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 connections 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 their learning pace.

Executive Summary on Teaching Interest I will continue my Machine Learning & Data Science and Quantum Algorithms for computational sciences & Engineering (CSE) courses, and could offer Scalable High-Order DG/DPG FEM, Digital Twins with SciML, Adjoints methods in CSE/ML, and Advanced Fluid Mechanics and/or wave propagation. Each course culminates in a partner-defined capstone project prototyped on campus testbeds. This pedagogy prepares students to turn rigorous models into deployable capabilities.

Detailed Teaching Interest. My teaching has been driven by my unique cross-disciplinary background in engineering and mathematics. I focused on mathematics from the 1st grade through the 12th grade (I was always a member of my school team competing in local and national math olympiads). Undergraduate, master's, and PhD education in computational sciences & engineering 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 graduate math classes in the UT math department during my postdoctoral training here at UT Austin.

Given the aforementioned background and experience, and my research interest, I was assigned to teach the Applied Mathematics sequence I & II since I became a faculty member in Fall 2013. Both were qualifying exam courses for PhD students in the Department of Aerospace Engineering & Engineering Mechanics (ASEEM), and the second one was also a qualifying exam course for PhD students at the Oden Institute. I have designed my math classes for mixed undergraduate/graduate students, focusing on topics that typical engineering programs would train students in (including MIT, where I got my PhD degree) and that I have seen often in my computational science, engineering, and mathematics career. The class is useful not only for students' preparation for qualifying exams, but also for their research. The content of the class is at the intersection of real analysis, functional analysis, linear operator theory, optimization, calculus of variation, and computational geometry. Graduate students across all the departments under the Cockrell School of Engineering have been taking these classes as they are essential for their PhD research.

Ten years ago, I created the first machine learning class (didn't exist in either ASEEM or the Oden Institute) for graduate students. Six years ago, I transitioned the class to accommodate both undergraduate and graduate students. 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 for their careers and publications (I get appreciation letters from students every year).

From Fall 2025, the class will also include the latest developments in machine learning and data science, such as diffusion models, reinforcement learning, large language models, transformers, etc. One of the important components of this class is the final team project in which each team of 2-3 students applies/extends the knowledge/methods in class to tackle a project of their interest.

I am currently teaching a new undergraduate/graduate class "Quantum algorithms for scientific computing" (which is not yet offered at most universities, including UT Austin). It is timely to equip our students with knowledge of developing algorithms to effectively harness future quantum computers for solving challenging scientific and engineering problems. Because I am working on quantum-accelerated real-time scientific machine learning digital twin algorithms, I will have opportunities to integrate research and education in this quantum class.

I would like to continue teaching the machine learning and quantum classes, as they provide our students with essential knowledge on the current and emerging technologies and methods for their research, industrial jobs, and contribution national priorities.

Given the fact that my PhD is in CFD with a minor in fluids and my research in computational geophysics, I could teach **advanced fluid mechanics** and **wave propagation**. These classes could serve many engineering departments. I would also like to create new classes based on my book "The roles of adjoints in computational science, engineering, and mathematics". In these classes, students will see a systematic and unified view of adjoints and the constructive derivations of why adjoints are necessary for many practical applications (including machine learning), again based on my years of experience developing adjoint methods for various problems in engineering, sciences, and mathematics. In addition, I can offer two other classes out of my research portfolio: (i) Scalable Parallel High-Order Discontinuous Galerkin Finite Element Methods, and (ii) Digital Twins with SciML (physics-aware, numerical methods aware, and data-assimilative modeling; real-time inference/control; operator learning; deployment on HPC/edge; safety and certification via UQ).