

WAVELINKS

FALL 2023

ELMORE FAMILY SCHOOL OF ELECTRICAL AND COMPUTER ENGINEERING

ENGINEERING TOMORROW'S WORKFORCE

ECE'S PIONEERING ROLE
IN ADDRESSING THE GLOBAL
SEMICONDUCTOR SHORTAGE

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PURDUE
UNIVERSITY

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MILIND KULKARNI

Interim Head

DAN JIAO

Associate Head of Resource Planning and Management

MITHUNA THOTTETHODI

Interim Associate Head of Teaching and Learning

MICHAEL ZOLTOWSKI

Associate Head of Faculty Mentorship and Recognition

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PURDUE ECE SOARS TO NEW HEIGHTS IN USNWR RANKINGS

**TOP 8
RANKED**

**UNDERGRADUATE
PROGRAMS**

U.S. NEWS & WORLD REPORT, 2024

**#1 RANKED
ONLINE MASTER'S**

ELECTRICAL ENGINEERING

U.S. NEWS & WORLD REPORT, 2023

**TOP 10
RANKED**

**GRADUATE
PROGRAMS**

U.S. NEWS & WORLD REPORT, 2024

PURDUE ECE'S LEGACY OF EXCELLENCE

In the latest rankings from the U.S. News & World Report (USNWR), the undergraduate, graduate, and online degrees offered by the Elmore Family School of Electrical and Computer Engineering (ECE) have once again placed amongst the nation's elite ECE programs.

The top 10 rankings for the undergraduate program include a highest-ever ranking for Computer Engineering, which jumped three spots to No.7. Electrical Engineering had an impressive showing as well, moving up two spots to No. 8.

At the graduate level, Purdue ECE once again garnered recognition for its exceptional offerings. USNWR ranked the Electrical Engineering graduate program No.8. The Computer Engineering graduate program secured No. 10.

The excellence of Purdue ECE extends beyond the confines of traditional classroom education through its online Master of Science in Electrical and Computer Engineering (MSECE) program. The online MSECE has claimed the top spot on the USNWR list for Electrical Engineering programs for the third consecutive year. This accomplishment underscores the department's commitment to delivering high-quality education through online platforms, catering to diverse learners worldwide.

These rankings are a testament to Purdue ECE's dedication to providing exceptional education and advancing the fields of Electrical and Computer Engineering. Across the undergraduate, graduate, and online programs, our climb in the national rankings reflects a commitment to innovation, research, and academic distinction. ///

DIMITRIOS PEROULIS: A VISIONARY JOURNEY LEADING PURDUE ECE

REFLECTING ON ACHIEVEMENTS AND SHAPING THE FUTURE OF THE UNIVERSITY'S LARGEST ACADEMIC DEPARTMENT

Dimitrios Peroulis is reflecting on his time as the Michael and Katherine Birck Head of the Elmore Family School of Electrical and Computer Engineering. After five years leading the department, he left in July 2023 to become the senior vice president for Purdue University Online.

Peroulis has a long history with Purdue ECE, starting in 2003 as an assistant professor. From 2014-2017, he served as the director of graduate admissions for ECE as well as the deputy director of the Birck Nanotechnology Center. He also has been the College of Engineering's academic lead for online learning since January 2018. Despite taking the position with Purdue University Online, Peroulis will continue in the school as is the Reilly Professor of Electrical and Computer Engineering.

Peroulis says it is rare to be part of a community with world-wide impact in innovation, research, learning, and entrepreneurship.

"I am very thankful for the opportunity to have served



"Our School is in a very strong position, and I am even more excited about our future. I am confident that our community will continue to lead in critical areas such as computing, semiconductors and physical AI."

Dimitrios Peroulis /Senior Vice President for Purdue University Online

our incredible current and former students as well as our world-renowned faculty and committed staff," he says. "I have also appreciated the constant encouragement and ceaseless energy within our School and University. Our School is in a very strong position, and I am even more

excited than ever about our future. I am confident that our community will continue to lead in critical areas such as computing, semiconductors and physical AI."

Under Peroulis' leadership, the School has become the nation's largest ECE program

with 120 faculty members and over 3,400 students, while achieving its strongest combined undergraduate, graduate and online rankings. Peroulis recruited more than 30 tenure-track/tenured faculty members and grew externally funded ECE expenditures by 31% to a record \$54 million.

During his tenure, Peroulis helped secure funding to name the School, the Electrical Engineering building, and a new state-of-the-art collaborative research area. The \$25-million gift from alumnus William B. Elmore to name the Elmore Family School of Electrical and Computer Engineering in 2021 has been structured to address both the immediate needs of the School as well as to ensure its long-term impact. A gift from alumnus Max W Brown led to the EE building being named the Max W & Maileen Brown Family Hall (BHEE). The naming has been structured to empower instructional innovation and research growth. The Chiminski Family Collaborative Research Hub was made possible by a gift from alumnus John R. Chiminski and his wife Laura A. Chiminski. This space, located on the second floor of the Materials and Electrical Engineering Building (MSEE), includes high quality, flexible work space for graduate students in multiple disciplines of ECE to work together. The facility improvements will continue after Peroulis' tenure, as renovations to BHEE are already underway.

Peroulis also strengthened the School's Diversity, Inclusion, and Belonging (DIB) efforts. He created a new ECE leadership team, achieving 40% female representation. Peroulis also organized and scaled-up DIB initiatives within the Project for Inclusion in ECE (PIECE) committee including: the first College-wide training program for all undergraduate and graduate TAs (2019); the first formal DIB ECE interview plan with specific feedback to the Head for all prospective faculty (2021); and the first departmental broadening participation plan with measurable success metrics (2022-2023).

Six new ECE-led interdisciplinary Centers/Institutes were launched under Peroulis' leadership, including three Elmore Emerging Frontiers Centers.

As the academic lead for online learning in the College of Engineering, he launched six new online graduate programs for the college, numerous credentials, and increased online enrollment by roughly 2.5 times. At the same time, he improved the College's U.S. News & World Report online program ranking from #5 (2018) to #2 (2023). Purdue online master's degrees in Electrical Engineering, Industrial Engineering, Mechanical Engineering and Engineering Management all rank No. 1 for 2023, as they did in 2022. The online Civil Engineering master's is No. 2, also the same as in 2022. Purdue's online master's program in electrical and computer engineering has been ranked No. 1 for three consecutive years, while increasing enrollment from 37 (Spring 2020) to 512 (Spring 2023).

Peroulis managed to achieve these milestones during what was a challenging time for higher education — the COVID-19 pandemic. Despite the disruption to traditional semesters, the School sustained enrollment and academic success, fully implementing

Purdue University's plan to offer both in-person and online classes. Besides creating the necessary structures to achieve this, the School also focused on supporting individuals with urgent needs, including raising more than \$74,000 to support 81 students with immediate financial struggles.

While the university launches an international search for a new leader of ECE, Milind Kulkarni has been appointed the interim head. Peroulis says he is confident Kulkarni will keep the School on the right track.

