

### Python code for spirograph g-code generation:

```
# setup

import numpy as np
import matplotlib.pyplot as plt

# https://www.wikiwand.com/en/Spirograph for mathematical formula
rho = 3
r = 98
R = 100
l = rho / r
k = r / R

thetas = np.linspace(0, np.pi*2*r, num=1000)

X = []
Y = []

for i in range(0, len(thetas)):
    value = 10*R*((1-k)*np.cos(thetas[i])+l*k*np.cos((1-k)/k*thetas[i]))
    short = round(value, 2) + 175
    withX = "X" + str(short)
    X.append(withX)

for i in range(0, len(thetas)):
    value = 10*R*((1-k)*np.sin(thetas[i])-l*k*np.sin((1-k)/k*thetas[i]))
    short = round(value, 2) + 150
    withY = "Y" + str(short)
    Y.append(withY)

coordPairs = list(zip(X, Y))

# Adding g-code syntax
start = ""
start = ""M201 X500.00 Y500.00 Z100.00 E5000.00 ;Setup machine max acceleration
M203 X500.00 Y500.00 Z10.00 E50.00 ;Setup machine max feedrate
M204 P500.00 R1000.00 T500.00 ;Setup Print/Retract/Travel acceleration
```

```
M205 X8.00 Y8.00 Z0.40 E5.00 ;Setup Jerk
```

```
M220 S100 ;Reset Feedrate
```

```
M221 S100 ;Reset Flowrate
```

```
G28 ;Home
```

```
G21 ;Metric units
```

```
G1 Z0.2 F3000 ;Raise Z
```

```
"""
```

```
stop = ""\nG91 ;Relative positioning
```

```
G1 Z5 F2400 ;Raise Z
```

```
G1 Z10 ;Raise Z more
```

```
G90 ;Absolute positionning
```

```
G1 X0 Y{machine_depth} ;Present print
```

```
M106 S0 ;Turn-off fan
```

```
M84 X Y E ;Disable all steppers but Z
```

```
"""
```

```
def g01(pair):
```

```
    return ("G01 " + pair[0] + " " + pair[1])
```

```
lines = list(map(g01, coordPairs))
```

```
list.insert(lines,1,lines[0]+" Z0")
```

```
lines[0] = lines[0] + " F2500"
```

```
file = open("spirograph.gcode", "w")
```

```
file.write(start + "\n")
```

```
for i in range(0,len(lines)):
```

```
    file.write(lines[i] + "\n")
```

```
file.write(stop)
```

```
file.close()
```

**G-Code output:**

M201 X500.00 Y500.00 Z100.00 E5000.00 ;Setup machine max acceleration

M203 X500.00 Y500.00 Z10.00 E50.00 ;Setup machine max feedrate

M204 P500.00 R1000.00 T500.00 ;Setup Print/Retract/Travel acceleration

M205 X8.00 Y8.00 Z0.40 E5.00 ;Setup Jerk

M220 S100 ;Reset Feedrate

M221 S100 ;Reset Flowrate

G28 ;Home

G21 ;Metric units

G1 Z0.2 F3000 ;Raise Z

G01 X225.0 Y150.0 F2500

G01 X225.0 Y150.0 Z0

G01 X221.32 Y161.18

G01 X211.62 Y168.11

G01 X199.48 Y168.1

G01 X189.36 Y161.01

G01 X184.98 Y149.31

G01 X187.93 Y137.17

G01 X197.14 Y128.92000000000002

G01 X209.18 Y127.46000000000001

G01 X219.63 Y133.19

G01 X224.62 Y143.85

G01 X222.29 Y155.4

G01 X213.49 Y163.43

G01 X201.44 Y164.86

G01 X190.54 Y159.03

G01 X184.79 Y147.94

G01 X186.27 Y135.54

G01 X194.43 Y126.25

G01 X206.21 Y123.36

G01 X217.27 Y127.8

G01 X223.49 Y137.8

G01 X222.55 Y149.54  
G01 X214.77 Y158.56  
G01 X202.97 Y161.43  
G01 X191.45 Y156.93  
G01 X184.41 Y146.61  
G01 X184.41 Y134.12  
G01 X191.39 Y123.93  
G01 X202.75 Y119.65  
G01 X214.25 Y122.74  
G01 X221.62 Y131.93  
G01 X222.09 Y143.7  
G01 X215.43 Y153.59  
G01 X204.05 Y157.84  
G01 X192.07999999999998 Y154.75  
G01 X183.86 Y145.34  
G01 X182.37 Y132.94  
G01 X188.08 Y121.99  
G01 X198.85 Y116.4  
G01 X210.63 Y118.09  
G01 X219.04 Y126.33  
G01 X220.91 Y137.96  
G01 X215.48 Y148.58  
G01 X204.68 Y154.16  
G01 X192.43 Y152.52  
G01 X183.14 Y144.15  
G01 X180.18 Y132.02  
G01 X184.55 Y120.47  
G01 X194.56 Y113.64  
G01 X206.47 Y113.92  
G01 X215.79 Y121.1  
G01 X219.03 Y132.42000000000002  
G01 X214.91 Y143.61  
G01 X204.85 Y150.44  
G01 X192.48 Y150.28  
G01 X182.27 Y143.08

