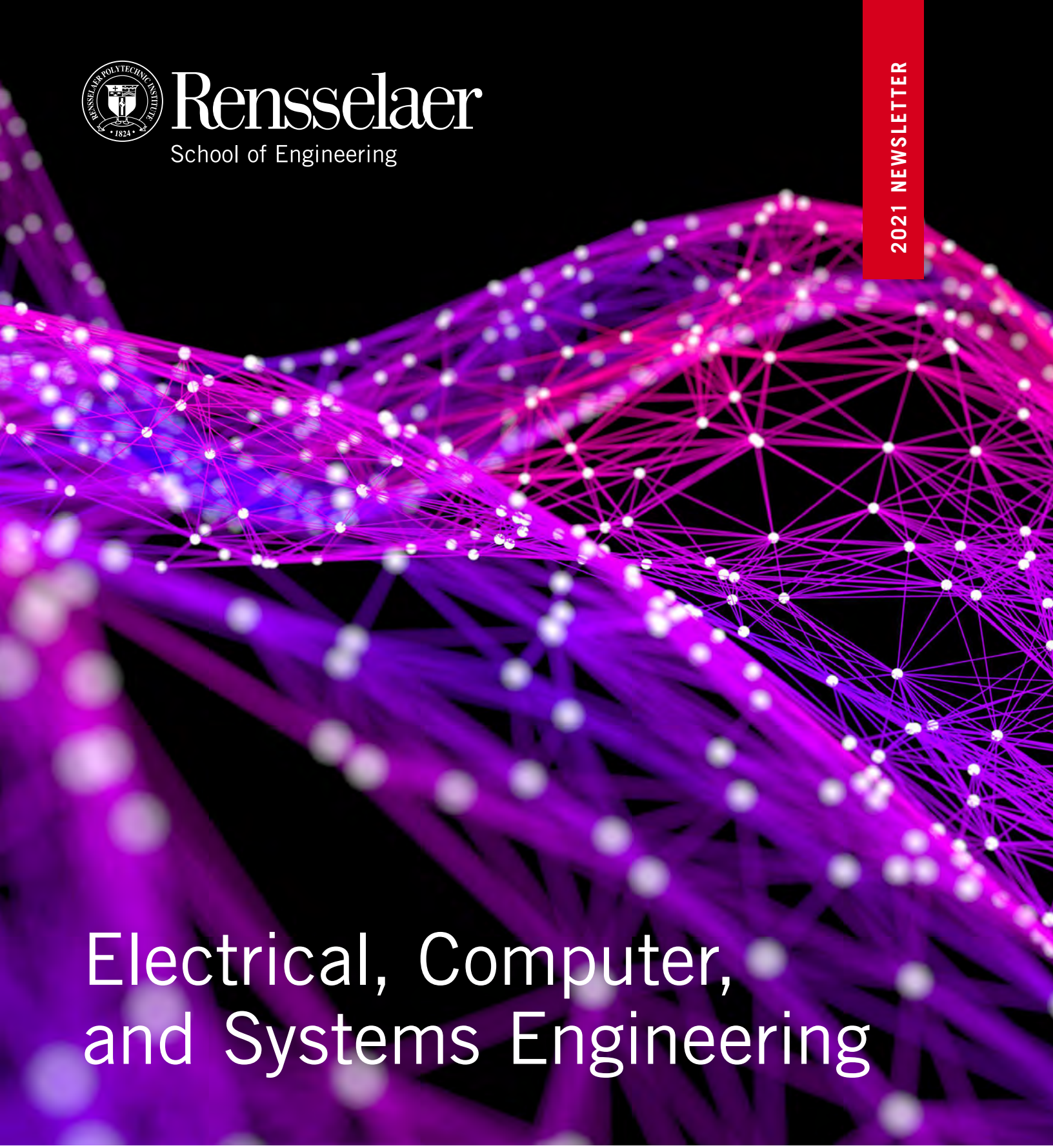
Rensselaer
School of Engineering

2021 NEWSLETTER



Electrical, Computer, and Systems Engineering

ecse
Electrical, Computer, and Systems Engineering at Rensselaer

ECSE.RPI.EDU

John Wen
Russell Sage Professor and Department Head,
Electrical, Computer, and Systems Engineering

ECSE Adapts and Grows During an Extraordinary Year

The year 2020 will remain in our collective memory for a long time. COVID-19 cut short the lives of many and caused untold suffering for many more. The disruption of, and impact on, the way we live and work has been drastic and profound. In March 2020, we moved nearly all our operations online. With vaccines now increasingly available, we are optimistic we will be back on campus almost fully this fall.