"He's someone who knows the school really well," says Peroulis. "I know he will be great at aligning the School with everything we need to do university-wide and at the College level." ///



Dimitrios Peroulis gives remarks at an event honoring Max W Brown and his family for his contributions to the School at the dedication of the Max W and Maileen Brown Family Hall of Electrical Engineering on September 12, 2022. (Purdue University photo/Dave Mason)

LEADERSHIP TRANSITION IN MOTION FOR PURDUE ECE

MILIND KULKARNI ASSUMES INTERIM DEPARTMENT HEAD ROLE AND
OUTLINES VISION FOR THE FUTURE



*Milind Kulkarni, Interim Head and Professor of Electrical and
Computer Engineering(Purdue University photo/Christine Petkov)*

The interim head of Purdue's Elmore Family School of Electrical and Computer Engineering has started his new role. In addition to serving as department head, Milind Kulkarni will also be the academic lead for Purdue Engineering Online. He takes over for Dimitrios Peroulis, who stepped down June 30, 2023, to take over as the new senior vice president for Purdue University Online.

"I've been very lucky to have Dimitri as a mentor and somebody that I have worked with over the last many years. They're big shoes to fill," says Kulkarni. "He's put ECE on a really great path and so, honestly, I think my job like any interim leader is to make sure that we stay on that trajectory. It's a little bit like the Hippocratic Oath, 'First, do no harm.'"

Peroulis says he has every confidence in Kulkarni to lead the department.

"He has the right mentality and approach to leading a big school," says Peroulis "He understands the complexity of the system at the Purdue and College of Engineering levels very well."

As head of the largest school in the College of Engineering and the largest ECE department in the nation, Kulkarni will lead 120 faculty members and roughly 3,500 undergraduate and graduate students. He joined the ECE faculty 14 years ago and says he considers the department his home.

"I love all the people that I work with and all the things I get to do here," says Kulkarni. "The opportunity to keep growing the department in the direction it's been going and keep doing the great things we've been doing and keep a steady hand on the ship until we find our next leader to take us to the next level was really attractive."



Milind Kulkarni is seen in his office during filming for Purdue Engineering Office Hours YouTube series. (Purdue University)

He says along with the rest of Purdue Engineering, ECE has grown tremendously over the last five years. Kulkarni says the growth has come at all levels, with more undergraduate and graduate students than ever and more faculty, as well.

“We’ve also established and really grown our online programs – our online master’s degree is the number 1 program in the country,” says Kulkarni. “We want to keep that going strong and continue growing the program and giving the opportunity of getting a Purdue ECE education to more students.”

Kulkarni says the opportunity to keep making Purdue ECE an exciting place for undergraduates is stimulating. He says the tremendous growth in undergraduate enrollment can be attributed, in part, to growth in areas such as artificial intelligence and machine learning, software engineering, and semiconductors.

“These are areas of growth for not only Purdue but the country for the next five or 10 years,” says Kulkarni. “So it’s really exciting to keep moving in that direction and take it to the next level by providing more opportunities to students like more educational programs, more internship programs, and more opportunities for students to connect with companies and alumni.”

Kulkarni points to two initiatives happening at the Purdue level that will provide significant opportunities to ECE’s faculty and students -- the Purdue Computes initiative and the new Purdue campus in Indianapolis.

“Purdue COMPUTES is a big investment into computing, both in terms of infrastructure and research capabilities and in terms of human investment,” says Kulkarni. “That’s my own area, I work in computer engineering, so the opportunity to be in on the ground floor of this effort and think about what this means for ECE is really appealing.”

He says he sees a lot of important opportunities for ECE at the Indianapolis campus.

“My undergraduate institution is North Carolina State. Because of NC State’s position in the Research Triangle of North Carolina, there were a lot of opportunities for working professionals to come take classes at NC State and get their degrees,” says Kulkarni. “Purdue offers that choice to people in the form of online programs, but that doesn’t work for everybody. So the opportunity to be in a big city and offer those opportunities from ECE to folks that live there is amazing.”

When he’s not working, Kulkarni likes to spend time with his wife, Monique, and their 7-year-old-daughter and 5-year-old son.

“One of the things I really like about being here is that I feel like I have a very good work-life balance,” he says. “I’m able to be in this dynamic, exciting department and do all sorts of cool things, but I’m still able to go home and go to my daughter’s dance recital or go to my son’s T-ball game.”

Kulkarni says he also likes to travel, read, play the piano and mandolin, and go to the movies.

He expects to serve as interim head of ECE for six months to a year, while an extensive search for a permanent head takes place. ///

FORMER ELECTRICAL ENGINEERING BUILDING NAMED MAX W & MAILEEN BROWN FAMILY HALL, RENOVATIONS UNDERWAY

A VISION FOR A MODERN, COLLABORATIVE, AND INNOVATIVE ECE FACILITY

In September 2022, Purdue University celebrated the naming of the Electrical Engineering Building on campus as the Max W & Maileen Brown Family Hall (BHEE). The naming is in recognition of a generous gift from alumnus Max W Brown (BSEE '70), his wife, Maileen, and their children, Max G and Ash.

In April 2023, the School launched a fundraising campaign to renovate the building. The project will transform BHEE into a modern and world-class ECE facility, equipped with the latest technology and resources to enhance teaching, learning, and research, and accommodate and support Purdue ECE's ever-increasing student enrollment and research needs.

"Our vision is to transform the EE building into a best-in-class facility that inspires the next generation of leaders in ECE," says Dan Jiao, Associate Head of Resource Planning and Management and Synopsys Professor of ECE. "We envision a space that is innovative, collaborative, and welcoming, where ECE's proud history meets modern technology, and students engage in experiential learning, collaborative research, and discovery."

The renovated space will include cutting-edge undergraduate instructional labs, collaborative graduate research spaces, inviting student lounge, TA and student collaboration space, renovated restrooms, as well as improved accessibility and energy efficiency. The fundraising campaign includes naming opportunities for many of these spaces.

Work is expected to be complete by August 2024. *///*



The Brown Family poses for a photo in front of the MSEE building during a visit to campus. (Purdue University photo/Dave Mason)



Rendering of the proposed TA and student collaboration space that will be located at the north end of the instructional labs.



Rendering of a newly renovated ECE Electronics Shop which provides students with free parts and support on their projects.



Rendering of a new instructional lab that will support the growing ECE student population for years to come.



BIRCK NANOTECHNOLOGY CENTER TO RECEIVE SIGNIFICANT UPGRADE

INVESTMENT IN RESEARCH FACILITY ADVANCES SEMICONDUCTOR INNOVATION

As part of Purdue Computes, a three-pronged strategic initiative launched in April 2023 to further scale research and educational excellence in the future of computing, Purdue University announced significant upgrades to the Birck Nanotechnology Center. This includes an investment of \$49-million in semiconductor cleanroom upgrade.

“Birck Nanotechnology Center has for decades been a critical home for discovery and technology development, both for Purdue researchers and those from industry and other universities who use our facilities,” says Zhihong Chen, the Mary Jo and Robert L. Kirk Director of the Birck Nanotechnology Center

and professor in the Elmore Family School of Electrical and Computer Engineering. “This investment will ensure that we maintain our state-of-the-art facilities, reclaim more space, and establish new capabilities for semiconductor R&D.”

