ALGONQUIN COLLEGE

Computer Engineering Technology – Computing Science

Course: Numerical Computing – CST8233
Term: Fall 2021

Lab #12

• Objectives

The main objective of this lab is to use R program to perform numerical integration using two different rules, namely; Multi-segment Trapezoidal rule and Multi-segment Simpson's 1/3 rule.

• 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. Integration

Integration is the process of measuring the area under a function between two values: the lower limit of the integration and the upper limit of the integration.

$$I = \int_a^b f(x)\ dx$$

where a is the lower limit of the integration and b is the upper limit of the integration. Numerically, solving this integration can be carried out using one of the following rules:

1. *Multi-segment Trapezoidal rule:*

$$I \approx \frac{b-a}{2n}\left[f(a) + 2\left\{\sum_{i=1}^{n-1} f(a+ih)\right\} + f(b)\right]$$

In this equation, n is the number of segments and h is the step size $h = \frac{b-a}{n}$. It can be shown that the more segments the more accurate answer.

2. *Multi-segment Simpson's 1/3 rule:*

$$I \approx \frac{b-a}{3n}\left[f(x_0) + 4\sum_{\substack{i=1 \\ i \text{ is odd}}}^{n-1} f(x_i) + 2\sum_{\substack{i=1 \\ i \text{ is even}}}^{n-2} f(x_i) + f(x_n)\right]$$

In this equation, x_0 is a, x_n is b, n is the number of segments and h is the step size $h = \frac{b-a}{n}$. It can be shown that the more segments the more accurate answer.

Step 2. Exercise

The kinetic energy of required to left an object is given by the following integration:

$$E = \int_a^b 10\, x\, e^{-x^2}\, dx$$

Find the total required energy to left this object from $a = 0$ to $b = 2$. You need to find this value using the two rules given in Step 1. Your final answer must be similar to the following table. The actual value of this integration is 4.91. This value is needed for absolute and relative errors calculations.

n	Trapezoidal	Simpson's 1/3	Absolute error	Relative error
1				
2				
3				
4				
5				

You need to demo this to your lab professor.