Even before the pandemic, the higher education landscape was quickly evolving. Vast resources are available within a few clicks online; data-driven tools track and predict student admission, learning, and health; and skills such as communication and teamwork are becoming as valuable as technical prowess. To stay current and remain effective, we are continually updating our curriculum and pedagogical approaches. Shayla Sawyer is leading the transformation of our curriculum toward project-based learning with a greater design focus, starting with the gateway *Electric Circuits* course. Mahmood Hameed is redesigning the freshman course, *Introduction to ECSE*, to introduce hands-on experience through personal instrumentation. We offer an array of new elective courses to provide students with a wide choice of concentration areas.

ECSE faculty conduct cutting-edge research that will have lasting impact, from Tong Zhang's next-generation computer systems that try to keep pace with Moore's Law, to Ali Tajer's artificial intelligence and machine learning (AI/ML) algorithms for more efficient and secure communication systems. Mona Hella, Agung Julius, and Shayla Sawyer are pioneering biosensor design to monitor human and environmental health; Joe Chow, Jian Sun, and Luigi Vanfretti are designing smart and resilient power grids to deliver electricity from clean sources; and Rich Radke, Qiang Ji, and Bob Karlicek are creating robots and automation systems to assist humans to be more capable and productive. These projects are funded by government agencies, industry, and consortia. We work with industry partners through multiple interdisciplinary research centers to transition our research findings to practice. Research enriches our education mission by infusing our curriculum with the latest tools and advances and by engaging our students in open-ended discoveries.

A key asset is our tens of thousands of alumni all over the world. We reached out to the alumni network to solicit volunteers to serve as industry advisers for our students and many responded, conducting one-on-one advising sessions, providing resume reviews, and participating in webinars and panel discussions. ECSE alumni have also generously given back to the department. Doug Mercer '77 endowed the Douglas Mercer Lab for Innovation and Exploration and the Mercer Distinguished Lecture series. Daniel Strassberg '56 left a legacy for future generations by bequeathing part of his estate for student scholarships and awards.

As an ECSE graduate from 1985, I most cherish the sense of community in ECSE. We strive to strengthen this bond in our community of students, staff, faculty, and alumni. We have developed vibrant online communal spaces, re-energized the HKN and IEEE student societies, enhanced our web and social media outreach, and actively engaged our alumni.

We mourn the passing of current and former faculty Jack McDonald, Herb Freeman, and Charlie Close. We bid farewell to ECSE faculty Mike Wozny, Yannick LeCoz, Manoj Shah, Jeff Braunstein, Amar Khoukhi, and staff Priscilla Magilligan, David Nichols, Mick Neal, and Hayleigh Sanders, through retirement or departure. We also welcome the injection of fresh energy and ideas from new Assistant Professors Tianyi Chen and Santiago Paternain, Lecturer Dylan Rees, and student coordinators Rama Hamarneh and Kelley Kritz.

As the world changes around us, our mission remains the same: to educate highly skilled engineers and conduct impactful research focusing on "applications for the common purposes of life." While we are energized by the prospect of getting back to normal, the slower pace of the past year has cleaned up our air, reduced human interference of other species, and afforded us time and space to reflect. As we renew the push forward with our mission, we would benefit from stepping back from our frenetic pace from time to time to remember, and to learn from, this extraordinary year.

