Teaching Interest

Teaching philosophy. My teaching philosophy is to equip my students with a fundamental understanding and working knowledge of mathematical methods and algorithms, with intuitions and connection with practical problems, so that they have a solid background to self-learn advanced techniques and develop new methods/algorithms to tackle problems beyond the classroom. The principle of my teaching style is to adapt to students needs, perspectives, and learning pace.

Teaching Interest. My teaching has been driven by my unique cross-discipline background in engineering and mathematics. Math was my major from the 1st grade to the 12th grade (I was always a team member of my schools to compete in local and national math olympiads). Undergraduate, master's, and PhD education in computational aeronautics made me realize that I could not solve more complex practical problems without being able to derive mathematical formulas and methods. I thus took all the appropriate graduate math classes (including two semesters of functional analysis, two semesters of probabilities, analysis of PDEs, etc) in the UT math department during my postdoctoral training there.

Given the aforementioned background and experience, I have designed my math class, for mixed undergraduate/graduate students, focusing on topics that I have seen often in my computational science, engineering, and mathematics career. The class is useful for not only students' preparation for qualifying exams, but also their research. The content of the class is at the intersection of real analysis (mathematical logic, proving techniques, pointwise/uniform/L^2 convergence of sequence and series of functions), functional analysis (inner product space, normed space, metric space, convergence in metric spaces, $C(\Omega)$ and $L^2(\Omega)$ spaces, existence and uniqueness of a solution of nonlinear system of ordinary differential equations, a universal approximation theorem for neural networks), and linear operator theory (continuous linear functional, closed range theorem, eigenvalue problems in infinite dimensions, and the singular value decomposition of compact linear operators, and solvability of linear operator equations). For math students, I would keep the core of this class but with detailed analysis and rigorous proofs for all the results. Further, I will add the Banach-Necas-Babuska theorem and its application in linear operator equations.

I would like to create new classes based on my book "The roles of adjoints in computational science, engineering, and mathematics". In these classes, the student will see a systematic and unified view on adjoints and the constructive derivations of why adjoints are necessary for many practical applications (including machine learning), again based on my years of experience on developing adjoint methods for various problems in engineering, sciences, and mathematics.

Six years ago, I created a new machine learning class (didn't exist in my department) for a mix of undergraduate and graduate class that, unlike many machine learning classes, I cover the motivations and the mathematical derivations of many standard supervised and unsupervised machine learning methods, and show the students how to implement them for particular problems with real data in the Scikit-learn environment. This class has been extremely successful in terms of preparing students in their career and publications (I get appreciation letters from students).

I proposed a new graduate class "Quantum algorithms for scientific computing" which I start teaching in Fall 2025. It is timely to equip our students with knowledge on developing algorithms to effectively use future quantum computers.