Teaching Statement

Rabia Tugce Yazicigil Kirby
Electrical and Computer Engineering (ECE) Department, Boston University (BU)

The teaching experience started for me in the first year of my undergraduate studies, and since then, teaching and learning have always been mutually inclusive throughout my career.
Summary of my teaching and mentoring experiences:

- Instructor for graduate- and undergraduate-level courses, mainly Digital VLSI Circuit Design, Analog VLSI Circuit Design, Introduction to Electronics, Freshman Advising Seminar courses at Boston University with teaching scores above the departmental average
- Successfully mentored 52 Undergraduate, M.S. and Ph.D. students, and postdoctoral researchers in their research
- Instructor for Seminar in Undergraduate Advanced Research course at MIT in 2015
- Several guest lectures including Analysis and Design of Digital Integrated Circuits and High-Speed Communication Circuits at MIT
- Co-developed a new VLSI Design Lab course with Prof. Peter R. Kinget at Columbia University
- Teaching assistant for Advanced Analog IC Design course for two semesters

2014 Millman Teaching Assistant Award of Columbia University

My educational objective is to develop multifaceted activities to refocus foundational integrated circuit and chip design training. I will continue training a diverse talent pool for the workforce in developing semiconductor-enabled platforms interfacing with emerging fields, including synthetic biology, security, signal processing, and next-generation wireless communications. The goal here is to impact the students directly through their studies and their communities through their own initiatives by transcending traditional electrical engineering (EE) disciplines via integrating interdisciplinary areas.

Throughout my experience as an Assistant Professor at Boston University, my goal has been to teach the fundamentals of integrated circuit (IC) design while inspiring questions like "How are ICs essential to larger system design?", "How do systems and the associated interfaces impact the circuit-design specifications", or "How do we co-design circuits with other domains, such as signal processing". I have revamped BU's IC-design curriculum through newly-introduced design labs, lecture materials (e.g., lecture notes, topics covered in class), and course projects, resulting in enrollment growth of 77% over the 2022-2023 academic year. This is consistent with my passion for teaching as demonstrated through my high teaching scores (4.50-4.90 out of 5.00), which is above the departmental average, and strong positive feedback I received from the students. Students especially liked the practical hardware (integrated circuit) design training that Introduction to Electronics (EC410), Digital VLSI Circuit Design (EC571), and Analog VLSI Circuit Design (EC580) provide for job interviews, research positions, and internships.
Many students from my undergraduate- and MS-level courses inquire to do research with my group after their interests are piqued in IC and systems design applied to interdisciplinary fields.

Here are some student testimonials from BU course evaluations (sic):

- Digital VLSI Circuit Design (EC571):

  (1) Professor Yazicigil is very knowledgeable when it comes hardware in general and always has real-life examples to share with the class. She knows what the important topics are and what is a focus in industry and gives example interview questions which is very helpful. I think she has been the best professor I have taken a class with at BU.

  (2) Professor is really passionate about the subject and really cares if the students are learning and puts the effort into their learning.

- Analog VLSI Circuit Design (EC580):

  (1) Rabia is an amazing teacher. She makes sure that all of us understands the concept that she is teaching. She talks about how as a designer we would have to make certain decisions. That's what I love about the class. I like to go to her office hours to ask more questions and she is always very welcoming and helpful. I would love to take more courses taught by her.

  (2) I really liked how passionate she is in teaching. She makes sure everyone in the class understood the concept. It's very easy to ask a question to her in class or out of the class. I generally understand better when going over an example instead of just theoretical knowledge. Solving examples in the class with similar concepts but different approaches or wordings helped me understand better.

- Introduction to Electronics (EC410):

  (1) Professor is probably the best if not one of the best professors I have had at BU. She is very open to feedback and improving her course within the week of the given feedback. Professor is constantly available for office hours and meetings whenever you need to ask for help. Having asked people who took the course with different professors, I realized the way professor teaches is the best because I fully understand the device and how to solve it compared to just solving the device only. She is also very helpful not just in the course but for career paths and a big supporter of under grad researchers. Overall, Professor Rabia has been an amazing professor.

  (2) The professor is excellent at explaining the concepts in the course. The lecture notes summarize the book, and there is no need to go over the book if the lecture notes were studied very well. Overall, she is an excellent professor who always makes sure that the students understand the course's concepts before explaining new ones. She is one of the best professors I have ever had, who cares so much about the students learning from the course rather than just doing her job

In 2023, I also taught a 90-minute **Tutorial** on Physical-Layer Security for Energy- and Latency-Constrained Integrated Systems at the **IEEE International Solid-State Circuits Conference (ISSCC)** and presented a technical lecture that was broadcasted on YouTube to thousands of undergraduate and new graduate students at the **2023 ISSCC Circuit Insights** event.

