Kathmandu University
MCSC-202 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 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: $x_0 = \frac{a+b}{2}$)**
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: $x_1 = x_0 - \frac{f(x_0)}{f'(x_0)}$)**

B. Interpolation

3. Construct the finite difference table of the function $f(x) = e^x$ on the interval $-1 \leq x \leq 1$ by dividing the interval by equally space points of step-size 0.1
4. Estimate the value of the function $f(0.21)$ and $f(0.29)$ applying Newton's forward and backward interpolation polynomials using following table:

x	0.20	0.22	0.24	0.26	0.28	0.30
y	1.6596	1.6698	1.6804	1.6912	1.7024	1.7139

5. Estimate $y(2)$from the following data using Lagrange's formula

x	0	1	3	4	5
y	0	1	81	256	625

C. Numerical Integration

6. 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: $I = \frac{h}{2}[y_0 + 2(y_1 + y_2 + \cdots + y_{n-1}) + y_n]$)**
7. 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: $I = \frac{h}{3}[y_0 + 4(y_1 + y_3 + \cdots + y_{n-1}) + 2(y_2 + y_4 + \cdots + y_{n-2}) + y_n]$)**

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

8. 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: $y_{i+1} = y_i + hf(x_i, y_i)$]**

9. 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:** $y_{i+1} = y_i + \frac{1}{2}(k_1 + k_2),\ where\ k_1 = hf(x_i, y_i)\ and\ k_2 = hf(x_i + h, y_i + k_1)$]

10. 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$h = 0.1$.

E. Curve Fitting

11. Using least square method to fit the straight line $y = a_0 + a_1 x$ to the following data:

x	1	2	3	4	5	6
y	2.4	3.1	3.5	4.2	5.0	6.0

Using this fit estimate the value of y at $x = 2.5$

12. Using least square method to fit the curve $y = ae^{bx}$ to the following data:

x	2	4	6	8	10
y	4.077	11.084	30.128	81.897	222.62

Using this fit estimate the value of y at $x = 9$