ALGONQUIN COLLEGE

SCHOOL OF ADVANCED TECHNOLOGY

ICT - Applications & Programming
Computer Engineering Technology – Computing Science

Numerical Computing – CST8233

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Lab #6 – Solving Ordinary Differential Equations (ODE)

In this lab, you will write a script to solve ODE using Euler's method.

You will need to show your lab professor to get your grades.

Grades:

2% of your final course mark

Deadline

During the lab period of Week 14.

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 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:

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

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 $0 \leq t \leq 6$ 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:

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

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.