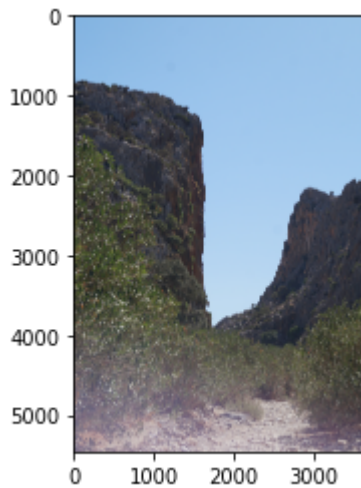


```
import cv2
from matplotlib import pyplot as plt
import numpy as np
from scipy.signal import convolve2d
```

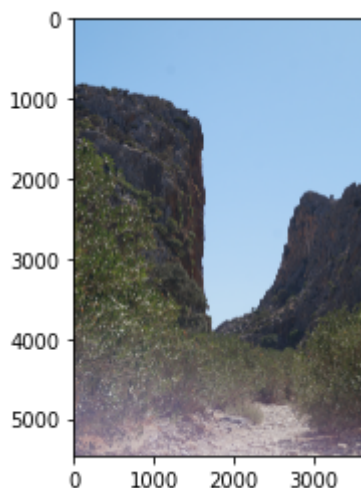
```
img = cv2.imread('img.JPG')
img = cv2.cvtColor(img, cv2.COLOR_BGR2RGB)
plt.imshow(img)
```

<matplotlib.image.AxesImage at 0x7f71af8ce358>



```
gauss_d1 = cv2.GaussianBlur(img, (3, 3), 0)
gauss_d2 = cv2.GaussianBlur(img, (7, 7), 0)
plt.imshow(gauss_d1)
plt.imshow(gauss_d2)
```

<matplotlib.image.AxesImage at 0x7f71af9034a8>



```
image = np.zeros((256, 256), np.float32)
gauss_d1 = np.zeros((256, 256), np.float32)
gauss_d2 = np.zeros((256, 256), np.float32)
ganglionic = np.zeros((256, 256), np.float32)
res = np.zeros((256, 256), np.float32)
```

```
for i in range(13):
```

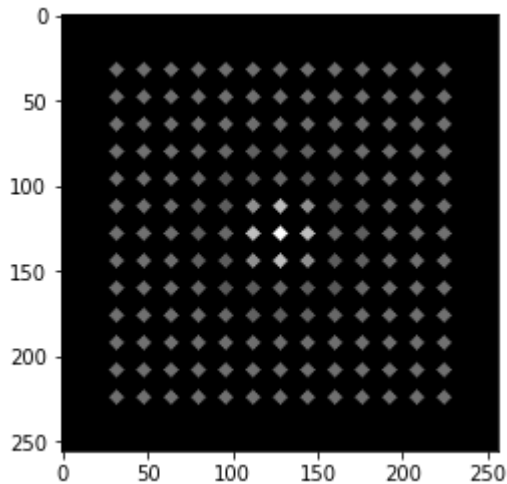
```

for j in range(13):
    image = np.zeros((256, 256), np.float32)
    cv2.circle(image, (j + 122, i + 122), 1, (127, 127, 127), -1, 8, 0)
    gauss_d1 = cv2.GaussianBlur(image, (3, 3), 0)
    gauss_d2 = cv2.GaussianBlur(image, (7, 7), 0)
    ganglionic = cv2.subtract(gauss_d1, gauss_d2)
    v = ganglionic[128][128] * 3 + 128
    cv2.circle(res, (j * 16 + 32, i * 16 + 32), 2, (v, v, v), 3, 8, 0)