Upgrades will include procurement of specialized equipment for device fabrication and characterization, an effort to increase capacity in the 25,000-square-foot Scifres Nanofabrication Laboratory cleanroom, one of the largest academic cleanrooms in the nation. It will include a dedicated training bay for use in training those enrolled in the university’s Semiconductor Degrees Program, such as Purdue

undergrads, Ivy Tech students, and engineers in the field.

The upgrades will also create dedicated cleanroom and lab space for advanced packaging research – innovations in design, materials, and processing that are needed to integrate chiplets with different functionalities - and shared quantum transport and characterization facilities, which are important to future electronic and quantum information science applications. Work is expected to be completed in August 2024. The installation of new equipment in the renovated space will start in the first quarter of 2024. ///



Laura (left) and John (right) Chiminski pose for a photo with Purdue Pete at the dedication of the Chiminski Collaborative Research Hub on September 29, 2022. (Purdue University photo/Kristin Malavenda)

PURDUE ECE DEDICATES CHIMINSKI COLLABORATIVE RESEARCH HUB

The Chiminski Family Collaborative Research Hub opened in 2022 on the second floor of the Materials and Electrical Engineering Building (MSEE). The cutting-edge research space was made possible by a generous gift from alumnus John R. Chiminski and his wife Laura A. Chiminski.

“Laura and I are thrilled to enhance the research and collaboration experience of future generations of engineering students at Purdue,” said John Chiminski. “I’ve had the honor of chairing the School’s advisory board for the last decade, and continue to be impressed by the quality of this program and many accomplishments of our graduates around the world.”

The renovated area includes high quality, flexible work space for graduate students in multiple disciplines of ECE to work together; a project demonstration and poster presentation space surrounded by floor to ceiling glass to showcase the latest technologies from the Elmore Family School of Electrical and Computer Engineering; and a modern 10-person meeting room. ///

2022 OUTSTANDING ELECTRICAL AND COMPUTER ENGINEERS HONORED

The Elmore Family School of Electrical and Computer Engineer honored six alumni during the 30th annual Outstanding Electrical and Computer Engineering (OECE) awards ceremony. The OECE award was established by Purdue ECE in 1992 to honor the professional contributions of top graduates, and to thank them for the recognition their achievements bring to both Purdue and to the School.

The OECE ceremony took place September 29, 2022, in the Shively Club at Purdue University's Ross-Ade Stadium. The celebration is a highlight event each year. We look forward to honoring another class of OECEs in 2023. ///

Honorees included:

- George H. Goble (BSEE 1975)
- Jeff Gordon (BSEE 1983)
- Jennifer Graves (BSCEE 1986)
- Charles Mok (BSEE 1985, MSEE 1987)
- Jung-Min “Jerry” Park (PhD ECE 2003)
- Janet Y. Spears (MSEE 1988)
- Shawn D. Williams (BSEE 1985)



From left: John Chiminski, Barrett Caldwell, James Eaton, Janet Spears, Jennifer Graves, Jeff Sanders, Jung-Min Jerry Park, Charles Mok, and Dimitrios Peroulis at the 2022 OECE Awards. (Purdue University photo/Vincent Walter)



DR. HARSHITA SINGH WINS 2022 EATON AWARD IN DESIGN EXCELLENCE

Dr. Harshita Singh is the winner of the 2022 Eaton Award in Design Excellence. This unique award program recognizes outstanding work in the field of design by recent alumni and encourages promising young engineers to continue their work in design by recognizing their early achievements in the field. Singh is being recognized for work she did while a PhD student, part of which focuses on the design and construction of a new device, a “common-mode shorting network” (CMSN). The work proposes a new tool for CM mitigation. ///

Dr. Harshita Singh (right) with Professor James Eaton (left). (Purdue University photo/Vince Walter)



Professor Dave Meyer (left) stands with the recipients of the Undergraduate Teaching Awards. (Purdue University photo/Kristin Malavenda)

UNDERGRADS RECOGNIZED WITH 2023 UNDERGRAD EXCELLENCE AWARDS

The second annual ECE Undergrad Excellence Awards recognized the efforts of undergraduate students who help with classes as undergraduate teaching assistants, are integral parts of research groups, embark on incredible design projects, and perform all manner of service to the department through student societies and other volunteer groups. ///

UNDERGRADUATE TEACHING AWARDS

Bryston Cotton
Jonathan Lane
Nicole Wang
Kathleen Stevenson
David Nickel
Brian Yuan

UNDERGRADUATE RESEARCH AWARDS

Darren Wu
Xinyu Yang

UNDERGRADUATE SERVICE AWARD

Denae Galloway

SENIOR DESIGN AWARDS

Project Arbr: Gabrielle Whitis, Benjamin Pemberton, and Hugo Day

Project R.A.C.H.E.L.: James Hubbard, Micah Morefield, Jack Meyers, and Bartosz Stoppel

It's Called (Car) Soccer: Vaishakh Deshpande, Aaryan Garg, Justin Qualley, and Peter Sperry

Guitar Multi-FX Pedal: David Nickel, Henry Oo, John Ramthun, and Michael Scirocco

Real Time Health Tracker: Celia Parker, Jack Detweiler, Lucas Brookes, and Juan Carlos Guadiano

PURDUE ECE TO PLAY A KEY ROLE IN NEW 3-PRONGED 'PURDUE COMPUTES' INITIATIVE

EMPOWERING FACULTY, RESEARCH, AND SEMICONDUCTOR INNOVATION AT PURDUE UNIVERSITY



As student interest in computing-related majors and the societal impact of AI and semiconductor chips continues to rise rapidly, Purdue University is embarking on a major initiative, Purdue Computes. The effort consists of three dimensions: academic resource of computing departments, strategic artificial intelligence research, and semiconductor education and research. The Elmore Family School of Electrical and Computer Engineering will play a major role in the success of Purdue Computes.

The first pillar is a significant investment in Purdue's computing faculty:

- Similar to the Purdue model of Agricultural and Biological Engineering, which has ranked No. 1 in the country, the Department of Computer Science will have affiliations with both the College of Science and the College of Engineering. Productive collaborations spanning computer engineering and other areas in the Elmore Family School of Electrical and Computer Engineering, which offers a minor in AI applications, will follow.
- Over the next five years, across Computer Science, Computer Engineering and related departments, 50

Purdue has entered into another landmark international agreement, this one with the government of India, to advance workforce development, research and development, and industry partnerships in semiconductors. At a signing ceremony on May 9 are, from left, Purdue President Mung Chiang and Vijay Raghunathan, Purdue professor and Associate Head of Graduate and Professional Education for Electrical and Computer Engineering and Director of Semiconductor Education for Purdue. (Purdue University photo)

Where the
physical meets
the virtual.

