VIRGINIA TECH

ece

THE BRADLEY DEPARTMENT OF
ELECTRICAL & COMPUTER
ENGINEERING

2018

New choices, new opportunities
P.3

VIRGINIA TECH™

About the cover:
With the new undergraduate experience, students will have more opportunities to choose their own course of study, and follow their passions.

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Editor: **Scott Bailey**

Produced by Uncork-it Inc. Photos by Shawn Sprouse, unless noted.

from the ece DEPARTMENT HEAD

Luke Lester
ECE Department Head

I am pleased to report that the Bradley Department of Electrical and Computer Engineering (ECE) at Virginia Tech continues to grow in terms of the number of new students who are entering the program, the quantity of students who are graduating with ECE degrees, and the number of faculty members we are hiring.

In 2017 we greeted about 470 new sophomores into the Electrical Engineering (EE) and Computer Engineering (CPE) degree programs, which is the fourth consecutive year of enrollment at about 500 students. International students now represent 20-30 percent of our entering classes, demonstrating that our program's reputation for excellence has not just a national reach, but also a global one.

Last year 267 BS degree students in EE and CPE graduated, which is our highest since the early 2000's. The 54 Ph.D. students that graduated in academic year 2016/2017 represents our all-time high, which is a testament to the strength of our graduate program. Indeed, in terms of research expenditures, we are now ranked eighth in the country, having moved up two positions since the last NSF Higher Education Research & Development (HERD) Survey.

I am proud to tell you that US News & World Report ranks our graduate programs in the top 20 for the second consecutive year and the third time in the last five years. The electrical engineering program is ranked 18th in the country, and computer engineering is placed at 17th. I believe that this exciting news is a result of our continued efforts to get the word out through our annual reports, print publications, Google Scholar, online videos, and web-based news stories that have all raised the visibility of our faculty's high-quality efforts in research and education.

To complement our sustained and robust student enrollment, we hired seven new faculty members in 2017 who are profiled in the subsequent pages of this report. Furthermore, as I write this report, we have hired another three faculty members so far in 2018. This new cohort is having an immediate impact on our research by expanding our portfolio in new technical areas such as neuromorphic computing, distributed systems, 5G wireless, and high voltage systems.

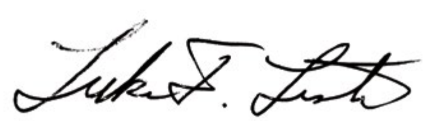
They are also influencing the comprehensive revision and modernization of our sophomore and junior-year curriculum that is now underway as part of our five-year NSF Revolutionizing Engineering Departments (RED) grant that we were awarded in 2016. My thanks again especially to Tom Martin who has been leading the charge on this signature effort.

The world is embracing a new type of engineer—a design thinker who is innovative, flexible, and collaborative. Our faculty is refuting the national view that electrical and computer engineering departments are just educating "toolmakers"—people who are learning their trade in silos that are merely repositories of knowledge. Nowadays, the reality is that ECE encompasses many exciting technical disciplines.

Our new ECE curriculum will reflect this truth by emphasizing design and innovation, disciplinary depth, and a range of learning experiences. We are in the process of re-invigorating our undergraduate courses to provide multiple paths through the curriculum that give students the freedom to choose a variety of concentrations—from biomedical applications to digital arts.

Please consider supporting our efforts with a financial gift to the ECE department. Your donation will not only help expand students' academic experiences and disciplinary skills, but also allow us to broaden the kinds of students entering the program and the range of careers they pursue.

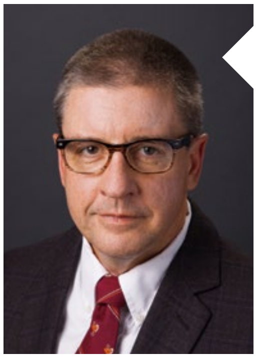
Thank you and go Hokies!



Luke Lester
Department Head

from the

ADVISORY BOARD CHAIR



Ken Schulz (MSEE '84)
Chair
ECE Advisory Board

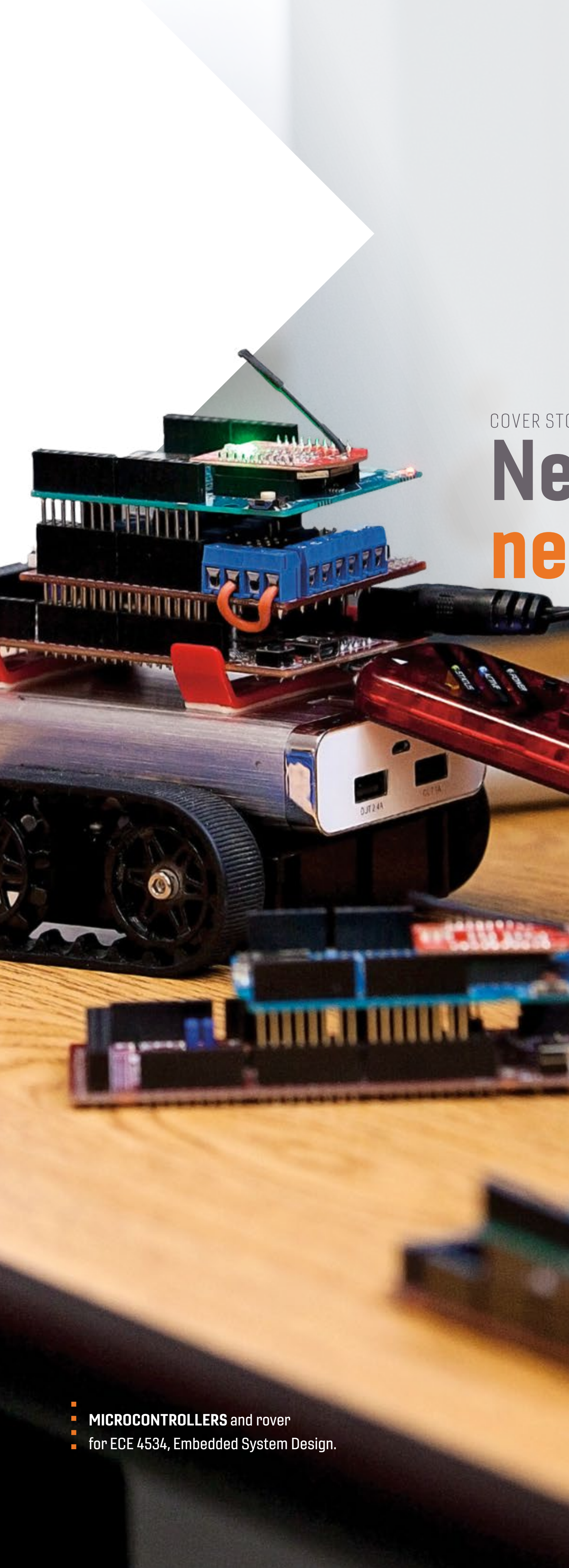
The Virginia Tech ECE Advisory Board has had another fulfilling year serving the department. In 2017, we welcomed six new members. Ivan Lai from Clarity Strategies & Engineering Solutions, R.J. Balanga from the U.S. Government, Andrew Consiglio from Pratt & Whittney, Keith Kennedy from Micron, Thomas Drayer from DoD, and Jeff McWhirt from Digital Reality. We thank outgoing board members John McHenry, Peter Hadinger, Tim Winter, Michael Chapman, Mike Keeton, and Thomas Joseph for their service to the department.

Key issues the board has been involved with are the reformulation of the undergraduate curriculum and strengthening ties with industry. With the introduction of the 12 undergraduate majors within the ECE curriculum (see next page), industry will soon enjoy engineering students specifically trained in our most critical areas of need. This will not only help industry, but also increase the importance of Virginia Tech overall. In 2017, board members continued to provide industry perspective as input to ECE's RED grant initiative from the National Science Foundation. The board has also been active exploring the possibility of faculty sabbaticals in industry to further develop strategic relationships between Virginia Tech and industry.

In 2017, we also saw continued growth in the numbers of engineering students attending Virginia Tech and the impressive growth in faculty to accommodate. Going forward, the board looks forward to continuing to help Luke Lester prepare for continued growth of the ECE Department and to contributing to the many strategic initiatives being introduced at Virginia Tech.

I would like to express my sincerest thanks to the board, our Vice-Chair Lynn Hamilton-Jones, and Luke, for their support and the opportunity to serve the ECE department.

Kenneth Schulz
Chair, ECE Advisory Board



MICROCONTROLLERS and rover for ECE 4534, Embedded System Design.

COVER STORY

New choices, new opportunities

Revised ECE experience prepares students for careers in far-flung fields

ECE is reformulating every level of its undergraduate experience, creating a dozen new majors and offering a seven-course base common to all electrical and computer engineers.

The new experience reflects today's reality that electrical and computer engineers create technology that is transforming modern life—from transportation, agriculture, and manufacturing, to healthcare, education, entertainment, and social interactions.

The department is changing both its curriculum and undergraduate culture—in an effort to broaden the range of careers students can pursue and broaden the pool of students who choose ECE.

Historically, electrical and computer engineering has consisted of five basic areas: electricity (e.g. power systems), electronics, electromagnetics, hardware, and software.

"The traditional five areas are too constraining today," says Luke Lester, ECE department head. Students are taking their EE or CPE degree into more varied careers—working everywhere from investment banks to NGOs to medical firms, he explains. As a go-to field for innovation, "we want to encourage more students to go into careers beyond the traditional ones," he says.

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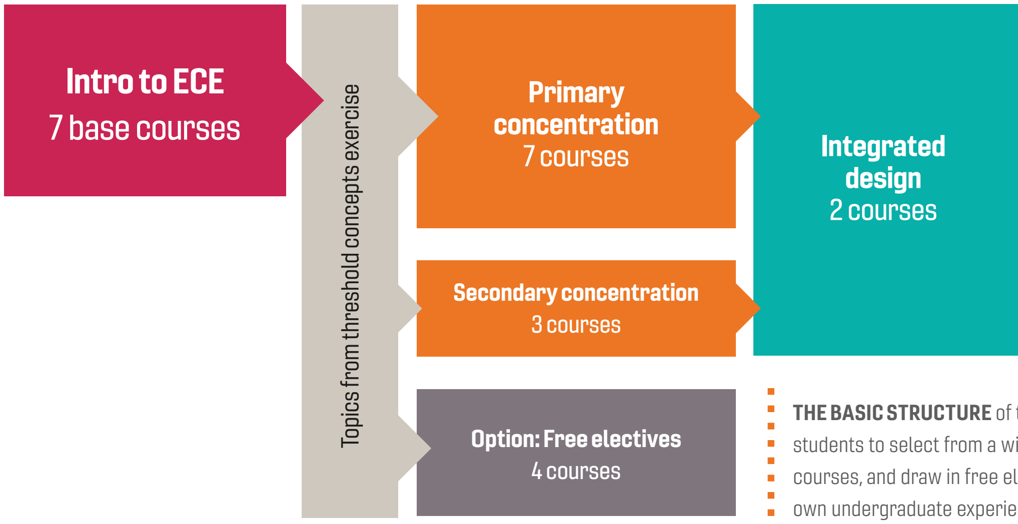


THE BASIC STRUCTURE of the new curriculum allows students to select from a wide array of rigorous foundational courses, and draw in free electives to further customize their own undergraduate experience.

The challenge is how to prepare students for such varied career paths.

ECE currently accomplishes this primarily with technical electives in the senior year, but the new goal is to bring more of that excitement to the earlier years.

"The undergraduate program should not be static," says Lester. And there are changes coming to every year of studies in ECE.

Branching into many paths

Instead of pushing students onto a single path, with technical electives in the senior year, this new model allows students to choose the course of study that reflects their personal career goals and interests.

These changes will allow undergraduate students to make conscious choices about what to do next, at every stage of their journey, according to Lester.

There will still be an option for a traditional electrical or computer engineering degree, but students will also be able to choose to explore one or two sub-disciplines.

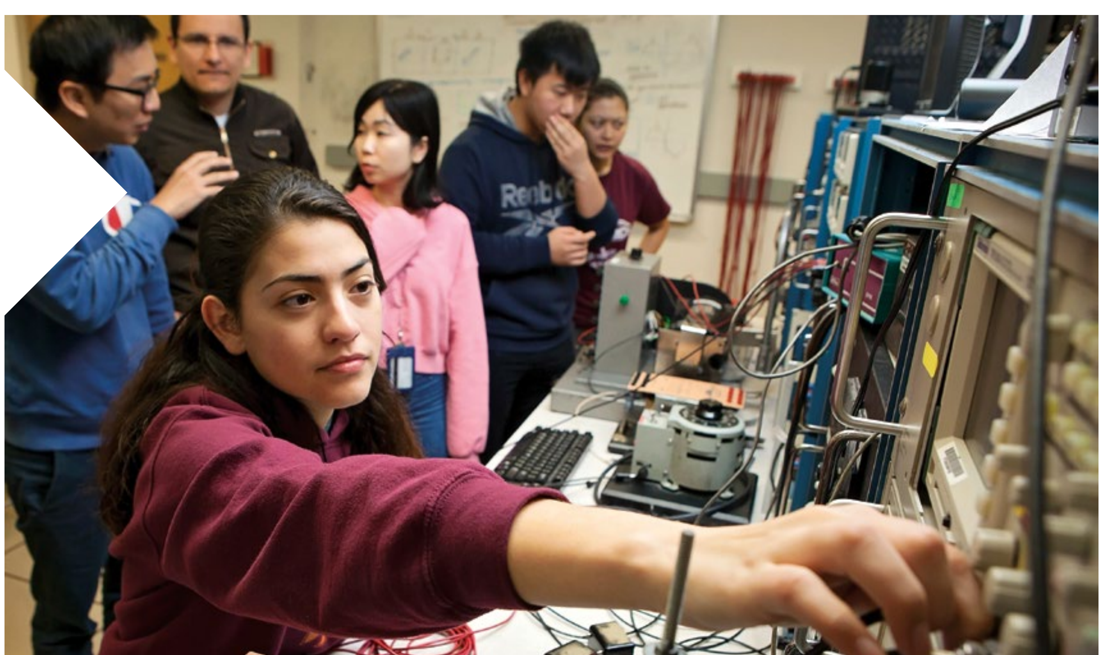
"We want students to jump right into the exploration process." says Jaime De La Ree, assistant department head for undergraduate programs.

Tom Martin, ECE professor and Bradley Faculty Fellow of Education, describes a major change in the undergraduate experience as a change in approach—from asking students to pass a set of classes, to asking them to solve the problems they need to solve. Martin is a leader on a $2 million grant from the National Science Foundation (NSF) program called Revolutionizing Engineering Departments (RED). The RED team has been focusing on a new curriculum model that blends science, engineering, creativity, and design.

A common base

The foundation of the new curriculum is a set of seven courses, predominantly in the sophomore year, that are common to all EE and CPE students. The courses, which will begin to be introduced in January 2019,

GENESIS ALVAREZ, a Ph.D. student in power systems, preps a workstation in the Faraday Power Systems Laboratory.



will help students explore foundational ECE concepts that are motivated by hands-on experiences.

A key element of the common base is the integration of threshold concepts. "These concepts can be hard for students to grasp, but once they understand them, a lot of other things make sense," explains Martin.

These classes will also introduce each of the possible paths that students will be able to choose.

"The whole point is to prepare the students for making those choices later," says Lester. "Then they're prepared to make a choice about what career path to follow. How can they make a choice if it's never presented as an opportunity?"

The common courses will also make it easier for students to change their minds and move between specializations, says Martin.

By exposing students to the full range of ECE topics, earlier in their studies, students will not only be able to choose their next set of classes, "but also have the opportunity to progress farther into those fields," De La Ree notes. "We want to accommodate new areas of expertise in the junior year," De La Ree says, allowing students to take later courses and gain deeper, specific expertise.

"Our department has always been known for its academic rigor, and that's not going away," says Lester. "But it is also a priority to give students exposure to worthy design problems in each of these possible areas, while teaching core concepts."

12 New Majors

Beginning in fall 2018, ECE students will have the option to choose among seven different majors within their EE degree and five in CPE. Lester describes the majors as guidelines to help students form their academic experience to meet their interests and goals.

Offering 12 majors and two undergraduate degree options requires significant resources, Lester acknowledges. "With at least 85 faculty members who teach students, and many more researchers, Virginia Tech's ECE department is ready for this challenge. Providing variety is what a large department should do," he says.

"We are engaged in pushing the boundaries in so many areas—from developing 3D chips that mimic the human brain, to securing information and the country's infrastructure. We want to convey the excitement of our department's research to our undergraduate students," he says.

"We want the students to be excited about what they're doing, and where they're going," he adds. "We want to open the possibilities."

The new majors will enable students to not only choose between electrical and computer engineering, but also say, 'I want to study cybersecurity,' or 'I want to study machine learning,' or 'I want to study power systems.'

Giving students more choices means that they (and their professors) won't have to work around students who do not want to be in a particular course, who are just doing it to check the box, explains Lester. "That's another goal: students should be motivated to learn."

The flip side is that students may need to put more effort into discovering their interests, and determining their paths from an early stage. ECE's team of professional academic advisors will help students navigate their options. Advising will become more in depth—almost an interview process, says Lester.

"We have the resources to help the students take ownership of their studies," he says. "This is how we train students to become lifelong learners. Isn't that the ultimate goal of education?"

