REGULATIONS

- **Due date:** 15 January 2022, Saturday, 23:59 (Not subject to postpone)
- Electronically. You will be submitting your program source codes through text files as well as the report nameSurname.pdf by means of the AYBUZEM system.
- **Team:** There is **no** teaming up. The homework has to be done and turned in individually.
- **Cheating:** Source(s) and Receiver(s) will receive zero and be subject to disciplinary action.

1 Interpolation

Find an interpolation function that exactly passes through the given following data points using divided differences.

x	0	1	2	4	6
y	1	9	23	93	259

1.1 Code implementation

Write a python code for the following function returning the value of the interpolation function at the point *interpolationPoint*

def myInterpolationFunc(xData,yData,interpolationPoint)

DATASET: data1.txt , data2.txt, data3.txt, data4.txt

Compare the results of **myInterplationFunc** with python built in **interp1d** function by answering the following questions.

- What is the value at points 1.2, 10.5 and 17.3 for data1?
- What is the value for data2 at points 10.3, 20.2 and 29.7?
- What is the value for data3 at points -0.82, 0.40 and 0.91?
- What is the value for data4 at points -0.51, 0.72, 0.97?

Furthermore, plot the interpolation function which is returning function of python built-in **interp1d** for data1.txt and show xData and yData values given in data1.txt

2 Numerical Integration

Compute the value of the following integral

$$\int_1^2 \frac{e^{-x}+x}{x} dx$$

a. Trapozoidal rule for n = 4

b. Simpson $\frac{1}{3}$ rule by taking n = 2

3 Root Finding

In this section, you will implement Bisection and Newton-Raphson methods.

3.1 Bisection Method

Write a python function for Bisection Method. This function returns an approximation of the root for a given function f.

def *bisection(f,a,b,iterNum)*

Calculate the roots of the following functions approximately using the Bisection method. Plot a figure where x axis is number of iterations that changes between 10 and 50 and y axis corresponds to root values.

1.
$$f_1(x) = \frac{1}{2}x - (x+1)^{1/3} \qquad Interval : [3,4] \tag{1}$$

2.
$$f_2(x) = x^3 + 5x^2 + 7x + 5 \qquad \text{Define interval } \ddot\smile \tag{2}$$

3.2 Newton-Raphson Method

Write a python function calculating an estimation of the root of f function by using Newton-Raphson method.

def *newtonRaphson(f,x0,numIter)*

1. Calculate the root of the following function approximately using Newton-Raphson method. Plot a figure where x axis is the number of iterations that changes between 5 and 20 and y axis corresponds to estimation of the root values.

$$f(x) = x^3 - x - 1 \qquad x_0 = 1 \tag{3}$$

2. Estimate $\sqrt{5}$ value using Newton-Raphson method. Plot a figure where x axis is the number of iterations that changes between 5 and 20 and y axis corresponds to estimation values.

4 Solutions of Ordinary Differential Equations

Consider initial value problem with h =0.1

$$\frac{dy}{dx} + x = y \qquad y(0) = 0$$

a. Use Euler Method to obtain an approximation to y(0.1)

b. Use Fourth Order Runge-Kutta to obtain an approximation to y(0.1)
(*Note: You are expected to solve these questions by explaining all the steps as described in the lecture notes, without writing any code for the options a and b.*)

c. You are expected to write a *myRungeKutta* function to obtain an approximation to y(20)

d. You are expected to write a *myEuler* function to obtain an approximation to y(20)

REPORT FORMAT

You download report.zip and open via Overleaf. Write all answers and comments in this report. Your report should include answer of the above questions clearly.

Submission: You submit a zip file including

- the3 folder including source codes
- your report, nameSurname.pdf