THAT'S OUR

*GIANT
LEAP*



FACTS & FIGURES

STRIVING TO BE FIRST, BEST, AND
ONLY IN EVERYTHING WE DO

/// FACULTY

126

TOTAL FACULTY, AND
STILL GROWING

39

IEEE FELLOWS

11

OPTICA FELLOWS

7

NATIONAL ACADEMY
OF ENGINEERING
MEMBERS

4

SPIE
FELLOWS

/// RESEARCH & INNOVATION

\$54

MILLION IN ANNUAL
RESEARCH AWARDS

37

PATENTS AWARDED
TO ECE FACULTY IN
FY23

8

NATIONAL ACADEMY
OF INVENTORS
MEMBERS

3

ELMORE EMERGING
FRONTIERS
RESEARCH CENTERS

2

SRC DARPA CENTERS:
COCOSYS,
COGNISENSE

2

NSF ERC CENTERS:
IOT4AG, ASPIRE

/// UNDERGRADUATE STUDENTS

2049

ENROLLED
FALL 2023

1299

COMPUTER
ENGINEERING

750

ELECTRICAL
ENGINEERING

/// GRADUATE STUDENTS

1418

ENROLLED
FALL 2023

127

ON-CAMPUS
THESIS MS

493

ONLINE MS

97

PROJECT TRACK
MS

545

PHD

156

4+1 BS/MS



PURDUE UNIVERSITY TAKES CENTER STAGE IN ADDRESSING GLOBAL SEMICONDUCTOR SHORTAGE

ECE LEADS THE WAY WITH CRITICAL RESEARCH, EDUCATION, AND PARTNERSHIPS



Mark S. Lundstrom, Don and Carol Scifres Distinguished Professor of Electrical and Computer Engineering

Semiconductors are a crucial element in the manufacturing of many consumer electronics we use on a daily basis, such as smartphones, cameras and automobiles. The COVID-19 pandemic initiated a shortage of semiconductors, mainly due to a surge in buying laptops and other devices needed for remote work and school. An ongoing semiconductor shortage would damage every industry, weaken global security, and change everyday life as we know it.

As the United States strives to reclaim a leading role in the global semiconductor industry, Purdue University is acting to ensure the nation is prepared to meet the ever-growing demands for these essential components in virtually all of our electronic devices.

“A university that wants to be the most consequential university in the nation should address the most consequential problem that the country currently faces,” said Mark Lundstrom, Purdue’s Chief Semiconductor Officer and Special Advisor to the President and Don and Carol Scifres Distinguished Professor of ECE. “And that problem is the semiconductor challenge because it underlies everything else that we want to do. So I think the fact that we have made this not only an engineering priority, but a university priority -- that we feel we have a responsibility to help the nation address this challenge-- that’s what the most consequential university would do.”



The Elmore Family School of Electrical and Computer Engineering is playing a key role in these efforts. From education to global partnerships to research and new centers, Purdue ECE is working hand-in-hand with industry, government, and academia to train the next generation of workers, bring high-tech jobs onshore and ensure that the next big breakthroughs happen right here in what Purdue President Mung Chiang has called the budding Silicon Heartland.

INNOVATIVE EDUCATION

Purdue's Semiconductor Degrees Program (SDP) is the first comprehensive set of innovative, interdisciplinary degrees and credentials in semiconductors and microelectronics in the country. The SDP is advised by an industrial board consisting of CTO/EVP-level executives of more than 25 leading global semiconductor companies, including Microsoft, Texas Instruments, IBM, and Qualcomm. The program will educate both graduate and undergraduate students, enabling a quick ramp-up of skilled talent and creating a next-generation semiconductor workforce.

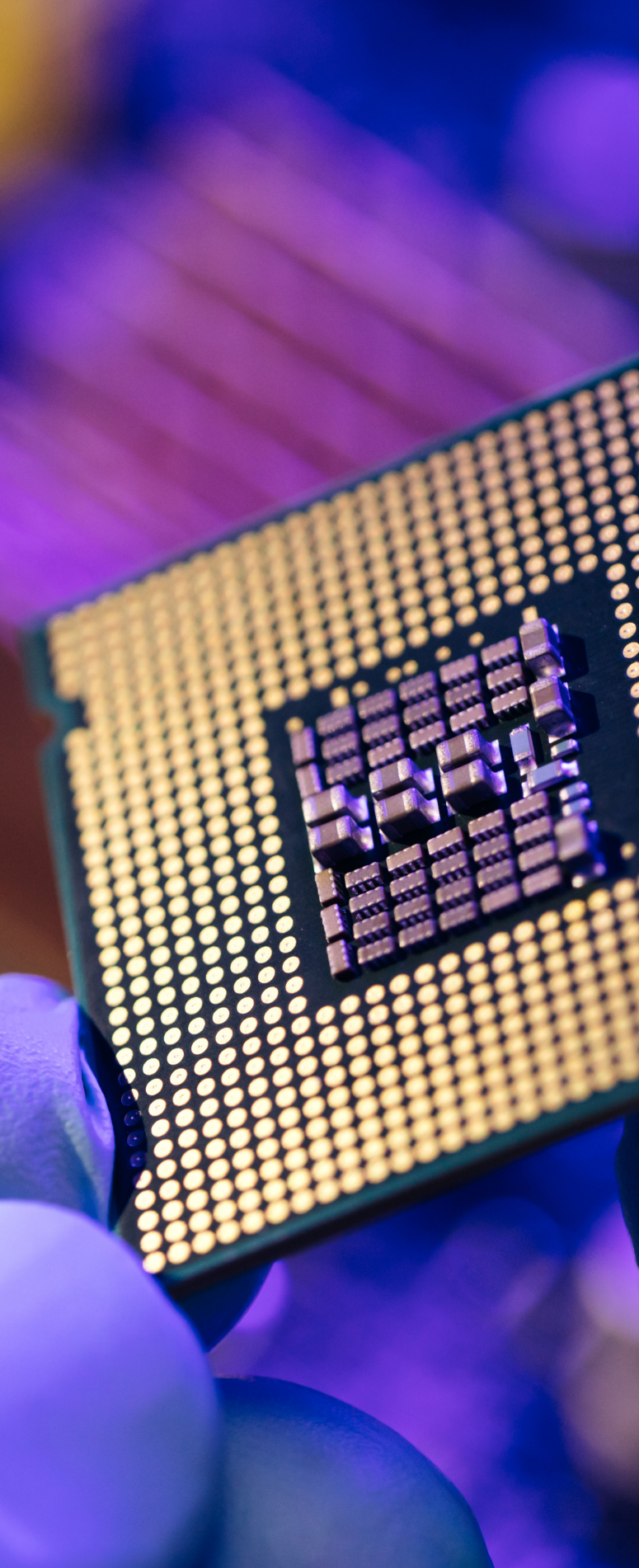
Purdue has also partnered with Ivy Tech Community College, the nation's largest singly-accredited statewide community college system, to develop industry-driven credentials and experiential programs. For instance, with funding from the Indiana Economic Development Corporation's READI program, Purdue and Ivy Tech have developed a new semiconductor workforce development program for the Greater Lafayette region. The two-week program

Purdue started the Summer Training, Awareness and Readiness for Semiconductors (STARS) program this year to jump-start students' training for careers in the semiconductor industry. (Purdue University photo by John Underwood)

targets high school juniors and seniors, using hands-on activities, visits to area manufacturers, and talks from industry leaders to build a pipeline of bright young minds pursuing education and employment in the semiconductor industry.