Motivation and Encouragement

I am convinced the first step towards learning a new topic is personal motivation, ownership of the project, and mentor's encouragement. To emphasize the importance of intellectual curiosity and creativity, I encourage my students to ask "what if" and "why", and to search for non-traditional solutions to problems. A great way to embolden their motivation, especially in research, is encouraging them to take ownership of the project by guiding them through asking the right questions that help them find the next step. When I pose a research problem, I first encourage students to derive their own solutions before I provide my explanation or solution. Not only does this get the students actively involved but it also encourages them to think outside the box.

When I mentor undergraduate students, I teach them to approach research by envisioning the solution and guide them by thinking about the full problem scope before diving into the details. For example, we start a project by identifying the figures we would use for a publication and how we would convey our ideas to the research community. Even from my early mentoring days, this approach resonated with one of my students through the MIT SuperUROP advanced undergraduate research program; his learning process under my guidance and mentoring style was highlighted in MIT news as he expressed himself: "You're thinking of the problem, but you're also trying to envision its solution ... and filling in the space between.", – Daniel Richman. When a student takes the ownership of the project with the proper guidance, no challenge is too great for them to overcome. Using these techniques, I mentored Daniel to successfully design the digital component of a prototype chip without him having any prior design experience. The work resulted in him receiving the SuperUROP Outstanding Research Project Award and Outstanding Presentation Award, and presenting our research project to Apple CEO Tim Cook in 2017.

Nowadays, I always devote time to closely mentor students and share my personal motivation to do impactful research. I define the scope of the project and set concrete and achievable milestones by working closely with them. It is essential to teach students real-world use cases through today's applications to motivate practical design solutions. With my approach, I want my students to gain hands-on design experience as part of their projects. For example, my first Ph.D. student, Qijun (Mandy) Liu, built an end-to-end system demonstration of a hybrid microfluidic-bioelectronic system, which was presented at the 2024 IEEE International Solid-State Circuits Conference, while working in collaboration with another student from a different academic department. Mandy was awarded the **IEEE International Solid-State Circuits Conference SRP best poster award** in 2023 related to this hybrid platform technology. In the scope of a project, I also aim to teach my students how to write journal and conference papers, and how to present their research effectively.

Effective writing and communication is especially important, as it allows for the research to become more impactful through the research community abroad. For instance, research activities with my undergraduate and high school students have resulted in **7 IEEE peer-reviewed conferences** (ISSCC'23, A-SSCC'23, WoWMoM'23, ISIT'23, BioCAS'22, CICC'21, DySpan'19) and **an ACM journal paper** in **five years at BU**.

With my aim of building a diverse community, I have mentored three women Ph.D. students (one defended her Ph.D. thesis in December 2023), two women M.S. students, seven women ECE and BME undergraduate students through the BU's Undergraduate Research Opportunities Program (UROP) and DoD-funded STEM Pathways Program, and an undergraduate student from the BU chapter of the National Society of Black Engineers (NSBE). In addition to building this community, I really advocate for my students' successes in the classroom, laboratory, and world. Particularly, at every opportunity, I nominate them for awards and workshops (e.g., two women students were selected as **2024 IEEE Solid-State Circuits Society (SSCS) Rising Stars**; one woman student was selected for the **2023 IEEE SSCS Predoctoral Achievement Award – the highest**

possible achievement for a Ph.D. student in this field), while also providing them with networking and career opportunities.

My goal has always been to inspire their curiosity and foster their efforts to work on interdisciplinary research in my laboratory. Not only were these relationships and research projects successful on paper (e.g., publications co-authored by those students), but they also inspired the students to continue their scientific careers in their next steps. Frequently, I share my own experience in science and academic journey with the students to provide them comfort and confidence that they can achieve it too. As a result, Yidi Wu (ECE'23), a woman undergraduate, is currently pursuing her graduate studies at Georgia Tech. I also mentored Elizabeth Diamond (ECE'22) starting her freshman year until her graduation (four years) to develop miniaturized ingestible capsules published in the IEEE Custom-Integrated Circuits Conference (CICC) 2021, in which she was selected as one of the **IEEE SSCS Next-Generation (NextGen) Circuit Designers** in 2022.

