ME415/515 Computational Simulation and Analysis
Spring 2024

ME415/515 is a senior-level advanced undergraduate/graduate course on the application of numerical methods and simulation techniques for the computational analysis of engineering systems in various disciplines. The emphasis of the course is on the basic implementation, accuracy, convergence, stability and efficiency of the numerical methods used to solve linear, nonlinear algebraic and differential equations. Throughout the course, several case studies will be used to illustrate the approach and the application of methods. Students must have **strong background** in linear algebra and differential equations, such as MATH201 and MATH202.

COMSOL's model library is extensively used to demonstrate multidisciplinary examples which include but not limited to various sensors and actuators.

Texbooks

- *Numerical Methods Using MATLAB,* 4th ed, J.H. Mathews, K.D. Fink, Pearson, 2004.
- *Numerical Methods with MATLAB,* A. Gilat, V. Subramaniam, Wiley, 2011

References

- *Applied Numerical Methods for Engineers Using MATLAB and C,* Schilling and Harris, Brooks & Cole, 2001
- *Finite Difference Methods for Ordinary and Partial Differential Equations*, R.J. LeVeque, SIAM, 2007.
- *COMSOL modeling library*, Comsol Inc (available online)

Instructors

- Serhat Yesilyurt, syesilyurt@sabanciuniv.edu, FENS 1052, x9579
  Office Hours: Flexible, drop emails when you need, make appointments if necessary.
- Recitation Assistant: TBA

Grading

Grading methods and weights are subject to change according to the progress in regulations about online vs hybrid lectures.

- Midterm: 30%
- Final Exam: 35%
- Quizzes: 5%
- Take-home assignments (7-9): 15%

- Assignments are due Fridays at 11:59 pm unless otherwise noted.
- Late returns will be subject to grade cuts of up to 50%.

Each student is responsible for their take-home assignment. Students may discuss the solution strategies among themselves, but must work on their assignemments independently. Duplicitous solutions, answers, explanations, graphs etc, will cause a zero grade.

- Term project: 15%
  - A simulation-based analysis study must be carried out for the design analysis of a part or a component that involves a 2D transient or a 3D model. Examples could be obtained from COMSOL model library. Mesh convergence and validation of the numerical results must be presented. Variations in the geometric dimensions as well as importance of physical assumptions must be presented in the results. Project reports must be in ASME or IEEE conference format including the sections Introduction, Approach, Results and Conclusion. (Further details will be provided in the assignment.)
- Attendance: In-class attendance is required. NA grade if attendance is less than 50%, letter-grade-down if attendance is less than 70%.

Tentative Schedule

Week 1-2: Part 0: Introduction, error analysis, sources of error, Taylor's series
Week 3-8: Part 1: Solution of nonlinear algebraic equations (root finding)
- Solution of linear system of equations
- Solution of ordinary differential equations
- **Tentative Midterm (8-10th week)**

Week 9-13: Part 2: Numerical solution of partial differential equations (Bending and deformation of beams and plates, temperature distribution in solids, velocity and pressure distribution in flows, potential distribution in electrostatic actuators)
- Application of the finite-difference method to one-dimensional, two-dimensional and time-dependent problems; solution of heat equation, convection-diffusion eqution, and the wave equation.

Week 14: Project presentations (10 minutes each during lecture and recitation hours.)