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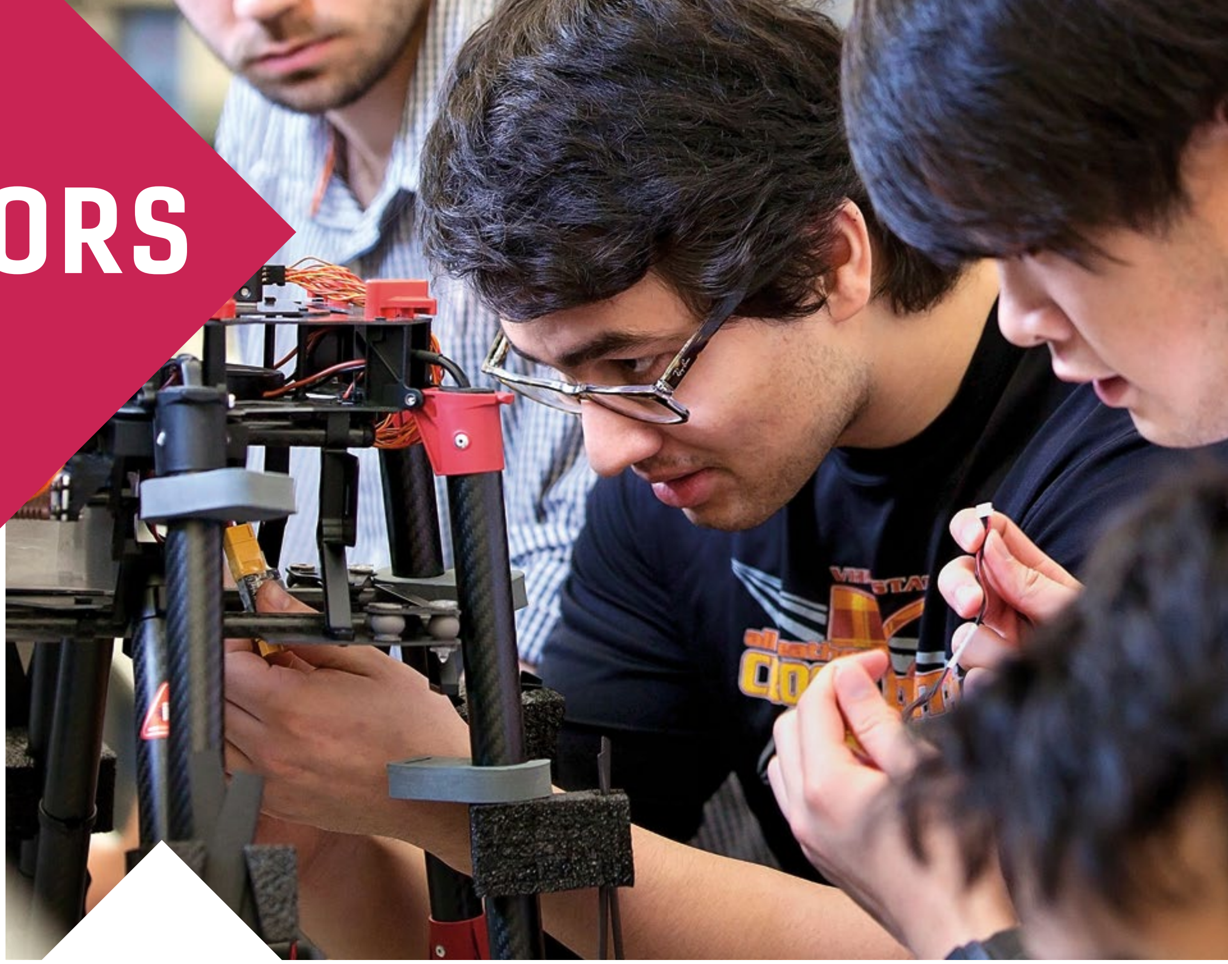
MAJORS

- Controls, Robotics & Autonomy (EE & CPE)
- Machine Learning
- Software Systems
- Chip-Scale Integration
- Micro/Nanosystems
- Photonics
- Space Systems
- Radio Frequency & Microwave
- Communications & Networking
- Networking & Cybersecurity
- Energy & Power Electronics Systems
- General EE & CPE

STUDENTS IN THE ELECTRONICS LABS explore everything from diodes and transistors to electronic circuits.



JUAN ALFARO (left) and Wilbert Chan, both CPE seniors, adjust a drone for their Major Design Experience project, with industry sponsor NAVAIR.

Controls, Robotics & Autonomy

Controls, robotics and autonomy goes above and beyond robots—it seeks new ways to interact with the world, interpret information, regulate processes, and teach systems how to make autonomous decisions.

Engineers in this field work on aerial vehicles, vehicular networks, deep learning in robotics, autonomous decision making, autonomous teams and swarms, human-robot interaction, and other projects. Machine learning, optimization, embedded systems, and signals and systems are all important for this field.

Typical career paths include control/automation engineers and robotics engineers. Advanced degrees are common for many robotics/autonomy startups and specific thrusts in larger corporations.

Electrical Engineering

EE common courses (p. 13), plus:

ECE 2574 Introduction to Data Structures and Algorithms

ECE 3704 Continuous and Discrete System Theory

ECE 3714 Introduction to Control Systems

MATH 3144 Linear Algebra I or MATH 4144 Linear Algebra II

5 Controls, Robotics & Autonomy Electives

Computer Engineering

CPE common courses (p. 13), plus:

ECE 3714 Introduction to Control Systems

ECE 4524 Artificial Intelligence and Engineering Applications

ECE 4580 Digital Image Processing

ECE 4704 Principles of Robotic Systems

4 Controls, Robotics, & Autonomy Electives

Machine Learning

Machine learning is the art of teaching computer systems how to learn on their own. Machine learning techniques are being rapidly integrated into a growing number of fields, including self-driving cars, speech and visual recognition, effective web search, marketing, and understanding of the human genome.

Career opportunities in machine learning include software engineers, data scientists, and machine learning or computer vision engineers.

Computer Engineering

CPE common courses (p. 13), plus:

ECE 4424 Machine Learning

ECE 4524 Artificial Intelligence and Engineering Applications

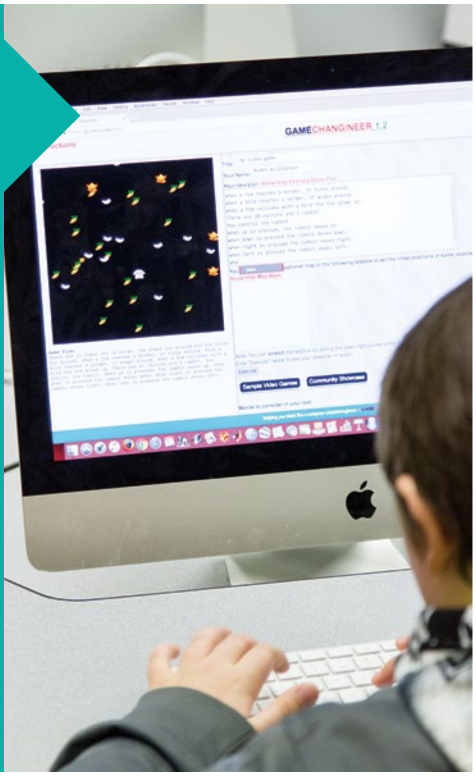
ECE 4525 Video Game Design and Engineering or ECE 4580 Digital Image Processing

ECE 4554 Introduction to Computer Vision

4 Machine Learning Electives

Outreach

GameChangineer, a video game design platform designed by ECE's Michael Hsiao, addresses the similarities between language and programming, and teaches students core skills that are common to both. Hsiao has been working with outreach and college aspiration programs to incorporate computer science and coding into the Virginia's Standards of Learning curriculum. He has piloted GameChangineer in local school districts.



DAVID FRANUSICH

Software Systems

Software systems engineers write complex software systems of all sizes for applications including machine learning, cyber physical systems, and infrastructure software.

This means they need to be confident and comfortable with hardware/software interactions and equipped with a ready knowledge of how hardware features can be exploited for designing and implementing software.

Career possibilities include working as software engineers or architects, or in other jobs with a large programming component.

Computer Engineering

CPE common courses (p. 13), plus:

ECE 2524 Introduction to UNIX for Engineers

ECE 4524 Artificial Intelligence and Engineering Applications

CS 3214 Computer Systems

CS 4304 Compiler Design and Implementation

4 Software Systems Electives

Chip-Scale Integration

Chips are ubiquitous in engineering applications, including communications, networking, automotive, industrial control, robotics, medical instrumentation, smart grid, smart home, and the Internet of Things. Chip-scale integration harnesses the advances in integrated digital and analog electronics to add even greater functionality, improve performance, minimize power consumption, and expand applications.

Many chip-scale integration graduates become chip designers, working for small and large companies on chips that contain millions to billions of transistors and have architectures as complex as cities. Others become tool designers that automate, verify, and test the design and manufacturing of these chips. There are also many research opportunities in this fast-changing and impactful field.

Computer Engineering

CPE common courses (p. 13), plus:

ECE 3004 AC Circuit Analysis

ECE 3074 AC Circuit Analysis Laboratory

ECE 3544 Digital Design I

ECE 4514 Digital Design II

ECE 4540 VLSI Circuit Design

3 Chip-Scale Integration Electives

BRIAN MATHIS, a senior EE, works with a microcontroller and rovers for ECE 4534, Embedded System Design.

Micro/Nanosystems

Engineers who specialize in micro and nano systems work with electronics and circuits at an extremely small scale. To complicate matters, materials can change their characteristics and behaviors at the nano-scale. Engineers in this field are involved in applications ranging from creating more efficient solar cells to microprocessors that exceed the capabilities of traditional silicon-based processors. They are designing and building complete systems on a chip to detect and classify gas and toxins, advance cancer research, and other applications.

Micro/nanosystem engineers rely on a strong background in electronics and are well versed in the use of semiconductor materials.

Graduates in this major will be able to build careers in development and design with industry and government organizations—from multinational firms to small startups.

Electrical Engineering

EE common courses (p. 13), plus:

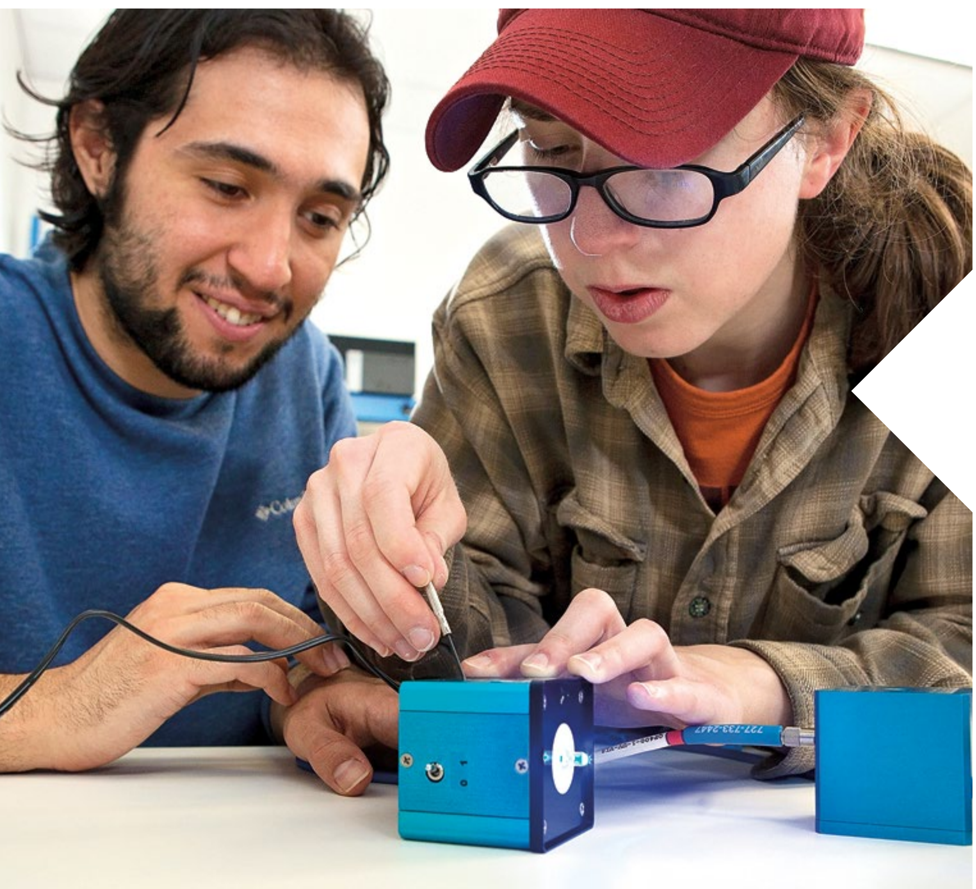
ECE 3204 Analog Electronics

ECE 3214 Semiconductor Device Fundamentals

ECE 3274 Electric Circuits Laboratory II

ECE 3614 Introduction to Communication Systems

5 Micro/Nanosystems Electives



CATHRINE CONNER (right), a sophomore EE, works with graduate student Seied Ali Safiabadi Taliin in the photonics lab to set up an experiment for an undergraduate course.

Photonics

Photonics involves the science of generation, transmission, manipulation, and detection of light, as well as the application of that light for communication, imaging, sensing, and other technologies.

LEDs and lasers, display technologies like LCDs, optical communication devices like optical fibers, medical imaging, and machine vision systems and processes all use photonics technologies. Photonics are also critical in optical computing and communications. Skills needed for the field include electromagnetics, photonics, and optoelectronics.

There are many career opportunities in photonics, including optical engineers and researchers in academic and government research agencies.

Electrical Engineering

EE common courses (p. 13), plus:

ECE 3106 Electromagnetic Fields

ECE 3134 Introduction to Optoelectronics

ECE 3174 Optoelectronics Laboratory

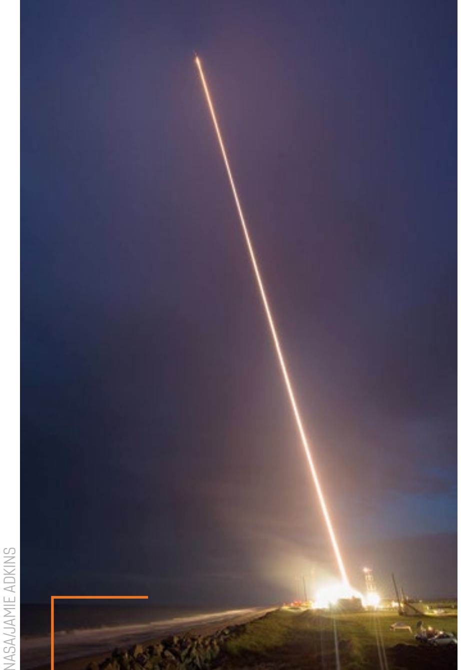
ECE 3614 Introduction to Communication Systems

ECE 4134 Photonics

ECE 4144 Optical Systems

3 Photonics Electives

GRADUATE STUDENT Ellen Robertson tests systems in a vacuum chamber at the Space@VT laboratory. Robertson, a Webber Fellow, is testing, designing, and simulating a neutral wind sensor for use on small satellites.



NASA/JAMIE ADKINS

Space Systems

Space systems engineers design, build, and test systems to withstand harsh and uncertain conditions of space and the near-Earth environment. This includes flight computers, power systems, communications, attitude determination and control, and instrumentation.

Systems engineering tasks may include integration and testing of all these systems into the spacecraft bus, and environmental testing to verify that the systems can survive the stresses of launch and the radiation environment of space.

There are career opportunities at large and small companies, government facilities and research labs, and universities with space science programs.

Electrical Engineering

EE common courses (p. 13), plus:

ECE 3104 Introduction to Space Systems and Technologies

ECE 3106 Electromagnetic Fields

ECE 3154 Space Systems Laboratory

ECE 3614 Introduction to Communication Systems

5 Space Systems Electives

In August 2017, the Virginia Tech RockSat-X team launched a payload on a NASA sounding rocket to demonstrate the commercial viability of software-defined radios in space.

It was a "massive success," said Hume Center researcher Zach Leffke, who is the Virginia Tech Ground Station (VTGS) principal investigator and an ECE alumnus.

The team detected thousands of transmitted signal packets from the VTGS in Blacksburg and from a mobile ground station parked at the launch site.

The payload contained a number of sensors connected to a microcontroller that monitored attitude, g-loading, temperature, pressure, and more, all of which worked flawlessly, said Leffke. "We could see that in real time in the downlinked data, so [it was a] major success for the electrical team."

Radio Frequency & Microwave

Radio frequency (RF) and microwave engineering focuses on the devices and systems that operate in the 300 kHz to 300 GHz range, and the signals those devices transmit and receive. Such devices are fundamental to the rapidly expanding use of wireless technologies.

Applications include communications, broadcasting, radar, navigation, RFID, remote sensing and astronomy, medical imaging, and electromagnetic compatibility. Circuits, electromagnetics, communications, and signal processing are all important skills in this field.

Career opportunities include design, analysis, and testing of RF circuits, antennas, radio wave communications links, and instruments for RF test, measurement, and metrology. Employers include organizations that develop RF components, receivers and transmitters, wireless communications systems, and RF instruments in industry, government, and research.

Electrical Engineering

EE common courses (p. 13), plus:

ECE 3106 Electromagnetic Fields

ECE 3204 Analog Electronics

ECE 3274 Electric Circuits Laboratory II

ECE 3614 Introduction to Communication Systems

5 RF & Microwave Electives

Communications & Networking

Wireless communications are now enmeshed in almost every aspect of modern life and the importance of wireless communications will only grow. The communications and networking field builds on a strong background in signal processing and communications. These areas overlap with other ECE specializations, which allows students to focus on a specific aspect of communications and networking, for example software-defined radio, or spectrum sharing issues.

Engineers who specialize in communications and networking work at companies of all sizes—from startups to large defense contractors. Others conduct fundamental research at universities and research institutions.

Electrical Engineering

EE common courses (p. 13), plus:

ECE 3704 Continuous and Discrete System Theory

ECE 3614 Introduction to Communication Systems

ECE 4614 Telecommunication Networks

ECE 4624 Digital Signal Processing and Filter Design

ECE 4664 Analog and Digital Communications Laboratory

ECE 4634 Digital Communications

3 Communications & Networking Electives

Outreach

In Fall 2017, rising seventh- and eighth-grade students from all over the commonwealth visited Virginia Tech to get a sense of what it means to be an engineer. This program is sponsored by the Center for the Enhancement of Engineering Diversity (CEED), which provides encouragement and support to engineering students, focusing on the under-represented population. The students shown here are working with a Raspberry Pi.