It is truly rewarding to see the impact of my mentorship as they grow into successful individuals.

Interaction, Collaboration and Communication

I believe that working in groups can add a valuable dimension to learning as I have discovered the importance through my own collaborative experiences; this has become my research group's *modus operandi*. Collaborating with researchers from diverse fields requires the ability to cross boundaries for system-level innovation, and I believe that working in interdisciplinary teams sparks new ideas and enables learning new technical concepts from complementary perspectives. By encouraging my students to work with their peers, my goal is to help them be team players and communicate ideas and concepts clearly. I believe that such communication is a valuable skill in its own right, but, more importantly, students will learn to think more clearly and effectively by explaining their reasoning to others.

Multifaceted Learning Through Critical Thinking

Learning cannot be prescribed by any recipe, and through my teaching experience, I have learned that students have very different learning styles. I therefore make an effort to create a multifaceted learning experience by presenting each new concept from a theoretical, numerical, visual and experimental perspective. By emphasizing the many approaches to understanding a new concept in electrical engineering, it is my goal that everyone can learn through critical thinking, no matter what their learning style.

Future Plans for Teaching and Mentoring

Curriculum Development

I plan to create a new hands-on chip design course "IoT Chip Design" for developing end-to-end system solutions for emerging applications, such as synthetic biology, signal processing, and hardware-based security for senior-level and new graduate students at Boston University. Learning the complete design cycle is extremely valuable for students by connecting theory learned with practical design experience. In addition to providing guidance and experience for their academic studies, I strongly believe the outcome of the projects with stand-alone demo systems is a great way for students to showcase their research experience during industrial job interviews. This course will train the next-generation chip designers and, hence, support the strategic national goal of promoting the research and development of semiconductor chip design. To bridge the education-to-semiconductor-industry gap, input from industry (e.g., Semiconductor Research Corporation -

SRC, Analog Devices - ADI) will be used to refine course materials periodically. The hands-on design course will include system concept development, integrated circuit design and simulations, semiconductor chip fabrication, and chip measurements. The course outcome will be a live demonstration of the students' system to highlight their individual and collaborative problem-solving abilities and presentation skills. To make our design methods broadly accessible, we will submit video demonstrations of the student-designed integrated systems to the peer-reviewed Journal of Visualized Experiments or highlight the integrated system demonstrations on the course website after the chip designs are published in peer-reviewed conferences or journals.

Interactive Wireless Security Hackathon

I will organize biennial cascading wireless hardware hacking and security competitions in collaboration with Prof. David Starobinski (BU ECE) to introduce security and wireless communication topics to graduate women students down to high school students. First, my graduate student and I will lead a three-day advanced wireless security hackathon for the BU Section of Society of Women Engineers (SWE) and Graduate Women in Science and Engineering (GWISE) students. Our first hackathon will focus on demonstrating false data injection attack against a biomedical device using a software defined radio (SDR). Next, we will collaborate with the Technology Innovation Scholars Program (TISP) and the STEM Pathways at BU to create a simplified and interactive template for a five-day wireless security hackathon, including a lesson module for coding and wireless hardware testing targeting grade 9-12 students (≈20 students collaborating in groups of two). A three-day coding lesson module will focus on the python language, and a two-day testing module will demonstrate the use of an SDR, e.g., PlutoSDR. I will work with Prof. David Starobinski, the Assistant Dean of Outreach and Diversity, Pamela Audeh, and the Director of STEM Pathways, Hailey Gordon, in organizing these wireless security competitions.

Research Involvement of Undergraduate and High School Students

I will continue engaging high school and undergraduate students and underrepresented minorities (URM) in research projects of my group utilizing my experience as a mentor of 22 high school and undergraduate students at BU. These proposed projects will be made available through the UROP, the STEM Pathways, the Research in Science & Engineering (RISE) Program at BU, and industry collaborations with tangible deliverables (e.g., already established collaborations with ADI and SRC). Furthermore, I will invite a URM student from the BU chapters of the National Society of Black Engineers (NSBE) and Society of Hispanic Professional Engineers (SHPE) every year to conduct research in my laboratory. A rising junior from the BU NSBE joined my group in Spring 2023 to work on developing sensor technologies for real-time bioreactor monitoring after my Introduction to Electronics (EC 410) course sparked his interest.

Teaching is a unique professional privilege. Universities are full of intelligent hard-working students motivated to solve tomorrow's challenges, and I have a growing passion for mentoring and teaching those open minds and sharing in their growth as scientists and individuals.