G01 X177.88 Y131.39  
G01 X180.83 Y119.4  
G01 X189.96 Y111.42  
G01 X201.81 Y110.28  
G01 X211.93 Y116.3  
G01 X216.49 Y127.16  
G01 X213.73 Y138.77  
G01 X204.56 Y146.74  
G01 X192.26 Y148.06  
G01 X181.25 Y142.13  
G01 X175.5 Y131.05  
G01 X177.0 Y118.8  
G01 X185.12 Y109.78999999999999  
G01 X196.74 Y107.25  
G01 X207.5 Y112.02000000000001  
G01 X213.32999999999998 Y122.26  
G01 X211.96 Y134.11  
G01 X203.81 Y143.13  
G01 X191.75 Y145.9  
G01 X180.12 Y141.33  
G01 X173.08 Y131.02  
G01 X173.12 Y118.67  
G01 X180.09 Y108.75999999999999  
G01 X191.34 Y104.86  
G01 X202.59 Y108.32  
G01 X209.59 Y117.78999999999999  
G01 X209.65 Y129.72  
G01 X202.62 Y139.65  
G01 X190.98 Y143.84  
G01 X178.88 Y140.69  
G01 X170.67 Y131.29  
G01 X169.23 Y119.03999999999999  
G01 X174.97 Y108.37  
G01 X185.67 Y103.15  
G01 X197.25 Y105.24000000000001

G01 X205.3299999999998 Y113.82  
G01 X206.81 Y125.66  
G01 X201.02 Y136.35  
G01 X189.96 Y141.91  
G01 X177.57 Y140.23  
G01 X168.29 Y131.88  
G01 X165.4 Y119.88  
G01 X169.83 Y108.6  
G01 X179.83 Y102.15  
G01 X191.57 Y102.85  
G01 X200.62 Y110.41  
G01 X203.5 Y121.99  
G01 X199.02 Y133.3  
G01 X188.7 Y140.13  
G01 X176.21 Y139.94  
G01 X165.99 Y132.76  
G01 X161.69 Y121.2  
G01 X164.75 Y109.47  
G01 X173.9 Y101.88  
G01 X185.65 Y101.18  
G01 X195.53 Y107.6  
G01 X199.77 Y118.76  
G01 X196.6700000000002 Y130.52  
G01 X187.24 Y138.54  
G01 X174.81 Y139.85  
G01 X163.82 Y133.93  
G01 X158.1700000000002 Y122.97  
G01 X159.8 Y110.97  
G01 X167.99 Y102.34  
G01 X179.57 Y100.2400000000001  
G01 X190.14 Y105.45  
G01 X195.68 Y116.0200000000001  
G01 X194.01 Y128.07  
G01 X185.6 Y137.16  
G01 X173.41 Y139.94

G01 X161.79 Y135.38  
G01 X154.88 Y125.17  
G01 X155.07 Y113.06  
G01 X162.17 Y103.5200000000001  
G01 X173.41 Y100.07  
G01 X184.53 Y103.97  
G01 X191.29 Y113.81  
G01 X191.07 Y125.98  
G01 X183.81 Y136.01  
G01 X172.04 Y140.22  
G01 X159.96 Y137.09  
G01 X151.87 Y127.78  
G01 X150.62 Y115.7299999999999  
G01 X156.53 Y105.42  
G01 X167.29 Y100.65  
G01 X178.79 Y103.2  
G01 X186.68 Y112.17  
G01 X187.91 Y124.28  
G01 X181.89 Y135.11  
G01 X170.71 Y140.69  
G01 X158.34 Y139.02  
G01 X149.21 Y130.74  
G01 X146.53 Y118.94  
G01 X151.1700000000002 Y107.9900000000001  
G01 X161.28 Y101.9799999999999  
G01 X173.01 Y103.14  
G01 X181.91 Y111.11  
G01 X184.57 Y122.99  
G01 X179.89 Y134.46  
G01 X169.46 Y141.34  
G01 X156.98 Y141.16  
G01 X146.9200000000002 Y134.03  
G01 X142.86 Y122.63  
G01 X146.16 Y111.2100000000001  
G01 X155.48 Y104.03

