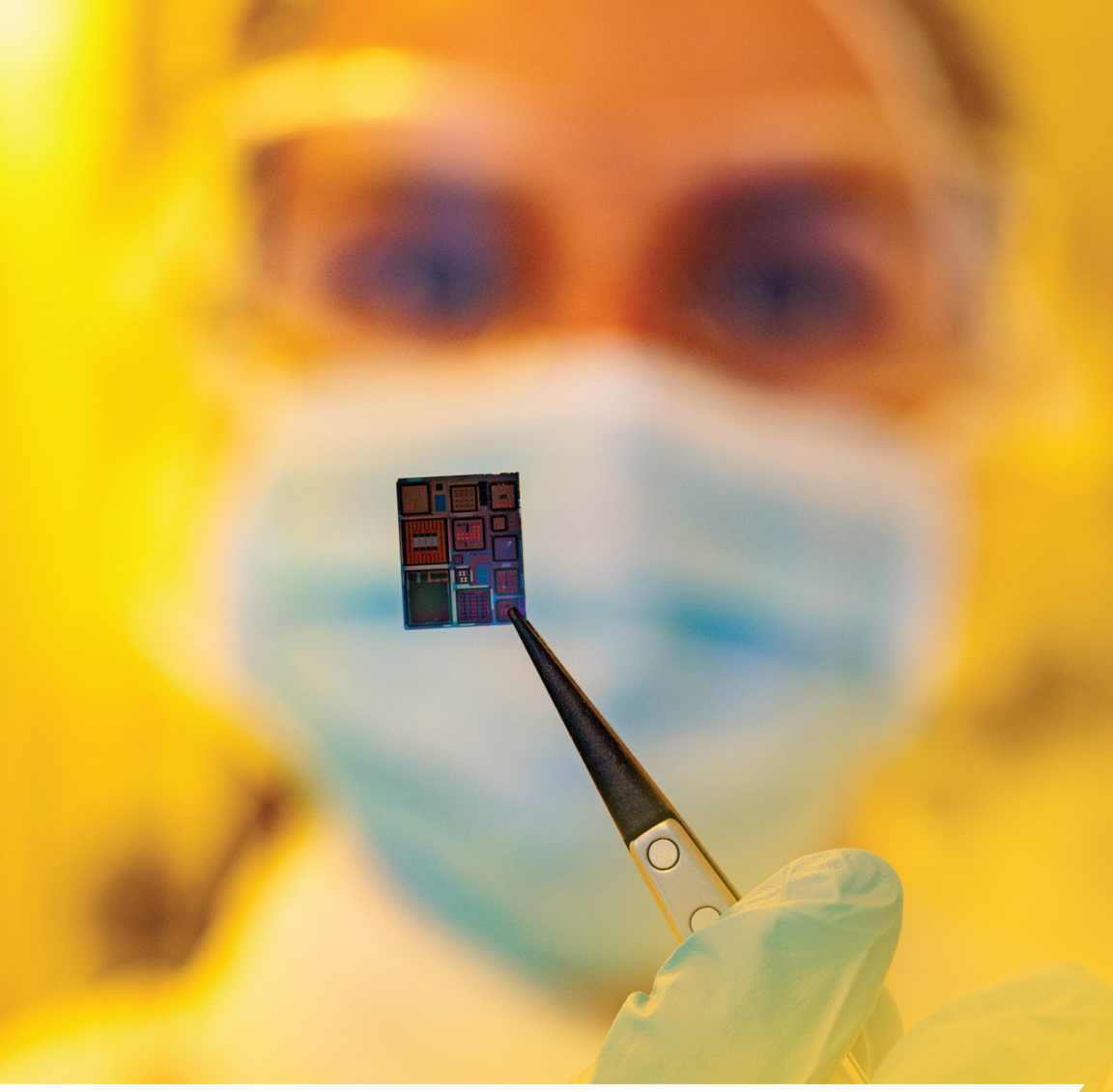


Technology-Oriented Solutions for Real-World Challenges

Department of Electrical and Computer Engineering

GW | Engineering

Message from the Chair

The Department of Electrical and Computer Engineering (ECE) at GW's School of Engineering and Applied Science wraps up another year of remarkable achievements as we prepare to welcome an exciting new year. Our programs have been modernized to be more diverse and flexible than ever, providing the necessary foundation and skills for impactful, lifelong learning while addressing emerging trends and strategic areas such as artificial intelligence (AI) and sustainability.