```

```
plt.imshow(res, cmap='gray')
```

<matplotlib.image.AxesImage at 0x7f71af880978>



```

def circle(filter=None, is_complex=False):
    chart = []
    res = np.zeros((256, 256), np.float32)
    v_prev = 0
    for i in range(30):
        image = np.zeros((256, 256), np.float32)
        cv2.circle(image, (128, 128), i, (255, 255, 255), -1, 8, 0)
        gauss_d1 = cv2.GaussianBlur(image, (15, 15), 0)
        gauss_d2 = cv2.GaussianBlur(image, (31, 31), 0)
        ganglionic = cv2.subtract(gauss_d1, gauss_d2)

        if filter is not None:
            ganglionic = convolve2d(ganglionic, filter)

        if is_complex:
            v = int(ganglionic.max())
        else:
            v = int(ganglionic[128][128])

        chart.append(v)
        cv2.line(res, (i * 8, 128 - v_prev // 5), ((i + 1) * 8, 128 - v // 5), (255, 255, 255))
        v_prev = v

    return chart

```

```

def ring(filter=None, is_complex=False):
    chart = []

```

```

res = np.zeros((256, 256), np.float32)
v_prev = 0
for i in range(30):
    image = np.zeros((256, 256), np.float32)
    cv2.circle(image, (128, 128), i, (255, 255, 255), 3, 8, 0)
    gauss_d1 = cv2.GaussianBlur(image, (15, 15), 0)
    gauss_d2 = cv2.GaussianBlur(image, (31, 31), 0)
    ganglionic = cv2.subtract(gauss_d1, gauss_d2)

    if filter is not None:
        ganglionic = convolve2d(ganglionic, filter)

    if is_complex:
        v = int(ganglionic.max())
    else:
        v = int(ganglionic[128][128])

    chart.append(v)
    cv2.line(res, (i * 8, 128 - v_prev // 5), ((i + 1) * 8, 128 - v // 5), (255, 255, 255))
    v_prev = v

return chart

def line(filter=None, is_complex=False):
    chart = []
    res = np.zeros((256, 256), np.float32)
    v_prev = 0
    for i in range(180):
        image = np.zeros((256, 256), np.float32)
        cv2.line(image, (128 + int(100 * np.cos(i / 57.2)), 128 + int(100 * np.sin(i / 57.2)),
                        (128 - int(100 * np.cos(i / 57.2)), 128 - int(100 * np.sin(i / 57.2))),
                        (255, 255, 255), 3, 8, 0)
        gauss_d1 = cv2.GaussianBlur(image, (15, 15), 0)
        gauss_d2 = cv2.GaussianBlur(image, (31, 31), 0)
        ganglionic = cv2.subtract(gauss_d1, gauss_d2)

        if filter is not None:
            ganglionic = convolve2d(ganglionic, filter)

        if is_complex:
            v = int(ganglionic.max())
        else:
            v = int(ganglionic[128][128])

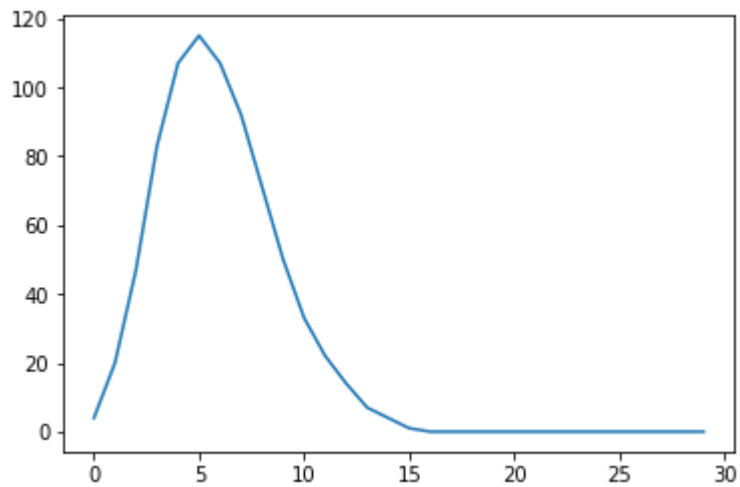
        chart.append(v)
        cv2.line(res, (i * 8, 128 - v_prev // 5), ((i + 1) * 8, 128 - v // 5), (255, 255, 255))
        v_prev = v

    return chart

chart = circle()
plt.plot(chart)

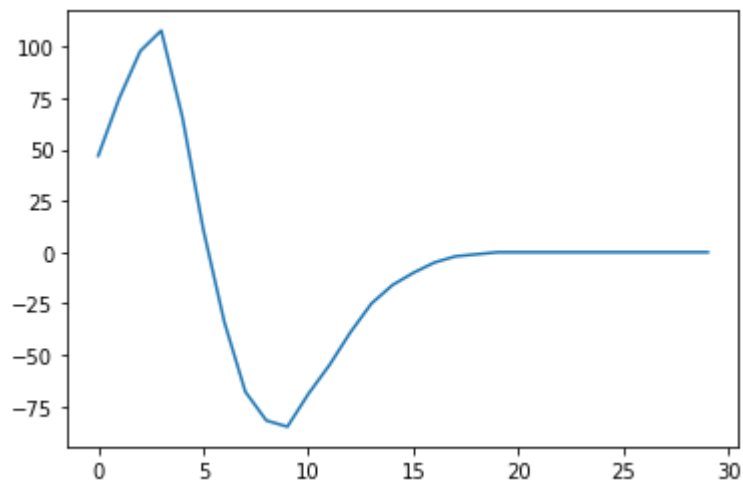
```

```
[<matplotlib.lines.Line2D at 0x7f71af7e3b38>]
```



