CS 450 (ECE 491, MATH 450, CSE 401) - Numerical Analysis

Instructors:

Professor Michael Heath is the course director and wrote the textbook for this course. Other professors who teach this course are Luke Olson, Anil Hirani and more recently Paul Fischer.

Prerequisites:

The listed prerequisites are: CS 101 or CS 125; CS 357 or MATH 415, and MATH 285. It is really a good idea to have taken these courses or their equivalents (such as ECE 190 instead of CS 125, Math 286 instead of Math 285, etc.) beforehand, especially MATH 415. The material in CS 450 builds upon many of foundational concepts in these prerequisite courses, so students would be at a significant disadvantage if they didn't come in with the proper background. This is one of the few ECE/CS courses that will revisit every MATH 415 concept in some way, shape, or form. If a student doesn't have the required background but still wants to take a similar class, CS 357 provides a much gentler introduction to a portion of the material covered in this class and doesn't require students to be familiar with linear algebra and differential equations.

When to Take It:

CS 450 is a popular course for both advanced undergrads and beginning grad students and is offered every semester. There really isn't any other undergrad course that follows on to CS 450, so an undergrad who wants to take this class can take this class whenever it works best. However, this class opens up some research opportunities, so an undergrad interested in the area should take CS 450 earlier to give themselves the opportunity. Likewise, CS 450 is a great foundational course for grad students, so depending on a students specialization, they may want to take it sooner than later.

Class Content:

Numerical Analysis is about using computers to solve mathematical problems that come up in all fields of science and engineering. Students will learn about many of the foundational algorithms along with their theoretical underpinnings. This class builds on itself the entire semester: it starts off with a brief introduction to floating-point arithmetic and the challenges it poses. Next it moves into numerical linear algebra: looking at solutions to linear systems, linear least-squares, and eigenvalue problems. Next, it covers nonlinear systems and nonlinear optimization. After that it moves on to interpolation (filling in the gaps in data sequences), after which it tackles numerical quadrature - numerically evaluating derivatives and integrals. Finally, the class looks at differential equations, covering initial value problems, boundary value problems, and partial differential equations. CS 450 is an introductory survey, so it covers a lot of material at a basic level, giving students a solid background to go wherever they want in scientific computing. This class has a lively pace and rarely gets boring, so it is a very enjoyable course, especially for students who are interested in an area of ECE/CS that requires any kind of numerical computation (signal processing, controls, communications, robotics, numerical circuit analysis, etc).

Work:

CS 450 has 7 homeworks that are assigned approximately every-other week. Each of these homeworks will have a handful of problems, and most of the problems involve the implementation and analysis of algorithms and concepts presented in class. The problems on the homework will either be written much like homeworks in previous math courses or will require you to implement a certain algorithm using the numpy and scipy libraries in Python. The homeworks can require some thought, and the time commitment can vary depending on the homework but generally they can take a substantial amount of time. The class has three exams, two midterms and a final that are taken in the CBTF. There are also short quizzes after each chapter taken online. All exams and quizzes are multiple choice and test a students conceptual and mechanical understanding of the ideas presented in class. They do not require a lot of messy math (that's what we have computers for, and why people take this class).

Life After:

As mentioned before, there are really no undergraduate courses that directly follow CS 450. However, grad students and interested undergrads who want to dive further into numerics can take one of CS 554: Parallel Numerical Algorithms, CS 555: Numerical Methods for PDEs, CS 556: Iterative and Multigrid Methods, or CS 558: Topics in Numerical Analysis. Most students who take CS 450 will probably not take these advanced courses, but many will be involved in jobs or research that uses scientific computing in some fashion - anything from simulating rockets at NASA to designing algorithms for high-speed trading on Wall Street.