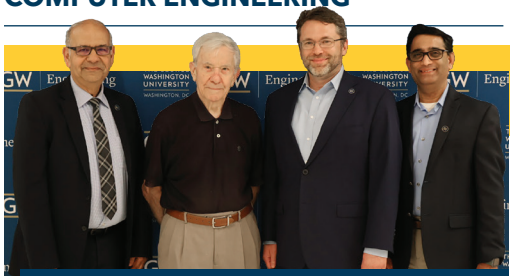
Our faculty continues to excel in research, making a clear mark on their field and areas of national priorities. Prof. Gina Adam received the prestigious Department of Energy Early Career Research Award, along with other funding, and the IEEE-HKN C. Holmes MacDonald Outstanding Teaching Award. Prof. Tian Lan was appointed to the FCC Technological Advisory Council and secured millions in research funding from DARPA, ARO, and NSF for his groundbreaking work on multi-agent AI for security and mixed reality. Prof. Ahmed Louri was recognized as a member of the IEEE Computer Society's (CS) Golden Core 2024, selected as a member of the IEEE CS Awards committee, and named Editor-in-Chief for the IEEE Transactions on Sustainable Computing

Additionally, last year saw the issuance of a substantial number of patents, and numerous faculty members were inducted into the National Academy of Inventors. On the student front, our IEEE Power and Energy Society-Industry Applications Society Joint Student Branch, mentored by Prof. Payman Dehghanian, received an award recognizing it as being among the top-performing student chapters in the U.S.

Congrats to our ECE students and faculty! We look forward to another exciting and rewarding year ahead. Raise high, ECE!

Tarek El-Ghazawi, Ph.D., IEEE Fellow
Professor and Chair
Department of Electrical and Computer Engineering
School of Engineering and Applied Science
The George Washington University

EMPOWERING INNOVATION IN ELECTRICAL AND COMPUTER ENGINEERING



(L TO R): **Tarek El-Ghazawi, Chair of the ECE Department; Hermann J. Helgert, ECE Professor Emeritus; Dean John Lach, GW Engineering Dean; and Suresh Subramaniam, GW's Vice Provost for Graduate and Postdoctoral Affairs and ECE Professor.**

Rooted in Washington, D.C., the ECE Department exemplifies growth and innovation, excelling in cutting-edge electrical and computer engineering research. Committed to excellence, it leverages in-house facilities and collaborations with local tech and governmental agencies to nurture the next generation of technology leaders. A key highlight is the establishment of the Helgert Family Endowed Fellowship, initiated by Prof. Hermann J. Helgert, a longtime faculty member dedicated to advancing wireless communications.

With nearly 50 years of service at GW Engineering, Helgert has profoundly impacted the school's growth and reputation, mentoring countless graduate students and advocating for significant infrastructure developments like the 500,000-square-foot Science and Engineering Hall. His generous $3M donation aims to recruit and retain exceptional ECE doctoral students by ensuring they can focus on rigorous studies without outside employment.

Helgert's motivation stems from gratitude for what GW has given him and his family, including three family members who also earned degrees here. By guiding students in a field that has dramatically evolved, he has been at the forefront of a technological revolution. His expertise in wireless networks enriched the curriculum while positioning the department as a leader in high-impact research, from internet connectivity to cellular communications. Advocating for student involvement in research, he demonstrates how the department's innovative education empowers students to harness technology's transformative potential to shape the future.

(L TO R): **ECE students Mitchell Shemtov, Caitlyn Hollander, and Kalan Smith engage as a team to solve complex engineering problems.**

BUILDING BONDS: STUDENT EXPERIENCES WITHIN THE ECE FAMILY

At GW Engineering, the ECE Department is more than just an academic unit; it's a thriving community extending beyond the classroom. ECE students experience a unique blend of academic rigor and social engagement, fostering a tight-knit family that encourages collaboration and enables students to grow together.

Study abroad programs are one notable opportunity for students to broaden their horizons. Through partnerships with universities worldwide–such as those in South Korea, Australia, England, and Ireland, to name a few– ECE students gain invaluable insights into global engineering practices that enhance their educational journey.

In Washington, D.C., the department cultivates students' collaborative skills through team-based, hands-on capstone projects addressing practical engineering problems to reinforce technical skills and promote teamwork and communication. Carefully selected from industry partners, government agencies, non-profit organizations, and alumni, these projects form interdisciplinary teams across all engineering disciplines to mirror professional endeavors and drive impactful solutions for the greater good.