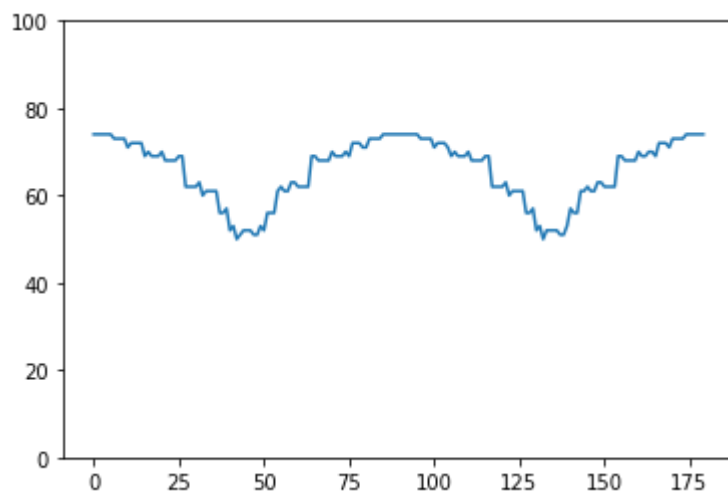
```
chart = ring()
plt.plot(chart)
```

```
[<matplotlib.lines.Line2D at 0x7f71af74b320>]
```



```
chart = line()
plt.plot(chart)
plt.ylim(0, 100)
```

```
(0.0, 100.0)
```



```
filter1 = [11, -11, 11, -11] # фильтр границ
```

```

filter1 = [[1, -1, 1], [1, -1, 1], [1, -1, 1]] # фильтр границы
filter2 = [[1, -2, 1], [1, -2, 1], [1, -2, 1]] # фильтр черной линии на белом фоне
filter3 = [[-1, 2, -1], [-1, 2, -1], [-1, 2, -1]] # фильтр белой линии на черном фоне

```

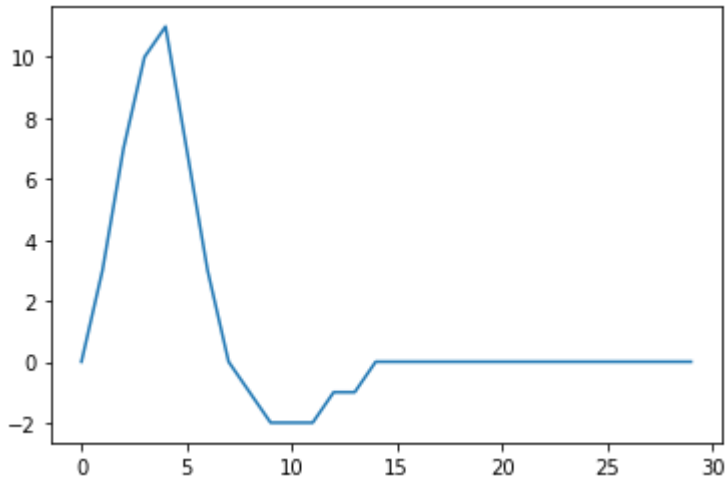
Реакция простых клеток:

```

chart = circle(filter1)
plt.plot(chart)

