Amro M. Farid
Teaching Statement

Teaching Philosophy: We use the motto “Empowering Your Network” to describe our efforts at the LIINES (Laboratory for Intelligent Integrated Networks of Engineering Systems). While this motto is certainly applicable to our research program to develop intelligent and integrated engineering systems, it is even more applicable to our teaching philosophy. Education is personal empowerment. Leadership is collectively empowering one’s network of peers and junior colleagues to address a common problem. Thus at the LIINES, we are interested in educating leaders who are capable of empowering themselves and others to address the engineering grand challenges that face society today. This teaching ethic permeates through our classroom environment and our 1-on-1 advising.

The Learning Environment: My teaching career spans two seemingly different universities with many similar characteristics. The Masdar Institute of Science & Technology, as a start-up graduate-student-only university in Abu Dhabi, UAE focused on engineering research in sustainability. The Engineering Systems & Management (ESM) department (where I was appointed) drew students from all engineering disciplines including computer science and IT; usually straight out of their undergraduate programs with no industrial experience. Similarly, the Thayer School of Engineering at Dartmouth features a unified engineering science major for undergraduates and the Ph.D. in Engineering at the graduate level. Both environments emphasized cross and interdisciplinary education in intimate learning settings. With the exception of my undergraduate core class (Linear Dynamic) Systems (ENGS 22) which had over-enrollments of 50+ students, my classes have had 5-10 students. In my teaching career, I’ve had the pleasure of developing a total of four new graduate courses between these universities, and teaching enhanced versions of them since then. At Masdar, Systems Architecture (ESM 501) is a course devoted to the early design and concept generation phase of complex projects irrespective of commercial sector or application. Similarly, at Dartmouth, Model Based Systems Engineering, Analysis & Simulation (ENGG 199) covers much of the same material and adds the fundamentals of network science and dynamic systems simulation. At Masdar, Techno-Economic Analyses in Power System Operations (ESM 616) covered a classical text in power systems operation with an emphasis on recent research trends. At Dartmouth, Energy Systems (ENGS 175) has a broader scope that includes electric power, natural gas, transportation, district heating and cooling systems.

Learning Objectives – Challenges & Accomplishments: My teaching philosophy is distilled into several learning objectives.

1. Develop New Engineering Course Materials to Engage w/ Grand Societal Challenges: Developing four new engineering courses from scratch is an opportunity to engage students with grand societal challenges. In the systems engineering classes (ESM 501 & ENGG 199), I emphasized that 80% of a system’s performance and cost is determined early on by its architecture. Modern day sustainability issues like electrified-transportation, the energy-water nexus, and urban planning were framed as challenges of system architecture. In the energy systems courses (ESM 616 & ENGG 199), we gained a broad perspective of energy policy concerns as found in the MIT Future of the Electricity Grid Study and the DOE Water-Energy Nexus report. The students became immediately aware that energy systems could no longer operate “business-as-usual” but that the drivers of decarbonization, deregulation, decentralization, electrification, and consumer participation would motivate the delivery of the course’s technical content. For example, electrified transportation was presented as an opportunity to simultaneously manage congestion and power grid balancing. Similarly, the energy-water nexus was presented as an opportunity to flex the urban metabolism of a smart city. Finally, electricity market operations were taught through the lens of deregulation, and consumer-driven preferences. These newly developed courses steeped their technical rigor in ongoing socio-technical engineering challenges.

2. Foster Systems Thinking: the Ability to Model Complex Systems at Different Levels of Abstraction: Grappling with large complex systems will remain a pressing challenge in the 21st century and many students find a big transition to abstract thinking. Some remain excessively detail oriented and others become too vague – either way missing the “big picture”. In systems engineering, we taught several engineering design and modeling methodologies (e.g. SysML/UML, Axiomatic Design, OPM, DSM) and not just one. By exposing students to multiple frameworks, they came to see “the wood from the trees”; to abstract fundamental concepts such as system function, form, scale and temporality. In power and energy systems, the well-known optimization problems (e.g. economic dispatch, unit commitment, and optimal power flow) were presented as successive developments in modeling arising from the elimination of assumptions. Finally, in the undergraduate core
linear dynamic systems course, I exposed students to systems thinking concepts (e.g. across, through, effort, and flow variables) so that they could model systems irrespective of their specific energy domain or discipline.

3. Make Experiential Learning the Primary Learning Mode: In class, I emphasize that the study of large complex systems is not a spectator sport. In order for students to appreciate the complexities of systems problems, they have to learn by doing. In the systems engineering classes, students would reverse-engineer the form, function, and concept of a system or product of their choice. In the power and energy systems classes, part of class time would be used to develop simulation and optimization code so that they could get “live feedback” of how course material translated into practice. Even at the undergraduate level with established content, I introduced classroom polling and left time for students to solve problems in class. Problem sets are far less dramatic when a student walks out of class saying “I can do this!”. In all these courses, I seek to grow engineering leaders by creating learning environments that are a microcosm of real-life engineering practice.

