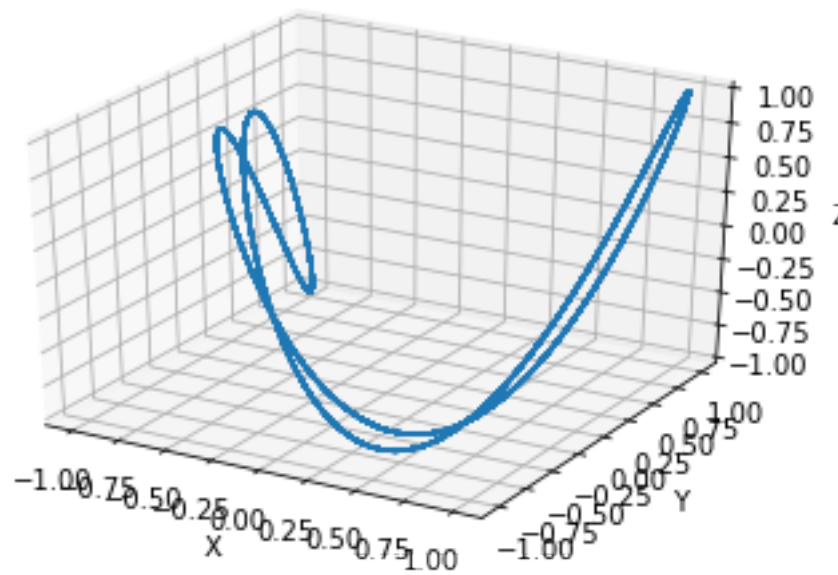


(c) $x = 1, v_x = 0, z = 1, v_z = 0, y = +1, v_y = 0.3$

```
[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 = plt.subplots()
      ax = plt.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()
```

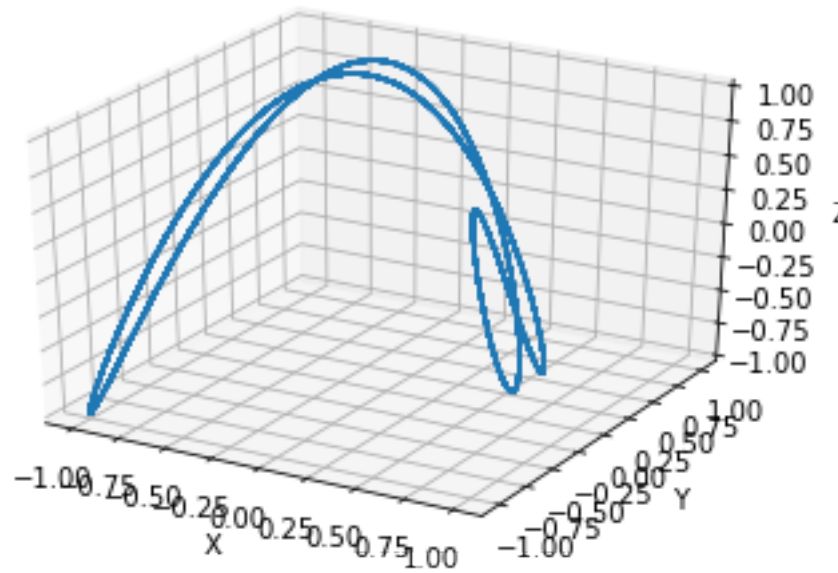


(d) $x = 1, v_x = 0, z = 1, v_z = 0, y = -1, v_y = 0.3$

```
[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
      tfinal=100
      ps = Lissajous(ln, m,v,p,h, tfinal)
      fig, ax = plt.subplots()
      ax = plt.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) $x = 1, v_x = 0, z = 1, v_z = 0, y = 0, v_y = 0.3$

```
[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 = plt.subplots()
      ax = plt.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()
```