2021-22
Electrical and Computer Engineering

BOSTON UNIVERSITY

IMPACT REPORT

A letter from the Chair:

I'm proud to share a glimpse of the latest exceptional academic year here at Boston University's Department of Electrical and Computer Engineering. Our pioneering researchers continue to break new ground across a broad field of specializations, boosted by partnerships like the Red Hat Collaboratory and at the forefront of exciting new interdisciplinary endeavors like the freshly announced Robotics and Autonomous Systems Center. We celebrate the achievements of our eminent faculty and newest graduates alike, while giving back to our community through initiatives like Professor Densmore's biotech outreach program for under-served Boston-area high school students. Read on for a taste of the vital, synergistic work our diverse, collaborative community is engaged in.

Professor W. Clem Karl, ECE Chair

Department Highlights

Research

$38M
Total Funding

200%
Growth Over 10 Years

Faculty Honors

45
Society Fellows

4
National Academy Members

Graduate Programs

14th
Ranked CE Program

15th
Ranked EE Program

Among Private Institutions

Undergrad Program

30%
Admissions Selectivity

89%
Growth over 10 Years

Research for a Better Today

Exposing Lingering Malware: Hackers make use of app installation history to target unsuspecting smartphone users with malicious apps before they can be removed from the market. To counter this tactic, Professor Gianluca Stringhini's solution uses a similar targeting tactic – to warn app store shoppers before they tap "download."

Improving Recovery: Working with an interdisciplinary team of computer and neuroscientists, Professor Prakash Ishwar has co-created a predictive model to help forecast an aphasic stroke patient's road to recovery. Their breakthrough: the brain's operations while in a resting state are a crucial factor in the process.

Modeling Fertility: Professor Ioannis Paschalidis and his team have combined a variety of medical datasets to build a new, more accurate model for predicting fertility outcomes. Their findings will also help to pinpoint the health factors most associated with successfully achieving pregnancy - both biological, and social.

Tracking GPS Disruption: With support from NASA, Professor Toshi Nishimura is leading the most comprehensive study to date into scintillation, an ionospheric phenomenon that interferes with GPS signals. An improved understanding of scintillation will be essential to circumventing its effects on our technology.

Introducing the new Robotics and Autonomous Systems Center (RASTIC)

State-Funded, State-of-the-Art: In May 2022, the creation of RASTIC was announced at BU. This **2,000-square-foot dedicated R&D space**, funded 50-50 by BU and a grant from the Massachusetts Technology Collaborative, a public agency, is slated to open in summer 2023. Professor Ioannis Paschalidis, co-PI of the MassTech grant, explained, "the lab is unique in that it emphasizes AI in robotics and auto-autonomous systems, has a strong soft robotics component, and considers applications in transportation, smart cities, and emerging new areas for robotics."

Funding for the Future of Society

Smarter, Secure Networking

Through a trio of research projects backed by a combined **$3M in NSF grants**, Professor Alan Liu's team aims to build more robust protections for our essential communications systems, all while boosting their functional capacity. The projects include: designing next-gen telemetry infrastructure, developing optics-enabled in-network defenses to resist denial of service attacks, and investigating a new three-part method of analyzing and managing wireless networks in real time.

