Jadavpur University
Session 2022-2023, Odd Semester
Computer Programming and Numerical Methods

1. Find $\frac{dy}{dx}$ using forward, backward and central differencing schemes for $y = Sin\ x$ using (i) $\Delta x = 0.1$ (ii) $\Delta x = 0.01$ for $0 \leq x \leq \pi$ and determine the relative percentage error, defined as

   $\left| \frac{\frac{dy}{dx}|_{numerical} - \frac{dy}{dx}|_{exact}}{\frac{dy}{dx}|_{exact}} \right| \times 100$ in each case with the exact derivative given by $\frac{dy}{dx}|_{exact} = cos(x)$.

   Comment on the result.

2. Write a function to find the integration of a function f within the limits a and b by Trapezoidal and Simpson's $1/3^{rd}$ integration method. f, a and b should be provided as arguments of the function `integrate`. Write the main function to take the name of the integrand function and the limits of integration as command line arguments.

3. Write a program to solve the following differential equations by (i) Euler method, (ii) Runge-Kutta second order method. Compare your solutions. In each method estimate the truncation error and choose an appropriate step size.

   $$\frac{dy}{dx} = 2xy, y(0) = 0.5, solution\ for\ 1 \geq x \geq 0$$

   $$\frac{dy}{dx} = x^2 + y^2, y(0) = 1, solution\ for\ 1 \geq x \geq 0$$