I. Teaching Philosophy.

As a lifelong learner my teaching philosophy is shaped by my previous professors who excelled at describing conceptually difficult topics. My teaching style is also molded by my experiences in classrooms as a Hispanic, first-generation student. My goal as a Principal Investigator and Professor in Vanderbilt BME is to excel in both research and teaching with courses that are as dynamic as the projects conducted in my lab. Thus, every course I teach will include core engineering principles, interactive projects, and professional development curriculum to mold our students into well-rounded engineers ready to succeed in every career path. To accomplish these goals, my class will rely on these principles:

- **Foster Equity:** A hidden curriculum exists in the classroom that effects numerous personal identities. Our Black, Brown, and Indigenous students often carry a weight not felt by their white peers, particularly as the struggle for racial justice outside the classroom and in society remains a constant battle. Our first-generation students often feel unprepared and unsupported in an academic environment. Those from low-income backgrounds, many of whom balance both work and school, do not have the same support system many of their peers find in family resources. Our students that care for dependents often need extra flexibility. These are all unseen, often unheard, challenges lurking in the background of our lecture halls. I strive to build a classroom built on equity, respect, and understanding. I will respect the time of each student, and understand their external responsibilities and struggles. Importantly, this respect and understanding is bidirectional. Each student will have mutual respect and understanding for their professor, peers, schoolwork, and education. This level of equity will be achieved through flexible due dates, one-on-one meetings with students, and setting classroom objectives as a team.
- **Contextual Lecturing:** People remember stories, not lectures. I will structure my courses into a semester-long storyline. The goal of this approach is to give students the vision for how each lecture, and the course as a whole, fits into their overall training as a biomedical engineer. By consistently recalling what they previously learned, what they are currently learning, and where they are headed, this approach will increase the long-term retention of learned core curriculum. Giving context to material is also a core skill my students will learn. They will understand how to present their own work to a wide-ranging audience and give that audience a storyline that fits masterfully into the broader scope of a field.
- **Understanding, Not Memorization**: I will far outweigh understanding and creation of ideas over memorization. I care about a student's ability to think critically and explain how a differential equation describes a particular system, rather than their ability to regurgitate a memorized equation. Thus, tests and exams in my class room will rarely have a single solution, but instead focus on integrating multiple modes of information to form hypotheses and design solutions to complex problems.
- **Real-World Skill Development:** My goal is to train students to understand that being a well-rounded engineer extends beyond our technical knowledge. In my classroom, we will focus on developing skills such as clear communication, concise writing, intuitive data visualization, establishing collaborations, and identifying our implicit biases. These will be achieved by interactive projects designed to solve real-world issues in neuroscience and engineering.

These facets will produce a classroom of curious students with transferable skills that are extremely well prepared for any career path.

II. Interests in Course Development in BME.

As neuroengineering at Vanderbilt continues to grow, I want to be a part of building this program using my unique expertise in developing and applying state-of-the-art neural interfaces. Furthermore, the rising awareness in society of brain-machine interface research has fueled a growing interest in neuroengineering. Thus, a need exists to make this curriculum accessible to students. I envision beginning this curriculum with three foundational courses:

Introduction to Neuroengineering (Senior Undergraduates and Graduate Students): This will be a course geared towards engineering students with little to no background in biology or neuroscience. This course is also well-suited to be cross-listed in electrical and computer engineering and mechanical engineering. A key goal will

be to give students the scientific tools necessary to pursue a future in neuroengineering. We will discuss bioelectricity in nerve cells, muscles, axons, and dendrites from a circuit perspective. Hodgkin and Huxley will be introduced and students will use ionic conductance theory to model action potentials. Extracellular recordings of spiking activity and local field potentials will also be introduced. We will analyze the interface of a cell and patch pipettes as well as solid-state electrodes and model various modes of intracellular and extracellular coupling. Neuromodulation with electrical techniques will be discussed. In addition, we will discuss the mechanisms of optical recordings and manipulations. The goal will be to review many of the existing methods to read and write neural activity, culminating in a final hypothesis-driven research idea by each student. This course is an excellent opportunity to give history and context to many neurotechnologies, giving our students the understanding for how to apply these tools to many different scientific questions.

Neural Data Analysis (Senior Undergraduates and Graduate Students): In this course, I will teach students the basics of a wide range of neural analysis techniques. We will focus on using real data sets from invertebrates, rodents, non-human primates, and humans to replicate published results. For example, we will use principle-component analysis to reveal the low-dimensional manifolds that exist in neural activity during motor movements. Students will get hands-on experience analyzing the different bands of local field potentials recorded from the human brain in both the time and frequency domain. We will spike sort single-units recorded from rodent hippocampus to reveal place cells in freely moving animals. Students will also gain experience working with the most commonly used open-source analysis pipelines such as KiloSort, Suite2P, and Caiman. This course will provide skills transferrable to academic labs, industry data science, and any other profession requiring data analysis.

Reviews in Neuroengineering (Graduate Students): This course will be a literature review. Students will act as reviewers, read papers regarding major advances in neurotechnologies, and provide written feedback. They will learn to be respectful yet critical in their reviews. Furthermore, this is an excellent opportunity to center equity and bias in our conversations and critically analyze academic publishing. This course will culminate in the students choosing a preprint to review, with the option of emailing their review to the authors.

III. Interests in Existing BME Courses.

With my training in physics, neuroscience, and engineering I also am prepared to teach a variety of courses that already exist in the Vanderbilt BME curriculum:

BME 4000 – Bioelectricity: My background with electrophysiology in muscles and neurons, intracellular recordings with patch clamping, extracellular recordings with solid-state electrodes, and pharmacology makes me well-suited to teach this core course.

BME 4200/5200 – BioMEMs: My extensive background in a wide range of micro- and nano-fabrication techniques, as well as experience in teaching these skills to students makes BioMEMs a standout course for my teaching style. This type of conceptual learning within a classroom, followed by hands-on work in the fabrication facilities is my ideal teaching scenario. Furthermore, fabrication is becoming more common in biomedical research, yet few students have experience in this key skill.

BME 4500 – Nanobiotechnology: Much of my own work focuses on the nano-bio interface and nano-neurotechnology. This is a fascinating field that is in many ways still nascent in our understanding of how nanoscale materials interact with living organisms and cells.

BME 6110 – Research and Professional Development in BME: This is a course that directly falls within my core teaching philosophy. The development of both technical and ‘soft’ skills is critical to generating well-rounded engineers. I am passionate about engaging with students on topics of written and oral communication and other skills critical for success in the workforce.

IV. Summary.

Whether teaching existing curriculum or developing new courses at Vanderbilt, I will have an empowering, student-focused approach that prepares our biomedical engineers for long-term success.