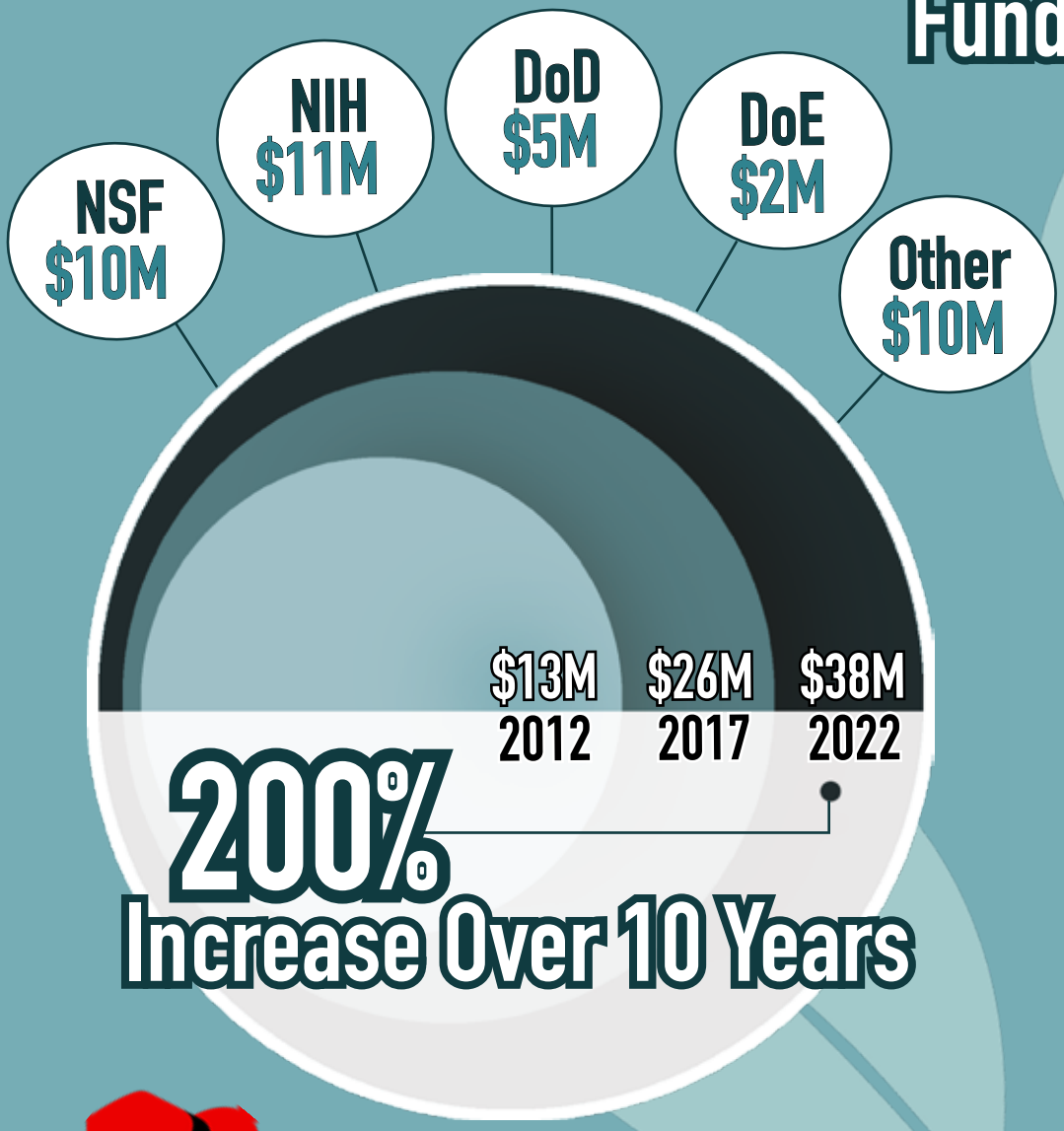
A GRAND Endeavor

With the support of a **$5M DARPA grant**, Professor Rabia Yazicigil is developing the latest in an ambitious series of collaborative projects centered around the novel future-proof universal decoder algorithm, GRAND. Professor Yazicigil is developing custom chips to bring new GRAND variants from theory to application; ones which leverage "soft information" to improve efficiency.

Driving the Autonomous Future

Professor Ajay Joshi and a team of researchers at Boston University, Harvard University, and Lightmatter, backed by a **$4.8M IARPA grant**, have teamed up to develop a new Electro-Photonic Computing (EPiC) system for Autonomous Vehicles: one which can answer the crucial triple challenge of processing capacity, low latency, and energy efficiency.

Funding Snapshot



200% Increase Over 10 Years

Red Hat Partnership Stimulates New Growth

The **Red Hat Collaboratory**, Boston University's unique partnership with Red Hat, was renewed in 2021 with a **$20M** expansion dedicated to supporting research, community building and collaborative innovation. ECE faculty and team members received a combined total of **$1.5M** in funding from the Collaboratory's inaugural Research Incubation Awards for projects that engage deeply in its mission; in AI, cloud computing, societal data modeling, and more.

The Power of a Synergistic Approach

Intelligent, Autonomous & Secure Systems

Automobile See, Automobile Do: Human infants learn to walk by watching and mimicking the movements of those around them; a technique that Professor Eshed Ohn-Bar is hoping to emulate with self-driving cars. Ohn-Bar's new training paradigm teaches AVs to drive safely by leveraging data shared between cars.

AI You Can Trust (With Your Life): With AI-based applications proliferating at every level of society, increased security and reliability are crucial. Professor Wenchao Li and his team are developing a combination of computational proof methods and machine learning techniques to make AI systems more trustworthy, and less vulnerable to adversarial influences.

Synthetic Biology, Tissue Engineering & Mechanobiology

Automating a Better Bio-Future: A new computer-aided design program, developed by Professor Douglas Densmore and colleagues, will allow researchers to design and study custom genomes quickly and at a large scale; paving the way to world-changing advances in cancer treatment, reduction in fossil fuel use, and more.