```

[<matplotlib.lines.Line2D at 0x7f71af687fd0>]

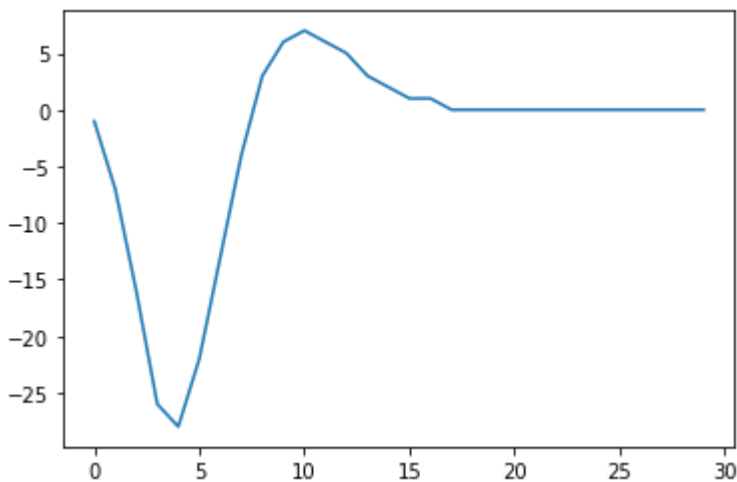


```

chart = circle(filter2)
plt.plot(chart)

```

[<matplotlib.lines.Line2D at 0x7f71af6706a0>]



```

chart = circle(filter3)
plt.plot(chart)

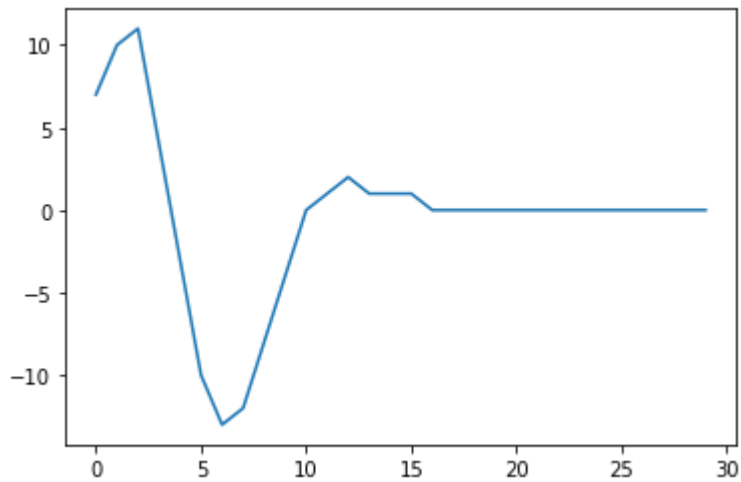
```

```
[<matplotlib.lines.Line2D at 0x7f71b07095f8>]
```



