TEACHING STATEMENT

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When asked about my teaching goals and philosophy, I cannot help but think about my experiences as a student. The classes I learned the most from are ones that left me with an intuitive understanding of something that previously confused me. As a teacher, nothing compares with sharing the satisfaction of that “Aha!” moment with my students.

Last spring, I taught my first large lecture course to undergraduates, Applied Mathematics 105 *Ordinary and Partial Differential Equations* at Harvard University, which had approximately 100 students. In addition to lecturing, I was responsible for writing problem sets and rubrics, coordinating teaching assistants, writing and grading exams, and mentoring final projects. That was a very eye-opening experience from several points of view. One challenge of this particular course was the broad variety of student backgrounds and ability levels. Although the course has several prerequisites, a large fraction of students had taken them years before and were no longer familiar with the basic material. It quickly became a necessity to conduct lectures at a level which would not lose the bottom students while still keeping the enthusiastic ones engaged. Being an Applied Mathematics course, grounding the mathematical ideas in real world applications helped to solidify some of the more abstract concepts for the students. This culminated in final group projects in which students collected data, analysed it, and finally attempted to model it. Working with these groups to help them accurately translate their ideas into the language of PDEs brought out the students’ innate curiosity and enthusiasm for math.

Upper level compulsory courses present a different set of challenges. The goal is to help students build a toolkit they will be able to use in the rest of their academic or research careers. I think a strong basis in mathematics is crucial to success in upper level physics classes. Although students concurrently take calculus and electrodynamics and quantum mechanics, they are frequently taught as though they are unrelated. For instance, many of the problems in Jackson’s *Electrodynamics* are an exercise in solving boundary valued problems, while $\mathcal{H} |\psi\rangle = E |\psi\rangle$ is an eigenvalue problem. Yet, students will encounter these types of problems repeatedly in other contexts – as Feynman states in section 12-1 of his *Lectures: Vol II*, “The same equations have the same solutions.” A holistic approach to teaching the core physics curriculum helps students place each subject into a broader context, while a solid mathematical framework gives students the ability to understand the meaning and derivation of many of the equations and concepts they encounter.

Designing original graduate and topical courses is one of the most exciting parts of teaching – getting to share your passion for a certain topics with students, while simultaneously getting to explore new advances and recent literature with them. These courses aim to help the student become a successful scientist. One of the most valuable experiences I had in any course I took was the final for Advanced Statistical Mechanics. We were tasked with writing and presenting a short original research proposal not based on our current research. As proposals are a crucial element of any scientific career, I will include this practice in my graduate courses whenever possible.

Two classes I will develop are upper level or graduate courses in elasticity theory and mathematical methods of materials. The elasticity theory course will initially closely follow *Elasticity Theory* by Landau and Lifshitz. Few textbooks are as insightful and elucidating to experts as they are to novices. The clear and simple pedagogy builds a deep understanding
of the subject matter, while the problems are crafted to discover and explore a myriad of different phenomena. Additionally, a classic, such as *A Treatise on the Mathematical Theory of Elasticity* by A. E. H. Love, beautifully complements Landau and Lifshitz. We begin by defining the strain and stress tensors and deriving the equations of equilibrium for both isotropic and crystalline materials. Deformations of plates and rods introduce the Airy stress function and buckling instabilities, respectably. The elasticity of dislocations provides a first look into nonlinearities. This background allows us to investigate a variety of topics, including the theory of cracks, fracture mechanics, non-affine responses, different nonlinear elasticity theories and liquid crystal elasticity.

A topical course in the mathematical aspects of materials will introduce students to several mathematical techniques used in current research. It is based on the theme, “the only math that can’t be applied is the math you don’t know.” This course can be easily tailored to the interests of a particular group of students. Possible topics include, complex analysis and special functions, differential geometry and minimal surfaces, and an introduction to homotopy theory and topological defects in ordered matter. Although any of these subjects contains ample material to cover in several advanced courses, together, they give a broad and diverse overview.

Additionally, I anticipate using textiles and clothing to further STEM education through outreach to schools and underprivileged students. Familiar every-day items engage students with hands-on examples of many aspects of science, technology, engineering and math. Knit and crochet stitches shed light on the microscopics of crystals and defects. Understanding why your clothes fit is really a lesson in three-dimensional geometry and curvature. Weaving, sewing and knitting are three manual technologies, the mechanization of which fueled the industrial revolution. The concept of translating craftsmanship to a mass-produced manufacturing process gets to the heart of many of the challenges and goals of engineering.