The Cure for a Broken Heart? Unlike some parts of the body, the cells in heart tissue cannot self-repair - so Professor David Bishop and his CELL-MET colleagues are attempting an ambitious new approach: lab-grown tissue for direct transplant to a damaged heart.

Photonics & Optical Systems

Tiny Laser, Large Impact: Utilizing fractional calculus–a novel mathematic approach–Professor Luca Dal Negro and his Utah University collaborator are studying equally novel types of miniaturized laser structures, capable of operating efficiently over multiple frequency bands and releasing so-called "photons on demand."

Illuminating Cancer's Hidden Signposts: Professors Ji-Xin Cheng and Lei Tian are utilizing novel combinations of machine learning and tuned laser pulses to develop innovative microscopic imaging platforms for mapping live cancer cells, in order to investigate a theorized metabolic switch which may be the key to understanding--and combating--drug resistance.

Neuroengineering, Neuroinformatics & Neuroscience

Brain Wave Archivist: Wearable neurological sensors combine near infrared spectroscopy (fNIRS), EEGs and eye-tracking software to create a complete picture of brain activity in real-world conditions. Professor David Boas is developing a cloud-based web platform that will automate the storage of this data and help users standardize its formatting for ease of analysis and meaningful collaboration.

Giving Your Neurons a Nudge: Professors Ji-Xin Cheng and Chen Yang's two ongoing neuromodulation projects could LITERALLY change your mind. In the first, they're investigating a wide array of therapeutic applications for optoacoustic stimulation of neural circuits; in the second, the inhibiting effects of microwaves on those same neurological processes may offer a drug-free form of pain management.

Materials By Design

Accessible Diagnostics, Smaller Magnets: In order to make MRI technology more portable and affordable, Professor Ioannis Paschalidis and fellow BU researchers are developing an ultra-low-field system. To this end, they are developing metamaterials to physically boost the signal from significantly smaller-than-standard superconducting magnets, using a purpose-built computational material designer.

Super-Sensitive, High-Res, Microscopic: Leveraging two major areas of professional competence–cutting-edge nanotechological design and quantum optics–Professors Alexander Sergienko and Abdoulaye Ndao are working to develop novel metasurfaces which can generate entangled-photon inferometric readouts, in order to vastly improve sensitivity and resolution in a new generation of sensors for nano- and microelectronics.

Faculty Recognition

Shining a Light:

Professor Miloš Popović was honored with a **2021 IEEE Region 1 Technological Innovation Award** in recognition of his pioneering work on the development of silicon photonic circuits, as well as his ongoing, cutting-edge contributions.

Emeritus Elected Fellow:

The **Materials Research Society** named eminent **Professor Emeritus Theodore Moustakas** to their **2022 class of fellows**, becoming the latest in a lengthy list of institutions to pay tribute to his career and its impact on industry and society.

A Lifetime of Commitment:

In recognition of his "seminal research in information coding theory and enormous contributions to the promotion of diversity in engineering education," **Professor Robert M. Gray** was awarded the **2020 Okawa Prize** by the Okawa Foundation for Information and Telecommunications.

Celebrated Innovator:

With an impressive array of patents and three company launches under his belt, **Professor Selim Ünlü**, BU's **2021 Innovator of the Year**, embodies the award's core values: transforming cutting-edge research into inventions and products to benefit society.