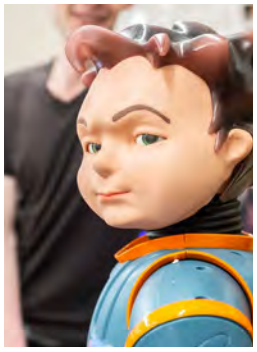
Research Highlights

Human-Centered AI

Research at the Intelligent Systems Laboratory (ISL) led by Prof. Qiang Ji focuses on human-centered AI, which develops advanced computer vision and machine learning algorithms to enable computers to perceive the world like humans do, and to allow natural interactions between humans and computers. One particular area of research is developing socially assistive robots such as companion robots that "live" side-by-side with humans to assist them both cognitively and physically. Toward this goal, ISL has developed various computer vision algorithms to recognize and understand humans' facial and body behaviors, including facial expression, head pose, eye gaze, body pose, and body gestures. A robot equipped with these computer vision algorithms can perform various visual tasks, including looking for and identifying a person, estimating his/her age and gender, recognizing various body gestures, determining the human's focus of attention and maintaining eye contact, and recognizing humans' emotion. Besides the visual capabilities, we are also equipping the robot with speech and natural language processing capabilities. With these multimodal capabilities, the robot can naturally interact with humans, much like humans interact with each other, using speech, facial expression, and body gestures, unlike current AI-assistants such as Amazon's Alexa or Apple's Siri that can only perform verbal interactions with humans. ISL possesses two robots: Pepper and Zeno. Pepper is an advanced humanoid robot; it is equipped with multimodal sensors and can interact with people through both speech and body gestures.

Zeno looks more like a person and has motors in its face to act as artificial muscles to produce different facial expressions. Through the embedded computer vision algorithms, the robot is now able to closely mirror human facial expressions in real time, right down to eyebrow and eyeball movement. It has been used to interact with children with autism.

Research in ISL has been supported by various federal agencies, including the National Science Foundation, the Defense Advanced Research Projects Agency, various agencies in the U.S. Department of Defense, and the U.S. Department of Transportation, and by companies including Honda, Boeing, and IBM.



Pepper robot and Zeno robot.

New Faculty Spotlight

Tianyi Chen

Tianyi Chen joined Rensselaer as an assistant professor in 2019, following his doctoral program at the University of Minnesota, where he received the Doctoral Dissertation Fellowship. Chen's research touches on areas of machine learning, signal processing, optimization, and wireless networks. His current research focuses on developing resource-efficient machine learning algorithms that can learn machine learning models by leveraging data distributed among multiple users without compromising user privacy. Chen has received multiple awards, including being named a finalist for the Best Student Paper Award at the Asilomar Conference on Signals, Systems, and Computers, the inaugural recipient of IEEE Signal Processing Society Best Ph.D. Dissertation Award, and an NSF CAREER award.

Santiago Paternain

Santiago Paternain received a B.Sc. degree in electrical engineering from Universidad de la República Oriental del Uruguay in 2012, an M.Sc. in statistics from The Wharton School at the University of Pennsylvania in 2018, and a Ph.D. in electrical and systems engineering from the University of Pennsylvania in 2018. Following a postdoctoral appointment at the same institution, he joined Rensselaer in 2020 as an assistant professor. His research interests lie at the intersection of machine learning and control of dynamical systems. In particular, the goal of the research is to leverage data acquired from hard-to-model systems to synthesize controllers that allow the agent to perform complex tasks.

James Dylan Rees

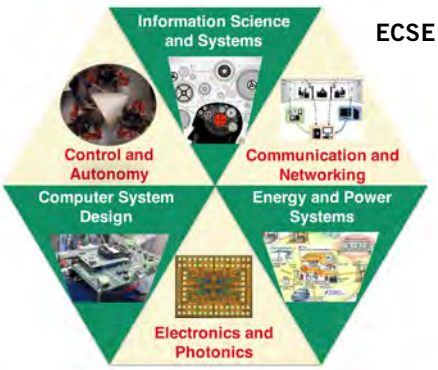
James Dylan Rees joined Rensselaer, where he completed his doctoral work, as a lecturer in 2021. He completed postdoctoral work through the Darrin Fresh Water Institute. His research combines microbiology with semiconductor, device, sensor, and materials engineering. One of his major research projects focuses on growing dissimilatory metal-reducing bacteria under anaerobic conditions, utilizing their "metal-breathing" capabilities to bio-assemble semiconductor nanomaterials. He is also interested in studying how biofilms of bacteria and other microorganisms respond to environmental changes at biofilm-electrode interfaces. Rees is interested in contributing to new avenues of socially oriented and design-oriented STEM pedagogy, harnessing insights from the classroom and from collaborators in fields such as design studies, engineering ethics, and science and technology studies.