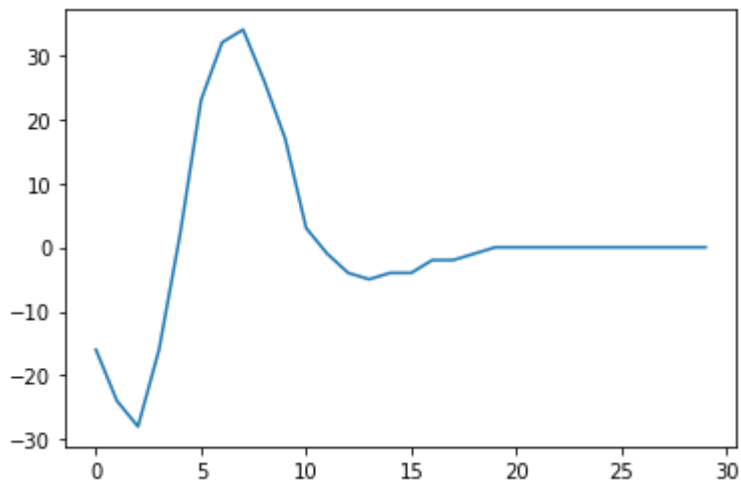
```
chart = ring(filter1)  
plt.plot(chart)
```

```
[<matplotlib.lines.Line2D at 0x7f71aff1e390>]
```



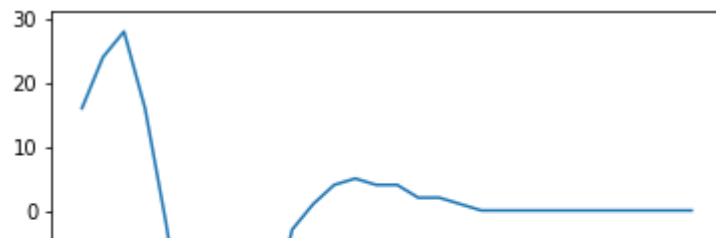
```
chart = ring(filter2)  
plt.plot(chart)
```

```
[<matplotlib.lines.Line2D at 0x7f71af70d470>]
```



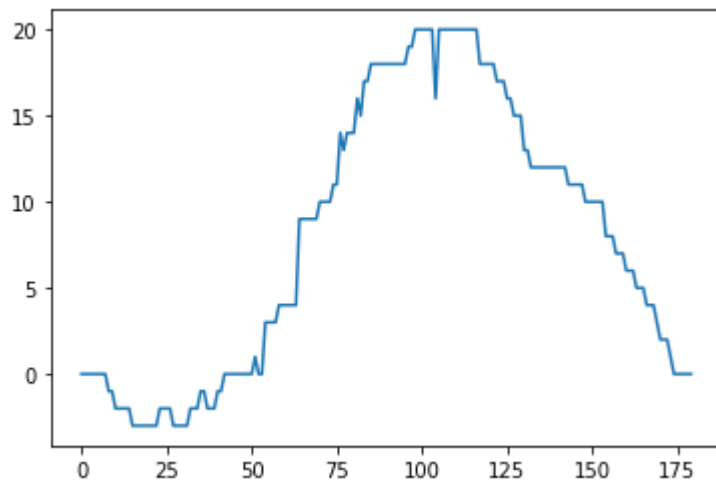
```
chart = ring(filter3)  
plt.plot(chart)
```

```
[<matplotlib.lines.Line2D at 0x7f71af98e7f0>]
```



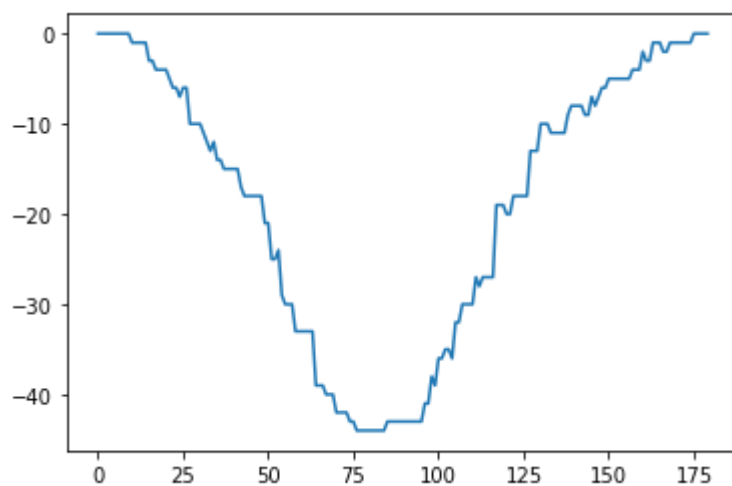
```
chart = line(filter1)
plt.plot(chart)
```

```
[<matplotlib.lines.Line2D at 0x7f71af07fbe0>]
```