Outside the classroom, the department organizes unforgettable outings, from industry field trips to Honeywell and Duke Energy to social picnics for students and faculty. These events enhance educational experiences while creating shared experiences that build bonds and professional networks lasting well beyond graduation. In the ECE Department, every student is not just a learner but a vital part of a vibrant community dedicated to innovation and collaboration.

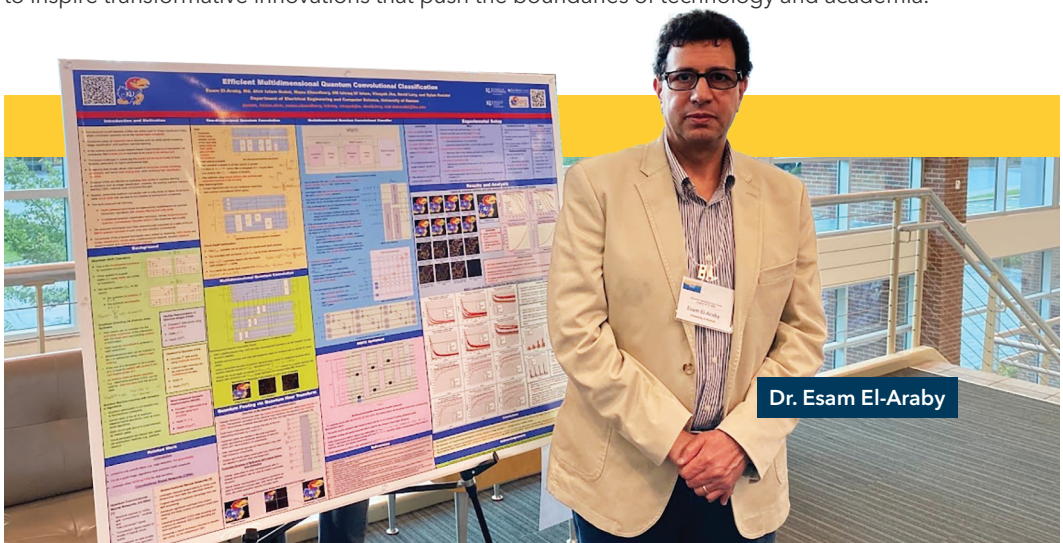
Alumnus Dr. Esam El-Araby Drives Transformative Innovation in Quantum and Reconfigurable Computing

A distinguished alumnus of the ECE Department, Dr. Esam El-Araby, M.S. '05, Ph.D. '10, is making his mark in academia through pioneering research at the University of Kansas (KU). Leading the KU Advanced Reconfigurable and Quantum research group, El-Araby is advancing quantum computing, high-performance reconfigurable computing, and hardware virtualization. His contributions shape new frontiers in technology and position him as a leading figure in his field, with his research in quantum computing centers focusing on optimizing quantum algorithms for high-impact applications such as pattern recognition in hyperspectral imagery for remote sensing and high-energy physics.

El-Araby's team develops quantum machine learning techniques to improve classification accuracy for complex, multidimensional data. These techniques optimize quantum architectures to reduce computational time, addressing practical challenges in data-intensive applications and advancing the field by enhancing algorithm efficiency on quantum machines. One of his notable contributions is optimizing quantum compilation using genetic and evolutionary algorithms, which is essential for bridging the gap between theoretical quantum algorithms and practical implementation. This research provides pathways to execute these algorithms more effectively on real quantum machines. Additionally, his work applies quantum algorithms to solve partial differential equations, tackling complex mathematical problems with cutting-edge quantum techniques.

El-Araby's innovative work has earned him a series of accolades, including consecutive Best Poster awards at the Oak Ridge National Laboratory's Quantum Computing User Forum in 2023 and 2024, as well as finalist recognition for Best Research Poster at SC23 and SC24, the world's largest international conference and exhibition for high-performance computing, networking, storage, and analysis. These accomplishments are backed by major federal grants, including an NSF CAREER Award (2020-2025) and an NSF Major Research Instrumentation grant (2011-2013). These grants highlight his research's significance and his role as a thought leader in the field.

