University Setif-1, Ferhat Abbas
Faculty of Sciences
Department of Chemistry/Physics

Numerical methods and programming

Exercice 1

Consider the following integral :

$$I = \int_0^1 (e^{x^2} + x), dx$$

1- Determine an approximate value of I using Simpson method with an accuracy $\varepsilon = 10^{-3}$.

2- Determine n, the number of subintervals required by the trapezoidal method to approximate the integral I with the same accuracy $\varepsilon = 10^{-3}$.

Exercice 2

We want to compute an approximate value ξ of the square root of 5 (i.e., $\sqrt{5}$).

1- Determine an interval of the form $[a, a+1]$, with $a \in \mathbb{N}$, in which ξ can be estimated.

2- To compute an approximate value of $\sqrt{5}$, we must solve a certain equation $f(x) = 0$. Give the expression of the function f in the form of a polynomial of degree 2.

3- Compute ξ with an accuracy $\varepsilon = 10^{-4}$ using the Newton–Raphson method, choosing $x_0 = a + 1$ as the initial point.

4- Determine the number of iterations n required by the bisection method to obtain an approximate solution with the same accuracy $\varepsilon = 10^{-4}$.

Exercice 3

Consider the following Cauchy problem :

$$(P) \begin{cases} \frac{dy}{dt} + \cos(t)y = -\cos(t), & t \in [0, \pi] \\ y(0) = 0, \end{cases} .$$

1- Taking $h = \frac{\pi}{4}$ as the step size, determine an approximate value of $y(\pi)$ using the Euler method and then the second-order Runge–Kutta method (RK2).

2- Verify that $y(t) = e^{-\sin(t)} - 1$ is the exact solution of problem (P).

3- Evaluate the results obtained in Question (1).

<u>**N.B. :**</u>

- Perform all calculations with four digits after the decimal point, without rounding.
- Calculators cannot be shared.