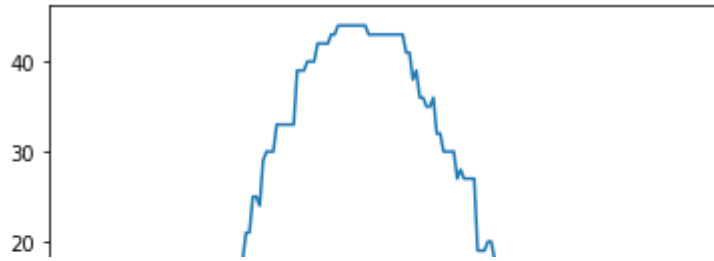
```
chart = line(filter2)
plt.plot(chart)
```

```
[<matplotlib.lines.Line2D at 0x7f71af511320>]
```



```
chart = line(filter3)
plt.plot(chart)
```

```
[<matplotlib.lines.Line2D at 0x7f71af4eea90>]
```

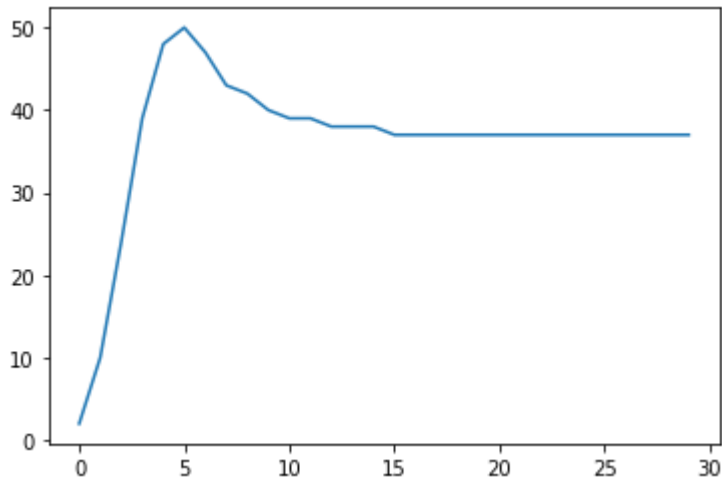


Реакция сложных клеток



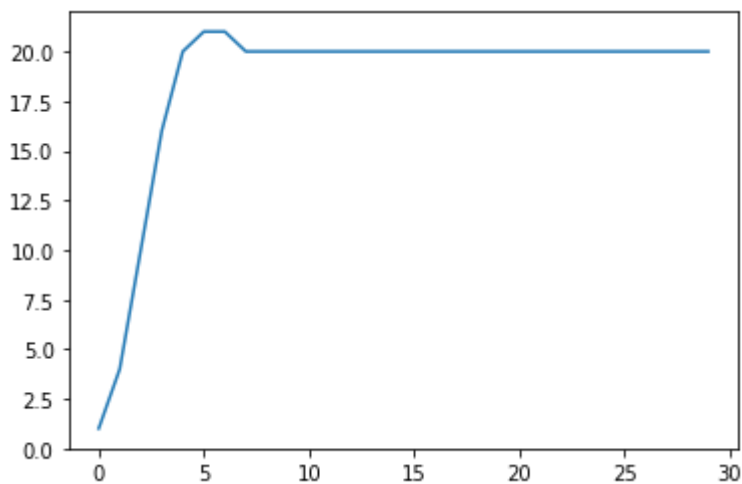
```
chart = circle(filter1, is_complex=True)
plt.plot(chart)
```

```
[<matplotlib.lines.Line2D at 0x7f71af454390>]
```



```
chart = circle(filter2, is_complex=True)
plt.plot(chart)
```