With his leadership, El-Araby is not only advancing scientific knowledge but also mentoring a new generation of researchers who will continue to explore and expand the boundaries of quantum and high-performance computing. His journey exemplifies how GW Engineering ECE alumni are equipped to inspire transformative innovations that push the boundaries of technology and academia.



Dr. Esam El-Araby

How Women in ECE at GW Are Shaping the Future of Technology

At GW Engineering, diversity is central to innovation and addressing societal challenges. With 45% of our school's undergraduate population being women–nearly double the national average–this commitment to diversity is woven into the fabric of the ECE Department, where continuous efforts enhance representation among faculty and support the success of diverse female students and alumni.

Prof. Mona Zaghloul

The department has historically led GW Engineering in gender diversity since hiring Prof. Mona Zaghloul as its first female faculty member in 1980. Building on Zaghloul's work to diversify the department, new faculty member Prof. Nan Wu aims to broaden the ECE pipeline for underrepresented students through K-12 outreach and mentorship, recently guiding a female undergraduate through transitioning to graduate studies. In research, Prof. Gina Adam mentors a gender-balanced team of undergraduate and graduate students to develop neuromorphic technologies, leveraging their diverse skills with support from varied funding sources. These efforts have fostered success stories, such as Aicha Evans, who credits her experience in the department as foundational to her entrepreneurial journey.

Prof. Nan Wu

"As a woman of color in a traditionally male-dominated field, I understand firsthand how important it is for people to see themselves in the positions they aspire to. Representation is key to unlocking potential, and I believe that fostering an inclusive and diverse team--where differing backgrounds, perspectives, and experiences are celebrated–is essential to driving innovation and success." **Aicha Evans, B.S. '96, CEO, Zoox**

Prof. Gina Adam

Evans serves as a role model for women aspiring to leadership positions, leading Zoox in delivering safer, cleaner autonomous transportation experiences. Inspired by Marie Curie, she encourages students to embrace curiosity, seek understanding before taking action, and not shy away from challenging paths, as stepping outside one's comfort zone teaches invaluable lessons. Evans emphasizes that a strong support system is crucial for navigating difficult times, exemplified by her former ECE Prof. Can Korman and the late CS Prof. Arnold Meltzer during her time at GW Engineering.

The ECE Department is characterized by a collaborative, diverse community that provides an inclusive environment for students, faculty, and alumni to succeed. As the department continues developing technological-oriented solutions to society's most pressing challenges, this inclusion remains essential to ensuring that emerging technologies support all populations.

Driving Neuromorphic Computing Advancements Through Neuroscience Collaborations

Training artificial intelligence (AI) models like GPT-3 consumes roughly as much energy as 130 U.S. homes annually and contributes to the technology sector's 2-3% share of global emissions—figures that will only grow as AI advances. To develop sustainable AI solutions in the U.S., the Department of Energy (DOE) is funding researchers like Prof. Gina Adam, whose interdisciplinary collaborations with neuroscientists are pioneering brain-inspired hardware and algorithms that require significantly less energy than current AI models.

Inspired by the hippocampus, Adam is developing novel spiking neural networks capable of learning and adapting at scale, supported by a DOE Early Career Research Award. She will build on key neuroscience concepts, including cell assemblies and spontaneous resting-state dynamics, investigating how these concepts can emerge in hardware-relevant network models. Alongside transistor circuitry tape-outs, she will explore analog devices with adjustable time parameters to enhance neuronal and synaptic diversity within neural network hardware systems.