Purdue has developed an interactive, seminar based, one-credit hour course to introduce semiconductor technology, its role in everyday life, impact, and career opportunities to science and engineering students. Introduction to Semiconductors is being taught by Muhammad Hussain, professor of electrical and computer engineering, and is offered both in-person and online. Every week industry representatives discuss relevant semiconductor products, company profiles, career prospects, and answer questions from students.

Upon completion of the Introduction to Semiconductors course, students will be offered opportunities to develop deep-tech skills like Integrated Circuit (IC) design, fabrication and packaging, and semiconductor device and materials characterization through the Purdue Summer Training, Awareness, and Readiness for Semiconductors (STARS) program. The STARS program has two tracks: chip design and semiconductor manufacturing, and is the equivalent of a summer internship.



Semiconductors, crucial in the manufacturing of consumer electronics, were scarce during the Covid-19 pandemic. (iStock)

CUTTING-EDGE RESEARCH CENTERS

The faculty of the Elmore Family School of Electrical and Computer Engineering lead and engage in a wide range of research related to semiconductors and microelectronics. Some lead centers where this is the sole focus. Purdue ECE faculty have been tapped for leadership positions in two new research centers launched by the Semiconductor Research Corporation (SRC) and the Defense Advanced Research Projects Agency (DARPA) through the Joint University Microelectronics Program 2.0 (JUMP 2.0).

Research conducted in the Center for the Co-Design of Cognitive Systems (CoCoSys) seeks to enable seamless human-AI collaboration. Researchers will enable human-AI systems through synergistic advances in neuro-symbolic-probabilistic algorithms, technology-driven hardware motifs, algorithm-hardware codesign, and collective and collaborative intelligence. Anand Raghunathan, Silicon Valley Professor in ECE, is the Purdue principal investigator and associate director of CoCoSys. Co-PIs are Kaushik Roy, the Edward G. Tiedemann Jr. Distinguished Professor in ECE; Vijay Raghunathan, ECE professor, associate head of graduate and professional programs, and director of semiconductor education; and Sumeet Gupta, ECE associate professor.

Vijay Raghunathan, professor of electrical and computer engineering and director of semiconductor education, is the Purdue PI of the Center on Cognitive Multispectral Sensors (CogniSense). Stanley Chan, associate professor of ECE, is the co-PI. CogniSense addresses the demand for high-quality unobstructed perception for the safe operation of emerging autonomous systems. By designing sensors that dynamically adapt to “what is being sensed” and “how sensed signals are processed” according to real-time changes in the environment, CogniSense research is projected to dramatically reduce the volume of data produced by these sensors.

“The Elmore Family School of Electrical and Computer Engineering at Purdue has a rich history of leadership in SRC-funded research,” said Dimitrios Peroulis, the former Michael and Katherine Birck Head and Reilly Professor in the Elmore Family School of Electrical and Computer Engineering. “We are excited that our faculty are key contributors to these new centers that will strongly impact the future of cognitive sensing and computing systems.”

GROUNDBREAKING RESEARCH

Purdue research in semiconductors spans the “full stack” from materials and devices, to circuits, systems, and architecture. Once again, Purdue ECE researchers are at the forefront of these efforts.

- The Rapid-HI Design Institute is a multidisciplinary effort led by faculty from the Elmore Family School of Electrical and Computer Engineering - Dan Jiao, Synopsys Professor of ECE and Associate Head of Resource Planning and Management, Cheng-Kok Koh, professor of ECE, and assistant professors of ECE Joy Wang and Qiang Qiu. The goal of the Institute is to automate the Heterogeneous Integration (HI) design from intent to fabrication. Heterogeneous integration (HI) is the assembly and packaging of individual components, such as CPUs, GPUs, memory, FPGAs, transceivers, and power regulators, which are separately manufactured or designed using diverse technologies and different semiconductor processes onto a single substrate.
- Kaushik Roy, Edward G. Tiedemann Jr. Distinguished Professor of ECE, and Anand Raghunathan, Silicon Valley Professor of ECE, lead research on new approaches to information processing in C-BRIC, the \$36M SRC/DARPA Center for Brain-inspired Computing and in the Institute for Cognitive Computing. The goal is to deliver key advances in cognitive computing to enable a new generation of autonomous intelligent systems.
- Under the leadership of Peide “Peter” Ye, Richard J. and Mary Jo Schwartz Professor of Electrical and Computer Engineering, Purdue faculty are actively engaged in the exploration of novel electronic materials and devices for post-Moore era semiconductor technologies. One of the utilized technologies is called atomic layer deposition (ALD), which is a key process in fabricating semiconductor devices in particular as the dimension of state-of-the-art device technology is approaching single-digit nanometer length scales.
- Probabilistic Spin Logic (PSL) is a novel approach for information processing that is being explored by a team led by Supriyo Datta, Thomas Duncan Distinguished Professor of Electrical and Computer Engineering, Zhihong Chen, professor of ECE and Mary Jo and Robert L. Kirk Director of Birck Nanotechnology Center, and Joerg Appenzeller, Barry M. and Patricia L. Epstein Professor of Electrical and Computer

Engineering. The team has published many other breakthroughs, most notably an experimental demonstration of optimization and invertible logic using unstable magnetic tunneling junctions (MTJs), and the feasibility of MTJs to demonstrate that complex circuit operations are achievable in realistic hardware systems.

- Appenzeller, Chen, and Ye, along with Muhammad Ashraful Alam, Jai N. Gupta Professor of Electrical and Computer Engineering, and David B. Janes, professor of ECE, are actively engaged in the exploration of emerging logic, memory, and interconnected technologies. The team has focused on experimental demonstrations of these technologies based on novel materials including low-dimensional materials and ferroelectrics.

Under the leadership of Prof. Alam, Purdue is well-known for fundamental work on the reliability physics of semiconductor logic and memory devices, both for application-specific consumer electronics and radiation-hardened secure electronics for defense applications.



During the two-week READI program, high school students work on a paper electronic project. (Purdue University photo)



Leaders from Purdue University and various Greek universities and organizations gathered to sign a series of MOU. (Niki Pateraki photo)

GLOBAL PARTNERSHIPS

Purdue is now the only university in the nation with bilateral partnerships in semiconductors with Europe, India and Japan.

Vijay Raghunathan, director of semiconductor education at Purdue and a professor of ECE, says these agreements send a very strong message.

“It is a reflection and a recognition of Purdue being not just America’s leading university in semiconductor workforce and R&D but also blazing a trail globally in terms of academic institutions putting together international partnerships,” said Raghunathan.

These agreements mark Purdue’s ongoing global outreach effort to help ramp up skilled talent for the next generation of the semiconductor workforce.

- Purdue University entered into a transformative agreement to become the flagship academic partner and collaborator with the government of India. Purdue is established as a key collaborator with India and the India Semiconductor Mission (ISM) in skilled workforce development and joint research and innovation in the burgeoning fields of semiconductors and microelectronics.
- A series of Memoranda of Understanding between Purdue and four universities in Greece will create vital academic, research, and innovation collaboration among the partners, and study abroad opportunities for Purdue students. An agreement with the American-Hellenic Chamber of Commerce for Purdue to offer training for workforce development in Greece and also for companies and industry in Greece to partner with faculty at Purdue and pursue research and innovation.

