



Computer Engineering Technology – Computing Science

Course: Numerical Computing – CST8233

Term: Fall 2021

Lab #11

- Objectives

The main objective of this lab is to use R program to solve Ordinary Differential Equations (ODEs) numerically.

- Earning

This lab worth 1.5 % of your final course mark. Each student should complete this lab and demo the codes of the exercises to the lab professor during the lab session.

- Steps

Step 1. Ordinary Differentiation Equations (ODE)

ODEs are equations that involve some ordinary derivatives, as opposed to partial derivatives) of a function. First order ODEs are considered in this course. ODEs arise in many contexts of mathematics and natural sciences. Solving an ODE means finding the equation of the dependent variable in as a function of the independent variable.

The algorithms used in this course to solve ODEs require two conditions:

1. The ODE can be written in the form of $\frac{dy}{dx} = f(x, y)$, and
2. The initial value of $y(0) = y_0$ is given.

In this lab, you will use Euler's Method to solve a given ODE. Using this method, you can find successive values of y given a step size h . This step size defines the difference between two x values. The formula used to find y values is given as:

$$y_{i+1} = y_0 + f(x_i, y_i) h$$

Before applying this formula, the given ODE must be re-written in the form of $\frac{dy}{dx} = f(x, y)$.

Step 2. Exercise

The motion of a mass is modelled using the following ODE:

$$y'' + y \cos t = 0$$

where y is the displacement and t is the time. The initial value of y is $y_0 = 1.241$.

- A. Write R program that finds the values of displacement between $0 \leq y \leq 6$ for the following step sizes, $h = 0.5, 0.25$ and 0.1 . Plot the displacement for each case.
- B. The solution of this ODE is:

$$y = 0.5 e^{\sin^2 t} e^{-\sin t}$$

Plot the displacement for the same range mentioned in part A using this solution and find the absolute and relative errors when $h = 0.5$

Hint: All angle values must be in radians.

You need to demo this to your lab professor.