VPS STUDIOS

PHOTOS COURTESY OF JOSEPH TRONT

GENCYBER CAMP participants start out the week-long residential portion by operating a drone and then learning how to hack their drone.

Outreach

Trickle-down cybersecurity

Teaching teachers how to secure their classrooms in the digital age

For the third year, the ECE department hosted two GenCyber camps for 50 high school teachers from across the country. The cybersecurity educational camps took place June 25-29 and July 9-13 on the Virginia Tech campus.

There's more public awareness of the need for cybersecurity, but not necessarily the know-how, says ECE's Joseph Tront, the project's principal investigator.

"I think that's where we make our first impact—providing teachers with first-level defense strategies to keep the bad guys at bay," says Tront. "Then teachers do what they do best—spread the knowledge."

Networking & Cybersecurity

Networking and cybersecurity is the backbone of today's IT industry, which is in turn a main driving force for economic growth. There is a serious shortage of graduates with these skills.

Computer engineers in this field draw on hardware and software skills to ensure the efficient and safe transmission of data and energy through networks such as wireless cellular and the power grid. State-of-the-art work in the field includes network and information security, cryptography, social networks, reliability, capacity, energy efficiency, and resilience.

Large and small companies, government agencies, universities, and research institutions seek cybersecurity graduates.

Computer Engineering

CPE common courses (p. 13), plus:

CS 4264 Principles of Computer Security

ECE 4564 Network Application Design

ECE 4560 Computer and Network Security Fundamentals

ECE 4614 Telecommunication Networks

4 Networking & Cybersecurity Electives

VIRGINIA TECH NEWS

Members of the Virginia Tech Cybersecurity Club placed second in the 2018 Virginia Cyber Cup Capture the Flag competition.

In 2017, the Virginia Tech team placed first, and was awarded the first Virginia Cyber Cup by Virginia Gov. Terry McAuliffe. ECE undergraduates Mark Carman, Tom Conroy, Riley Cooper, Drew Dudash, and Andrew Pham are among the team members. From left to right: Virginia Secretary of Technology Karen Jackson, Andrew Pham, Samuel Hentschel, Hithesh Peddamekala, Gov. Terry McAuliffe, Josiah Pierce, and Zachary Burch with the Cyber Cup trophy in 2017.

The multifaceted goals of the cybersecurity camp are:

1. Improve cybersecurity awareness among high school teachers.
   The program empowers teachers with the knowledge they need to keep their classrooms and students safe from cyber-attacks, says Tront.
2. Motivate high school teachers to integrate cybersecurity into lessons.
   The camps target high school teachers of any discipline, encouraging English teachers, math teachers, computer teachers, and librarians to tie cybersecurity information into their lessons.
3. Raise awareness of Virginia Tech's role in cybersecurity education and boost recruitment of high school students for Virginia Tech's cybersecurity program.

"Even just 'here's an example of a secure password,' or 'stay away from these kinds of websites'" can help, says Tront. "Students—especially non-STEM students—need to be exposed to these topics so they can protect themselves."

The program equips and excites teachers, but Tront and his colleagues hope that teachers will spread their enthusiasm to students who might pursue cybersecurity studies, ideally through Virginia Tech's new cybersecurity minor or other programs in ECE and computer science.

The complete camp experience consists of one week on the Virginia Tech campus, plus five online sessions. Participants, who enroll in beginner classes or advanced classes, start out the week-long residential portion by operating a drone and then learning how to hack their drone.

"This piques their interest, and they start asking questions and wanting to learn more," says Tront. "We have a good time with that exercise."

Student interns provide demonstrations of cybersecurity on the Internet of Things, which includes how heating and air conditioning systems can be commandeered by attackers and how lighting systems can be adversely controlled to trigger medical conditions.

The success of the effort, Tront emphasizes, is due to the hard work of a few key players: Ingrid Burbey is the project manager of the teachers' GenCyber program at Virginia Tech and David Raymond, deputy director of information technology security at Virginia Tech, is the lead instructor for the camp.

Along with Burbey, Tront, and Raymond, the Virginia Tech Information Technology Security Office is collaborating with the team to provide support for the Virginia Tech GenCyber Camps. The two campus events are sponsored by the National Security Agency and the National Science Foundation. The camps will run again in mid-June 2018.

MUHAMMAD SYAFIQ ROSLEY, a senior EE, works on an independent project in the Power Systems Research Laboratory.

VIRGINIA TECH BOLT TEAM

Virginia Tech's Battery Operated Land Transportation (BOLT) motorcycle team placed second overall in the eSupersport class in the team's first American Historic Racing Motorcycle Association race at the New Jersey Motorsports Park. The BOLT team is currently modifying their motorcycle, BOLT III, to reduce its weight and improve overall performance characteristics. They are also working on the chassis for the next iteration–BOLT IV.

Energy & Power Electronics Systems

Energy and power electronics systems engineers maintain stability in today's electrical power infrastructure while preparing for, designing, and building smart grids of the future. Modeling, analysis, and design of power systems components and power electronics systems are important skills for this field.

Graduates can choose careers with large-scale energy transmission and distribution, or device-scale power conditioning. With developments in the smart grid, increased use of electric cars, energy storage, smart buildings, and alternative energy sources, career paths in power transmission and distribution include everything from traditional control and protection roles in electric utilities, to new jobs in green engineering and alternative energy startups. Jobs at the device scale are typically in startup power electronics firms or on development teams at large firms.

Electrical Engineering

EE common courses (p. 13), plus:

ECE 3204 Analog Electronics

ECE 3304 Introduction to Power Systems

ECE 3354 Electric Power Engineering Laboratory

ECE 3704 Continuous and Discrete System Theory

ECE 4224 Power Electronics

ECE 4334 Power System Analysis and Control

4 Energy & Power Electronics Electives

General Electrical Engineering

The imagination of electrical engineers has transformed the world. EEs develop the tools and techniques to sense, measure, convert, transmit, control, and receive energy and intelligence. In doing this, EEs work on projects as small as mosquito-sized robots, to controlling massive, million-mile structures, such as the nation's power grid.

EEs can work in product development, product testing, system management, sales, and consulting in industries including amusements, wireless communication, consumer electronics, power, transportation, manufacturing, automotive, chemical, pharmaceutical, defense, and more.

Common ECE Courses for all EEs

Initial 7-course ECE common core, plus:

ECE 3004 AC Circuit Analysis

ECE 3074 AC Circuit Analysis Laboratory

ECE 3105 Electromagnetic Fields

ECE 4805 & ECE 4806 Senior Design Project

Requirements such as Mathematics, Physics, English, Statistics, and Engineering Economy

For a general EE degree, students also take

ECE 3106 Electromagnetic Fields

ECE 3204 Analog Electronics

ECE 3274 Electronic Circuits Laboratory II

ECE 3304 Introduction to Power Systems

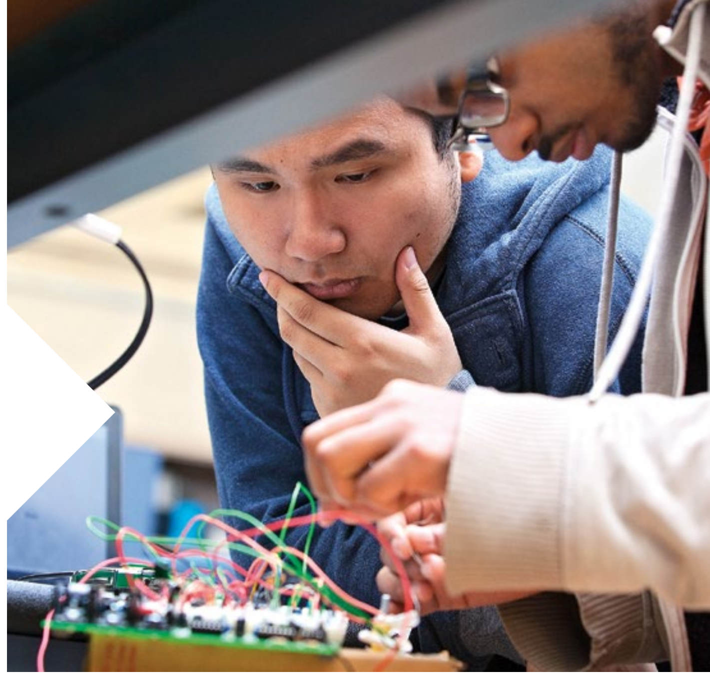
ECE 3354 Electric Power Engineering Laboratory

ECE 3614 Introduction to Communication Systems

ECE 3704 Continuous and Discrete System Theory

3 EE Technical Electives

CPE JUNIORS Congyi Guan (left), Olivia Ritz, and Kevin Kawecki (right) are modeling autonomous transportation research on ground robots.



HUSAM ELSHEIKH (right) and Mark Dionisio, both senior EEs, test their levitation project for ECE 4206, an electronic circuit design course.

General Computer Engineering

Computer engineers embed computers in other machines and systems, build networks to transfer data, and develop ways to make computers faster, smaller, and more capable. They are making computers more mobile, and incorporating computers into fabrics, clothes, and building materials.

Computer engineers have the option of moving into hardware or software positions, or blending the two. Industries hiring computer engineers include financial services, computer manufacturers, chemical companies, defense contractors, consulting, transportation, manufacturing, and consumer goods. Computer engineers are equally successful in large multinational firms and small startups. ece

Common ECE Courses for all CPEs

Initial 7-course ECE common core, plus:

ECE 2500 Computer Organization and Architecture

ECE 2574 Introduction to Data Structures and Algorithms

ECE 3574 Applied Software Design

ECE 4534 Embedded System Design (Major Design Experience)

Requirements such as Mathematics, Physics, English, Statistics, and Engineering Economy

For a general CPE degree, students also take

ECE 2524 Introduction to UNIX for Engineers

ECE 3544 Digital Design I

2 CPE Design Technical Electives

4 CPE Technical Electives

From space science to public policy

Michael Sherburne named College of Engineering's 2018 Outstanding Senior

Michael Douglas Sherburne has been named the College of Engineering's 2018 Outstanding Senior. Throughout his time at Virginia Tech, he has made it his mission to understand both the engineering he studies and the complex social issues that surround it.

As a researcher and a leader, Sherburne has explored interests from space science to public policy.

Engineering Research

Sherburne is currently active in several research and design projects at Virginia Tech.

For his senior capstone project, Sherburne is the lead electrical engineering student for a team working on a dense plasma focus device for the nuclear engineering program based in mechanical engineering. "We're developing a new nuclear fusion tool to generate neutron radiation for experiments," explains Sherburne.

He is also working with Space@VT for an honors thesis project sponsored by Los Alamos National Laboratory. He is designing a 30 kV, 500 A Linear Transformer Driver (LTD) that will power the next-generation Magnetized Shock Experiment at Los Alamos National Laboratory.

Finally, Sherburne is the lead electrical engineering undergraduate researcher for Space@VT's Plasma Diagnostic Laboratory, where he plays a key role in the creation of a fiber optic network. Colin Adams, an assistant professor in aerospace and ocean engineering, praises Sherburne's control systems work in the plasma accelerator experiment: "Michael has made critical contributions… while training undergraduate students and working with graduate students."

MICHAEL SHERBURNE (left), the College of Engineering's 2018 Outstanding Senior, interned at the Lawrence Livermore National Laboratory (right).

Cultural research

Sherburne is interested in more than just the engineering aspects of scientific advancement. He received a 21st Century Studies Fellowship and led an investigation into water quality issues within Sri Lanka. He analyzed how cultural barriers can stymie local science efforts, and his results were published and presented at the 8th International Perspective on Water Resources and the Environment conference, an organization under the American Society of Civil Engineers.

Leadership activities

Tying together his interests in politics and science, Sherburne co-founded Students on Capitol Hill in 2014 to influence legislative bills affecting the space industry.

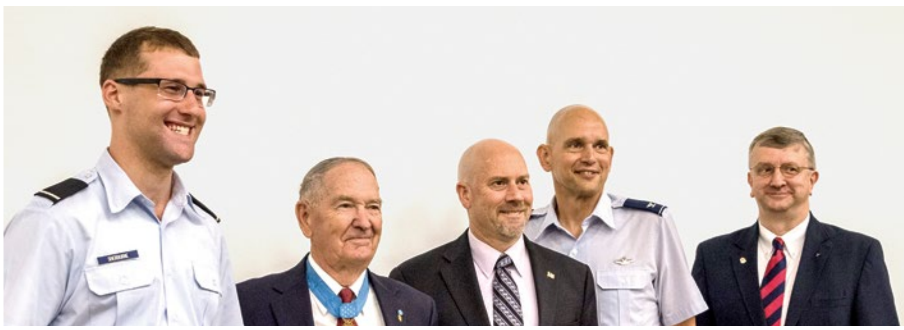
As a result of these lobbying efforts, Sherburne obtained an internship in Congressman Robert Hurt's (VA-05) Washington, D.C. office.

"The experience gave me some insight into how scientists and engineers can most effectively lobby their interests in a complex political environment," says Sherburne.

Closer to home, Sherburne serves as president of Omicron Delta Kappa—the National Leadership Honor Society for college students—and has been arranging meetings with other student leaders and administrative officials to amplify a wide and diverse range of voices.

JASON LAUREA, LLNL

MAJOR GENERAL RANDAL FULLHART



ABOVE: Sherburne tests a new radio frequency capacitor sensor in a National Ignition Facility auxiliary lab at Lawrence Livermore National Laboratory.
BELOW: Sherburne received the Medal of Honor Foundation and AFCEA Educational Foundation Scholarship award.

Sherburne has also taken on leadership roles throughout his years in the Virginia Tech Corps of Cadets (VTCC). As a squadron commander in Air Force ROTC, he is responsible for the training of about 30 cadets. As a platoon leader, Sherburne was responsible for the training and well-being of almost 40 cadets during his last semester in the VTCC.

What's next?

After graduating, Sherburne will serve as a developmental engineering officer in the Air Force Institute of Technology, where he will begin his graduate studies.

"I am excited about finding new ways to improve our scientific endeavors and to inspire others to push beyond boundaries," says Sherburne.

Sherburne is graduating with honors this May, with a bachelor of science in electrical engineering and minors in 21st century studies and leadership studies.

Sponsored by the Virginia Tech Alumni Association and the senior class, the Outstanding Senior Award recognizes exceptional academic achievement and leadership by a graduating senior from each of the university's eight colleges. Recipients have a minimum grade-point average of 3.75 on a 4.0 scale and are selected by faculty and students within their respective colleges. ece

education

SHERBURNE'S ADDITIONAL AWARDS

- College of Engineering William C. McAllister Leadership Scholarship
  2015–2017
- Congressional Medal of Honor Foundation and AFCEA Medal of Honor Scholarship
  2017
- 4-year Air Force ROTC High School Technical Scholarship
  2013–2017
- Virginia Tech Corps of Cadets Emerging Leadership Scholarship
  2013–2017
- Virginia Tech University Honors College Enrichment Grant
  2017
- Department of Electrical and Computer Engineering Joe T. and Roberta D. May Scholarship
  2014, 2017
- Department of Electrical and Computer Engineering George R. Powley Award
  2016
- Department of Electrical and Computer Engineering Juanarena Scholarship
  2015
- Claire and Wayne Horton Scholarship
  2015
- VTCC Harold & June Hankins Leadership Scholarship
  2015

Tapping customer relations skills to engage students

Adam Barnes, assistant professor of practice, feels strongly about making every class work for his students. With more than 20 years of industry experience, Barnes has an arsenal of hands-on techniques to promote classroom engagement.

Before coming to Virginia Tech, Barnes was a senior engineer at Vatell Corporation, one of the world's leading heat flux sensor suppliers, located in Christiansburg, VA.

But the industrial experiences Barnes draws on most often are those that involved communicating with customers.

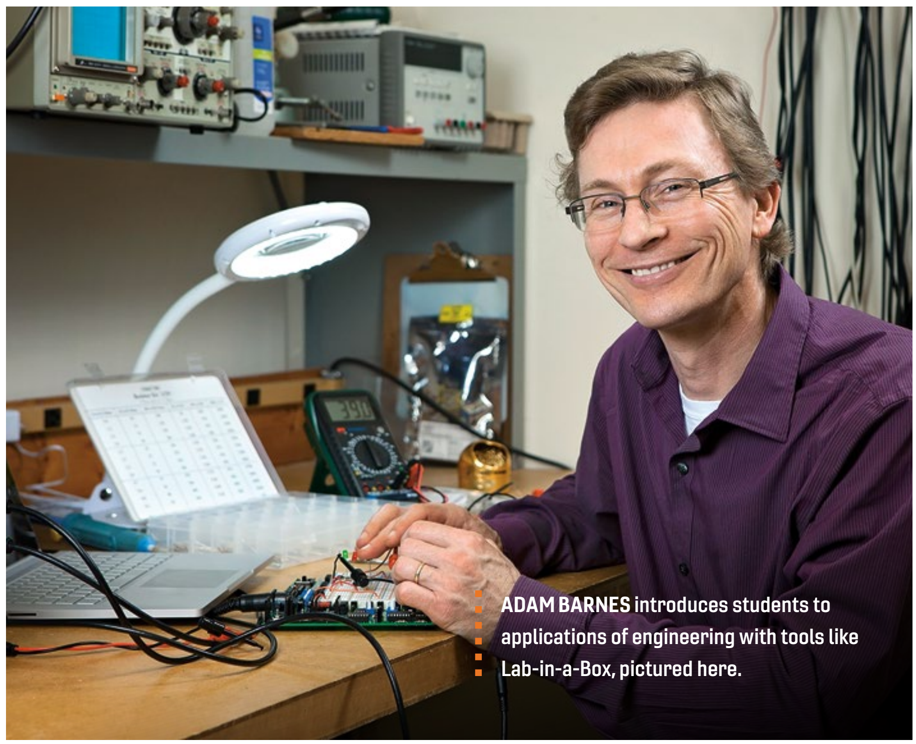
"The ability to talk to a wide range of people with different backgrounds, education levels, and language barriers serves me well," says Barnes. "It has allowed me to see things from multiple perspectives and forced me to come up with different ways to explain things without getting hung up on vocabulary."

