Teaching Statement

Ali Khanafer

Since the commencement of my engineering education, my ultimate goal has been to embark on a career in academia and to participate in educating future generations. Excellent teachers are perhaps the first to implant the love of a subject into a student’s heart; they are therefore the enablers of future scientists and engineers. As a professor, I plan to follow in my teachers’ footsteps by excelling as an educator in the classroom and as a mentor outside the classroom.

1 Teaching and Advising Experience

Graduate studies have provided me with opportunities of acquiring different teaching experiences. I enjoy helping students during office hours, and I often offer extended hours to help as many students as possible. While pursuing my master’s degree at the University of Toronto (UofT), I was a teaching assistant (TA) for three undergraduate courses: circuit theory, wireless communication, and communication theory. I was responsible for assisting students in conducting experiments and grading laboratory reports for the wireless communication and communication theory courses.

Because students’ feedback would inform me of what worked and what did not, I created evaluation forms asking students to offer their opinion on my performance and to suggest ways to improve the course. Their feedback was very positive, and many of them recommended interesting add-ons to the course. For the circuit theory course, I was responsible for giving tutorial lectures where I would solve exercise problems. Lecturing was an invaluable experience as it introduced me to the process of preparing class material and teaching in academia.

At the University of Illinois at Urbana-Champaign (UIUC), I was involved in teaching four graduate courses. In spring 2013, I was the TA for the optimal control course taught by Prof. Daniel Liberzon. I was very passionate about teaching this subject as it is one of my favorite topics. This subject is fundamental and quite advanced and the students came from different departments, including mathematics and engineering. I had to be always ready to answer very deep questions about the material, which provided me with a great teaching experience and deepened my knowledge further. My responsibilities included grading the homework assignments and holding weekly office hours. The grading scheme for this course required students to resubmit their assignments until they solved all problems correctly. To ensure the students were up-to-date with their assignments, I met with them regularly and often outside my assigned office hours. The repeated interaction with the students led to a dynamic relationship with them, and the discussion about optimal control has continued until this day.

I was a guest lecturer for a graduate control theory course offered by my advisor, Prof. Tamer Başar. I was delighted to know that two of the lectures I was to teach were on optimal control; during these lectures,
I introduced Pontryagin’s Maximum Principle and presented many applications. My strategy during each lecture was to start by a quick review, motivate the lecture by practical applications, and then delve into the details. To stimulate the students, I would ask multiple questions during the class to challenge them and encourage them to think actively about the material. This was the first time I was giving lectures in a large graduate class, and the experience only increased my love for teaching. My passion about teaching has also intensified after receiving the Ernest A. Reid Fellowship Award in Electrical Engineering for demonstrating potential in contributing to engineering education in the spring 2013 semester.

In fall 2012, I was TA for the information theory course for which I was responsible for holding weekly office hours, grading homework assignments, and updating the course website. Since the main focus of my research is control and decision theory, teaching a course from the communications area was of particular interest to me as it helped me broaden my knowledge. I am excited to be a TA for Prof. Tamer Başar’s game theory course in spring 2014 for which I will be responsible for grading the homework assignments and holding office hours for students. Game theory is another favorite subject of mine and is the core of most of the research problems I have dealt with.

Besides teaching, I have also been involved in supervising two undergraduate students working on different research projects. Since it requires a different style of teaching than that in the classroom, advising students helped me develop mentoring and teaching skills. Since I was working with undergraduate students, I needed to provide extra details and examples to ensure the students have the required background to carry out their tasks. At UofT, I participated in advising a student in his graduation project which consisted of developing a toolbox to speed up communication systems simulations using parallel computing.

At UIUC, starting fall 2013, my advisor offered me a unique opportunity to be the research mentor of a third year undergraduate student who is interested in working in our group. My responsibilities included assigning the student a suitable problem and meeting with him regularly in order to guide him through the project. I plan to continue to work with the student, in the spring 2014 semester, on extending some of my prior results; this will expose him to theoretical research at an early stage in his career. The first step I took was to provide the student with a collection of papers to read in order to familiarize him with the current literature. I start each meeting by answering his questions, and then I explain a theorem or a concept in detail. My ultimate goal is to guide the student to produce publishable novel results so as to introduce him to academic writing.

2 Teaching Philosophy and Courses

My teaching and advising experience led me to develop a teaching strategy consisting of three main components:

1. **Participatory lectures:** I believe that encouraging discussions during lectures is the best way to clear confusion and to build the students’ confidence about the material. Although participation could limit the time available to present material, it provides a feedback signal about the level of understanding among the students.

2. **Encouraging students to correct mistakes:** While grading provides students with feedback on their performance, there could be many missed opportunities if students do not attempt to correct their mistakes. One way to exploit the provided feedback, is to offer incentives for students to re-submit their homework assignments or tests. Although this requires more effort from the students and the graders, it is very crucial for them to fill in the gaps in their knowledge.
3. **Mini-research projects:** Research provides an ideal venue for applying the theory learned in class. I plan to encourage undergraduate students to engage in research projects in the early stages of their studies. I believe this will drive them to go beyond what textbooks teach and instill in them the love of exploring. As for graduate students, I believe that working on mini-projects helps them expand their background; such exposure would be especially useful for students searching for a dissertation topic. If scheduling does not allow for projects, then assigning homework problems that require reading external references could be an alternative—extra credit would be offered as an incentive for solving these.

My strategy since the beginning of my graduate studies has been to strengthen my theoretical knowledge by taking courses spanning a broad range of topics. Besides engineering courses, I have taken advanced courses offered at the departments of computer science and mathematics. This has allowed me to acquire techniques from other fields that often become handy in solving engineering problems. Moreover, taking courses enabled me to enrich my background, which will allow me to teach various topics in the future. As an advisor, I believe it is important for me to be aware of diverse techniques and theories in order to provide preeminent advice.

Courses I am well-equipped to teach include game theory, optimal control theory, control system theory and design, nonlinear control, and stochastic control. My background in advanced mathematics enables me to teach (graduate-level) probability, detection and estimation, and random processes. I also enjoy teaching fundamental engineering courses such as circuit theory, signals and systems, and communication systems.

### Research and Teaching

I worked on network problems emanating from game, control, and communication theories. This makes me enthusiastic about creating and teaching courses at the intersection of these related areas. While communication and control theories are fundamental engineering subjects, game theory has roots in economics, and this will provide engineering students with a breadth component in the material they study. The main challenge in creating such courses would be to tell the students a complete story that emphasizes the reasons behind studying network problems at the intersection of these areas, while highlighting tools from each field that help in tackling these problems.

As a specific example, I plan to create a course dealing with optimal control and differential games on networks. Although a standard course on optimal control is necessary, the integral part networks play in today’s world entails presenting the challenges faced when applying optimal control or differential game theories to network problems. In fact, the examples that one finds in classical optimal control texts fail to provide intuition about optimality in dynamic networks. This hints at the fact that we are in need of a textbook that addresses such issues: a project I am eager to undertake upon my graduation, and a first step towards which would be developing notes for such a course.

My teaching experience and research projects have only increased my passion and motivation to participate actively in the progress of engineering education. Teaching is a very rewarding experience as it enables me to participate in educating the future engineers and our future leaders. As a payback to the engineering and science communities, I strongly believe that it is my duty and obligation to become an excellent teacher.