Teaching Statement

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Interdisciplinary research in Electrical Engineering and Computer Science has lead to a fast evolution of new concepts. Researchers, engineers, and students need to evolve to solve the challenging problems continuously. Thus, in addition to imparting students the knowledge and understanding of existing concepts, there is a need to create quality engineers and researchers who can adapt to these evolving concepts by teaching themselves. Given my interdisciplinary research experience, I have extensive experience in teaching myself new areas, and I firmly believe that interdisciplinary coursework can develop this skill of self-teaching. These courses foster one to learn different disciplines with a clear goal of achieving class projects. I strongly believe in teaching these courses by applying the concepts in practice and building systems. Beyond self-teaching, a good researcher needs right approach to solve challenging problems. My goal with teaching is to impart students with the knowledge and skills to teach themselves and necessary skepticism to become independent quality researchers and engineers.

I, along with Prof. Aaron Schulman and Prof. Sachin Katti, designed and implemented the above in the interdisciplinary class on embedded system at Stanford University. I TAed this class, which combined basic concepts of circuits and signal processing and applied them in practice. With the help of assignments, we taught the skill of solving small problems, by harnessing upon skills from areas of hardware design, embedded system, and programming. The class assignments led to the design of an embedded system from scratch, which can measure power for any android smart phone. Measuring power needs to measure voltage and current drawn by the phone, and initial assignments were on measuring voltage and current with appropriate benchmarks to promote rigorous evaluation and right skepticism. For example, an assignment was to measure voltage needed to boot-up microprocessor, configure clocks and the ADC, calibrate the ADC and reading and interpreting them and checking with actual voltage measured by multi-meter. The final assignment led to measuring the power of phone and showed the importance of solving two small sub-problems (voltage and current) to build it into an application. With the help of students projects, we taught them to choose the right problem, and then break down the large problem achieving this by skills of small problem solving. The final class project involved choosing smartphone application to measure and profile power consumption of it, like Facebook, WhatsApp, etc. The data collected by students was composite power drawn by smartphone including the operating system, the display and the application of interest. I helped students to identify the right experiments to understand power consumption of each of the components and then combine this data with a machine learning algorithm to decipher individual power consumption of application of interest.

Besides the embedded systems class, I had experience with designing and running another interdisciplinary course. I helped Prof. Sachin Katti and my colleague Aditya Gudipati start a new interdisciplinary undergraduate class on networking and communications (E40N: Building Networked Systems). Currently, students learn the basic concepts behind communication networks in several separate classes: learning basic signal processing and communication techniques in one or more introductory EE classes, while learning about packets, inter-networking and distributed systems in separate CS classes. Due to this segregation of courses, many students do not get a holistic view. Instead, we designed this undergraduate course so that students are exposed in a hands-on fashion to all the layers: going from building basic modems for point-to-point communication channels to stringing them together to form larger networks. Wireless is an attractive, practical setting for such a class, due to the availability of software radios from which students can learn hands-on about basic ideas in signal processing, coding, modulation/demodulation, and also build networks out of simple wireless links. As a quarter long project, the students collaboratively worked on designing a working walkie-talkie system from scratch on software radios. This project was used as the vehicle to teach the students basic concepts in communications and networking.

With my research spanning multiple areas in EE and CS, I can teach classes on signal processing, computer networking, information theory, wireless communications, wireless networks, networked systems. However, I am particularly excited about designing new interdisciplinary classes. To list a few, I would like to introduce a wireless networks class with implementation focus on mmWave, since a lot of new applications can be enabled using mmWave. I would provide students with the mmWave transceiver and allow them to implement their ideas, which could result in research projects. I would like to teach a class on embedded system with low power backscatter communications to empower students to think end-to-end energy consumption for low power devices. This would allow students to build their class of IoT sensors.

Beyond Teaching, I have mentored several students over the years, from junior students Manikanta Kotaru, Emily McMilin, Austin Duffield, Joseph Samuel, Hongzi Mao, Sandeep Chincalli to senior student as Kanthi Nagraj and Kiran Joshi. Each student has different strengths, realizing that and helping them more in the areas where they are weak and at other times letting them take charge of other things builds a full fleshed researcher. I mentored Manikanta while working on BackFi, a low power ambient (WiFi) backscatter communications system, and helped him learn the difference between applied signal processing and the theory. I taught him the necessary calibration needed to make signal processing theory work in practice. Manikanta went on to build a full-fledged state of the art localization system, which was published in SIGCOMM. Similarly, I have helped Emily, Kanthi and Hongzi. I also had the opportunity to work with the senior students as Kiran, where I learned to operate on our strengths and combine them to solve the problem quickly.

With the Teaching and mentoring, I have developed a gradual method to establish and foster the right approach in researchers. The method is to teach: (1) solving small problems (2) dividing a large problem into small problems (3) finally choosing an impactful and tractable problem. I will help students in finding right tools to solve the sub-problems and allow them to argue with each other merits of different solutions constructively. Next, I will help them apply these solutions to address small problems and then with extensive evaluation verifying working of solutions in practice. In process teaching them necessary critical thinking and skepticism. Next, to

teach dividing a large problem into smaller ones requires breaking into right smaller problems. This needs an iterative process, and the important part is it to learn from the failure of the last iteration. I will help the students to analyze and understand what smaller problem can be solved and what cannot be solved, challenges in putting together the solutions to the multiple smaller problems. Finally, choosing the problem is the most important. I will teach students to strongly argue with each other if the problem is important and tractable but with the formal approach and critical thinking. It would allow students to become an independent researcher.