Taking the Lead

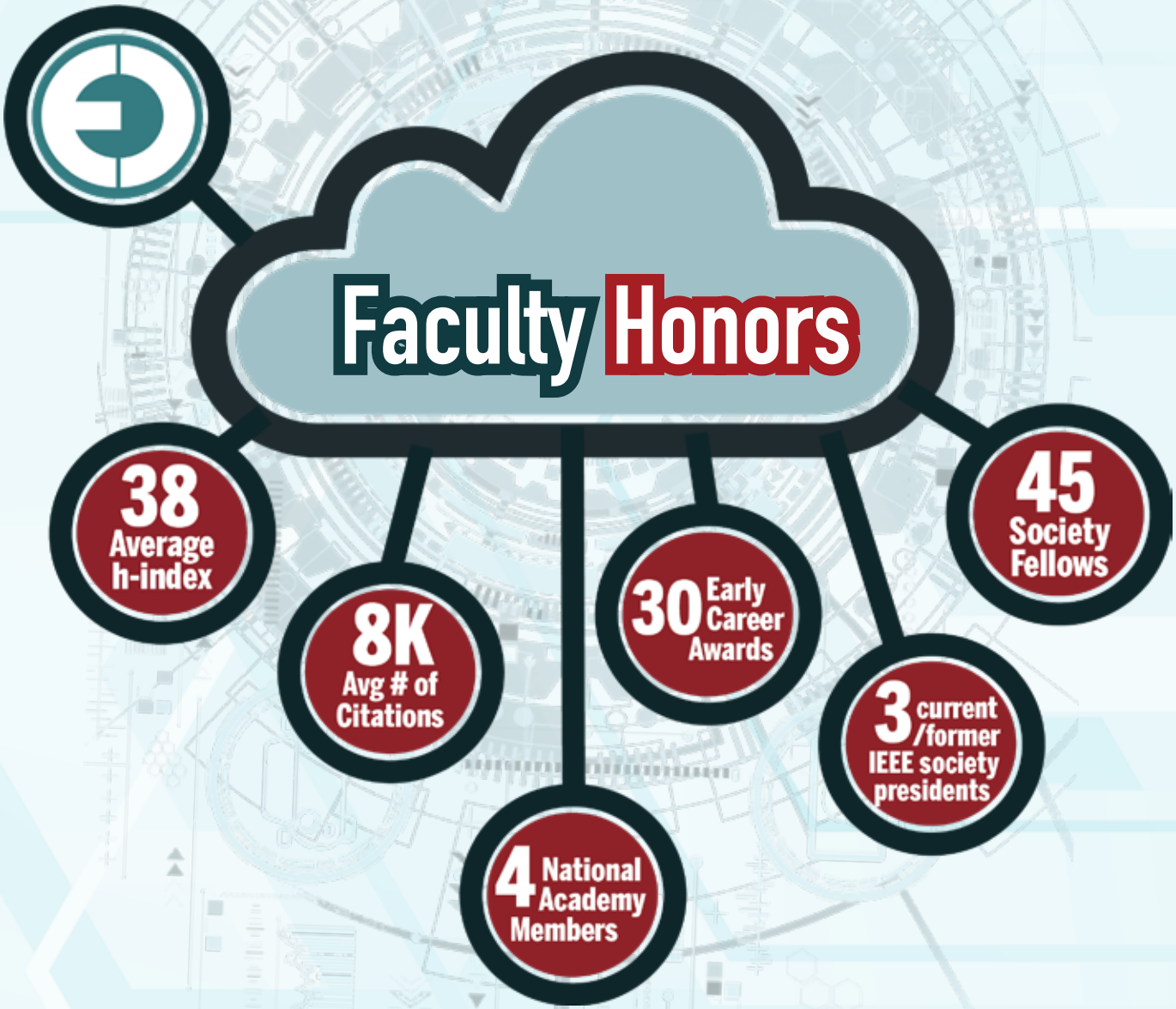
The Rafik B. Hariri Institute for Computing

Professor Ioannis Paschalidis has been appointed the new Director of the Hariri Institute. Recently awarded the title of Distinguished Professor of Engineering, he is widely recognized as a leader in the fields of systems and data science, specifically with regard to applications in computational biology, health, and autonomy.

The Center for Information & Systems Engineering

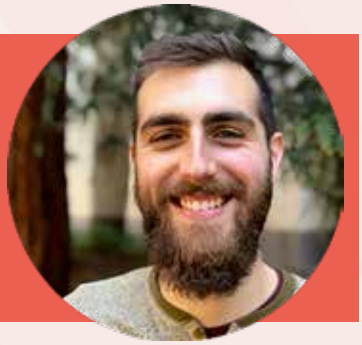
Professor Ayse Coskun, who has been tapped to assume the role of Director, sees BU CISE as, in her own words, "a catalyst," bringing together experts from different specialties to collaborate on projects beyond the scope of their individual fields. Coskun has earned accolades for her research on embedded systems, high performance computing, energy efficiency, and more.

Faculty in Numbers



12%	10%	31	12	8
Female Faculty	URM Faculty	Full Professors	Associate Professors	Assistant Professors

Student & Alumni Achievements



A Highly Acclaimed Dissertation: Dr. Joshua Rapp (PhD '20) was presented with the **2021 IEEE Signal Processing Society Best Ph.D. Dissertation Award** for his doctoral thesis. This is only the latest accolade for Rapp's graduate work, already the recipient of both the 2020 ECE Department Outstanding Dissertation Award, and the 2020 IEEE Signal Processing Society Young Author Best Paper Award.