G01 X167.27 Y103.8  
G01 X177.05 Y110.65  
G01 X181.12 Y122.13  
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G01 X155.89 Y143.46  
G01 X145.05 Y137.59  
G01 X139.66 Y126.75  
G01 X141.57999999999998 Y115.03  
G01 X149.98 Y106.78999999999999  
G01 X161.65 Y105.15  
G01 X172.19 Y110.78999999999999  
G01 X177.6 Y121.7  
G01 X175.77 Y133.96  
G01 X167.26 Y143.12  
G01 X155.09 Y145.9  
G01 X143.64 Y141.36  
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G01 X137.5 Y119.38  
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G01 X151.16 Y109.86  
G01 X162.74 Y112.85  
G01 X170.58 Y122.18  
G01 X171.7 Y134.52  
G01 X165.61 Y145.44



G01 X154.45 Y151.02  
G01 X142.25 Y149.32  
G01 X133.41 Y141.08  
G01 X131.09 Y129.43  
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G01 X163.94 Y124.35  
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G01 X153.41 Y133.07  
G01 X162.38 Y141.63  
G01 X164.98 Y153.86  
G01 X160.25 Y165.4  
G01 X149.95 Y172.14  
G01 X137.88 Y171.74  
G01 X128.49 Y164.47  
G01 X125.2599999999999 Y153.17  
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G01 X139.38 Y135.52  
G01 X151.57 Y135.95  
G01 X161.5 Y143.38  
G01 X165.54 Y155.22

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G01 X133.5 Y169.8299999999998  
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G01 X148.39 Y152.23  
G01 X160.79 Y152.78  
G01 X170.8 Y160.29  
G01 X174.83 Y172.0799999999998  
G01 X171.5 Y183.92000000000002  
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G01 X150.31 Y192.22  
G01 X140.45 Y185.81  
G01 X136.31 Y174.75  
G01 X139.51 Y163.2  
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G01 X172.21 Y160.82  
G01 X177.62 Y172.05  
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G01 X167.34 Y192.87  
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G01 X139.69 Y179.28  
G01 X141.5 Y167.44  
G01 X150.0 Y158.66  
G01 X162.18 Y156.25  
G01 X173.68 Y161.17

G01 X180.39 Y171.67000000000002  
G01 X179.96 Y183.95  
G01 X172.68 Y193.56  
G01 X161.34 Y197.03  
G01 X150.25 Y193.13  
G01 X143.61 Y183.36  
G01 X143.99 Y171.38  
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G01 X183.11 Y170.94  
G01 X184.15 Y183.19  
G01 X178.07 Y193.59  
G01 X167.22 Y198.38  
G01 X155.75 Y195.82999999999998  
G01 X147.99 Y186.92000000000002  
G01 X146.94 Y174.98  
G01 X153.12 Y164.44  
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G01 X176.73 Y161.26  
G01 X185.74 Y169.87  
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G01 X165.75 Y160.43  
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G01 X179.27 Y198.87  
G01 X167.52 Y199.11

G01 X157.88 Y192.29  
G01 X154.03 Y180.93  
G01 X157.54 Y169.21  
G01 X167.25 Y161.46  
G01 X179.72 Y160.53  
G01 X190.51 Y166.76  
G01 X195.78 Y177.85  
G01 X193.73 Y189.73  
G01 X185.26 Y198.01  
G01 X173.62 Y199.64  
G01 X163.23 Y194.01  
G01 X158.06 Y183.19  
G01 X160.14 Y171.14  
G01 X168.86 Y162.29  
G01 X181.13 Y159.87  
G01 X192.59 Y164.76  
G01 X199.14 Y175.15  
G01 X198.52 Y187.18  
G01 X191.09 Y196.41  
G01 X179.73 Y199.41  
G01 X168.74 Y195.06  
G01 X162.32 Y184.93  
G01 X162.95 Y172.72  
G01 X170.55 Y162.89  
G01 X182.45 Y159.02  
G01 X194.4 Y162.51  
G01 X202.15 Y172.04  
G01 X202.97 Y184.06  
G01 X196.69 Y194.1  
G01 X185.77 Y198.44  
G01 X174.34 Y195.43  
G01 X166.75 Y186.13  
G01 X165.92 Y173.93  
G01 X172.29 Y163.26  
G01 X183.65 Y158.0