Alumni Spotlight

Linda Rivera

I hold B.S., M.S., and Ph.D. degrees, all in electrical engineering from Rensselaer. Before transferring to Rensselaer, I obtained an associate's degree in science from Norwalk Community College.I joined Pratt & Whitney, one of the few military and commercial jet engine manufacturers in the world, in 2013, working for the Control & Diagnostics Systems organization. Soon after joining, I became the integrated product team lead for the blade health monitoring system, developing on/off board algorithms to detect fan blade damage for the F135 military engine program. I was recognized in 2015 with a special award for significant contributions to the F135 program.

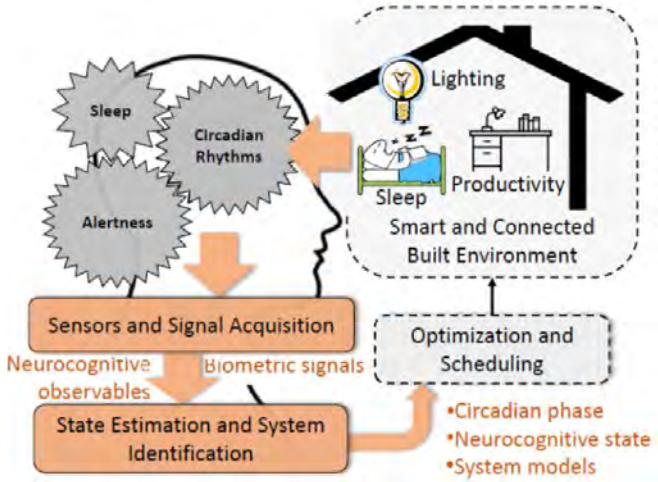
After recognizing the great need the company as a whole had for modernizing their digital technologies, I sought out an opportunity in the Military Engines Aftermarket division, as part of the Digital Transformation & Analytics (DT&A) organization, exploring and demonstrating possible applications of data science in the P&W Military Engine business, as well as managing large-scale projects using the Agile methodology to achieve standard ME-wide processes. In 2019, as I continued following the digital transformation thread, I accepted an opportunity with a group in Brooklyn called The Digital Accelerator (DX), which has a mission of accelerating innovation in the digital space for Raytheon. I am currently a senior technical project manager, working on several efforts ranging from data science engagements aimed at developing predictive analytics to prevent engine related issues or malfunctions, to developing digital applications for the military business that bring efficiency to their sustainment operations.



ECSE Core Areas

ecse.rpi.edu/research

Research Grants



Biometric Signal Sensing and Processing for Controlling Circadian Rhythms

ECSE faculty members Agung Julius and Mona Hella received a grant from the National Science Foundation (NSF) to combine smart wearables and algorithms to assess each person's circadian rhythm, providing personalized feedback as to what light, sleep, and work schedule would be ideal for their internal clock. The team will develop wearable hardware and software that incorporate various sensors capable of capturing useful biometric information. The collected biometric data from the individuals will be used to help build and test the team's mathematical models that describe the dynamics of the individual's circadian rhythms.

The Rensselaer team will be working with researchers from Thomas Jefferson University to conduct a pilot study on the effectiveness of their devices and algorithms. This interdisciplinary project is being facilitated by the Lighting Enabled Systems and Applications (LESA) Center at Rensselaer. It is the latest in a series of research advancements by Julius, in collaboration with other LESA Center faculty, aimed at understanding how human-centric lighting can impact circadian rhythm.

Risk Segmentation and Portfolio Analysis for Pareto Dominance in High Renewable Penetration and Storage Reserves

ECSE faculty members Koushik Kar and Joe Chow are co-investigators on a recent $2.66 million contract from the Department of Energy's ARPA-E program to develop market mechanism and risk assessment techniques to support cost-effective and risk-informed integration of renewable energy resources into the grid. In collaboration with UL Technologies, NC State, and Sandia National Labs, the Rensselaer team is developing risk-scoring techniques for renewable generation and storage assets, and risk-adjusted stochastic unit commitment

solutions to integrate them into electricity markets at reasonable computation complexity. The team is collaborating closely with Independent Service Operators (ISOs) such as NYISO (NY) and ERCOT (TX) toward reducing system cost and improving grid stability under high renewable penetration.