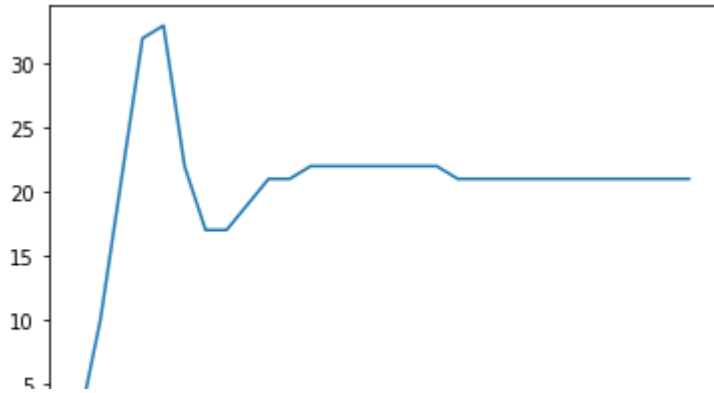
```
[<matplotlib.lines.Line2D at 0x7f71af432ba8>]
```



```
chart = circle(filter3, is_complex=True)
plt.plot(chart)
```

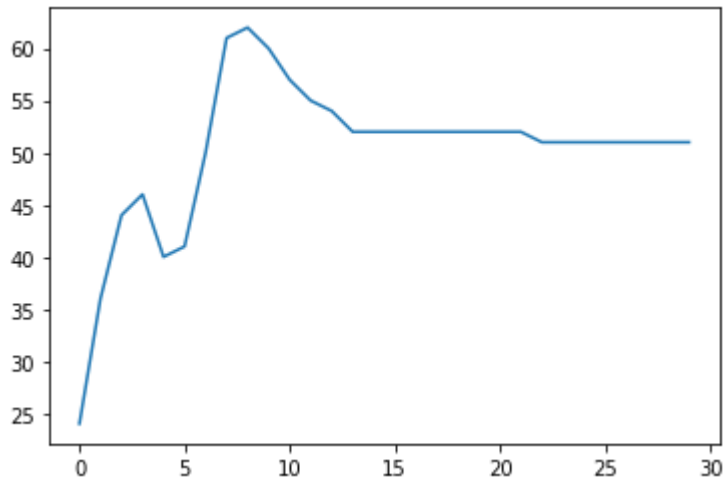


```
[<matplotlib.lines.Line2D at 0x7f71af39f438>]
```



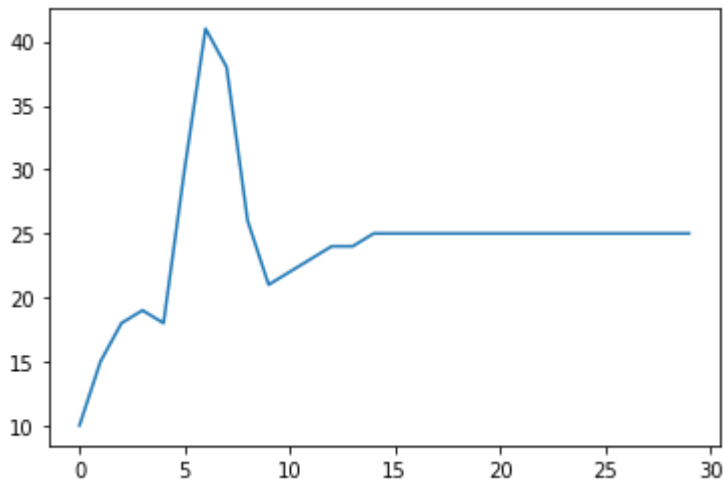
```
chart = ring(filter1, is_complex=True)
plt.plot(chart)
```

```
[<matplotlib.lines.Line2D at 0x7f71af379c50>]
```