- Purdue signed a landmark international agreement, partnering with Micron, Tokyo Electron, and other educational institutions in the United States and Japan to establish the “UPWARDS Network” for workforce advancement and research and development in semiconductors.
- Purdue University and the state of Indiana reached a first-of-its-kind agreement with a cutting-edge European nano- and digital technology innovation hub, Interuniversity Microelectronics Centre (imec). imec will have a presence on Purdue’s campus, working side-by-side with faculty and students at the Birck Nanotechnology Center. Additionally, Purdue students and faculty will have an opportunity to work in Belgium.
- Purdue University and the Indian Institute of Technology Madras (IIT Madras) will soon launch a dual-degree master’s program in semiconductors as part of a newly signed agreement to cooperate in education and research in semiconductors and microelectronics. The proposed dual-degree program will focus on an innovative, cooperatively developed curriculum to meet the industry’s growing needs. The partnership would also involve research collaboration.

The Elmore Family School of Electrical and Computer Engineering is uniquely positioned to help Purdue achieve its goals related to semiconductors and microelectronics: research and development, workforce development, and business growth. Purdue ECE is continually strengthening its leadership in the semiconductor and microelectronics industry, making significant investments in developing the next generation workforce and supporting novel research to usher in new processes and technologies. ///

RESEARCHERS UNCOVER A NEW METHOD FOR GENERATING SPINNING THERMAL RADIATION

TEAM LED BY PROF. ZUBIN JACOB REVOLUTIONIZES THERMAL RADIATION
GENERATION FOR APPLICATIONS IN INFRARED TECHNOLOGY

Researchers at Purdue University have made a groundbreaking discovery in the field of thermal radiation, uncovering a new method for generating spinning thermal radiation in a controlled and efficient manner using artificially structured surfaces, known as metasurfaces. The team, led by Zubin Jacob, Elmore Professor of Electrical and Computer Engineering, published its findings in the journal *Science Advances*.

Thermal radiation, which originates from random fluctuations in materials, is traditionally considered an incoherent signal. Most conventional thermal emitters show weak to zero circular polarization in the emitted heat. Surprisingly, the thermal radiation reaching the earth from many astronomical objects possesses significant circular polarization. This intriguing phenomenon leads to the discovery of strong magnetic fields in some condensed stars, offers explanations of puzzles about the early universe, and even provides a possible signature of life.

“Spinning thermal radiation is extremely rare in nature and is only found in some condensed stars,” says Jacob. “Our work provides a new way to generate this type of radiation, which has potential in a variety of applications, including thermal imaging and communication.”

The researchers discovered that by using a metasurface made up of an array of F-shaped structures, they were able to generate predominantly left-handed circularly polarized thermal radiation in all directions, resulting in non-vanishing optical helicity for the first time. The team reached 39% of the fundamental limit in optical helicity with their design and also showed that the characteristics of emitted thermal photons can be tailored by the

symmetries of the metasurface, demonstrating effective control over thermal radiation in its various properties.

The unique spin textures of the engineered thermal emission from our metasurfaces can be exploited as high-contrast infrared beacons in outdoor environments, as the background thermal emission from other natural objects is highly incoherent without any spin textures. The research was funded by the DARPA Nascent Light Matter Interaction (NLM) program. ///



Zubin Jacob, Elmore Professor of Electrical and Computer Engineering



Purdue University engineers, from left, John Haddock, Nadia Gkritza, Dionysios Aliprantis and Steve Pekarek stand in the lab where they are testing technology they designed to enable electric vehicles to receive power from the road. (Purdue University photo/Vincent Walter)

BUILDING THE FIRST HIGHWAY SEGMENT THAT CAN CHARGE ELECTRIC VEHICLES AS THEY DRIVE

If you've wanted an electric vehicle but worry how far you could drive between charges, Purdue University engineers and the Indiana Department of Transportation are working on a solution: highways that could wirelessly charge EVs on the go.

An electrified highway in Indiana would serve much of the nation's traffic. Eighty percent of the U.S. is within a day's drive from the state's pass-through highways.

The research team, including Dionysios Aliprantis, professor of electrical and computer engineering, and Aaron Brovont, a research assistant professor of ECE, plans to construct a quarter-mile test bed to provide power to heavy-duty trucks on U.S. Highway 231/U.S. Highway 52 in West Lafayette. In the next several years, the hope is to electrify a section of interstate.

The results of this study are a step toward figuring out how

to transfer high power to longer stretches of pavement at highway speeds and equip EVs to obtain power along them. As reported by The New York Times, CNBC, Scripps, and other news outlets, the research has the potential to define the future of EV charging.

The project is funded by INDOT through the Joint Transportation Research Program at Purdue. It is also affiliated with a National Science Foundation Engineering Research Center called Advancing Sustainability through Powered Infrastructure for Roadway Electrification (ASPIRE). Utah State University leads ASPIRE in partnership with Purdue, the University of Colorado Boulder, the University of Texas at El Paso and the University of Auckland in New Zealand. Nadia Gritzka, associate professor in the Schools of Civil Engineering and Agricultural and Biological Engineering, is the campus director of ASPIRE's Purdue location.

Researchers anticipate it may be 20 to 30 years before EVs can receive the power they need while driving at highway speeds. It would be up to manufacturers to decide whether to incorporate receiver coils into their vehicles. ///

PURDUE AGRIVOLTAIC FARMING STRUCTURES AND SOFTWARE HARVEST SOLAR POWER MORE EFFICIENTLY

INNOVATIVE MODULES ARE MOUNTED LOW AND ROTATE TO ALLOW FARM EQUIPMENT TO PASS

Purdue University researchers have improved upon traditional solar energy structures used in agrivoltaic farming, a sustainable system that generates electricity from the sun while row crops like corn, rice, soybeans and wheat concurrently grow on the same land.

The patent-pending Purdue structures and software optimize food production for farmers and maximize solar energy production. Research about the improved agrivoltaic panels was published in the January 2023 issue of the peer-reviewed IEEE Journal of Photovoltaics. It also has been published in the Journal of Photovoltaic Technology and Nature Sustainability and presented at IEEE Photovoltaic Specialists conferences.

Traditional agrivoltaic structures cast shadows, decreasing crop yield. These structures are also incompatible with large-scale agriculture because they are mounted high to allow farm equipment to freely move around them. This requires a deeper foundation, which dramatically increases the cost. The Purdue modules are mounted much lower, which makes the system more affordable and decreases the time needed for a return on investment.

Muhammad Ashraful Alam, the Jai N. Gupta Professor of Electrical and Computer Engineering, said the Purdue agrivoltaic structures can be implemented for full-scale farming and use current farm equipment.