Maximizing the Performance Potential and Reliability of Flash-Based Solid State Devices for Future Storage Systems

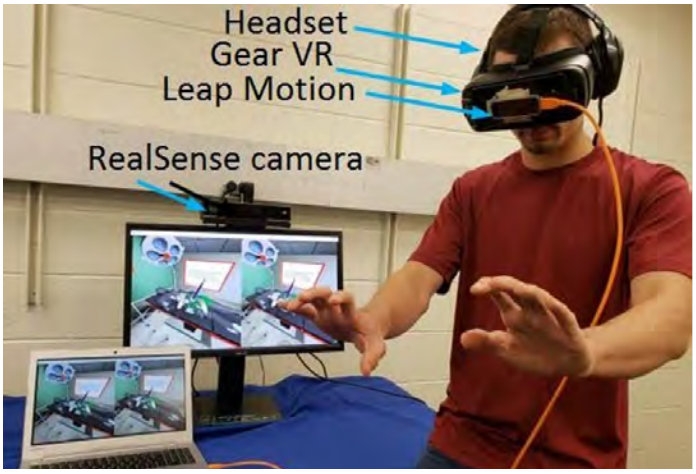
ECSE faculty Tong Zhang received this NSF-sponsored project to develop techniques that can improve the efficiency of data management software (e.g., databases and filesystems) by leveraging new data storage hardware with built-in data compression. The simple idea of empowering data storage devices with additional computing capability has recently received significant interest in the industry. This has led to the commercialization of solid-state drives (SSDs) with built-in transparent lossless data compression. Such new storage hardware creates a large but completely unexplored space for simplifying the design and implementation of data management software.

Intelligence-Sharing Tools Will Enable Smarter Devices

With the support of a National Science Foundation Faculty Early Career Development Program (CAREER) grant, Tianyi Chen, an assistant professor of electrical, computer, and systems engineering and member of the Rensselaer-IBM Artificial Intelligence Research Collaboration (AIRC), is exploring how to make knowledge-sharing tools for machine learning algorithms a reality.

"I think in the future, the main terminal of intelligence will be our phones. Our phones will be able to control our computers, our cars, our meeting rooms, our apartments," Chen said. "This will be powered by resource-efficient machine learning algorithms and also the support of future wireless networks."

Through his collaboration with the Lighting Enabled Systems and Applications (LESA) Center at Rensselaer, Chen will validate the algorithms he develops using the center's smart conference room.



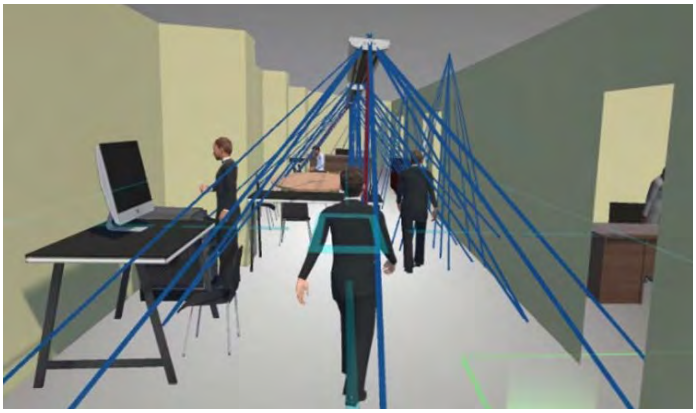
Virtual Operating Room Team Experience (VORTeX)

ECSE faculty member Hussein Abouzeid participates in a new four-year $2.3 million grant from the National Institutes of Health, started in Fall 2020, to develop a first-of-its-kind virtual operating room. VORTeX is a distributed networked system that enables operating room participants wearing head-mounted displays to remotely interact in a realistic virtual operating room. This environment enables operating teams, from nurses to surgeons, to train and practice essential technical skills with no risk to real patients. This multidisciplinary project focuses on the design of intelligent resource-aware algorithms that enable the client interaction stations and the virtual operating room system (running in an Amazon Web Service cloud) to interact while maintaining the time-sensitive requirements of the interactive audio/video application. The project, led by Suvranu De, is developing and testing a prototype system in collaboration with various other Rensselaer faculty, medical teams from Beth Israel Deaconess Medical Center and Albany Medical Center, and the University of Central Arkansas.

