GLG490/598 Numerical methods

Homework #4

Due 11:59pm, 2/18/2021

(100 points)

Question: write a C code to use the Rectangle method, Trapezoid method and Simpson's method to determine the integration of:

$$\int_0^1 x^3(1+x^4)^3\,dx$$

Formular for Rectangle method:

$$\int_a^b f(x)dx = h\sum_{i=1}^{n-1} f(x_i + \frac{h}{2})$$

Formular for Trapezoid method:

$$\int_a^b f(x)dx = \frac{h}{2}\sum_{i=1}^{n-1}[f(x_i) + f(x_{i+1})]$$

Formular for Simpson's method:

$$\int_a^b f(x)dx = \frac{h}{6}\sum_{i=1}^{n-1}\left[f(x_i) + 4f\left(x_i + \frac{h}{2}\right) + f(x_{i+1})\right]$$

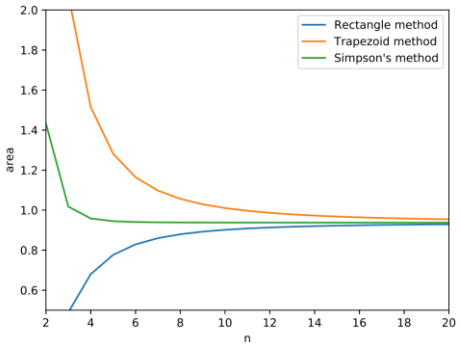
where n is the number of nodes, and $h = (b-a)/\,(n-1)$ is the width for each column (or the spacing between 2 neighboring nodes), x_i is the x for the ith node.

Requirements:

1. You need to write **ONE** single code to use all three methods calculate the integration.
2. You need to try multiple values of n in the code. The best way is to use n in a 'for loop'. When writing the for loop of n, I use 'for(n=2;n<=20;n++)'
3. You need to write the output data both to the screen and to a file named "HW04.output.dat". The output should be exactly the same as follows:

```
$ ./a.exe
2 0.149933 4.000000 1.433289
3 0.489102 2.074966 1.017724
4 0.679730 1.515757 0.958406
5 0.776304 1.282034 0.944881
6 0.828788 1.164489 0.940688
7 0.859753 1.097744 0.939083
8 0.879339 1.056432 0.938370
9 0.892440 1.029169 0.938016
10 0.901604 1.010267 0.937825
11 0.908252 0.996638 0.937714
12 0.913223 0.986496 0.937647
13 0.917032 0.978749 0.937604
14 0.920014 0.972699 0.937576
15 0.922392 0.967886 0.937556
16 0.924317 0.963995 0.937543
17 0.925898 0.960804 0.937533
18 0.927211 0.958157 0.937526
19 0.928314 0.955935 0.937521
20 0.929248 0.954053 0.937517
```

4. You will need to write a python plot to plot the data “HW04.output.dat” to show the area as a function of n for all three methods. The figure should be the same as follows (you can use different colors for these curves, but remember to include the legend in the figure):



How to submit your homework

1. Name your C code as ‘FirstName-LastName-HW04.c’ and your python code as ‘FirstName-LastName-HW04.py’
2. Send your code file to Mingming.Li@asu.edu and enter the email subject title as “Numerical Methods Homework 04”