Making Waves at FiO+LS 2021: Dr. Hayk Gevorgyan (PhD '22) won a prestigious **Emil Wolf Outstanding Student Paper Award** from Optica for a paper presented at the Frontiers in Optics and Laser Science conference,

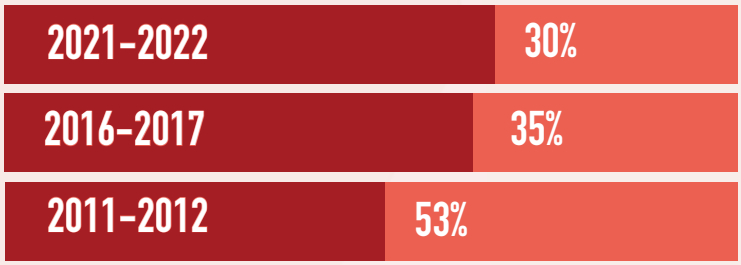
Decoding Potential, Demonstrated: PhD Candidate Arslan Riaz won the **Best Research Demo Award** at the 2022 International Conference on Communication Systems & Networks. As a member of the WISE-Circuits lab, Riaz is engaged in several projects to develop hardware based on GRAND and its novel variations, of which the chip he demonstrated is the first realization.

Boosting Cultural Accessibility with VR: ECE alum Dr. Emily Lam (PhD '20) is collaborating with former advisor Professor Tom Little on a **visionary new start-up, Rtangent**, which offers users the opportunity to explore museums, historical sites, and more, virtually or in augmented (in-person) reality … with a live, human guide with whom they can interact.

Jump-Starting Biotech Career Possibilities for Boston High School Students:

Academic Snapshot

Selective Admissions



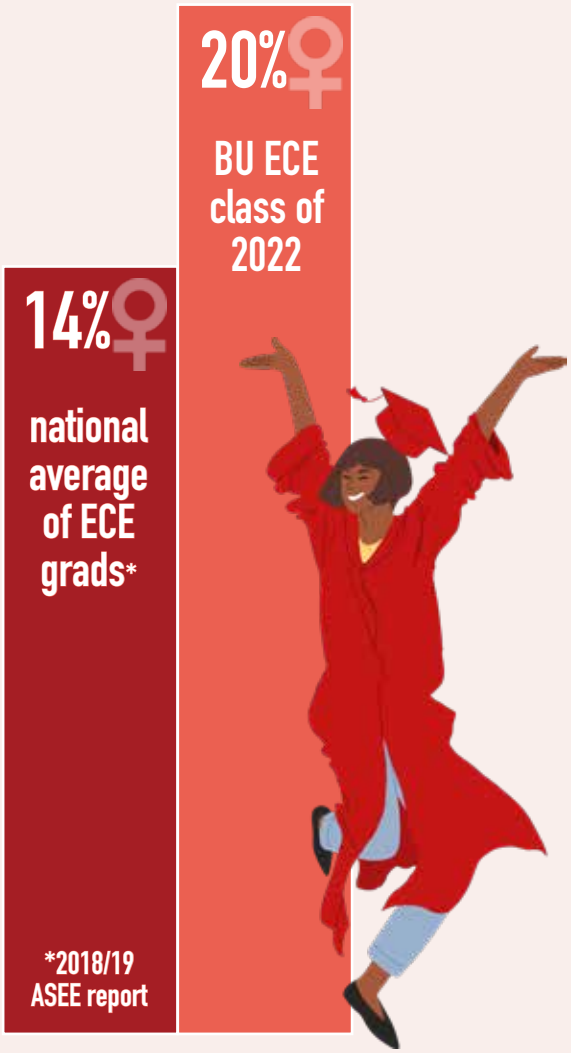
% undergraduate applications accepted

Enrollment

487 undergraduate

162 masters

159 doctoral



BU ECE Women Top National Average for B.S. Degrees!

Professor Douglas Densmore is bringing his passion for education to a new synthetic biology-focused **STEM outreach program** for underserved Boston-area high-school students, building on years of related experience and programming. Funded by a **$2.3M grant** from the **Department of Defense**, more than 600 students (and their teachers) will take part in coursework, research rotations, hackathons, workshops, networking opportunities, and even an international competition; all designed to position them for success in higher education and beyond. "Engineering biology is the future," says Densmore; a future he'll help prepare these students to lead.

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If she builds it...

Professor Rabia Yazicigil is hard at work building the future: chip by tiny chip. In addition to a practical focus on turning theory into working prototypes, and an apparent knack for attracting support from national agencies and private foundations alike, she is an outstanding example of a team player. Recent partnerships with researchers at MIT, The National University of Ireland, and industry have yielded groundbreaking results which could revolutionize wireless communications and dramatically improve healthcare for people around the world who suffer from GI tract illnesses... Her multidisciplinary approach models the best of BU Engineering's convergent research values. "By collaborating with people from diverse backgrounds," she affirms, "we contribute to society and help people."