He illustrates the advantages of this skill with an experience from one of his lectures: "In class one day, we were discussing a problem that involved a forklift," Barnes recalls. "Halfway through the discussion, a student raised her hand and asked, 'what is a forklift?'"

"She was from another country, and although her English was excellent, 'forklift' was not a word she had ever needed to know."

For Barnes, moments like this remind him that all students have different backgrounds, with unique gaps and strengths.

"Sometimes I'm surprised by what students don't know," says Barnes. "Then other times I'm simply amazed by how savvy and imaginative they can be."



ADAM BARNES introduces students to applications of engineering with tools like Lab-in-a-Box, pictured here.

Barnes, who joined ECE after two years in Virginia Tech's Department of Engineering Education, teaches Electric Circuit Analysis Laboratory (ECE 2074) and Applied Electrical Theory (ECE 2054).

Barnes also brings his experience to the interdisciplinary Revolutionizing Engineering Departments (RED) grant committee, which is completely revising the sophomore year curriculum. Because Barnes is driven to communicate effectively with his students, he knows that the new curriculum must connect, engage, and resonate with the students of today. ece

INTRODUCING

ADAM BARNES

- Joined ECE August 2017
- Instructor, Virginia Tech Department of Engineering Education, 2015–2017
- M.S., electrical engineering, Virginia Tech, 1997
- B.S., electrical engineering, Virginia Tech, 1995

Making way for next-gen power electronics

Wide bandgap devices poised to replace silicon

The power electronics research community is balancing on the edge of a game-changing technological innovation: As silicon (Si) semiconductors—traditionally employed for the conversion, control and processing of electric power—approach their material limitations, next-generation wide bandgap (WBG) electronics are poised to overtake them.

WBG power electronics can operate at higher voltages, temperatures, and switching frequencies, with greater efficiency, than existing Si devices.

"These characteristics can reduce energy consumption, which is critical for national economic, health, and security interests," says ECE's Mona Ghassemi, an assistant professor. Ghassemi focuses on high-field dielectrics and electrical insulation materials and systems.

Incorporating WBG devices in high-voltage applications requires analysis of a wide range of behaviors, innovative packaging and designs, and updated modeling capabilities.

In her analysis work, Ghassemi is investigating how WBG electronics handle high electric stress and control partial discharges in high voltage high-density environments. She is also conducting WBG electrical insulation failure analysis.

Results from her analysis will drive design and implementation changes, and Ghassemi is also exploring WBG semiconductor packaging technology designs. Semiconductor packaging protects power electronics from damage and supports electrical connections between the device and the circuit board. As chips evolve, and rely more heavily on WBG technology, chip packaging design must keep abreast of the changes, she explains. She is specifically working on packaging technology that allows researchers to better exploit WBG materials' ability to withstand high blocking voltage, high power density, high frequencies, and high temperatures.

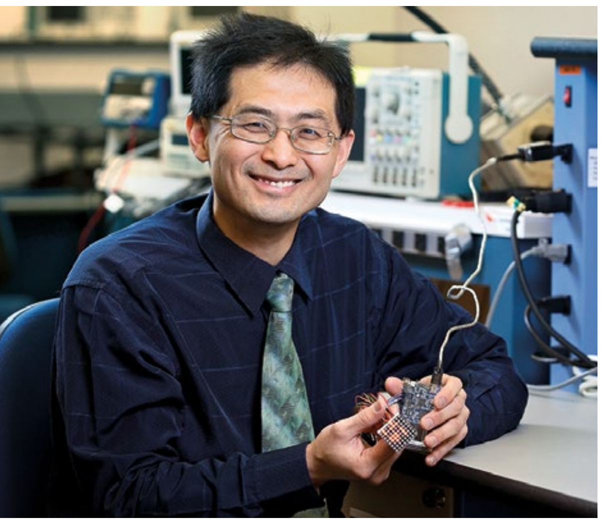
Ghassemi is seeking methods to increase voltage-blocking capability. Together with improved packaging, this can help control the local electric field that may otherwise become large enough to raise partial discharges within the module. ece

INTRODUCING

MONA GHASSEMI

- Joined ECE August 2017
- Postdoctoral fellow, University of Connecticut, 2015–2017
- Postdoctoral fellow, University of Quebec, Canada, 2013–2015
- Ph.D., electrical engineering, University of Tehran, Iran, 2012
- M.S., electrical engineering, University of Tehran, Iran, 2007

Dreams: from concept to construction



WEI-JER (PETER) HAN provides his students with hands-on experiences to reinforce the lessons they learn in lecture.

INTRODUCING

Wei-Jer (Peter) Han

- Joined ECE March 2017
- Assistant professor of practice, DeVry University, 2002–2016
- M.S., systems engineering, Missouri University of Science and Technology, 1995
- B.S., marine engineering, National Taiwan Ocean University, 1992
- Ron Taylor Award for excellence of performance, 2011

Wei-Jer (Peter) Han champions a deep integration of lecture with lab, theory with application. He is dedicated to helping students build their dreams, and this goal drives many of his efforts. "Some students have had a dream in mind for many years," Han explains. He wants to create opportunities in the curriculum for students to integrate what they have learned in their classes to realize their dreams—whether they want to make better audio filtering headphones or a self-driving car.

Han joined the ECE department as an assistant professor of practice in March 2017 to help improve the laboratory components of many of the courses. In 2017, Han taught Electric Circuit Analysis (ECE 2004) and Introduction to Computer Engineering (ECE 2504). He is currently teaching Electric Circuit Analysis Lab (ECE 2074) and AC Circuit Analysis Lab (ECE 3074).

Before joining Virginia Tech, Han was an assistant professor of practice at DeVry University, where he designed, developed, and taught online and on-campus courses in electronics, analog and digital systems, embedded systems, programming, and VHDL. During this time, he also designed and released electronics products, including a siren amplifier and controller area network (CAN), an FPGA with Raspberry PI interface, and circuit boards for educational purposes.

His academic career, however, evolved from a background in industry. From 1995–2002, Han was an electrical engineer in automotive communications, focusing on automotive networking and wireless systems. This foundation informed his approach to instruction, both at DeVry and now at Virginia Tech.

"Comprehensive learning is not just knowledge of theory or something prepared for a test," Han says. "I like to bring applications into the classroom, so students can see the manifestation of theory in the real world." ece

Using AI to seek slow zones in crowded networks

Within the next four years, an estimated 29 billion connected devices will compete for a slice of the already-overcrowded radio spectrum, according to industry trend predictions like the Ericsson Mobility Report.

By improving spectrum efficiency, tapping unoccupied channels, and establishing protocols for sharing previously restricted bands, ECE's Lingjia Liu is exploring new ways to meet the skyrocketing demand.

Minimizing interference

Liu, who joined the department as an associate professor in 2017, is developing methods to manage wireless interference (which can mean dropped calls or poor connections) and find the best way to allocate spectrum access in heavily used networks.

He is incorporating a technique called spatial sensing for device-to-device communication, which allows devices to identify and use local empty spaces and periods of low traffic within the network bands. Short-range and local communication strategies like this help optimize spectrum and energy use.

Liu plans to develop a framework for analysis and design based on detection theory and stochastic geometry. After determining the best design and techniques to use, Liu's team will evaluate the effects of this strategy on overall network performance.

LINGJIA LIU incorporates spatial sensing for device-to-device communication to help optimize spectrum and energy use.

Tapping temporary availability

Liu and Yang (Cindy) Yi, an assistant professor in the ECE department, are designing a network architecture that allows devices to dynamically search for spectrum bands that are temporarily not at full capacity in their area and use them for short-range communications.

Because dynamic spectrum access is so computationally complex, the proposed network's computing devices will mimic the neurobiological architecture of the human brain—one of the most efficient and sophisticated systems in the known universe.

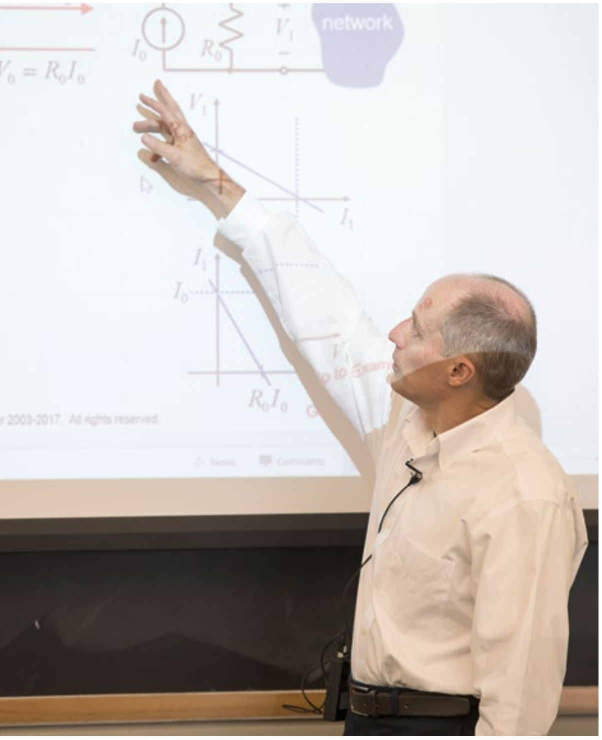
This new wireless network design shifts the focus from a centralized base-station-controlled approach to a more decentralized system, says Liu. In the new model, individual users will play stronger roles in spectrum access, changing the network topology by using smart computing devices.

"In this way, we will enable our nation's next-generation wireless network in an intelligent, spectrum-efficient, and energy-efficient dynamic spectrum environment," says Liu. ece

INTRODUCING

LINGJIA LIU

- Joined ECE August 2017
- Associate professor, University of Kansas, 2016–2017
- Assistant professor, University of Kansas, 2011–2016
- Senior research/standard engineer, Samsung Research America, 2008–2011
- Ph.D., electrical and computer engineering, Texas A&M University, 2008
- B.S., electronic engineering, Shanghai Jiao Tong University, 2003
- Summer Visiting Faculty Fellow, U.S. Air Force Research Laboratory, 2013–2017
- Best Paper Award, IEEE Globecom, 2016
- Individual Gold Medal, Samsung Telecommunications America, 2011



I see fields

Mayer's many visualizations clarify complex concepts

INTRODUCING

JEFFREY MAYER

- Joined ECE January 2017
- Associate professor, Penn State, 1997–2016
- Ph.D., electrical engineering, Purdue University, 1991
- M.S., electrical engineering, Purdue University, 1988
- B.S., electrical engineering, Purdue University, 1987

When teaching complex or theoretical topics, Jeff Mayer, a collegiate associate professor of ECE, reaches into his background in power systems, power electronics, and controls. Then there are his years of research on power system survivability in extreme conditions and following catastrophes.

He also mines his seemingly endless library of visualizations and models.

"Pure mathematical modeling doesn't work for most of us," he says. The visualizations particularly help students look at magnetic fields, he says. "Being able to see the fields, understand flux, and figure out torque is much easier with a visual model."

Mayer, who teaches AC Circuit Analysis (ECE 3004), Introduction to Power Systems (ECE 3304), and Electrical Theory (ECE 3054), incorporates MATLAB modeling in his lesson plans and uses it as a tool to unlock concepts for his students. With MATLAB, he says, "students can get started without knowing a whole lot of computer background."

While the visualizations are not necessarily eye-popping, "I can generate the field plots for a variety of different machines or configurations," says Mayer. "It allows students to see the impact of changes in the winding structure and the geometry of the machine, for instance."

Recently, he wanted to show students that although a power circle diagram and nose curve are derived in different ways, they are fundamentally related. Both are connected to power flow through a transmission line, and he developed a 3D model to demonstrate this relationship.

"Once you have it in 3D, you can show the classical sections, the power circles, and nose curves in different ways and uncover new relationships between the variables," says Mayer.

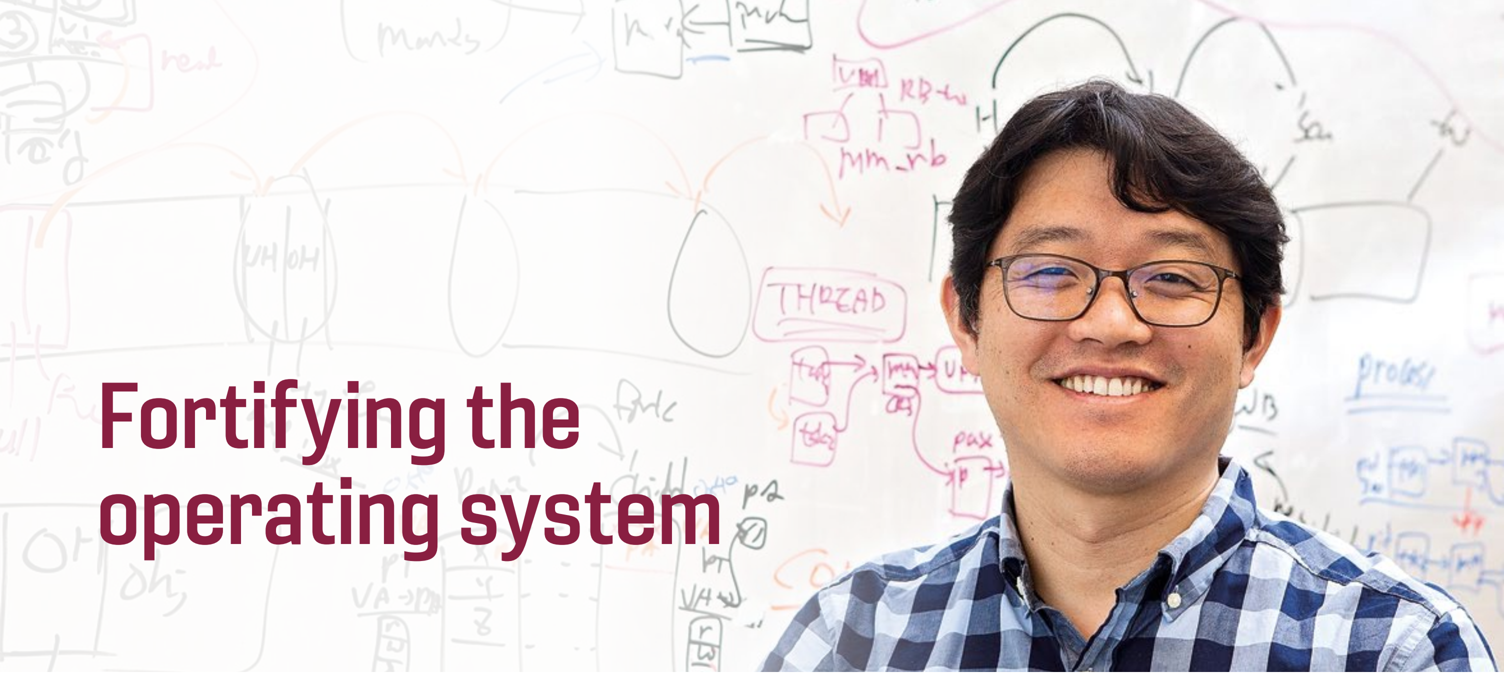
It can make a difference for students, says Mayer. "If they're interested, MATLAB's symbolic toolbox for Laplace and Fourier transforms can make life so much easier."

He has also developed a compact circuit simulator that uses fewer than 100 lines of code. With the simulator, students can model any circuit of interest, including symbolic models, and generate information like frequency responses.

Mayer also employs modeling in his research projects. He is currently building a model to express the input impedance of high-frequency power converters.

He is also developing models for power flow. "Although the power flow field matured and became standard ages ago, it doesn't work as well at the extremes," he says. ece

JEFF MAYER incorporates visualizations and MATLAB modeling into his lesson plans, and uses them as tools to unlock complex concepts for his students.



Fortifying the operating system

INTRODUCING

CHANGWOO MIN

- Joined ECE August 2017
- Research scientist, Georgia Institute of Technology, 2016–2017
- Postdoctoral fellow, Georgia Institute of Technology, 2014–2016
- Ph.D., mobile systems engineering, Sungkyunkwan University, Korea, 2014
- Principal software engineer, Samsung Electronics, 2005–2014
- Staff research and development engineer, IBM Korea, 1998–2005
- M.S., computer science, Soongsil University, Korea, 1998
- B.S., computer science, Soongsil University, Korea, 1996

As hardware and applications evolve, so must operating systems. Operating systems may be the workhorses of computer engineering, but rapidly changing demands from both hardware and applications keep it an active research area.

"There are a lot of changes these days," says ECE's Changwoo Min, who recently joined the department as an assistant professor. He describes recent advances that challenge operating systems, including parallel and multicore computing, nonvolatile memory, machine learning, and stronger computer security. Each, he says, comes with its own demands and possibilities.

The multicore challenge

One advance that impacts operating systems is the use of multicore platforms.

The essence of multicore scalability and performance is coordination, Min says. "Coordination is all about ordering. Which event happens first, and which event happens later."

Although the typical method for ordering operations is the timestamp, "timestamp generation itself can be a scalability bottleneck." Min proposes to cut down on this time cost by using a physical timestamp.

Nonvolatile memory advantages

With the emergence of nonvolatile memory, the performance of storage devices is several orders of magnitude faster, says Min. However, users are unable to take full advantage of the increased speeds because the operating system has become the bottleneck. Min and his collaborators have been analyzing the behavior of widely-deployed file systems and identifying aspects of file system design that must be brought up to speed.

Machine learning demands

New applications incorporate big data and machine learning, and Min sees this as an opportunity to figure out the data requirements and customize the operating system itself.

