EME 521 – MATHEMATICAL MODELING

COUPLED PROCESSES OF DEFORMATION, FLOW AND TRANSPORT

GROUP PRESENTATION RUBRIC

The only deliverable for the course will be a group presentation and associated handout materials. This is to (i) encourage you to explore and to think critically and creatively about a particular solution method and (ii) to understand it sufficiently well that you can communicate and share your understanding with a student audience as a tutorial. The guidelines for this are as follows:

Participants will work either individually or in small groups to develop a tutorial presentation to communicate the principles of a prescribed numerical method of relevance to this class. The presentations will be posted on the course web-page as a tutorial for future participants. These will be selected from the following *viz*:

1. SPH – Smoothed particle hydrodynamics
2. LBM – Lattice-Boltzmann Method
3. BEM – Boundary Element Methods
4. X-FEM – Extended Finite Element Method
5. DEM – Distinct Element Method
6. Level-Set Methods
7. Phase Field Methods
8. Lattice Methods
9. Peridynamics

See syllabus for details of these various methods (i.e. Wikipedia, etc.).

See prior presentations on the course resources page: https://personal.ems.psu.edu/~fkd/courses/EGEE520/

Participants will select their preferred topic in the first few weeks of class and will be grouped with similar-selecting participants. The presentation will take one or more (75 min) periods per group and will therefore be substantial, authoritative and complete.

Groups will arrange a first meeting and planning session to define structure and responsibilities, and to elect to present either **in-class** or **on-line** - by the end of week #6. Group members will report this on canvas.

Presentations/video-links and any multiple choice questions will be due on Friday of week #14 (late April).

Groups will upload their presentations and supply 10 multiple choice questions each with four answers by the time of the first in-class presentation.

Presentations should include:

1. **Introduction [10%]** Provide context to the method. How is it different from others we have discussed? In what situations does it perform best? Are there special features of note? Are there particular shortcomings?
2. **Historical Perspective [10%]** What are the origins of the method? When was it developed and by whom? Why was it developed? What significant evolution has it gone through?
3. **General Principles [20%]** Describe the physical basis of the method in as simple format as possible (e.g. our heuristic derivation of FEM for flow with Darcy's law).
4. **Governing Equations [20%]** Expand on the general principles and derive or define the governing equations. A physics-based rather than mathematics-based exposition will likely be preferred by your audience (*e.g.* our virtual work derivation for FEM for solid mechanics or isoparametric elements for FEM).
5. **Hand-Calculation Example [20%]** Complete a simple 1D or similar example that utilizes the general principles and governing equations and completes a simple calculation (*e.g.* the conductance/stiffness matrix for 1D simple or isoparametric elements for FEM).
6. **Numerical Example [10%]** Complete a simple numerical example if it is feasible to demonstrate the mothod (rather than the component matrices in #5 above). We have used hand calculations, EGEEfem, Matlab and Comsol in this mode.
7. **Example Applications [10%]** Chose some examples, maybe including animations – many of which are available online - to demonstrate the applicability of the method.
8. **Peer Review []** Not a topic but a multiplier on your grade.

Grading:

Group grade (80%) based on the presentation using the rubric above, review and completion of online quizzes for the presentations (10%). Individual grade modified (10%) from anonymous peer review among group.

Sample Quiz Question (Multiple choice with single or multiple correct answers, etc.)**:**

1. Boundary element methods have specific advantages over domain type methods
    a. **They reduce the dimensionality of the problem by one order (e.g. from 2D to 1D)**
    b. Require discretization of the volume of the domain
    c. Are particularly good for constitutively nonlinear problems
    d. Have sparse solution matrices
2. Question 2……etc.
    a. **Answers to Q2**