4. Inspire Learning by Social Interaction: Large complex systems are never implemented by just one person. And so the learning environment has to encourage peer-to-peer social interaction. In the systems engineering classes, the plentiful and diverse readings were followed up by round-table discussions in recognition that so much of modern engineering design is about cordially hashing out ideas with peers around the same table. The reverse engineering assignments were completed and presented in teams. “When your team presents a concept to a CTO, CFO, or VC...”, I would say, “...you live and die together.” Naturally, they were assessed on not just modeling fundamentals but also clarity, polish, and social/business relevance because go/no-go decisions rely on all of the above.

Student Testimonials:

- “Excellent course customized for Electric Power & Engineering students!” (Those who joined the ESM cohort.)
- “This is an excellent course, with very useful and focused content.”
- “This is a very useful course and should be included among compulsory courses for all ESMs, since it is probably the one most closely associated to Engineering Systems.”
- “I felt that this course was a very interesting course, and I believe will be one of the most useful courses I will take while at Masdar Institute.”
- “I enjoyed the class and Dr. Amro’s extremely systematic way of teaching and presenting material... He should continue to use the examples from his personal experiences using system architecture. His examples helped provide more depth and understanding for the specific topic, as well as clarifying in what way a tool or idea can be applied.”
- “Glad to join this course... It also helped me to develop systems thinking. Professor Amro is really knowledgeable and gives instruction in an effective way.”
- “I believe the most effective aspects of the course were the lectures that explained abstract thinking and then followed with worked out concrete examples of the new concepts explained in class.”
- “Very clear step by step techniques to approach the content – interesting applications like Simscape and multi-energy systems that will help me in my future engineering career.”
- “I learned the most when the professor wrote examples by hand.”
- “The professor was open for multiple office hours.... His office hours were AMAZING.”
- “A really great and compassionate guy who actually cares about his students and very intelligent.”
- “Amazing energy. Really cares about what he is doing.”
- “Prof. Farid’s approach to discussion based learning, with a motivating project for implementation, not only increases the depth of knowledge one reaches on the subject matter, but also valuable skills engineers use well beyond their years as an undergrad/grad student.”
- “He was very good at responding to students and incorporating our specific interests into class. Most class discussions were well facilitated and questions he posed contributed to my learning.”
- “He is very careful with his teaching, assigned problems, and in-class examples – he seldom made mathematical errors. His in-class explanations of the lab experiments helped tremendously toward understanding the relevance of their concepts and reinforced what we were currently learning.”
- “He was very well organized and answered questions well.”
“Prof. Farid doesn’t brush over responding to questions in lecture, but instead talks very in depth about the questions and their related topics, which often leads to interesting discussions.”

“Prof. Farid is very approachable, which makes seeking help easier.”

“Amro’s willingness to meet students at their current level of exposure and invest in them to help them grow was evident from my first interaction with him.”

“Amro was able to guide me towards this success because of three key qualities he has as an advisor. First, he works very closely with his students; with Amro, you never feel like you are on your own, or like you have a boss you need to please – he is your partner. Secondly, he is excellent at helping his students graduate to a new level of capability; he pushes you to just outside your comfort zone, but not further than that, and by so doing helps you unlock capabilities you didn’t realize were within reach. Finally, Amro is a consummate interdisciplinary researcher; he develops a fundamental understanding of new fields and guides his students to do the same.”

“His exquisite approach of teaching pushes students to exceed expectations of themselves.”

“As a wife, mother and a graduate student, Dr. Amro completely understood the conflicting roles I had to fulfill. He structured flexible working hours and a work from home schedule providing family-academia balance. This supportive environment ensured I continued to thrive as a student and eventually I was able to graduate on time as an honor student.”

“Prof. Farid is one of the most student-friendly professors I know.”

“While Prof. Farid was always happy to get involved and offer help with the research, he also gave enough independence to his students if they wanted to pursue ideas of their own. This is a rare approach in academia as many professors consider this a risk and require their students to spend all their time on the pre-defined concepts.”

“Professor Farid manages to find a very productive and educational balance of guidance and independent exploration.”

“Professor Farid deeply cares about the success of his students. He spends a lot of time with his students, he works harder than any of his students, and he demands high quality work and commitment in return.”

“Finally, Professor Farid carries his commitment to his students well-beyond the confines of the (under)graduate programs. He actively mentors lab alumni and provides them with guidance in their academic and industrial careers. Professor Farid is a dedicated teacher/scholar who aims for nothing but his student’s success. I am personally looking forward to sustaining a long-lasting professional relationship with Professor Farid.”

“Dr. Farid cares deeply about his students and continues to invest significant amounts of time supporting the learning needs of his students.”

“I am forever grateful to Dr. Farid for his support and mentorship. He believed in me when I didn’t.”