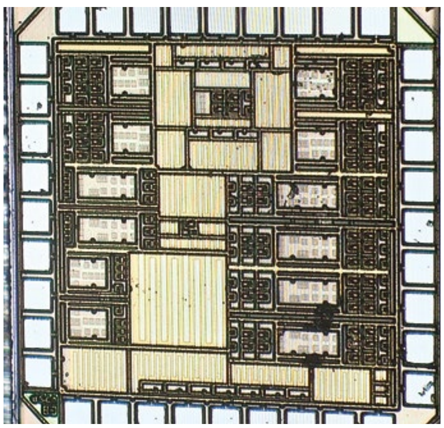
One way to do this is with a hardware accelerator, such as a graphics processing unit (GPU). For applications like big data and machine learning that require a lot of computation, the operating system should be able to recognize these types of operations and send them to an accelerator for processing. Min likes to think of these new operating system architectures as "a new customer requiring something completely different."

Security concerns

Security concerns are rising, and Min is working to minimize operating system vulnerabilities. He is working with ECE's Binoy Ravindran on software re-randomization, which looks at how adversaries attack existing infrastructure via software.

One traditional attack is for the adversary to determine the system's memory contents and analyze them to find a piece of code that can be exploited. To thwart these attacks, "we just change the memory," explains Min. "We randomly change the contents of the memory while maintaining the semantics of the code and data." ece

Brain-inspired ICs



INTRODUCING

YANG (CINDY) YI

- Joined ECE August 2017
- National Science Foundation (NSF) CAREER Award, 2018
- Assistant professor, University of Kansas, 2014–2017
- Air Force Research Lab (AFRL) Visiting Faculty Research Fellow, 2014, 2017
- United States Air Force (USAF) Faculty Fellow, 2015, 2016
- Ph.D., electrical and computer engineering, Texas A&M University, 2009
- M.S., electrical engineering, Shanghai Jiao Tong University, 2005
- B.S., electrical engineering, Shanghai Jiao Tong University, 2003

The human brain is among the most efficient, sophisticated systems in the known universe, deftly handling pattern and speech recognition, information processing, and even power consumption. Plus, it only weighs about three pounds and fits inside a skull.

"The brain is one of the best templates available for big data analysis and classifications," explains Yang (Cindy) Yi, an ECE assistant professor.

Yi was awarded the National Science Foundation (NSF) Faculty Early Career Development (CAREER) Award to design three-dimensional (3D) neuromorphic integrated circuits—ICs that mimic the human brain.

The CAREER grant is one of the NSF's most prestigious awards, given to junior faculty members who are expected to become academic leaders in their fields.

"My dream for this technology is that it will improve the quality of human life," says Yi. "We want to build chips to model some of the lost or damaged brain functions, allowing people who have suffered some brain injury to reclaim their former lives or move forward to new ones."

With the grant, Yi will address design challenges, including architecture, integration, speed, and efficiency.

Encompassing evolutionary systems

"The human brain evolved to solve a huge number of complicated problems," says Yi. "Which makes our job easier."

Based on an architecture that mimics bio-neurological processes, Neuromorphic Computing (NC) systems "leverage evolutionary behaviors to address specific problems that have not been solved by current CMOS (complementary metal-oxide-semiconductor) digital computing," says Yi.

NC systems are poised to surpass 100 million "neurons" with 1 trillion "synaptic connections" within the near future, Yi notes. They will require high complexity, high connectivity, and massively parallel processing to accomplish increasingly demanding computational tasks.

Traditional integration will be incapable of meeting these requirements, but Yi is exploring this technology in a new dimension—literally.

3D integrated circuit design

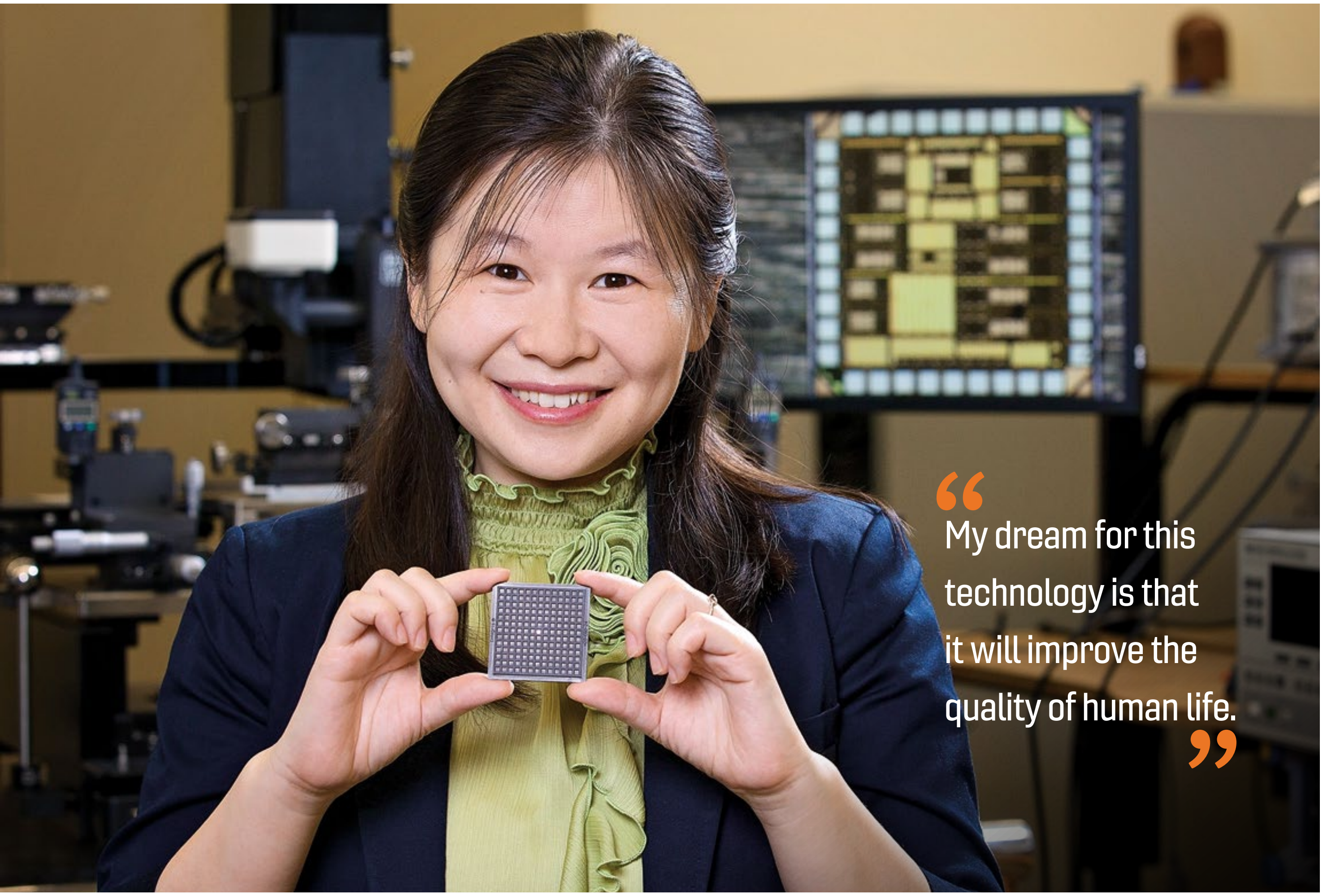
The human brain isn't flat—another obvious advantage it holds over current integrated circuit technologies.

Current 2D integrated circuit technology is approaching its physical and material limits, says Yi. She is investigating how 3D integration technology can be used to create a neuromorphic system that is compatible with current technology—while operating at high system speed with high density and significant parallel processing, low power consumption, and a small design area.

Computational capacity and scalability

By combining the computational capacity of NC networks with the scalability advantages of 3D integration, Yi's team will be designing NC circuits and systems that more closely emulate the brain's information-processing infrastructure.

Specifically, they will be exploiting



YANG (CINDY) YI was awarded the NSF CAREER grant for her research designing three-dimensional neuromorphic integrated circuits that mimic the human brain, like the one pictured above.

time-dependent neural coding and delay-based dynamic nonlinear transfer. This work builds on Yi's extensive research over the past three years, when she fabricated three chips to mimic neural functions.

The first and second chips focused on temporal encoding, one of the main encoding schemes in brain cells. Yi and her team were able to encode the chips with multiple neural codes that operated simultaneously at different speeds while carrying complementary information.

"To the best of our knowledge, the neuron circuit we developed and tested is the first to present sensory data in this way," says Yi.

The third chip incorporates delayed feedback of computing nodes. In this one, Yi is designing the chip to mimic the nonlinear function and agile chaos of the human brain.

Reducing design area, boosting performance

To improve reliability and robustness of NC circuits and systems, Yi and her team will be reconfiguring and adapting idle through-silicon vias (TSVs)—high performance electrical connections that run through silicon—as membrane capacitors.

"Membrane capacitors typically occupy a significant portion of a chip's design area, and by using idle TSVs to pull double duty, we can substantially reduce design area and boost chip performance," explains Yi.

Emerging applications

"If successful, this technology could fuel potentially disruptive capabilities in real-time data analysis, time-series predictions, environmental perception for autonomous operations, and dynamic control systems," says Yi.

It could also improve the performance of current and future systems by significantly decreasing power, size, and weight budgets, and by enabling embedded and retrofit applications on legacy, mobile, and remote platforms.

Other applications of Yi's work could improve computing efficiency in wireless communication, cybersecurity, and big data analysis.

"Incorporating brain functionality will be a revolutionary change for the field," says Yi. "It's a very exciting time to be involved." ece

Probing the grid

The U.S. power grid, after faithfully delivering electricity to our neighborhoods for generations, is facing significant change to how it operates—thanks to solar-panel installations, wind farms, new energy storage systems, and even electric cars.

As utilities meet the challenges of incorporating distributed energy sources on the low- and medium-voltage grids, however, they are hindered by incomplete knowledge.

"Limited instrumentation and their sheer size has kept a full picture of distribution grids out of focus," says Vassilis Kekatos, an assistant professor in ECE.

Kekatos and his team hit upon a novel technique called grid probing to generate the information needed about what is often called the world's largest machine. Their pioneering process engages smart inverters outside their intended function.

For this effort, Kekatos, who specializes in power systems and smart grids, was awarded the National Science Foundation (NSF) Faculty Early Career Development (CAREER) Award. The CAREER grant is one of the NSF's most prestigious awards, given to junior faculty members who are expected to become academic leaders in their fields.

The state of the grid

Today's residential electricity networks are sprawling configurations (and reconfigurations) of decades-old infrastructure strung through a patchwork of smart updates. A utility company may own 3,000 feeders, each of which transfers power from substations to thousands of nodes, says Kekatos. Half of those nodes may be outfitted with smart meters, but those are only sampled hourly.

To accomplish any meaningful grid-wide optimization, we need to know the power consumed or generated at every node, the line and transformer parameters, and the grid layout—all in real time, says Kekatos.

"Utility companies do not have information this detailed," he says. "But we must acquire it to bring about the smart grids of the future."

Grid probing

Kekatos plans to use grid probing to close the information gap.

"Grid probing casts smart inverters in a second role," he explains. "This is in addition to their standard conversion and control functionality." Smart inverters are found in solar panels, energy storage devices, and electric vehicles and come with unprecedented capabilities in sensing, actuation, and communication. Kekatos wants to use them for discovery tasks as well.

He plans to direct smart inverters to inject a short burst of power through the grid, eliciting additional grid readings at the inverter meter. By comparing "probed" voltage responses with baseline voltages, he expects to discover non-metered loads and unknown network parameters.

The power injections will be minimally invasive, causing no harm, but could yield significant information for understanding the nonlinear behavior of power grids, he says.

KEKATOS developed a novel technique called grid probing to provide a more detailed picture of the grid—which is often called the world's largest machine.

Mapping

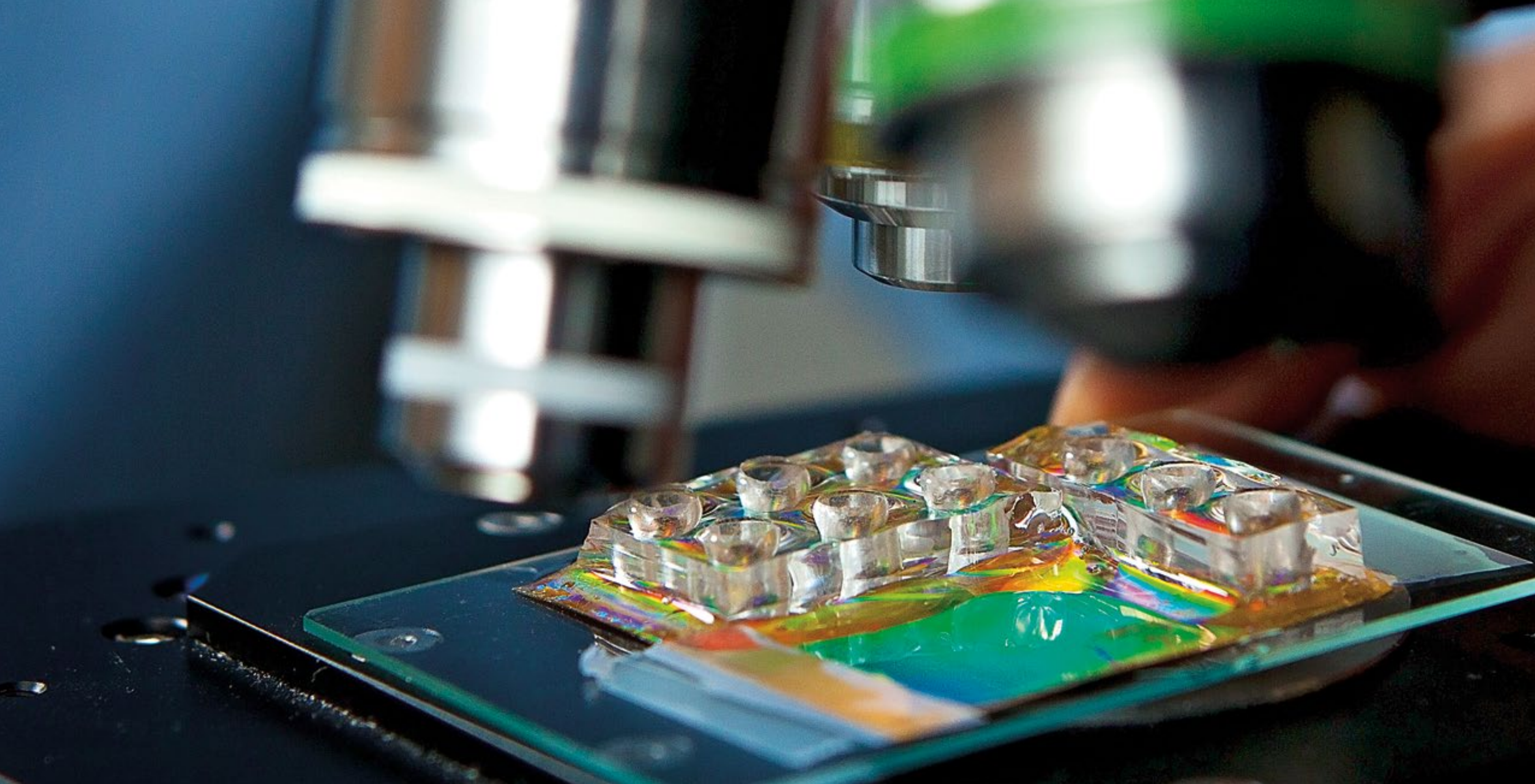
Kekatos and his team will combine data from the grid probing with data from existing smart metering and grid sensing. Coupling power system modeling with data analytics, they plan to map the connectivity and line parameters of the distribution networks.

Outreach and education

All CAREER awards have an educational component, and Kekatos has designed an integrated approach. Undergraduate students are actively involved in this research via grid visualization and cross-validation tasks. The students will also work with graduate students in testing and cross-validating grid learning schemes.

Kekatos has developed a new graduate-level course on power distribution systems with emphasis on multi-phase analysis, optimization, and learning.

The team is also reaching out to pre-college female students through the annual C-Tech² program, a two-week residential camp run by the Virginia Tech Center for the Enhancement of Engineering Diversity (CEED). The educational component of this project will feature hands-on learning activities and collaborative app-based games about electric power grids. ece



A PROTOTYPE of culture multiwell plates integrated with nanoscale multimodal transducers for real-time monitoring of living cells.

Using photons and electrons to peer inside the cell

Many of us may think of a cell membrane as the structure that holds a cell together, creating a building block of life. To Wei Zhou, however, it can also be a barrier to understanding what lies within. The assistant professor of ECE seeks to help scientists understand the biophysical and biochemical processes inside living cells.

By combining nanophotonics and nanoelectronics, he is building tools and processes to access the information hidden beneath the cell membrane in real time. Understanding the activities and signals inside of living cells is key to understanding disease and improving medical diagnoses and therapies, he says.

Zhou has been awarded a Young Investigator award from the U.S. Air Force Office of Scientific Research to develop a nanoscale multimodal transducer—a miniature device that takes advantage of optical and electrical phenomena at the nanometer level—to monitor and control the biological processes unfolding inside a living cell.

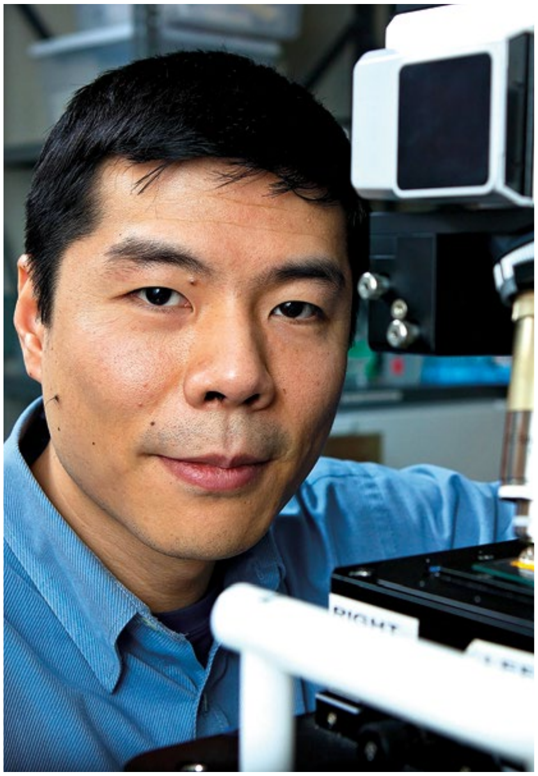
Combining fields at the nano level

Because of the distinct natures of electrons and photons, the operation and design rules of the device's nanoelectronic and nanophotonic components are totally different. They are products of separate fields with long, established histories, says Zhou, who specializes in both.

