

Problem 4

a)

Code:

```
import numpy as np

def driver():
    # define vectors
    t = np.arange(0, np.pi, np.pi / 30)
    y = np.cos(t)

    # compute sum
    S = 0
    for k in range(len(t)):
        S += t[k] * y[k]

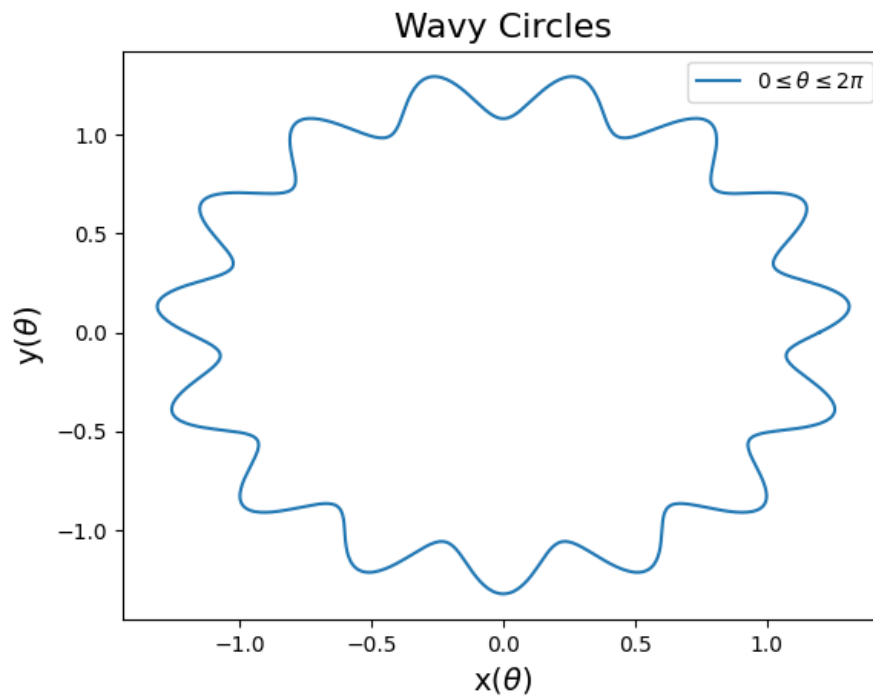
    # print sum and stop
    print("the sum is:", S)
    return

driver()
```

Output:

```
cedergrund@Gustavs-MacBook-Pro:~/Documents/fall-2023/APPM4600/homework/hw2/py_files|⇒ python3 prob4a.py
the sum is: -17.545259710757044
```

b)
i)



```
import numpy as np
import matplotlib.pyplot as plt

def driver():
    # constants
    R = 1.2
    delta_r = 0.1
    f = 15
    p = 0

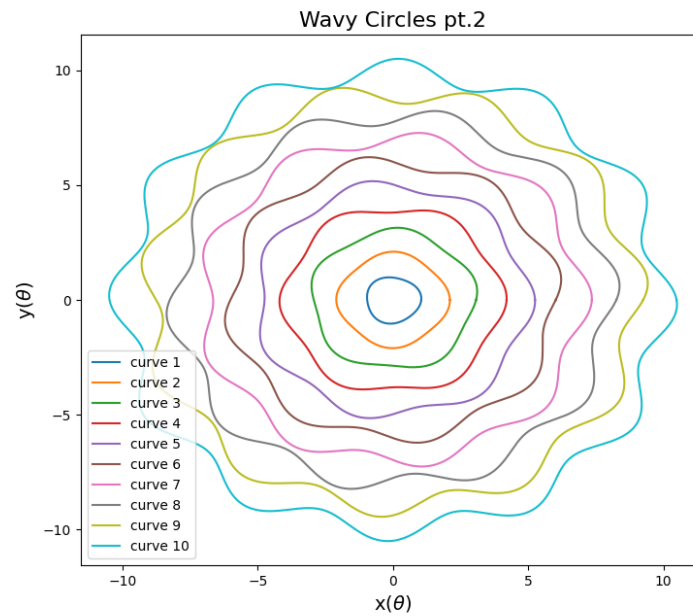
    # create parametric curves
    x = lambda x: R * (1 + delta_r * np.sin(f * x + p)) * np.cos(x)
    y = lambda x: R * (1 + delta_r * np.sin(f * x + p)) * np.sin(x)

    # map parametric functions over theta domain
    theta = np.linspace(0, 2 * np.pi, 1000)
    x_vals = x(theta)
    y_vals = y(theta)

    # plot figure and stop
    ax = plt.figure().add_subplot()
    ax.plot(x_vals, y_vals, label="$0 \leq \theta \leq 2\pi$")
    ax.set_title("Wavy Circles", fontsize=16)
    ax.set_xlabel("x($\theta$)", fontsize=14)
    ax.set_ylabel("y($\theta$)", fontsize=14)
    ax.legend()
    plt.show()
    return

driver()
```

ii)



```
import numpy as np
import matplotlib.pyplot as plt

def driver():
    # create parametric curves
    x = (
        lambda theta, R, delta_r, f, p: R
        * (1 + delta_r * np.sin(f * theta + p))
        * np.cos(theta)
    )
    y = (
        lambda theta, R, delta_r, f, p: R
        * (1 + delta_r * np.sin(f * theta + p))
        * np.sin(theta)
    )

    # plot 10 parametric functions using for loop
    theta = np.linspace(0, 2 * np.pi, 1000)
    x_vals = np.zeros((10, 1000))
    y_vals = np.zeros((10, 1000))
    ax = plt.figure().add_subplot()

    for i in range(10):
        curve_num = i + 1
        R = curve_num
        delta_r = 0.05
        f = 2 + curve_num
        p = np.random.uniform(0, 2)

        x_vals[i] = x(theta, R, delta_r, f, p)
        y_vals[i] = y(theta, R, delta_r, f, p)

        ax.plot(x_vals[i], y_vals[i], label="curve " + str(curve_num))

    # finish plotting and stop
    ax.set_title("Wavy Circles pt.2", fontsize=16)
    ax.set_xlabel("x($\\theta$)", fontsize=14)
    ax.set_ylabel("y($\\theta$)", fontsize=14)
    ax.legend()
    plt.show()
    return

driver()
```