Kathmandu University
Scientific Computing with Python
Assignmnet-II

Level: BE/B.Sc 2nd sem/2nd year **Course: Numerical Methods (MCSC-202)**

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Implement the following problems using Python 3 in Script file to get the results.

A. Finding Roots of the Equations: Present each iteration result in a table

1. Implement the **Bisection Method** to approximate the root of the equation $x^2 = sinx$ by taking the initial guesses $a = 0.5$ *and* $b = 1.0$. (**Algorithm:** $\boldsymbol{x_0 = \frac{a+b}{2}}$)
2. Implement the **Newton-Raphson's Method** to approximate the root of the equation $e^x = 4x$ by taking the initial guess $x_0 = 1.0$ (**Algorithm:** $\boldsymbol{x_1 = x_0 - \frac{f(x_0)}{f'(x_0)}}$)

B. Numerical Integration

3. Implement Trapezoidal-rule to approximate the definite integral $I = \int_0^{\pi} \frac{sinx}{e^x} dx$ by taking 20-equal divisions of the interval $[0, \pi]$. (**Algorithm:** $\boldsymbol{I = \frac{h}{2}[y_0 + 2(y_1 + y_2 + \cdots + y_{n-1}) + y_n]}$)
4. Implement Simpson's 1/3-rule to approximate the definite integral $I = \sqrt{\frac{1}{2\pi}} \int_{-4}^{4} e^{-\frac{x^2}{2}} dx$ by taking 50-equal divisions of the interval $[-4, 4]$. (**Algorithm:** $\boldsymbol{I = \frac{h}{3}[y_0 + 4(y_1 + y_3 + \cdots + y_{n-1}) + 2(y_2 + y_4 + \cdots + y_{n-2}) + y_n]}$)

C. Numerical Differential Equations: Present the solution in a table and graph it.

5. Implement **Euler's method** to approximate the solution $y(x)$ of the differential equation $\frac{dy}{dx} = x^2 + x, y(0) = 1$ on the interval $[0, 2]$ by diving it into 20- equal sub-intervals. [**Algorithm:** $\boldsymbol{y_{i+1} = y_i + hf(x_i, y_i)}$]
6. Implement **Runge-Kutta 2nd order method** to approximate the solution $y(x)$ of the differential equation $\frac{dy}{dx} = x^2 + x, y(0) = 1$ on the interval $[0, 2]$ by diving it into 10-equal sub-intervals. [**Algorithm:** $\boldsymbol{y_{i+1} = y_i + \frac{1}{2}(k_1 + k_2),\ where\ k_1 = hf(x_0, y_0)\ and\ k_2 = hf(x_0 + h, y_0 + k_1)}$]
7. Implement the Boundary valued second order differential equation $y'' - 64y' + 10 = 0$ by using **finite different method** with boundary conditions $y(0) = y(1) = 0$ and taking the step size$h = 0.1$.