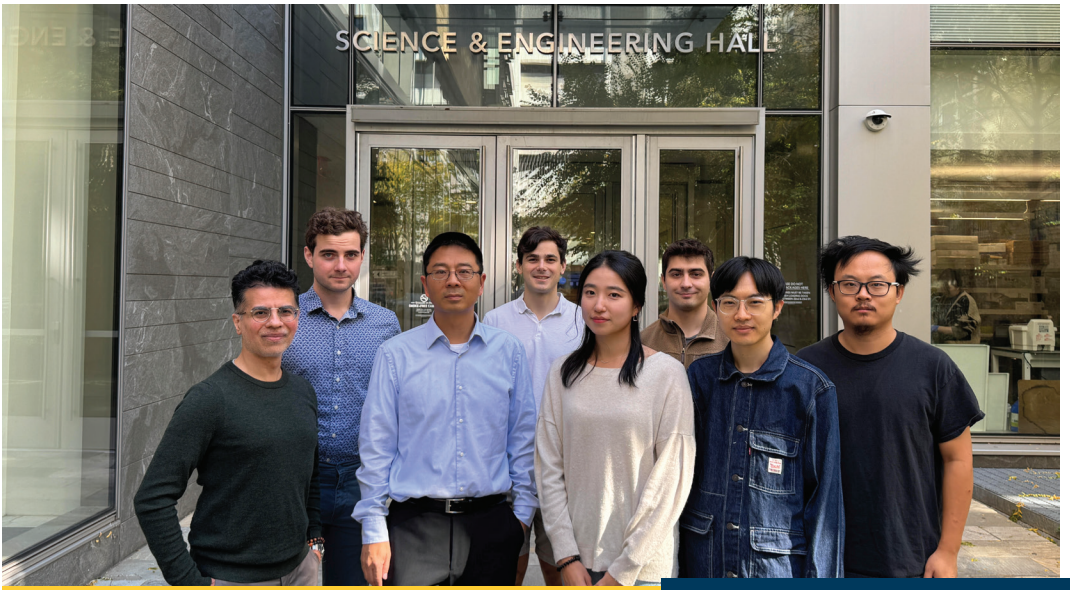
In a complementary effort, Adam is collaborating with Oak Ridge National Laboratory, the University of Tennessee, Knoxville, and George Mason University on a $7M ENGAGE project to develop paradigms for large-scale graph learning using spiking neural network insights. Graph neural networks are relevant for various scientific problems, from material discovery to experimental physics. The team seeks to create science-aware spiking neural networks and simulators for co-designing trainable graph neural networks, while GW Engineering leads the design of energy-efficient neuromorphic hardware suitable for the proposed innovations.

Adam's neuroscience collaborations enrich her research through invaluable insights and access to experimental data, enabling the translation of biological insights into spiking neural networks and analog circuitry. By understanding neuronal and synaptic diversity in the brain, they can identify the properties essential for neuromorphic hardware.

Apart from her research, Adam also contributes to efforts to define the community's strategic priorities. In September 2024, she was co-chair of the DOE Neuromorphic Computing for Science Workshop, leading over 70 participants from around the globe with expertise in neuroscience, microelectronics, and large-scale simulation to propose four priority research directions in neuromorphic computing. Through such interdisciplinary work, Adam advances scientific capabilities while addressing the urgent need for sustainable hardware solutions for next-generation AI.

Ph.D. students working in Prof. Adam's lab:
(L TO R) Lei Zhang, Susmita Karmaker, Zahin Ahmed, and Joey Kilgore.

Integrating Hardware and Systems Security for a Robust Defense



GraphLab faculty, researchers, and students.

As society increasingly relies on interconnected technologies, safeguarding the hardware and systems that form our digital infrastructure is vital. In the ECE Department, key members of this effort include Prof. Guru Venkataramani, who focuses on securing the hardware that underpins all computing systems, and Prof. Howie Huang, whose expertise lies in protecting computer systems and networks.

Prof. Guru Venkataramani

Vulnerabilities in hardware can undermine entire systems, making reliable processing and safeguards against malfunctions critical as untrusted and unverified technology enters global markets. At the microarchitectural level, Venkataramani investigates how malicious users exploit side channels in shared hardware that may leak sensitive information. His team developed the pioneering algorithm to detect such attacks, demonstrating how the coherence feature of multicore processors can also be manipulated for information leakage. To protect hardware in mission-critical environments, such as defense operations, he collaborates with the U.S. Navy to design self-healing systems that ensure graceful recovery from legacy issues or safe decommissioning.

Huang designs robust protection mechanisms at the system and network levels by employing graph-centric approaches for real-time threat detection in both computer systems and networks, addressing not only the technical aspects of cyberattacks but also the broader implications for enterprises and government entities. Particularly, in computer systems, he investigates how to detect malicious users and compromised systems, and in social networks, how misinformation and troll campaigns can impact significant events like elections. His innovations, sponsored by NSF and DARPA grants, have led to numerous publications, awards, and patents in network security, with successful deployment in Department of Defense environments.

Together, Venkataramani and Huang illustrate the interdependence of hardware and system security. Their active interdisciplinary collaborations enhance the functionality of their tools, ensuring they operate effectively in real-world applications. As they continue to push the boundaries of their respective fields, their complementary efforts cultivate a comprehensive defense against emerging cyber threats within the department while maintaining the integrity of computing systems.

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