PH434 Autumn 2025 – Programming Lab.

Practical Class 4 (Dated: 29.08.2025)

Question 1

A complex number $z = x + iy$ can also be written as a tuples (x, y). Define a function **complex_mult(z,w)** that multiplies two complex numbers z and w and outputs the resulting complex number as a tuple.

Using the above function to multiply the numbers **3 + 2i** and **2 + 4i**.

Do not use math, numpy or scipy.

Question 2

Define a function that takes a natural number n as input and checks whether it is prime using **if...elif...else**. Note **elif** is used to check multiple conditions.

If the input is not a natural number, an appropriate message should be printed.

Write separate functions, one using for-in loop and the other using while loop.

Question 3

The second order derivative of a function $f(x)$ is numerically given by:

$f''(x) \equiv \frac{df'(x)}{dx} = \lim_{h\to 0} \frac{f'(x+h)-f'(x)}{h}$, where $f'(x)$ is the derivative.

Please code the following:

1. Define a function called **float_list(start,end,steps)** that creates a list of real numbers from start to end with steps. Create a list from -2.0 to 2.0, increasing at steps of 0.01.
2. Define a function that finds the derivative $f'(x)$ and second derivative of $f''(x)$ of a function $f(x)$.
3. Consider the function $f(x) = x^4 - 2x^2$ for x in the range -2.0 to 2.0. Use the following command to plot the function $y = f(x)$, and the first and second derivative, $y = f'(x)$ and $y = f''(x)$, respectively.

   import matplotlib.pyplot as plt
   plt.plot(x,y)

4. Identify the points of maxima and minima from the plot. Comment on the behaviour of second derivative.

Question 4

Write a program defining a function **def digit_sum(num):** that takes an 6 or more digit integer as input and outputs the sum of all its digits. If the input is not an integer, the program should print an appropriate message.

Example#1 Input: 123456 Output: 21

Example#2: Input: 4.6 Output: Not an integer!

Example#2: Input: 1000000 Output: 1

Challenge

In quantum mechanics, unitary and Hermitian matrices are important operators. Write a function that checks whether a random 2×2 real matrix is unitary and Hermitian.

For a real unitary matrix U: $UU^T = U^TU = I$, where I is the identity matrix, and for a Hermitian matrix H: $H = H^T$, where U^T and H^T are the transposes. Test the Pauli matrices σ_x and σ_z.

Note: You need to write a function to multiply two 2×2 matrices and also one to generate the transpose. Both were done in previous classes.