MSDM5004 Spring 2024
Homework 2 Part II
Due Mar. 10

3. Write a code using MATLAB (or other programming language) to compute the derivative of $f(x) = \frac{\sin x}{x^2}$ at $x = 3$ using the central difference formula, and check the order of convergence.

4. Write codes using MATLAB (or other programming language) to solve the ODE

$$y' = t^{-2}(ty - \frac{1}{2}y^2), \quad t \in [1, 3],$$

with initial condition $y(1) = 4$, using the following three numerical schemes: (1) forward Euler method and (2) backward Euler method. Choose time step $h = 1/128$.

5. Consider the equation

$$\frac{\partial u}{\partial t} = \frac{\partial^2 u}{\partial x^2}.$$

Show that the numerical scheme

$$\frac{U_j^{n+1} - U_j^{n-1}}{2\Delta t} = \frac{U_{j+1}^n - 2U_j^n + U_{j-1}^n}{(\Delta x)^2}$$

is second order both in time and space.