POSSIBLE TOPICS FOR ASEN 6367 TERM PROJECT - Spring 2009

List Compiled as of March 14, 2013 — Others may be added

Topics suggested below are first come, first served. Taken topics will be marked as such under Status.

1. Develop a 4-node quadrilateral elements for axisymmetric solids that performs better in bending and near-incompressible conditions than the standard iso-P 4-node quadrilateral element called Quad4 in AFEM Chapters 2–7. Methods to be considered: Selective Reduced Integration (SRI), as well as the hybrid element presented in the Pian-Wu book. Compare with Quad4 and Quad8 on benchmark problems that may lead to shear and/or volumetric locking.

Flavor: Analytical + computational. Some symbolic computations may be required.

Status: Similar project tried by 2009 and 2011 groups (using HR in lieu of hybrid) but results were inconclusive. Presentation in 2011 was OK for results obtained. New source material: Pian-Wu book.

TAKEN 3/26/13 (see page 3)

Requirements: medium programming ability; physical insight to take some shortcuts as needed.

2. Develop an improved mass-stiffness matrix pair of a higher order 1D element for wave propagation dynamics.

Flavor: Analytical + computational (symbolic + numerical work). Above average knowledge of structural dynamics and dispersion analysis.

Background: Instructor can supply.

Status: Never done. TAKEN 3/18/13 (see page 3)

Requirements: knowledge of computational dynamics & dispersion analysis.

3. Morph 8-node RI plane stress quad into an ”optimal” 2D plane stress quadrilateral (in the sense of being distortion insensitive), and compare against distortion tests done in IFEM final exam.

Flavor: Computational (mostly numerical).

Background: Chapter 27 of IFEM. Notebook: PlaneStress.nb.

Status: Never tried, publishable if results exceed expectations.

Requirement: programming ability, some physical insight.

4. Modify QuadSOR to do thick shells of revolution.

Flavor: Analytical + computational.

Background: AFEM Chapters 2-7. Notebook: QuadSOR.

Status: done for thin shells in a 2011 project. Largely successful. This one involves keeping first order shear energy in shell element, so it is the shell equivalent of a Timoshenko beam model.

Requirement: above average programming ability, some knowledge of shell behavior.

5. Develop a template for the 8-node solid brick element. Investigate optimal selection of higher order stiffness matrix for the rectangular geometry, using bending benchmarks.

Flavor: Analytical + computational (lots of symbolic work)

Background: Instructor notebooks from 2009, David Khang’s MIT thesis.

Status: Tried in 2009. Zero progress, presentation only gives definitions and generalities. TAKEN 3/21/13 (see page 3)

Requirement: above average programming ability on a CAS; able to work hard.

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6. Develop a template for the a triangular Kirchhoff plate bending element with 12 degrees of freedom: 9 corner freedoms and 3 midside rotations.
   Flavor: heavy symbolic computation.
   Background: Instructor may supply.
   Status: Tried by a 2011 group. Little progress, mathematical level was overwhelming.
   Requirement: way above average ability in matrix algebra and symbolic computation. Publishable if (by miracle) successful.

7. Develop a template for the a quadrilateral Kirchhoff plate bending element with 12 degrees of freedom: 3 per corner.
   Flavor: heavy symbolic computation, ability to read C code.
   Background: instructor may supply material such as Haugen’s thesis and his C-code suite.
   Status: Tried by a 2011 group. Little progress. Publishable if (by miracle) successful. Not recommended unless you plan to work really hard.
   Requirement: above average ability in matrix algebra and symbolic computation, and physical insight.

8. Develop a plane stress (or axisymmetric, pick one) quadrilateral crack element using a hybrid variational principle.
   Flavor: Mostly analytical, some benchmark computations.
   Background: Pian-Wu book. Plane stress NB (or QuadSOR) available from instructor.
   Status: Never done in an AFEM project, but covered well in book.
   Requirements: MIT-level analytical ability.

9. Develop a template for quadratic pyramid elements with 13 or 14 nodes (pick one configuration) and find the optimal one (if it exists) using high order patch tests.
   Flavor: Analytical, symbolic and numeric computations, neither too demanding. Project is actually straightforward, can be easily done in about 3 weeks in Matlab or Mathematica.
   Background: AFEM Chapter 12.
   Status: Never done in an AFEM project. TAKEN 3/20/13 See page 3.
   Requirements: moderate analytical and programming ability.