“The system is designed with row crops in mind like corn, soybeans, wheat and rice,” Alam said. “The dimensions of



Purdue University researchers have created agrivoltaic structures that optimize the amount of electricity generated by solar farms. The modules are mounted lower than traditional solar structures and rotate to form a near-vertical structure when farm equipment needs to pass. (Purdue University photo/Mitch Tuinstra)

these structures have been fine-tuned to allow sunlight, rain and shadows to reach plants as needed. They also withstand harsh weather conditions including heavy rain and strong wind.”

Next steps to bring these improved structures to market include partnering with a solar energy developer. ///



The Center for Uncrewed Aircraft Systems aims to develop new advanced control systems. (iStock)

NEW PURDUE CENTERS SHAPING THE FUTURE

ECE LEADING THE WAY IN
AUTONOMOUS UAS RESEARCH
AND DEVELOPMENT, THE FUTURE
BEYOND 5G, AND CUTTING-EDGE AI
AND HPC TOOLS

ELMORE CENTER FOR UNCREWED AIRCRAFT SYSTEMS

The Elmore Center for Uncrewed Aircraft Systems (UAS) will conduct research on advanced control algorithms and develop prototypes for safe, trustable, and economic autonomous UAS. This center is a multidisciplinary effort led by faculty from the Elmore Family School of Electrical and Computer Engineering. Yung-Hsiang Lu, professor of electrical and computer engineering, is the center lead. Shreyas Sundaram, Marie Gordon Professor of Electrical and Computer Engineering is the co-lead. The center will provide a tiered approach to create and evaluate commercially viable UAS technologies. The first tier uses simulation to evaluate control algorithms and artificial intelligence for situational understanding. The second tier builds miniature cities and conducts experiments in natural and controlled environments at Purdue UAS Research and Test Facility (PURT). PURT houses the largest indoor motion-capture environment in the world with an area of 20,000 sq ft and a ceiling 30 ft high. The motion-capture system provides ground truth data for algorithm development and enables virtual and augmented reality. The third tier conducts outdoor experiments with line of sight between the UAV and the researchers. The fourth tier launches experiments beyond line of sight.

XGC CENTER LOOKS AT 5G AND BEYOND

The overall question driving the research of Purdue University's NEXT G Center (XGC) for Communications and Sensing is "What comes after 5G?" The team for the center is primarily made up of faculty from the Elmore Family School of Electrical and Computer Engineering. David J. Love, Nick Trbovich Professor of Electrical and Computer Engineering, is director of the center.

The center's research includes the following thrusts:

- Advanced broadband connectivity with the goal of achieving higher data rates, lower latencies, and improved reliability that would serve as the foundation for emerging applications, such as autonomous vehicles, advanced gaming, AR/VR, and telemedicine.
- Wireless research impacting agriculture and rural activities. James V. Krogmeier, professor of electrical and computer engineering, says this involves wireless capabilities far from traditional infrastructure.

XGC is also partnering with the Vertically Integrated Projects (VIP) Program, which provides an opportunity for undergraduate students to earn academic credit while engaging in research and design projects related to active research areas of Purdue faculty members and national, international, and industry-sponsored design challenges.

ONEAPI CENTER OF EXCELLENCE TO



Yung-Hsiang Lu, Professor of Electrical and Computer Engineering (Purdue University photo/Christine Petkov)



David J. Love, Nick Trbovich Professor of Electrical and Computer Engineering (Purdue University photo/Christine Petkov)

ADVANCE AI AND HPC TEACHING IN THE US

oneAPI is an open, multiarchitecture, multivendor programming model for CPUs and accelerator architectures, such as graphics processing units and field programmable gate arrays. Milind Kulkarni, Interim Head of the Elmore Family School of Electrical and Computer Engineering and professor of ECE, is the director of the center. Based on standards, oneAPI simplifies software development and delivers uncompromised performance for accelerated computing without proprietary lock-in. This is accomplished while enabling the integration of existing code. oneAPI allows developers to choose the best accelerator architecture for the specific problem they are trying to solve without needing to rewrite software for the next architecture and platform.

The oneAPI Center of Excellence is building oneAPI multiarchitecture programming concepts into the ECE curriculum; Purdue faculty will use curated content from Intel, including teaching kits and certified instructor courses. Faculty and students will be provided access to the latest Intel hardware and oneAPI software tools via Intel's Developer Cloud. David Inouye, assistant professor of ECE, will teach the pilot course in which oneAPI curriculum will be incorporated.

The collaboration also will connect Purdue students and researchers with Intel engineers, providing opportunities to discuss new innovations and developments in accelerator research, said Timothy Rogers, associate professor of ECE and the Purdue-Intel liaison. ///

PURDUE ECE FACULTY NAMED TO 2022 HIGHLY CITED RESEARCHERS LIST

PROFESSORS RECOGNIZED FOR CROSS-FIELD AND PHYSICS IMPACT

Three Purdue Elmore Family School of Electrical and Computer Engineering faculty have earned designations on Clarivate's 2022 list of Highly Cited Researchers. Highly Cited Researchers™ have demonstrated significant broad influence reflected in their publication of multiple highly cited papers over the last decade.

This is the third straight year Alexandra Boltasseva, the Ron and Dotty Garvin Tonjes Distinguished Professor of ECE, and Vladamir M. Shalaev, Bob and Anne Burnett Distinguished Professor of ECE, were on the list. Boltasseva was recognized for cross-field impact. Shalaev was recognized for impact in the field of physics. Alexander Kildishev, professor of ECE, is the newest addition to the list and was recognized for cross-field impact. ///



Alexander Kildishev, Professor of Electrical and Computer Engineering



Alexandra Boltasseva, Ron and Dotty Tonjes Distinguished Professor of Electrical and Computer Engineering



Vladamir M. Shalaev, Bob and Anne Burnett Distinguished Professor of Electrical and Computer Engineering

RECENTLY PROMOTED FACULTY

SEVEN ECE PROFESSORS
RECOGNIZED FOR TEACHING AND
RESEARCH EXCELLENCE



PETER BERMEL

Elmore Professor of Electrical
and Computer Engineering



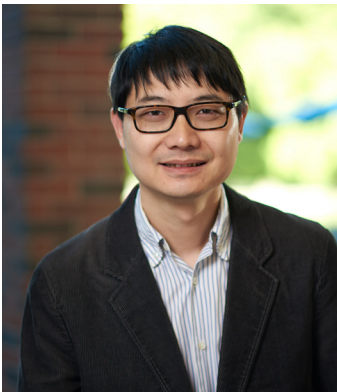
**ALEXANDRA
BOLTASSEVA**

Ron and Dotty Garvin Tonjes
Distinguished Professor of
Electrical and Computer
Engineering



ZUBIN JACOB

Elmore Professor of Electrical
and Computer Engineering



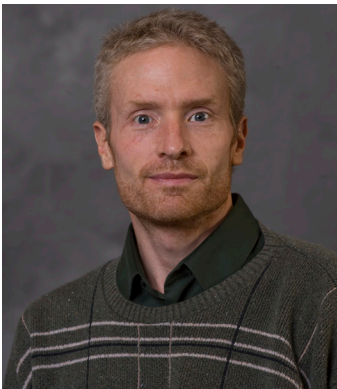
XIAOKANG QIU

Associate Professor of
Electrical and Computer
Engineering



**SHREYAS
SUNDARAM**

Marie Gordon Professor of
Electrical and Computer
Engineering



SCOTT SUDHOFF

Michael and Katherine Birck
Distinguished Professor of
Electrical and Computer
Engineering



