November 9, 2009

EMA 605 Project #2

Select one of the following project options:

Programming option: Write the necessary subroutines for a finite element of your choice (subject to the restrictions below) and implement these in the finite element program FEMCOD, or the program you wrote for Project 1 (FEMCOD is recommended because it has a skyline storage scheme and an efficient equation solver). You should not have to modify FEMCOD at all, except for the possible addition or modification of CALL statements to your subroutines.

You are responsible for all of the code for generating the element stiffness matrix and post-processing the data. Your element can be for linear steady state problems in solid mechanics, fluid mechanics or heat conduction. You should exercise your code on an illustrative problem for which an analytic solution is available, and you should use at least two meshes to study convergence of your FEA solution.

Objectives: Learn how to implement a sophisticated finite element, investigate accuracy and convergence, and show that FEM can yield good results.

Possible elements:
- 8-node (or higher) 3-D brick element.
- 9-node plane Lagrange quadrilateral.
- 6-node plane triangle (this is slightly more challenging).
- 8-node plane serendipity quadrilateral.
- 4-node (or higher) axisymmetric element.
- 4-node plane quadrilateral for heat transfer or fluid flow.

Possible problems:

Determine stress concentration factor for a hole in an infinite plate under uniform tension.

Determine the stress intensity factor for a mode I or II crack in plane stress or plane strain (see §8.7 of CMPW).

Potential, irrotational fluid flow around a cylinder (see§12.9 of CMPW).

Seepage under a dam.

Deep beam subject to tip load.

Numerous other possibilities!

Commercial Software Option: Use a commercial program (e.g., ANSYS at CAE, perhaps others) to model a realistic engineering problem. User guides for these programs are at CAE. You should choose a linear steady state solid mechanics, fluid mechanics or heat conduction problem that is representative of a complex industrial problem (and hence, does not have an analytic solution). You are responsible for learning how to access the program, generate mesh data, perform finite element analysis, post-process the data, and evaluating solution accuracy. You should analyze at least two meshes to study convergence of your FEA solution.

Objectives: Gain the "real life" experience of becoming familiar with a finite element code, modeling a realistic problem, and assessing the accuracy of the finite element solution, and writing a good technical report.

DEADLINES:

Tuesday, November 17* - Progress Report:

Programming option: Describe your project including the element you will program, the problem you will analyze, and the source of your analytic solution.

Commercial Software option: Cite the program you will use, review the user guide so that you are confident you can "get the program running", describe the problem you will analyze, and describe how you plan to assess the accuracy of your solution. Also, provide a detailed description of your prior experience with the program you plan to use.

* Please feel free to see me before this date with your ideas if you would like to get a head start on your project.

Thursday, December 10 - Final Report [10% off if late, no credit after Dec. 17]:

Programming option: Briefly describe your element and the problem that you are solving. Discuss accuracy, convergence, etc., in an easy to read, comprehensible manner using graphical presentation of data where appropriate. Put a copy of the program and pertinent or representative raw output in an appendix.

Commercial Software option: Briefly describe the problem you are solving, the element you are using for modeling, and any other pertinent information. Present results in graphical form where appropriate. Thoroughly discuss how accurate your FEM solution is and how you assessed this.

It is acceptable to discuss your project with other students, but all programming, analysis, writing, etc. must be done independently. All reports will be heavily graded on how well-written they are (a good report will present all of the important information as briefly and concisely as possible, and be easy and enjoyable to read). The body of your report should be typed.

Summary of deadlines:

Tuesday, November 17 - Progress report.
Thursday, December 10 - Project is due.
Thursday, December 17 - Latest date to turn project in.