G01 X195.93 Y160.04  
G01 X204.76 Y168.57  
G01 X207.0 Y180.4  
G01 X201.97 Y191.12  
G01 X191.63 Y196.73  
G01 X179.93 Y195.1  
G01 X171.29 Y186.77  
G01 X169.01 Y174.75  
G01 X174.06 Y163.4  
G01 X184.7 Y156.82  
G01 X197.14 Y157.38  
G01 X206.9200000000002 Y164.8  
G01 X210.56 Y176.27  
G01 X206.84 Y187.52  
G01 X197.25 Y194.31  
G01 X185.43 Y194.09  
G01 X175.85 Y186.85  
G01 X172.16 Y175.18  
G01 X175.82 Y163.3  
G01 X185.6 Y155.5  
G01 X198.01 Y154.57  
G01 X208.61 Y160.77  
G01 X213.59 Y171.73  
G01 X211.23 Y183.32999999999998  
G01 X202.51 Y191.22  
G01 X190.75 Y192.41  
G01 X180.38 Y186.36  
G01 X175.32 Y175.21  
G01 X177.54 Y162.98  
G01 X186.32 Y154.07  
G01 X198.53 Y151.66  
G01 X209.78 Y156.55  
G01 X216.03 Y166.84  
G01 X215.07999999999998 Y178.64  
G01 X207.36 Y187.51

G01 X195.82 Y190.09  
G01 X184.8 Y185.32  
G01 X178.45 Y174.85  
G01 X179.19 Y162.44  
G01 X186.84 Y152.55  
G01 X198.68 Y148.7  
G01 X210.43 Y152.21  
G01 X217.86 Y161.68  
G01 X218.32 Y173.51  
G01 X211.71 Y183.23  
G01 X200.56 Y187.16  
G01 X189.05 Y183.74  
G01 X181.49 Y174.11  
G01 X180.74 Y161.7  
G01 X187.16 Y150.96  
G01 X198.45 Y145.73  
G01 X210.54 Y147.81  
G01 X219.04 Y156.32  
G01 X220.9 Y168.01  
G01 X215.5 Y178.45  
G01 X204.9 Y183.69  
G01 X193.06 Y181.66  
G01 X184.4 Y172.99  
G01 X182.18 Y160.76  
G01 X187.27 Y149.33  
G01 X197.86 Y142.79  
G01 X210.1 Y143.42  
G01 X219.56 Y150.85  
G01 X222.79 Y162.24  
G01 X218.68 Y173.25  
G01 X208.77 Y179.7  
G01 X196.77 Y179.1  
G01 X187.14 Y171.53  
G01 X183.47 Y159.65  
G01 X187.16 Y147.69



G01 X196.89 Y139.93  
G01 X209.12 Y139.1  
G01 X219.39 Y145.35  
G01 X223.96 Y156.27  
G01 X221.18 Y167.69  
G01 X212.11 Y175.28  
G01 X200.12 Y176.12  
G01 X189.66 Y169.75  
G01 X184.6 Y158.38  
G01 X186.83 Y146.07  
G01 X195.56 Y137.21  
G01 X207.61 Y134.92  
G01 X218.55 Y139.91  
G01 X224.38 Y150.2  
G01 X222.98 Y161.87  
G01 X214.88 Y170.49  
G01 X203.0799999999998 Y172.75  
G01 X191.92000000000002 Y167.67000000000002  
G01 X185.54 Y156.99  
G01 X186.29 Y144.5  
G01 X193.9 Y134.66  
G01 X205.5799999999998 Y130.95  
G01 X217.04 Y134.6  
G01 X224.06 Y144.12  
G01 X224.06 Y155.88  
G01 X217.04 Y165.4  
G01 X205.5799999999998 Y169.05  
G01 X193.9 Y165.34  
G01 X186.29 Y155.5  
G01 X185.54 Y143.01  
G01 X191.92000000000002 Y132.32999999999998  
G01 X203.0799999999998 Y127.25  
G01 X214.88 Y129.51  
G01 X222.98 Y138.13  
G01 X224.38 Y149.8

G01 X218.55 Y160.09  
G01 X207.61 Y165.08  
G01 X195.56 Y162.79  
G01 X186.83 Y153.93  
G01 X184.6 Y141.62  
G01 X189.66 Y130.25  
G01 X200.12 Y123.88  
G01 X212.11 Y124.72  
G01 X221.18 Y132.31  
G01 X223.96 Y143.73  
G01 X219.39 Y154.65  
G01 X209.12 Y160.9  
G01 X196.89 Y160.07  
G01 X187.16 Y152.31  
G01 X183.47 Y140.35  
G01 X187.14 Y128.47  
G01 X196.77 Y120.9  
G01 X208.77 Y120.3  
G01 X218.68 Y126.75  
G01 X222.79 Y137.76  
G01 X219.56 Y149.15  
G01 X210.1 Y156.58  
G01 X197.86 Y157.21  
G01 X187.27 Y150.67  
G01 X182.18 Y139.24  
G01 X184.4 Y127.01  
G01 X193.06 Y118.34  
G01 X204.9 Y116.31  
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G91 ;Relative positioning

G1 Z5 F2400 ;Raise Z

G1 Z10 ;Raise Z more

G90 ;Absolute positionning

G1 X0 Y{machine\_depth} ;Present print

M106 S0 ;Turn-off fan

M84 X Y E ;Disable all steppers but Z



Spirograph picture

