Term Projects for ME 7540 - Advanced FE Methods - Spring 2016

THESE RULES ARE ADAPTED FROM CU BOULDER ASEN 6367

Guidelines

1. Each team project should involve two students - at most three. Forming teams is the responsibility of the students, but instructor can help. Teams may coordinate work by comparing results in related projects.

2. Projects may be proposed by students or taken from the potential subjects list at the end of this documents. **Project topics should be communicated to the instructor by Tuesday class after Spring Break.** The description should name the participating students, project title, and one sentence that identifies the subject.

3. Projects should be related to the subject matter of the course as a starting point. Essential features: (1) uses finite elements, and (2) use is relatively advanced compared to the introductory master level.

4. A project should involve two of the three elements: 1) computational implementation, 2) analytical formulation, 3) commercial/production code use. `pyfem2` may be modified or extended to meet the goals of a project. The instructor can work with groups to implement any backend or "boilerplate" code needed to complete a project.

5. A project must include verification, error analysis, and convergence analysis.

6. Expected workload for a two-student team is an average of 8-15 hrs/week per, including preparation of presentations and final report.

7. A project does not have to be successful. However, participants are expected to show evidence of a serious try. Negative conclusions may be as valuable as positive ones.

8. One presentation is required for each project: a 30-40 minute final presentation during the last week of classes. Presentations will be given during class time.

9. **A progress report and final report in PDF format will be due.** Due dates will be posted to Canvas. The report should describe: objectives, formulation, implementation (if appropriate), results and conclusions. It should contain appropriate references to any literature used. The report should include a listing of key software developed to obtain results.

Project ideas

1. Develop a 4-node quadrilateral element for axisymmetric solids. Test the element in a variety of loading scenarios. In particular, in bending and for incompressible materials.

Consider using reduced integration with hourglass control, selective reduced integration, etc. to overcome locking. Your element can be based on the element in the SANTOS chapter posted to Canvas.

2. Develop a Riks nonlinear solver for problems with instabilities. Test the solver using plane stress and plane strain elements.

3. Fracture mechanics simulations with extended FEM. Read the literature on extended FEM (XFEM). Find out whether the software you use can be used to run extended FEM simulations. If not you can either write your own 2D code or compare extended FEM with the virtual crack closure technique (VCCT) and run simulations with VVCT in ANSYS.

4. Modify an existing finite element code to be mesh free using the Material Point Method. Explore situations where meshfree methods are more appropriate than standard finite element methods. The instructor can provide notes and a "road map" on how to implement the method computationally.

5. Modeling the deformation of viscoelastic tires. Read the literature on viscoelastic models of tire material and the deformation behavior of the steel belts inside the tires. Simulate static and dynamic deformations of tires and figure out why tires might burst under some circumstances.

6. Develop a coupled thermal/structural solver. Read the relevant literature to determine solution strategies (staggered, implicit, explicit, etc.). Develop the solver in 1D or implement the solver in 2D in `pyfem2`.

7. Implement an element using nonstandard shape functions (bubble functions, hierarchal elements, b-spline, etc.)

8. Develop an explicit solver. `pyfem2` can be used. Modifications would include element mass matrices, global mass matrix assembly, wave speed determination, etc.