AMCS 394E
Contemporary Topics in Computational Science: Computing with the Finite Element Method

General information:

Starting date: January 24th, 2021.

Ending date: May 6th, 2021.

Time: Sun/Thu 13:15-14:45

Location: TBD

Instructors:

- Manuel Quezada de Luna (manuel.quezada@kaust.edu.sa).
- David I. Ketcheson (david.ketcheson@kaust.edu.sa).

Instructors' office:

- Manuel Quezada de Luna: Al-Khawarizmi building, room 4245.
- David I. Ketcheson: Al-Khawarizmi building, room 4202.

References and resources:

There is no text book. Instead we will consider multiple references like:

- Susanne Brenner and Ridgway Scott, The Mathematical Theory of Finite Element Methods. Springer Science & Business Media, 2007.
- Alexandre Ern and Jean-Luc Guermond, Theory and Practice of Finite Elements. Springer Science & Business Media, 2013.
- deal.II tutorials: `https://www.dealii.org/current/doxygen/deal.II/Tutorial.html`.
- Wolfgang Bangerth's lectures on deal.II: `https://www.math.colostate.edu/~bangerth/videos.html`.

Overview

This course focuses on the practical implementation of the finite element method for scientists and engineers. During the first part, we will cover the theory of the finite element method and describe the components needed to code a basic finite element solver. During the second part, we will learn to use some existing open source finite element libraries, focusing on hands-on experience with deal.II (https://www.dealii.org).

The student is expected to have knowledge of calculus, linear algebra, some exposure to differential equations and numerical methods for solving differential equations. In addition, prior programming experience is expected.

Schedule and organization

We will use Github to post different documents. The repository is
https://github.com/manuel-quezada/AMCS_394E_Comp_with_FEM.

Evaluation

The grading for the course is based on homework (40%) and a final project (60%).

Homeworks (40%)

The homeworks are programming assignments with a short report. Tentatively, there will be 4-6 homeworks starting from week 2 until around week 7.

Final project (60%)

For the final project, the student will work with a model that is important in his or her own research. An example of an appropriate topic is the solution of the shallow water equations in two dimensions. After choosing a problem, the student will use deal.II or another finite element library to solve the problem.

The entre project is composed of:

- Proposal. Around week 8, the student should submit a proposal with a description of the project, motivation, equation to be solved, expectations, etc.
- Progress report. Around week 12, the student should submit a report stating the progress of the project.
- Presentation. During week 15, the student should give a 20-25 minutes presentation of the project.
- Final report. At the beginning of the presentation, the student must submit a final report of his or her project. The final report should be around 10 pages long and include an introduction with a description of the project, the equation or model to be solved, the numerical method to be used, details of the implementation, numerical results, conclusions and references.

Tentative grading scale

90-100: A

85-90: A^-

80-85: B^+

75-80: B

70-75: B^-

60-70: C

$<$60%: F

Plagiarism

Plagiarism is the act of taking credit for the words or ideas of someone else. Any plagiarism will be grounds for failure in this course. All material that you hand in must be your own work. If you are in doubt, ask the instructor

Special Accommodations

If you have a personal activity, family, or religious conflict with the course schedule, you can expect to be heard sympathetically. Please contact me by the end of thesecond week of the term to discuss appropriate accommodations for any conflictsthat can be foreseen. For illness-related absences, there are standard procedures tofollow.