Eng M 918 – Homework 1 – Spring 2009

Purpose:

- Understanding the use of interpolation and quadrature on a fixed domain
- Development of the skills to document and test your programs
- Providing references and credit to work of others

Problem submission:

- All problems will be electronically submitted
- Your contribution to the results will be clearly identified and credit provided for any work done by others, references provided for published work. etc
- Each problem will include the code used to solve the problem (in the appendix/attachment)
- Each program will be properly documented, including
    - Program name and description
    - Original author and date
    - Modifications: authors, dates, and description
    - Notation for (main) variables and all input/output variables
    - Any additional comments (method descriptions, variables, etc)
- Each problem will include most of the following
    - Problem description
    - Description of solution process
    - Information to find the code (do not put code in problem solution if not needed to explain your work)
    - Tests done to verify the code
    - Results presented in graphs/pictures/tables
    - Convergence and error analysis
    - Summary and evaluation of results
- References (if not included as links or footnote in text)
- Appendices and attachments of related material

In the following use the C# program and the associated classes on the web to conduct the tasks. You will need the classes

a. Interpolation.cs (parent class to all interpolation classes)
b. InterpolationLineNNode.cs
c. Quadrature.cs (parent class to all integration classes)
d. QuadratureLine.cs
e. Matrix.cs

Use these four files as a base to develop your program. Use the domain [-1,1] in all cases.

1. Create a program that can interpolate a polynomial exactly by knowing the required number of values of the polynomial at the designated points.

2. You want to calculate the difference of two polynomials of known power by calculating the area between them. Construct a program to do this exactly. Compare your results to analytic results for the differences.
3. Use your shape functions to interpolate the functions Sin(x/n) for n = 1, 4, 8, 16, e^x, and some other challenging function you determine over the interval [-1,1]. Create an error measure and use it to compare your results.
4. For the functions of the previous problem compare the derivatives of the functions with those obtained by their interpolation.
5. Do the same as for the last problem, but for the integrals calculated using quadrature. Compare the results with the exact integrals.
6. Write a class to do Lobatto quadrature. Evaluate the results with polynomials functions of the orders that should be evaluated exactly.

Convert the four classes and the Lobatto quadrature class to C++ or Java and test your conversions. Evaluate your tests and justify why each is a sufficient test of the conversion.