HOMEWORK 1
MATH 375/CS375
FALL 2025

DUE FRIDAY, SEPT. 5

Instructions: Textbook Problems from Burden 10th edition.

Problems from Section 1.1. 2, 10, 11, 14.

Computer/MATLAB Part 1. In example 3 (section 1.1 page 9), they show 2 graphs in Figure 1.9 for $\cos(x)$ and a corresponding quadratic approximation. Main Tasks:

a) Replicate the figure with Matlab using a domain spacing of $h = 0.1$ for the computational domain $[-\pi, \pi]$

b) Include in the plot an approximation of degree 4 for $\cos(x)$, that is plot $P_4(x)$. This figure should contain the original function $f(x)$, $P_2(x)$ and $P_4(x)$. Describe your findings.

c) Plot the absolute error $e_2(x)$ and $e_4(x)$ on the computational domain $[-\pi, \pi]$ with $h = .1$. We use the definition from the absolute error which is given by $e_n(x) = |f(x) - P_n(x)|$. If you try smaller values of h does your error improve? Try $h = 0.1, 0.01$ and 0.001. Describe your findings.

Computer/MATLAB Part 2. Solve the following Initial Value Problem (IVP) given by the Logistic Model

$$N' = rN(1 - \frac{N}{K}), \qquad N(0) = N_0$$

Using the built-in function ODE45 found in MATLAB.

a) Using $r = 0.05$, $K = 1000$, and $N_0 = 100$ obtain a numerical solution and plot ($N(t)$ vs t) in the computational domain for t on $[0, T_f]$. Here T_f will be selected in a way that your figure captures the solution approaching to a fixed/constant value. What happens if $N_0 = 750$ or $N_0 = 1300$? Describe your findings.

b) Repeat part a) by implementing Euler's Scheme.

c) Using a single initial condition, plot both solutions at once using Euler's Scheme and Improved Euler's scheme. Describe your findings.

Note1: Show all your work.
Note2: Report any typos or bugs.
Note3: Include your .pdf file as a project report + a .zip folder with all your files so that your Project submission is visible on Canvas (we will run your codes).