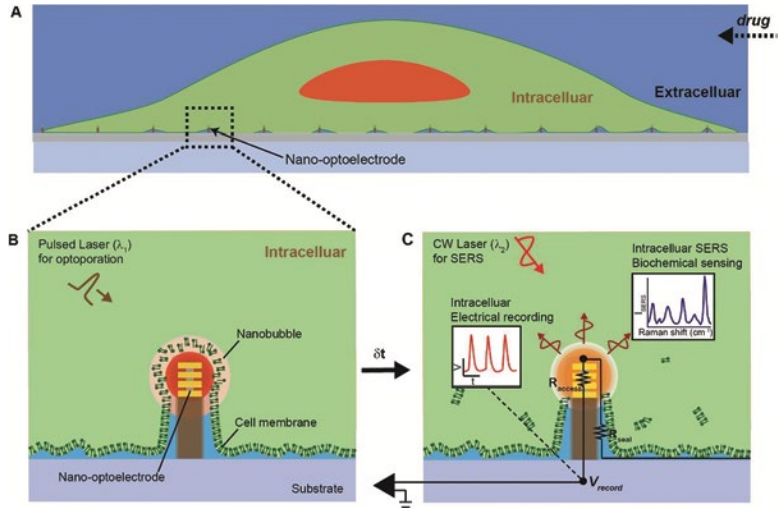
"Unsurprisingly, there is very limited research on hybrid electrical-optical nanodevices for interfacing with biological systems," he says.

A key innovation for his project is the plasmonic nano-optoelectrode, which can simultaneously serve as a nanoelectrode for detecting and adjusting local bioelectrical activities and as a nanoantenna for gaining intracellular access and sensing biomolecular fingerprints inside cells.

"This technology will go beyond the capability of purely electrical or purely optical



WEI ZHOU was awarded a Young Investigator award from the U.S. Air Force Office of Scientific Research to develop a nanoscale multimodal transducer to monitor and control the biological processes unfolding inside a living cell.



HOW DOES IT WORK?

A: The plasmonic nano-optoelectrode is a key innovation in Zhou's research, which allows a nanotransducer to access the inside of a cell with minimal damage.

B: Short laser pulses generate a miniscule vapor nanobubble, which opens a nano-sized hole in a cell's membrane, giving the device access to the cell's interior.

C: After slipping inside, the device can monitor and interact with bioelectrical and biochemical signals within a cell.

methods,"says Zhou. "No existing device has the ability to measure both optical and electrical signals in the same place at the same time."

Overcoming the cell membrane barrier

Before nano-transducers can interface with the cell, they need to slip inside it. Zhou will equip his devices with a way to create a "side door" from which they can observe activity or send signals in a controlled and minimally invasive manner (see figure above).

By converting optical energy into thermal heating, the device can generate a miniscule vapor bubble to open a nano-sized hole on the cell's membrane.

By slipping into the bubble, the device can be internalized into the cell itself, where it will perform its electrical and optical duties.

"Establishing a reliable intracellular interface between living cells and external materials or devices can lead to significant opportunities not only for cell studies, but also for healthcare diagnosis and therapy," says Zhou.

Nanoantenna component

In its role as a nanoantenna, the device concentrates light into a nanoscale spot beyond the diffraction limit—causing the photons to be absorbed or scattered, depending on how they interact with biomolecules.

While most of the scattered photons retain their original energy, a few of them are permanently, or inelastically, affected. Their energy shifts either up or down. This phenomenon, called Raman scattering, provides information about real-time biochemical signals.

Nanoelectrode component

Bioelectrical activity governs the movement of ions and metabolites across the cell membrane, and provides communication, processing, and coordination throughout large networks of cells.

Understanding these interactions requires accurate recording and control of voltage changes within the cell and across networks of cells, says Zhou.

Zhou will be using nanoelectronic components within his device to probe subcellular features and map bioelectrical behavior.

Measuring drug response

When the nanoscale multimodal transducer is operational, Zhou and his team plan to monitor and study the correlation between bioelectrical and biochemical activities of cells in response to drugs. Among others, they plan to study the effects of norepinephrine, because it can function in the heart and brain as a hormone and neurotransmitter.

The Air Force's Young Investigator Research Program annually awards funding to U.S. scientists and engineers who show exceptional ability and promise for conducting basic research. ece

Building a smarter world

WALID SAAD investigates ways to advance smart city technologies. For example, he is looking into the deployment of drones as flying antenna arrays to further enhance city connectivity.

It might start with the installation of smart light-responsive windows in your office building. Then a drone flight path will be designated above the mall. One morning, you will notice a self-driving car in your neighbor's driveway. Slowly but steadily, the city you live in will become more and more connected, its infrastructure keyed to monitor itself in smart, sustainable ways.

"Smart cities may be a buzzword now," says ECE's Walid Saad, the College of Engineering Faculty Fellow and associate professor. "But in the next few decades, we're going to start seeing it materialize around us."

Saad specializes in the technologies that enable smart cities, including wireless and cellular networks, cyberphysical systems, unmanned aerial vehicles, cybersecurity, smart grids, machine learning, big data analytics, and game theory. As of spring 2018, he is involved in 16 research projects (13 from the National Science Foundation and three from the Department of Defense) that advance various smart city technologies.

Wireless connections for a connected city

"Delivering high-speed, pervasive wireless services to trillions of mobile devices, as anticipated in the upcoming Internet of Things system, requires a huge transformation of today's wireless cellular networks," says Saad. Existing networks were not designed to handle the scale, density, and dynamics of all these devices.

Because there is not enough spectrum available for classical cellular systems, which operate below 6 GHz and handle the majority of wireless device communications, Saad is exploring millimeter-wave communications, using frequencies above 30 GHz. "Nobody is using these frequencies, but they are sensitive to blockage," explains Saad.

Using the standard cell network, we can move our phones around and still get a good signal. With millimeter-wave frequencies, however, just putting a hand between the antenna and base station is enough to disrupt communications. Saad hopes to integrate millimeter-wave communications with the traditional sub-6 GHz communications to take advantage of the benefits of each.

Smart fog computing

"Today, we're using cloud computation as the default for all of our device content requests because these huge data centers have high processing power," says Saad. "But there have been problems with wireless links and latency."

Using machine learning algorithms and online optimization techniques, Saad has been exploring smart computing in which individual devices autonomously evaluate options and decide where to send tasks and content requests. Should they use the slower, but more reliable, local "fog" network—or send it to the cloud?

Autonomous vehicles

Autonomous vehicles will be among the first technologies to benefit from data processing location answers. "Low latency, high reliability communications links are critically important for autonomous vehicles," says Saad.

Cars that communicate with others and the infrastructure cannot afford even a few milliseconds delay between sending and receiving data. "We must jointly design communication and control systems so that the network delivers information fast enough to keep autonomous cars stable, maintain equal distances between each car, and keep consistent speeds," notes Saad. His team is designing control systems for platoons of self-driving vehicles that use cellular networks to boost reliability and meet latency requirements.

Saad's team is investigating how existing cellular infrastructure can sustain autonomous drone users, such as those that will be used for delivery systems (e.g., Amazon Prime). Drones have an advantage over cars for wireless communications: they fly high enough that there are no blocks between them and their base stations. They, however, can create interference for users closer to the ground. Using deep learning algorithms, Saad hopes to help these drones plan paths that balance their interference and flight time concerns.

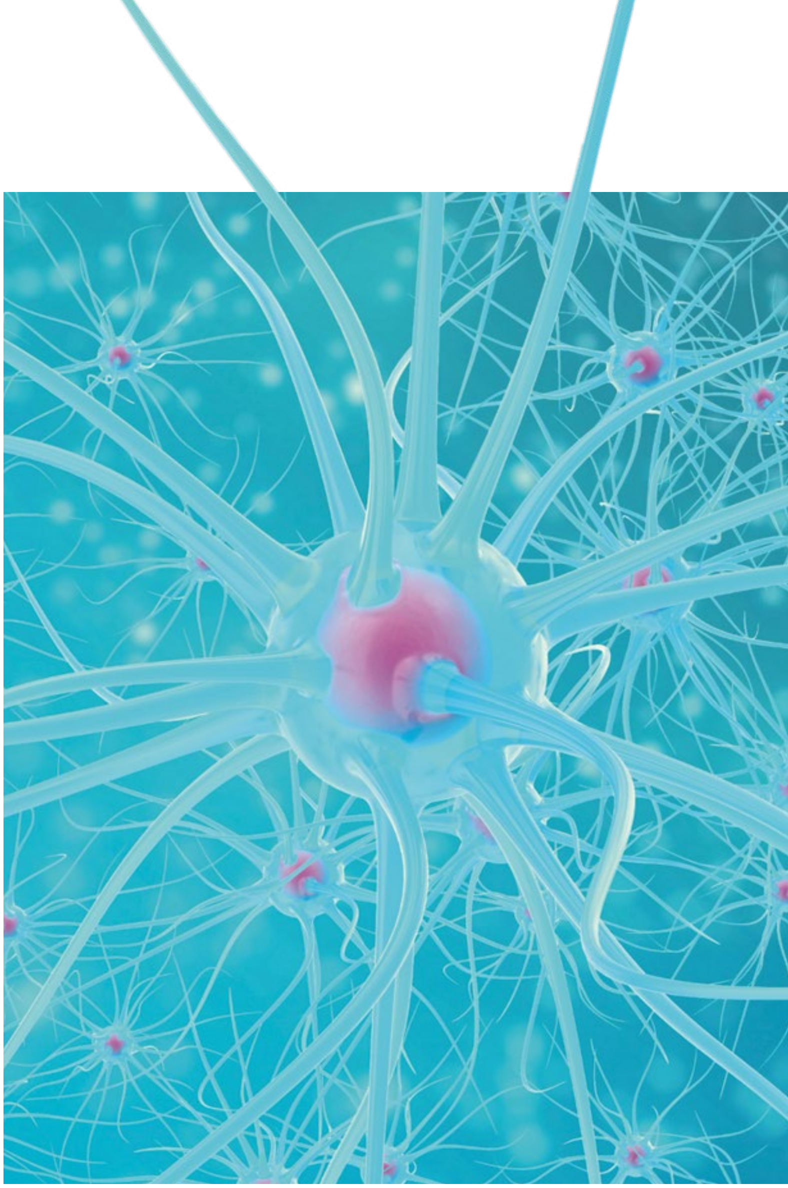
Physical and cyberphysical security

Drones also have unique security risks. "We must consider the security issues that pose risks, both through the network and in the skies," says Saad.

Besides developing machine learning techniques to fortify the systems, Saad and his team are considering problems such as FAA regulations that restrict drones to a maximum altitude of 400 feet, which places them in range of civilian hunting rifles.

"Many times, a network will be well protected against a technologically sophisticated hack, but vulnerable when it comes to something simple or even inane," says Saad. "Optimal defense theories focus on rational players," Saad explains. "Irrational is harder to predict and harder to defend against."

To meet these non-rational attackers, his team is employing game theory, along with the Nobel-prize-winning framework of prospect theory, to help plan drone routes that are unlikely to be in the path of attackers. Because drones are sensitive to flight times, an attacker is likely to wait for one along the shortest path a drone could take. Although flight times do matter, Saad points out that dealing with an attacker will take more time than a circuitous path. His team is also working on cyberphysical security problems that relate to autonomous vehicles and smart power systems. ece



Decoding chemical brain communications

Guoqiang Yu is forging new computational tools to shed light on the role of astrocytes—vitally important cells in the human brain. Astrocytes are little understood, but their impaired function may be associated with brain diseases such as Alzheimer's, stroke, epilepsy, and schizophrenia.

Yu, an assistant professor of ECE, is working on two RO1 grants from the National Institutes of Health (NIH) to help researchers understand astrocyte-neuron communication.

Astrocytes, from the Greek "star cells" in reference to their shape, are workhorses of the central nervous system. They wrap around neurons, nursing and protecting them; help to repair damaged tissue; maintain ion balance; and provide nutrients to nerve tissue.

Unlike neurons, astrocytes do not generate electrical impulses. They communicate among themselves and with neurons through chemical signals—including waves of calcium ions (Ca^{2+})—which aid the formation and function of synapses (connections between neurons) throughout the brain.

"A deeper understanding of the back-and-forth signaling between astrocytes and neurons in health and disease could lead to novel therapies for brain disorders," says Yu.

Researchers can observe these signals with advanced imaging, including microscopy and fluorescence, however the ability to analyze and interpret the data has lagged far behind, says Yu. "This has slowed the progress of brain disorder therapies," he says.

Correcting the lag

Yu, in collaboration with experimental neuroscientists from the University of California, Davis, is leading a $2.5 million grant from the National Institutes of Health to address this discrepancy.

By developing novel computational tools, which draw strength from a variety of advanced machine learning techniques like graph-structured tensor decomposition (GSTD), the research team will analyze the cellular properties of calcium signaling in a single astrocyte.

Then, because so much of an astrocyte's function depends on how it operates within

GUOQIANG YU (right) is working on two National Institutes of Health projects to help researchers understand the communication between neurons and astrocytes (left), vitally important cells in the human brain. Astrocytes are little understood, but their impaired function may be associated with brain diseases.

a network, the team will develop computational tools to analyze the properties of calcium signaling in a population of cells.

"The study of astrocytes at the network level has been unduly ignored so far," says Yu. "But we can gain insight into these inner workings by leveraging our experience in network biology and probabilistic modeling."

Finally, the team will package the developed computational tools into a user-friendly software program for experimental scientists. All source code will be available through public open-source hosting websites, so that anyone can modify and tailor the code to their specific application and need.

Understanding the injured brain

Yu's computational tools are already being put to work. He is currently collaborating with Stefanie Robel, an assistant professor at the Virginia Tech Carilion Research Institute, on another grant from the National Institutes of Health. Led by Robel, this project will test the hypothesis that astrocyte dysfunction induced by traumatic brain injury is a root cause of post-traumatic epilepsy.

"After years of assuming that neurological diseases are caused by direct damage to neurons, we now know that impaired astrocyte function precedes and is essential for the progression of many of these diseases," says Robel.

After identifying the primary cause of astrocyte dysfunction, the researchers will be monitoring neurons in areas with abnormal astrocytes to see if they become "hyperexcitable," which is a prerequisite for the development of epilepsy.

Yu and his team will be analyzing 2-photon *in vivo* imaging data acquired by Robel's team. ece

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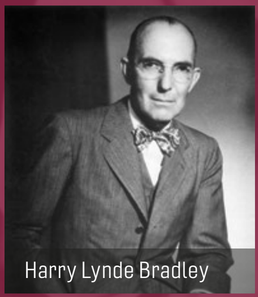
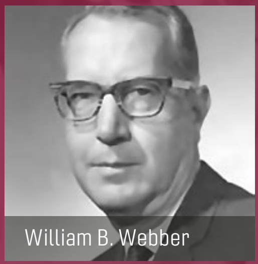

Harry Lynde Bradley


William B. Webber

IN SPRING 1987, the late Mrs. Marion Bradley Via established a generous endowment for the enhancement of the Department of Electrical Engineering. This endowment was in honor of Mrs. Via's late father, Harry Lynde Bradley, who was a pioneer in the electric motor control industry and cofounder of the Allen-Bradley Company of Milwaukee, which is now part of Rockwell Automation.

In recognition of this endowment, the department is called The Bradley Department of Electrical and Computer Engineering. Income from the endowment funds undergraduate scholarships, graduate and postdoctoral fellowships, and professorships in the continuing effort to improve the quality of our ECE programs. These fellowships and scholarships are among the most competitive in the country.

IN 1994, William B. Webber (EE '34) established a fund to encourage women engineers. Webber's career took him to Westinghouse, the U.S. Signal Corps, then to a booming company co-founded by an army buddy—Tektronix, Inc. Today, the William B. Webber Fellowship is awarded to high achieving women pursuing a graduate degree in electrical or computer engineering.

BRADLEY & WEBBER FELLOWS

Noah P. Allen

- BSEE '09 Georgia Institute of Technology
- MSEE '14 Virginia Tech
- *Advisor: Louis Guido*

RESEARCH: Allen is investigating the effects of unintentional atomic impurities and physical defects on the reverse leakage current, breakdown voltage, and on-resistance of Gallium Nitride vertical PN junctions.

Jacob Black

- BSEE '17 Virginia Tech
- *Advisor: Jonathan Black*

RESEARCH: Black is researching digital signal processing and the autonomous classification of radio frequency (RF) signals.

Jon Bunting

- BSCPE '17 Virginia Tech
- *Advisor: A. Lynn Abbott*

RESEARCH: Bunting is working on semi-supervised feature learning for hierarchical classification.

Anthony Carno

- BSCPE '15 Bucknell University
- *Advisor: Binoy Ravindran*

RESEARCH: Carno is investigating novel cooperative and non-cooperative scheduling techniques for heterogeneous-ISA (instruction set architecture) applications as part of the Popcorn Linux project.

Ryan Chan

- BSCPE '15 Binghamton University—SUNY
- *Advisor: Masoud Agah*

RESEARCH: Chan is investigating new applications for micro gas chromatography for analytical chemistry and developing a new gas chromatography device that allows for ultra fast parallel separations.

Shane Coyle

- BS Electrical Engineering Technology
- BA Physics '17 California University of Pennsylvania
- *Advisor: Bob Clauer*

RESEARCH: Coyle is researching magnetosphere-ionosphere coupling.

