MIDDLE EAST TECHNICAL UNIVERSITY
DEPARTMENT OF MECHANICAL ENGINEERING
ME 310 NUMERICAL METHODS
FALL 2022
PROGRAMMING PROJECT 4

Assignment date : 28.12.2022
Due date : 11.01.2023

The programming project will be submitted through METU-Class, as described in the "Programming Project Assignment Guidelines", which is posted on METU-Class.

Write a computer program to integrate any given function $f(x)$ from a to b using three point Gauss quadrature and Trapezoidal Rule. Utilize the Gauss quadrature formula in a multiple segment approach. Divide the domain of integration $[a\,b]$ into n, i.e. $n=1,2,3,\ldots$, segments and apply the Gauss quadrature formula to each segment separately. For Trapezoidal Rule, the number of segments is increased by a multiple of 2, i.e. $n=1,2,4,8,16,\ldots$. Evaluate the integrals with a pre-specified error tolerance starting from one segment and increasing the number of segments (as defined for each integration algorithm) until desired accuracy is reached. In Trapezoidal Rule, your code should not re-evaluate the function at the points which are already calculated at the previous steps.

Your code should do the following:

- User defines the function $f(x)$ defined as *f.ext* and *fp.ext* (i.e. consistent with your program language), bounds of integration $[a\,,b]$, and error tolerance ε_s. .
- Also find the integral of the given function using built-in capabilities of the software/computer language you are using. Compare the results. (If you are using a programing language such as C/C++, Fortran, etc. compare the result of your code and the result of a built-in function in a software package only in your report)
- Present the results by displaying them on the screen. Give the number of segments at each step and approximate percent relative error for each integral calculated using those segments.
- Plot the evolution of your integral results obtained from both approaches on single plot.
- Define a variable named as "*count*". Use this variable to track the number of function evaluations in Trapezoidal rule. Output this variable on the screen.

Present your results in a short report (a few pages of a word document only, saved as a pdf document) which should include the following:

- A basic introduction paragraph,
- Necessary formulations and calculations to write your code (type it in the word document),
- Your numerical results for sample *f(x)* functions,
- Your plotted graphics including the evolution of the numerical computation process by plotting the integral value as a function of number of segments.
- Discussion of the results and conclusion,
- Appendix section including your source code.

‡ 123456 is the first six digits of the student number of the project group leader.