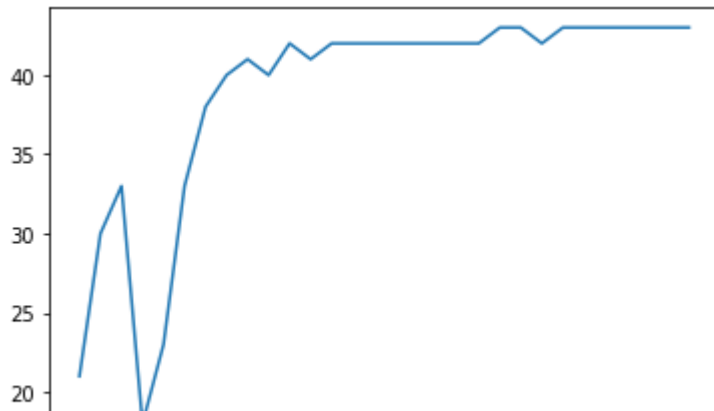
```
chart = ring(filter2, is_complex=True)
plt.plot(chart)
```

```
[<matplotlib.lines.Line2D at 0x7f71af2eb208>]
```



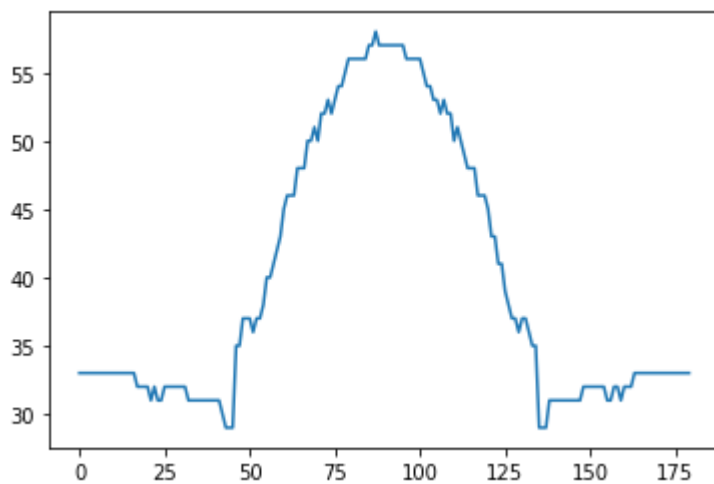
```
chart = ring(filter3, is_complex=True)
plt.plot(chart)
```

```
[<matplotlib.lines.Line2D at 0x7f71af249908>]
```



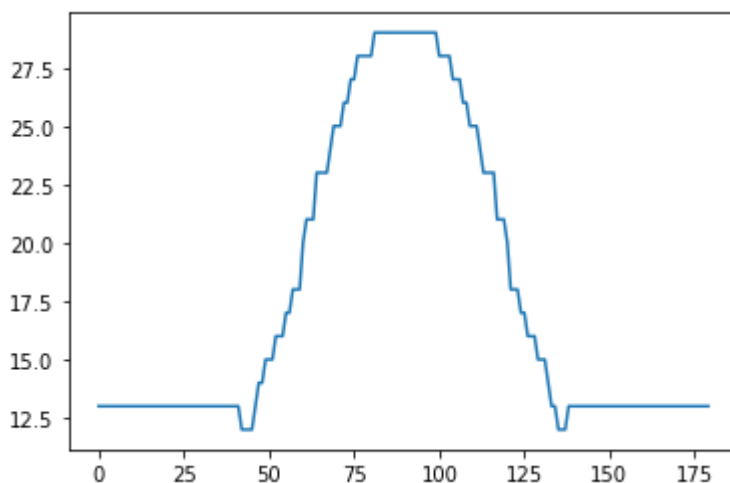
```
chart = line(filter1, is_complex=True)  
plt.plot(chart)
```

```
[<matplotlib.lines.Line2D at 0x7f71af229710>]
```



```
chart = line(filter2, is_complex=True)  
plt.plot(chart)
```

```
[<matplotlib.lines.Line2D at 0x7f71af187f60>]
```



```
chart = line(filter3, is_complex=True)  
plt.plot(chart)
```

[<matplotlib.lines.Line2D at 0x7f71af16ecf8>]