Sarah El-Helw

- BSEE '10 Georgia Tech
- MSEE '16 Virginia Tech
- *Advisor: Dushan Boroyevich*

RESEARCH: El-Helw is working on static and dynamic characterization of new silicon carbide devices.

Bryse Flowers

- BSCPE '14 Virginia Tech
- *Advisor: Chris Headley*

RESEARCH: Bryse works with the Hume Center to adapt machine learning techniques for wireless communication applications.

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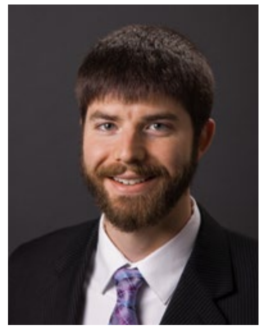
BRADLEY & WEBBER *FELLOWS*

Sarah Hanson

- BSEE '17 Virginia Tech
- *Advisor: A. A. (Louis) Beex*

RESEARCH: Hanson is developing an objective method of diagnosing Attention Deficit Hyperactivity Disorder (ADHD) in children using electroencephalogram (EEG) signals.



Steven Hauser

- BSEE '12 Virginia Tech
- *Advisors: Alan Michaels, A.A. (Louis) Beex*

RESEARCH: Hauser is researching applications of machine learning in wireless communication systems. His current focus is deep neural networks for automatic modulation classification on raw IQ data.

Larkin Lee Heintzman

- BSEE '15 Western Kentucky University
- *Advisor: Ryan Williams*

RESEARCH: Heintzman is researching the localization of robotic teams.

Ji Hoon Hyun

- BS '14 Virginia Tech
- MS '16 Virginia Tech
- *Advisor: Dong S. Ha*

RESEARCH: Hyun is designing high temperature circuits for energy harvesting.

Paul Steven Kennedy

- BSEE '17 Virginia Tech
- *Advisor: J. Michael Ruohoniemi*

RESEARCH: Kennedy is exploring the design of software defined radios in radar systems for ionospheric space science research.

Kruthika Kikkeri

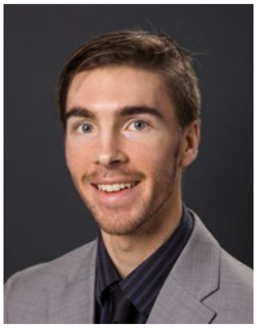
- BSEE '16 Virginia Tech
- *Advisors: Xiaoting Jia, Masoud Agah*

RESEARCH: Kikkeri is characterizing, separating, and sorting cancer, bacteria, and neuron cells based on their electrical signatures. She uses microelectromechanical (MEMS) technology and microfluidic fibers. She was awarded a National Science Foundation Graduate Research Fellowship in 2017.

Markus Kusano

- BSCPE '14 Virginia Tech
- MSCPE '17 Virginia Tech
- *Advisor: Chao Wang*

RESEARCH: Kusano is working on automated software fault localization and repair, particularly for concurrent programs. Techniques he is exploring include abstract interpretation, concolic execution, and bounded model checking.



Taylor McGough

- BSCPE '14 Virginia Tech
- *Advisor: JoAnn M. Paul*

RESEARCH: McGough is investigating artificial intelligence and computational modeling.

Hannah D. Mohr

- BSEE '17 Montana State University
- *Advisor: Jonathan Black*

RESEARCH: Mohr is applying multi-agent coordination to space-based systems. She focuses on formation control, while accounting for the restrictions of orbital mechanics.

Natalie Moore

- BSECE '16 Cornell University
- *Advisor: Jeffrey Reed*

RESEARCH: Moore is analyzing the effect of receiver nonlinearity on the probability density functions and error rates of modulated signals, with and without interference.

Daniel Neel

- BSCPE '16 Virginia Tech
- *Advisor: Peter Athanas*

RESEARCH: Neel is researching low latency convolutional neural network interference on hybrid memory cube (HMC)-enabled field programmable gate arrays (FPGAs).

Matt Nikkel

- BSCPE '17 Virginia Tech
- *Advisor: Al Wicks*

RESEARCH: Nikkel is researching autonomous vehicle path planning while considering vehicle dynamics.

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BRADLEY & WEBBER *FELLOWS*

Christopher E. O'Lone

- BSEE '12 Lehigh University
- MSEE '13 Lehigh University
- *Advisor: R. Michael Buehrer*

RESEARCH: O'Lone is using estimation theory and stochastic geometry to develop analytical models that can help researchers understand localization performance in wireless networks without needing complex computer simulations.

Timothy M. Pierce, Jr.

- BSEE '13 Hampton University
- MSEE '16 Virginia Tech
- *Advisor: Alfred L. Wicks*

RESEARCH: Pierce is investigating current measurement technology for pulsed power systems.

Ellen Robertson

- BSEE '14 Virginia Tech
- MSEE '17 Virginia Tech
- *Advisor: Greg Earle*

RESEARCH: Robertson is testing, designing, and simulating a neutral wind sensor for use on small satellites.

Ian Roessle

- BS Computer Science
- '08 California State University, Los Angeles
- MS Computer Science
- '13 Johns Hopkins University
- *Advisor: Binoy Ravindran*

RESEARCH: Roessle is researching the formal verification of x86-64 binaries. He has successfully run a symbolic execution of deeply embedded x86-64 binaries with Isabelle/HOL, a higher-order logic theorem proving environment.

Maymoonah Toubeh

- BSCPE '14 American University of Kuwait
- *Advisor: Pratap Tokekar*

RESEARCH: Toubeh is exploring the intersection of machine learning, robotics, and statistical inference. Her current research on applying uncertainty approximation in deep learning to a robotic planner will contribute to safe and risk-aware robotics.

Natalie White

- BSEE '16 University of Tennessee Knoxville
- *Advisors: Rafael Davalos, Xiaoting Jia*

RESEARCH: White is developing a 3D computational model that incorporates human tissue properties to optimize outcomes for cancer patients treated with irreversible electroporation (IRE), which uses pulsed electric fields to treat tumors.

Brian Worek

- BSCPE '17 Virginia Tech
- *Advisor: Paul K. Ampadu*

RESEARCH: Worek is investigating approximate storage for improving memory performance.

Oscar Yu

- BS '15 University of Texas at Austin
- MS '18 Virginia Tech
- *Advisor: Jason Lai*

RESEARCH: Yu is designing high efficiency power electronics for solid state transformers.

2017 | 2018 BRADLEY *SCHOLARS*

Elizabeth Hutz

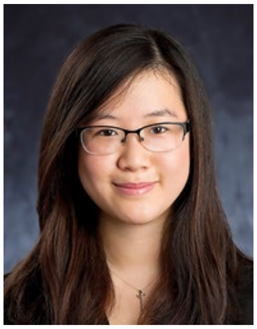
- BSCPE '18

After graduating, Hutz will join UTC Aerospace Systems (UTAS) in Vermont, where she will work on the embedded software design team. She interned at UTAS for two summers while at Virginia Tech, doing embedded software design and testing for a Pulse Health Monitoring System (PHMS), which collects and processes data from aircraft.

Danielle Lester

- BSEE '21

Lester hopes to use her electrical engineering degree and Spanish skills to work for an international company after grauation. In her Foundations of Engineering class, she presented on the impact of cyberattacks and worked on a project to market and prototype a windmill to generate energy.



Maureena Ma

- BSEE '21

Ma hopes to work in the biomedical field, helping create solutions for ailments from mental illness to cancer. One of her favorite projects so far was working on a delivery drone project in her Foundations of Engineering class. She is looking forward to taking advantage of research opportunities in the future.

BRADLEY *ALUMNI*

NAME	TITLE	COMPANY/FIELD	LOCATION
JoAnn Adams S BSEE '94	Co-Owner	Big Fish Design	Centreville, Va.
Robert Adams F MSEE '95, Ph.D. '98	Professor, ECE	University of Kentucky	Lexington, Ky.
Shawn Addington F BSEE '90, MSEE '92, Ph.D. '96	Professor and Head, Department of Electrical and Computer Engineering	Virginia Military Institute	Lexington, Va.
Sarah S. Airey S BSCPE '01	Speech Scientist	Recordsure	Cambridge, U.K.
Christopher R. Anderson S/F BSEE '99, MSEE '02, Ph.D. '06	Associate Professor	United States Naval Academy	Annapolis, Md.
Matthew R. Anderson S BSCPE '04	Network Architect	Cisco Systems	Washington, D.C.
Nathaniel August F BSCPE '98, MSEE '01, Ph.D. '05	Senior Technical Lead and Staff Engineer	Intel Corporation	Portland, Ore.
Stephen P. Bachhuber F BSEE	Senior Member of Technical Staff	Qorvo	Greensboro, N.C.
Mark Baldwin F BSEE '93, MSEE '05, Ph.D. '08	Engineer	Dominion Power	Glen Allen, Va.
William D. Barnhart S/F BSEE '00, MSEE '02	Electronics Engineer	Northrop Grumman	Redondo Beach, Calif.
Benjamin Alan Beasley S BSEE '09	Associate	Zeta Associates Inc.	Fairfax, Va.
Brian Berg F BSEE '90, MSEE '91, Ph.D. '01	President and Founder	Dimmersion LLC	Agoura Hills, Calif.
Ray Bittner F BSCPE '91, MSEE '93, Ph.D. '97	Principal Hardware Engineer	Microsoft Research	Redmond, Wash.
Aric Blumer F Ph.D. '07	Staff Hardware Engineer	Luna Innovations Inc.	Blacksburg, Va.
Bryan Browe F BSEE '97, MSEE '00	Senior IT Specialist (InfoSec)	Office of Financial Research	Washington, D.C.
Kirsten Ann Rasmussen Brown S BSEE '94	Vice President, Office of the Chairman	MicroStrategy Inc.	Tyson's Corner, Va.
Steven Edward Bucca F BSEE '87, MSEE '89	RF Engineer	ATK, Bell Aerospace	Broomfield, Colo.
Mark B. Bucciero F BSCPE '01, MSCPE '04	Computer Engineer	Logos Technologies	Raleigh, N.C.
R. Michael Buehrer F Ph.D. '96	ECE Professor	Virginia Tech	Blacksburg, Va.
Charles Bunting F MSEE '92, Ph.D. '94	Associate Dean of Research, College of Engineering, Architecture, and Technology and Bellmon Chair	Oklahoma State University	Stillwater, Okla.
Colin Burgin F	Student	Virginia Tech	Blacksburg, Va.
Carey Buxton F Ph.D. '01	Electrical Engineer	US Government	Spotsylvania, Va.
Scott Cappiello S BSCPE '94	Senior Director, Product Management	Paxata Inc	San Diego, Calif.
Matthew Carson S BSEE '98	Logistics Coordinator		South Asia
Matthew Carter F BSEE '09	Software Engineer	Metavine	San Jose, Calif.
Ricky Castles S BSCPE '03, MSCPE '06, Ph.D. '10	Assistant Professor	East Carolina University	Greenville, N.C.
Eric D. Caswell F Ph.D. '01	Director, Small Antenna Engineering	L-3 Randtron Antenna Systems	Linthicum Heights, Md.
Daniel Dae Cho S BSEE '06	IP Associate	Sheppard Mullen Richter & Hampton LLP	San Diego, Calif.
Jeffrey R. Clark F MSEE '03, Ph.D. '06	Proprietor	Black Dog Writing & Editing	Blacksburg, Va.
Ross Clay S BSCPE '09	Software Developer	Twitter	Raleigh, N.C.
Brittany Clore S BSCPE '10, MSCPE '12	Lead Cyber Security Engineer	The MITRE Corporation	McLean, Va.
Kevin B. Cooley S BSEE '02	Electrical Engineer	Automation Controls Inc.	Newport News, Va.
Thomas Alan Cooper S BSEE '10, MSEE '12	Software Design Engineer	KEYW Corporation	Severn, Md.
Carrie Aust Cox F MSEE '00	Senior Staff Engineer	Qualcomm	Apex, N.C.
David Casteel Craven S BSCPE '08	Senior Systems Design Engineer	Validation Debug, AMD	Austin, Texas
Stephen Douglas Craven F Ph.D. '08	Electrical Engineer	Tennessee Valley Authority	Chattanooga, Tenn.
Cass Dalton S BSCPE '03	Software Engineer	Technology Management Associates	Chantilly, Va.
Phillip A. Danner S BSCPE '91	President and CEO	SageCourse Enterprises LLC	Omaha, Neb.
Paul U. David F MSEE '15		Ettus Research	Santa Clara, Calif.
Bradley A. Davis F BSEE '86, MSEE '88, Ph.D. '00	Senior Principal Engineer	General Dynamics	Marion, Va.
Scott Davis S BSCPE '00	Software Engineer Manager	Kollmorgen	Radford, Va.

NAME	TITLE	COMPANY/FIELD	LOCATION
Jacques Delport F BSEE '13, MSEE '14			
Thurman Shaver Deyerle IV F BSEE '10, MSEE '13	Staff Hardware Engineer	Qualcomm	San Diego, Calif.
Brian M. Donlan F MSEE '05			
Sean Douglass F		Virginia Tech	
Thomas H. Drayer F BSEE '87, MSEE '91, Ph.D. '97	Technical Director	Department of Defense	
Bradley Duncan F Ph.D. '91	Executive Director, Graduate Academic Affairs	University of Dayton	Dayton, Ohio
Gregory D. Durgin F BSEE '96, MSEE '98, Ph.D. '00	Professor, ECE	Georgia Tech	Atlanta, Ga.
William Ashley Eanes S BSEE '95	Business Relations Manager	Duke Energy Corporation	Greensboro, N.C.
Richard Ertel F Ph.D. '99	Senior Staff Engineer	L-3 Technologies	
Lucy Fanelli F MSEE '14	Computer Engineer	Sandia National Laboratories	Albuquerque, N.M.
Brian Flanagan S/F BSEE '97, MSEE '98	Senior Design Engineer	Intel	Austin, Texas
Kevin Flanagan S BSCPE '00, MSCPE '01	ASIC Design Engineer	Intel	Folsom, Calif.
Todd B. Fleming F BSCPE '94, MSEE '96	Principal Engineer	Fleming Technologies	Blacksburg, Va.
Ryan Fong S/F BSCPE '01, MSCPE '04	Senior Engineer	Fourth Dimension Engineering	Laurel, Md.
Michael Fraser F MSEE '12, Ph.D. '16			Blacksburg, Va.
Jayda Blair Freibert S BSEE '98	Business Operations Manager	The Morin Company	Richmond, Va.
Daniel Friend F Ph.D. '09	Associate	Zeta Associates	Fairfax, Va.
Bradley H. Gale S BSEE '97		USPS	
Robert M. Gardner, Sr. F BSEE '03, MSEE '05, Ph.D. '08	Manager, Electric T&D Services	Dominion Energy	Richmond, Va.
Daniel J. Gillespie S BSCPE '95	Manager	Huron Consulting Group	Portland, Ore.
Brian Gold S BSEE '01, MSCPE '03	Engineering Director	Pure Storage	Mountain View, Calif.
Jonathan Graf S BSCPE '02, MSCPE '04	Founder and CEO	Graf Research	Blacksburg, Va.
Timothy Gredler S BSCPE '03	Controls Manager, Chillers	Daikin Applied	Staunton, Va.
Christopher Griger S BSCPE '02	Principal Hardware Architect	National Instruments	Austin, Texas
Daniel Hager S BSCPE '08, MSCPE '09	Embedded Software Engineer	Lockheed Martin Aeronautics	Atlanta, Ga.
Adam P. Hahn S BSCPE '03	Senior Software Engineer	Bloomberg LP	New York, N.Y.
Alexander Hanisch S BSCPE '03, BSMATH '03	Modeling and Simulation Scientist	Joint Warfare Analysis Center	Fredericksburg, Va.
Nathan Harter F MSEE '07	Senior Systems Engineer	G3 Technologies Inc.	Mount Airy, Md.
Dwayne Allen Hawbaker F BSEE '89, MSEE '91	Principal Professional Staff	The Johns Hopkins University APL	Laurel, Md.
William C. Headley F BSEE '06, MSEE '09	Research Scientist, Hume Center	Virginia Tech	Blacksburg, Va.
Matt Helton S BSEE '01	Control Systems Support Supervisor	Eastman Chemical Co.	Kingsport, Tenn.
Ben Henty F MSEE '01	Chief Scientist, Signals Group	The Johns Hopkins University APL	Laurel, Md.
Jason Hess F BSEE '97, MSEE '99	Manager for HW Engineering, Internet of Things Group	Cisco Systems	Austin, Texas
Erik Hia F BSCPE '99, MSCPE '01	Senior Manager, R&D Software	ADVA Optical Networking	Raleigh-Durham, N.C.
Daniel J. Hibbard F BSEE '02, MSEE '04	Engineering Director & Chief Engineer	Trident Systems	Fairfax, Va.
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Hugh E. Hockett S BSCPE '03	Senior Software Engineer and Master Inventor	IBM	Raleigh-Durham, N.C.
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Andrew S. Hollingsworth S BSCPE '03	Software Engineer	Charon Technologies	Herndon, Va.
Michael Hopkins F Ph.D. '14	Senior R&D Imagineer	Walt Disney Imagineering	Glendale, Calif.
Ellery L. Horton S BSCPE '04	Software Development Engineer in Test	Cision	Morrisville, N.C.

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NAME	TITLE	COMPANY/FIELD	LOCATION
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CHARLES BUNTING, professor of electrical and computer engineering, associate dean of research at Oklahoma State University.

READ MORE ABOUT THIS STORY AT:
www.ece.vt.edu/news/article/from-reverb-chambers-to-flipped-classrooms

A career in complex environments

ECE alumnus Charles Bunting (MSEE '92, Ph.D. '94) has spent the past 16 years studying interacting signals—both electromagnetic signals in a reverberation chamber and signals of comprehension from students in the classroom.