CARLA ZOLTOWSKI

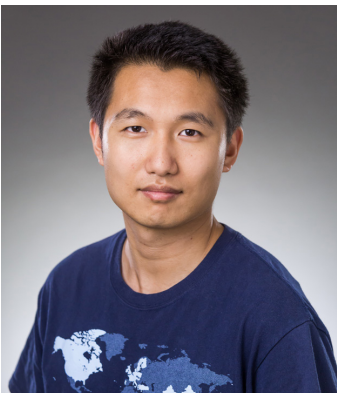
Clinical Associate Professor of
Engineering Practice

PURDUE ECE CONTINUES COMMITMENT TO EXCELLENCE BY ADDING FACULTY & LAB STAFF

The Elmore Family School of Electrical and Computer Engineering boasts an impressive faculty, with more than 120 dedicated members. Committed to excellence in every aspect of their work, our faculty members strive to be pioneers, leaders, and unrivaled experts in their respective fields. Among our accomplished team are eight National Academy of Inventors Fellows, 39 IEEE Fellows, seven National Academy of Engineering Fellows, a Gordon Award Winner, and three Frontiers of Engineering alumni. Whether they are mentoring and inspiring students, leading research centers, collaborating with industry, or creating startups to bring their ideas to the marketplace,

our faculty have a major impact on the world.

Our cutting-edge facilities, including the state-of-the-art Birck Nanotechnology Center, newly equipped laboratories in the field of robotics, and the generous investments made possible by the naming of the Electrical Engineering Building, have opened up exciting and novel opportunities for our faculty. These world-class resources empower our faculty members to push the boundaries of knowledge and innovation, reinforcing our commitment to excellence in the field of Electrical and Computer Engineering. ///



XIAOQI DANNY CHEN

Assistant Professor

Area: Computer Engineering

Computer networks, software defined networking



STEVE FRANCE

Assistant Professor of Engineering Practice

Area: Computer Engineering

Software engineering practices, processes, and management, quality assurance, system design and integration



YI DING

Assistant Professor

Area: Computer Engineering

Machine learning for systems, computer systems, computer architecture



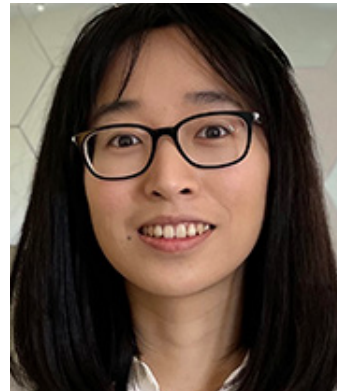
CONNOR HACK

Electronics Shop Managing Technician



SMITA SARMA

Senior Instructional Lab
Coordinator



JINGBO WANG

Assistant Professor

Area: Computer Engineering

Software engineering, formal
methods



GIFTY SHAJU

Instructional Lab Coordinator



**JENNA DIVINCENZO
WISE**

Assistant Professor

Area: Computer Engineering

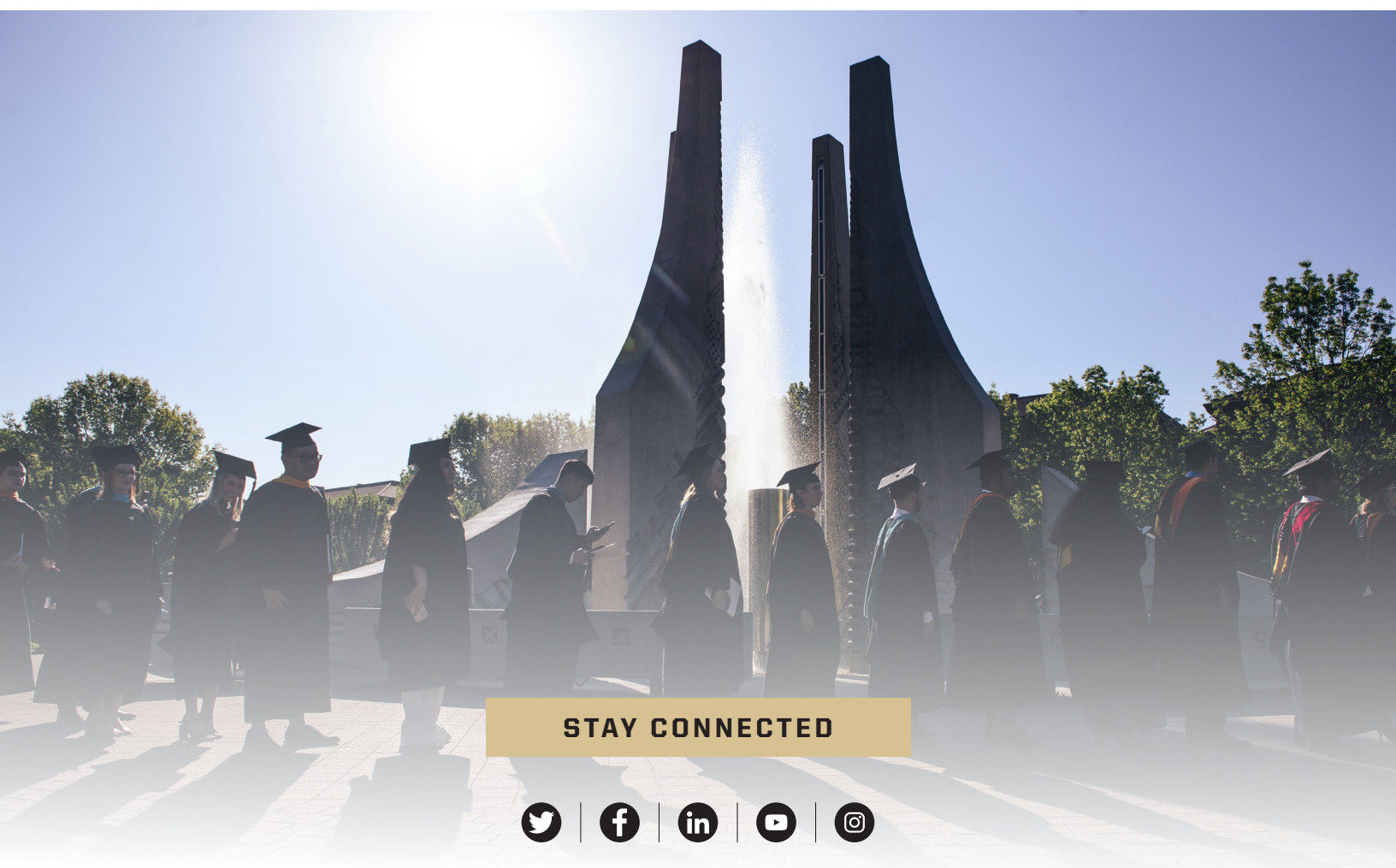
Software verification,
programming languages,
software engineering



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