He was recently named an IEEE Fellow for his educational contributions to electromagnetic compatibility and reverberation chambers.

A reverberation chamber is a highly reflective metal cavity where electromagnetic signals continuously bounce off the walls at all angles and back into the room. Because the room has such a low absorption rate, researchers can achieve strong, homogenous electromagnetic fields with moderate input power.

Bunting and his team use the chamber to look at how electronic systems from different industries—avionics, aerospace, automotive, and others—are susceptible to electromagnetic interference.

Educational research

After being awarded a Department Level Reform Grant from the National Science Foundation in 2005, Bunting used his experience in front of a classroom as a platform to explore engineering pedagogy.

He implemented what is now referred to as a "flipped classroom" with several junior-level electromagnetism classes and a circuits class. In this model, students read the text and took formative online quizzes outside of class and worked on problems previously relegated to homework in class with their peers. ece

ECE alum Matt Valenti elevated to IEEE Fellow

The IEEE recently elevated ECE alumnus Matthew Valenti (BSEE '92, Ph.D. '99) to Fellow for his contributions to cooperative diversity and the development of distributed turbo codes.

Valenti's work with distributed turbo codes—which enable mobile handsets to cooperatively communicate with a base station—evolved out his Virginia Tech dissertation.

Turbo codes are error correction codes used to clean up signals in 3G and 4G mobile communications. They made their debut in the early '90s, around the time that Valenti was returning to Virginia Tech to begin a doctoral program as a Bradley Fellow.

"It was a very exciting time to be interested in communications," says Valenti. "Wireless communications was ramping up, students were working on some really interesting projects, and there was a buzz going around."

More recently, Valenti has been thinking ahead to the future of cellular communications—specifically investigating technologies that are being considered for 5G, such as using higher frequency (millimeter) waves for communications and developing frequency-hopping radios.

He has been collaborating with the Army Research Laboratory and researchers from the University of Texas to build out these ideas.

"What I find most exciting about this field is how tight the connection is between theory and practice," says Valenti. "If you get the theory, then practice follows easily." ece

MATTHEW VALENTI, professor of computer science and electrical engineering at West Virginia University.

READ MORE ABOUT THIS STORY AT:
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Although every effort has been made to ensure the accuracy of this report, we acknowledge that errors may have occurred. If your name was omitted or listed incorrectly, please accept our sincere apologies and send corrections to the Office of University Development at (540) 231-2801, or contact: www.givingto.vt.edu/Contact/contact-form.html

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HONORS & ACHIEVEMENTS

Keynote Addresses

Y. Thomas Hou was keynote speaker at the Ninth International Conference on Wireless Communications and Signal Processing (WCSP), Nanjing, China, Oct. 2017.

Jih-Sheng (Jason) Lai gave keynote addresses at: the IEEE International Conference on Industrial Technology, Toronto, Canada, March 2017; and the Offshore Wind Generation Power Technology Symposium, Kaohsiung, Taiwan, June 2017.

T.-C. Poon was keynote speaker at the 9th International Conference on Information Optics and Photonics, Harbin, China, July 2017. He also gave the plenary lecture at the 13th School on Acousto-Optics and Applications, Moscow, Russia, June 2017.

Walid Saad gave a keynote address at the IEEE Vehicular Technology Conference Workshop on Backhaul Workshop on Next Generation Backhaul/ Fronthaul Networks, Toronto, Canada, Sept. 2017. He also gave a plenary talk at the APA Virginia Annual Conference, Roanoke, Va., July 2017.

Awards & Distinctions

Harpreet S. Dhillon was named a Clarivate Analytics Highly Cited Researcher. He was also named an Outstanding New Assistant Professor by the College of Engineering in 2017 and named a Steven O. Lane Junior Faculty Fellow for 2018.

Guo-Quan (G. Q.) Lu was named IEEE Fellow for his contributions in materials and packaging technologies for power electronics modules.

Fred C. Lee was named a National Academy of Inventors Fellow for 2018 for his contributions to the field of power electronics.

Vassilis Kekatos was awarded an NSF CAREER Award to implement a novel technique called grid probing, which employs smart inverters in a second role.

Yang (Cindy) Yi was awarded an NSF CAREER Award for her work on developing 3D neurotrophic integrated circuits—ICs that mimic the human brain.

Wei Zhou was awarded a Young Investigator Research Program (YIP) award from the Air Force Office of Scientific Research (AFOSR).

Walid Saad received the Best Young Professional in Academia Award from the IEEE Communication Society. With M. El-Bamby and M. Bennis, he also received a best paper award at the European Conference on Networks and Communications, Oulu, Finland, June 2017. He was also named a College of Engineering Fellow.

Lingjia Liu and **Yang Yi,** along with Jialing Li and Kangjun Bai, won a best paper award for "A Deep Learning Based Approach for Analog Hardware Implementation of Delayed Feedback Reservoir Computing System" at the IEEE ISQED Conference.

Amir I. Zaghloul was named a Fellow of the International Union of Radio Science (URSI).

Theresa S. Mayer received the Outstanding ECE Alumni award from Purdue.

Y. Thomas Hou was awarded a College of Engineering Dean's Award for Excellence in Service.

Xiaoting Jia was awarded an ICTAS Junior Faculty Award.

Jung-Min Park received a Dean's Award for Research Excellence and a College of Engineering Research Fellow.

Patrick R. Schaumont received a Certificate of Teaching Excellence.

Conference Chairs

Harpreet S. Dhillon was technical program co-chair of Track 2: MAC and Cross Layer Design, 28th Annual IEEE International Symposium on Personal, Indoor and Mobile Radio Communications (PIMRC), Montreal, Canada, Oct. 2017. He also was co-chair of the International workshop on Service-Oriented Optimization of Green Mobile Networks (IEEE GREENNET 2017), WiOpt 2017, Paris, France, May 2017.

Y. Thomas Hou is steering committee chair of the IEEE INFOCOM conference.

Jih-Sheng (Jason) Lai was general chair for the IEEE Asian Conference on Energy, Power, and Transportation Electrification, Singapore, Oct. 2017.

Lingjia Liu was industry program chair for the 2017 IEEE Wireless Communications and Networking Conference (WCNC), San Francisco, Calif., March 2017. He was also workshop chair for the International Workshop on Massive MIMO/FD-MIMO in 5G Mobile Communications, in conjunction with 2017 IEEE International Symposium on Personal, Indoor and Mobile Radio Communications (PIMRC), Montreal, Canada, Oct. 2017; and for the 6th International Workshop on Emerging Technologies for Beyond 5G Wireless Cellular Networks, in conjunction with 2017 IEEE Global Communication Conference (GLOBECOM), Singapore, Dec. 2017.

Jung-Min (Jerry) Park was appointed to the IEEE DySPAN steering committee.

Walid Saad was technical program symposium chair for IEEE Global Communications Conference (GLOBECOM), Selected Areas in Communications - Smart Grid Track, Singapore, Dec. 2017. He was also technical committee symposium co-chair for IEEE International Conference on Communications (ICC), Cognitive Radio and Networking Track, Paris, France, May 2017.

Ryan K. Williams was program committee chair for Unmanned Vehicle Systems International (AUVSI), Ridge and Valley Chapter, Conference on Trust in Autonomous Systems, Blacksburg, Virginia, Oct. 2017.

Editorships

Applied Sciences	T.-C. Poon	editor
IEEE Journal of Emerging and Selected Topics in Power Electronics	Jih-Sheng (Jason) Lai	editor
IEEE Journal of Selected Topics in Quantum Electronics	Luke F. Lester	editor-in-chief
IEEE/KICS Journal of Communications and Networks	Jung-Min (Jerry) Park	editor
IEEE Transactions on Green Communications and Networking	Harpreet S. Dhillon	editor
IEEE Wireless Communications Letters	Harpreet S. Dhillon	editor
MDPI Journal on Energies	Jih-Sheng (Jason) Lai	editor

Area/Associate Editorships

ACM Transaction on Sensor Networks	Y. Thomas Hou	associate editor
BMC Bioinformatics	Guoqiang Yu	associate editor
Chinese Optics Letters	T.-C. Poon	associate editor-in-chief
Energy Harvesting materials and Devices	Mantu K. Hudait	associate editor
EURASIP Journal on Wireless Communications and Networking	Lingjia Liu	associate editor
IEEE/ACM Transactions on Networking	Y. Thomas Hou	associate editor
IEEE Communication Turorials & Surveys	Walid Saad	associate editor
IEEE Transactions of Information Forensics and Security	Walid Saad	associate editor
IEEE Transactions on Communications	Allen B. MacKenzie	area editor
IEEE Transactions on Communications	Walid Saad	area editor
IEEE Transactions on Mobile Computing	Jung-Min (Jerry) Park	associate editor
IEEE Transactions on Mobile Computing	Walid Saad	associate editor
IEEE Transactions on Wireless Communications	R. Michael Buehrer	area editor
IEEE Transactions on Wireless Communications	Harpreet S. Dhillon	associate editor
IEEE Transaction on Wireless Communications	Walid Saad	associate editor
Nanotechnology Reviews	Mantu K. Hudait	associate editor
Radio Science	Amir I. Zaghloul	associate editor
Wiley's International Journal on Communication Systems	Lingjia Liu	associate editor

Editorial Board Memberships

Asian Journal of Physics	T.-C. Poon	editorial board member
3D Research	T.-C. Poon	editorial board member
Journal of Holography and Speckle	T.-C. Poon	editorial board member
Optics & Laser Technology	T.-C. Poon	editorial board member

Exceptional national & international service

Lingjia Liu was elected Vice-Chair, Americas, of the IEEE Technical Committee on Green Communications & Computing (TCGCC).

Jung-Min (Jerry) Park is an executive committee member of the National Spectrum Consortium (NSC).

T.-C. Poon serves as a Distinguished Chair Professor of Feng Chia University, Taiwan.

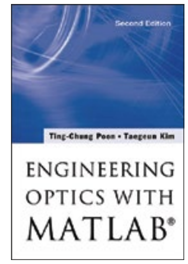
Jeffrey H. Reed was appointed to the Committee for Smart Communities by the governor of Virginia.

Sanjay Raman was re-elected to the IEEE Microwave Theory and Techniques Society (MTT-S) administrative committee.

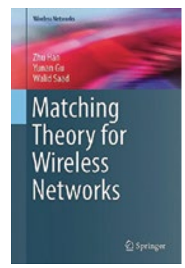
Walid Saad was elected vice chair of the Americas for the IEEE Communications Society Technical Committee of Cognitive Networks.

Amir I. Zaghloul serves as chair of International Commission C (Radiocommunication Systems and Signal Processing) of URSI, 2017–2020.

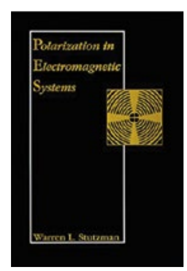
Books Published



T.-C. Poon co-authored Engineering Optics with MATLAB, Second Edition (World Scientific 2017).



Walid Saad co-authored Matching Theory for Wireless Networks (Springer 2017).



Warren L. Stutzman authored Polarization in Electromagnetic Systems, Second Edition (ARTECH House 2018).

ece FACULTY

A. Lynn Abbott
Associate Professor
Illinois '90

Masoud Agah
Virginia Microelectronics Consortium (VMEC) Professor
Michigan '05

Paul K. Ampadu
Professor
Cornell '04

Peter M. Athanas
Professor
Brown '92

Scott M. Bailey
Professor
Colorado '95

Joseph B. Baker
Associate Professor
Michigan '01

Adam E. Barnes
Assistant Professor of Practice
Virginia Tech '95

William T. Baumann
Associate Professor
Johns Hopkins '85

A. A. (Louis) Beex
Professor
Colorado State '79

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University Distinguished Professor
Virginia Tech '86

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Virginia Tech '95

Thidapat (Tam) Chantem
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T. Charles Clancy III
Associate Professor & L-3 Communications Cyber Faculty Fellow
Maryland '06

Jaime De La Ree
Associate Professor & Assistant Department Head
Pittsburgh '84

Harpreet S. Dhillon
Assistant Professor & Steven O. Lane Junior Faculty Fellow
UT Austin '13

Gregory D. Earle
Professor
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Ohio State '00

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Iowa State '11

Mona Ghassemi
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Dong S. Ha
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Peter Han
Assistant Professor of Practice
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NYU Tandon '98

Michael S. Hsiao
Professor
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Xiaoting Jia
Assistant Professor
MIT '11

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Professor
Duke '90

Vassilis Kekatos
Assistant Professor
University of Patras, Greece '07

Jih-Sheng (Jason) Lai
James S. Tucker Professor
Tennessee '89

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Roanoke Electric Steel Professor & Department Head
Cornell '92

Qiang Li
Assistant Professor
Virginia Tech '11

Elena Spinei Lind
Assistant Professor
Washington State University '10

Chen-Ching Liu
American Electric Power Professor
University of California, Berkeley '83

Lingjia Liu
Associate Professor
Texas A&M '08

Guo-Quan (G. Q.) Lu
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Harvard '90

Allen B. MacKenzie
Associate Professor
Cornell '03

Majid Manteghi
Associate Professor
UCLA '05

Gino Manzo
Adjunct Professor of Practice
Cornell MEng '76

Thomas L. Martin
Professor & Bradley Faculty Fellow of Education
Carnegie Mellon '99

Jeffrey S. Mayer
Collegiate Associate Professor
Purdue '91

Theresa S. Mayer
Professor & Vice President for Research and Innovation
Purdue '93

Ervin Meadows
Adjunct Professor of Practice
Virginia Tech '88

Scott F. Midkiff
Professor & Vice President for Information Technology and Chief Information Officer
Duke '85

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Liege '87

Changwoo Min
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Sungkyunkwan '14

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Willem G. (Hardus) Odendaal
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Rand Afrikaans '97

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Pittsburgh '94

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Professor & Assistant Department Head
Cornell '90

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Iowa '82

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Sanjay Raman
Professor & Associate Vice President, National Capital Region
Michigan '98

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Jeffrey H. Reed
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UC Davis '87

J. Michael Ruohoniemi
Associate Professor
Western Ontario '86

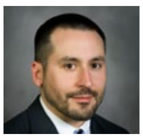
Walid Saad
Associate Professor
Oslo '10

TENURE & PROMOTION

Dushan Boroyevich was named University Distinguished Professor

Robert Broadwater was named Professor Emeritus

Rolando P. Burgos was granted tenure



T. Charles Clancy III was promoted from Associate Professor to Professor

Robert Clauer was named Professor Emeritus

Fred C. Lee was named University Distinguished Professor Emeritus

Douglas K. Lindner was named Associate Professor Emeritus

Walid Saad was promoted from Assistant Professor to Associate Professor with tenure

Yong Xu was promoted from Associate Professor to Professor

Vuk Marojevic was promoted from Research Associate to Research Assistant Professor

Dan M. Sable
Adjunct Professor of Practice
Virginia Tech '91

Ahmad Safaai-Jazi
Professor
McGill '78

Timothy D. Sands
University President & Professor
Berkeley '84

Wayne A. Scales
Professor
Cornell '88

Patrick R. Schaumont
Professor
UCLA '04

Kenneth Schulz
Adjunct Professor of Practice & ECE Major Design Experience (MDE) Lead & Principal Engineer
Virginia Tech '84

Daniel J. Stilwell
Professor
Johns Hopkins '99

Kwa-Sur Tam
Associate Professor
Wisconsin '85

Pratap Tokekar
Assistant Professor
Minnesota '14

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Professor
SUNY Buffalo '78

Anbo Wang
Clayton Ayre Professor
Dalian '90

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Grant A. Dove Professor
Maryland '95

Ryan K. Williams
Assistant Professor
Southern California '14

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Associate Professor
Wake Forest School of Medicine '02

Yong Xu
Professor
Caltech '01

Jason J. Xuan
Professor
Maryland '97

Yaling Yang
Associate Professor
Illinois '06

Yang (Cindy) Yi
Assistant Professor
Texas A&M '09

Guoqiang Yu
Assistant Professor
Virginia Tech '11

Haibo Zeng
Assistant Professor
Berkeley '08

Wei Zhou
Assistant Professor
Northwestern '12

Yizheng Zhu
Assistant Professor
Virginia Tech '07

Yunhui Zhu
Assistant Professor
Duke '13

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Kristie Cooper

Dave McPherson

Jason S. Thweatt
Advanced Instructor

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Mehrnaz Afshang
Postdoctoral Associate

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Bradley Distinguished Professor of Electromagnetics Emeritus & Research Professor

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Research Scientist

Guido Cavaro
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Raymond A. Greenwald
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Postdoctoral Associate

Jong Woo Kim
Postdoctoral Associate

Song-Hoon Kim
Postdoctoral Associate

Vireshwar Kumar
Postdoctoral Associate

Bharat Simha Reddy Kunduri
Postdoctoral Associate

Fred C. Lee
University Distinguished Professor Emeritus

Vuk Marojevic
Research Assistant Professor

Robert W. McGwier
Research Professor and Director of Research, Hume Center

Mohamed Mohamedin
Postdoctoral Associate

Yakoub Nemouchi
Postdoctoral Associate

Ruslan Nikolaev
Research Assistant Professor

Stephen Noel
Research Associate

Pierre Olivier
Postdoctoral Associate

Sebastian Peluso
Research Assistant Professor

Arun G. Phadke
University Distinguished Professor Emeritus & Research Professor

Bishnu Regmi
Postdoctoral Associate

Xiang Ren
Postdoctoral Associate

Kevin T. Sterne
Research Associate

Amer Tahat
Postdoctoral Associate

James S. Thorp
Hugh P. and Ethel C. Kelly Professor Emeritus & Research Professor

Brentha Thurairajah
Research Scientist

Frederic Tuong
Postdoctoral Associate

Freek Verbeek
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Daniel R. Weimer
Research Professor

Buse Yilmaz
Postdoctoral Associate

Amir I. Zaghloul
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Zhonghua Xu
Research Scientist

Bo Zhou
Postdoctoral Associate

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