Lighting Enabled Systems and Applications (LESA)

The Center for Lighting Enabled Systems & Applications (LESA), led by Professor Robert Karlicek, is a graduated NSF Engineering Research Center that continues to define how advanced LED lighting and integrated sensing and control systems are evolving to impact human health, data communications, building energy management systems, and even crop growth. When lighting becomes an electronically controlled device, it can enable much more than just illumination. LESA brings together industry and academia through research collaborations, proposal partnership, and education and training programs.

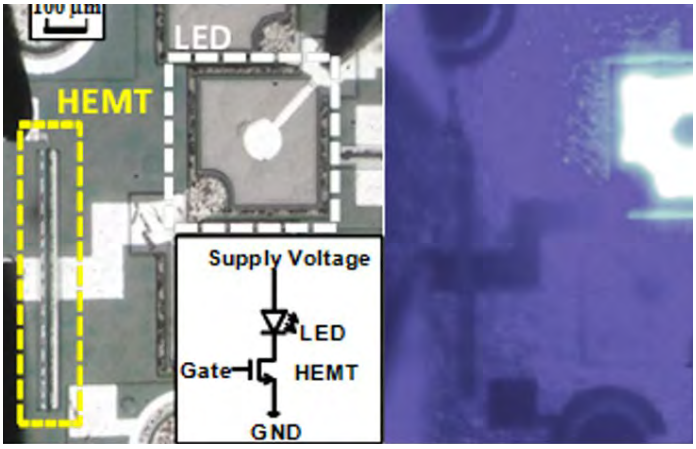
White light is a blend of colors, and with LEDs, the color mix can be precisely controlled. In addition to impacting human perception and comfort, the blue wavelengths in lighting can impact human circadian function, affecting both alertness and sleep. Professors John Wen and Agung Julius are uncovering the control mechanisms for how the timing and intensity of the blue



Simulation of people sensing and tracking using light-based technologies being developed at LESA.

component of white light impacts human circadian regulation. Professor Julius and Professor Mona Hella are developing improved biometric circadian rhythm sensors.

LED lighting can be turned on and off very quickly, and this feature can be exploited to transmit data like Wi-Fi. Visible light communication (sometimes called LiFi) offers even more bandwidth than Wi-Fi, and will likely become a part of indoor wireless communications, since evolving 5G and future 6G systems run into problems when operated indoors. This is an interesting dual use scenario where lighting can both illuminate and communicate. Professor Hella has developed advanced light receiver chips for LiFi by optimizing photodiodes and combining them with data



World's first demonstration of a monolithically integrated GaN transistor and LED, useful for LED displays and LiFi.

processing circuitry for high-speed communications. At LESA, researchers have demonstrated how lighting can be used to transmit high-quality video data using simple LED ceiling fixtures.

There are more interesting uses of LEDs well beyond ordinary illumination. In modern building systems, energy use is a big concern, and optimizing the control of lighting, heating, and cooling systems ideally should consider additional factors such as the impact of heat gain through windows and the comfort of building occupants. LESA faculty Sandipan Mishra and Koushik Kar have demonstrated that measuring the reflected color of room light using low-cost color sensors in the ceiling can be used to improve the control of heating and cooling system operation for significant improvements in building energy efficiency and occupant comfort. Recent work by Professor Karlicek has shown that these same color sensors can be used to locate people in the building with much better performance than standard motion detectors, and this data can also be used to significantly reduce building HVAC energy use (in addition to automatically control the lighting).

Once you can send data with lighting systems, the reflected digital information in the lighting can be used like radar, to safely create a 3D map of an occupied space, recording movement, pose, and location, not only of people, but of inanimate objects. Professor Richard Radke, working with Professors Karlicek and Hella, is developing a whole new approach to occupant sensing using reflected IR light, measuring occupant position, pose, and movement without using cameras, thereby preserving occupant privacy. This kind of information is extremely valuable to building owners (reducing energy use and improving building utilization) and health care facilities (patient movement and fall prediction/detection). The trick is to develop advanced light sensing systems that can provide this data at very low cost, and LESA's work

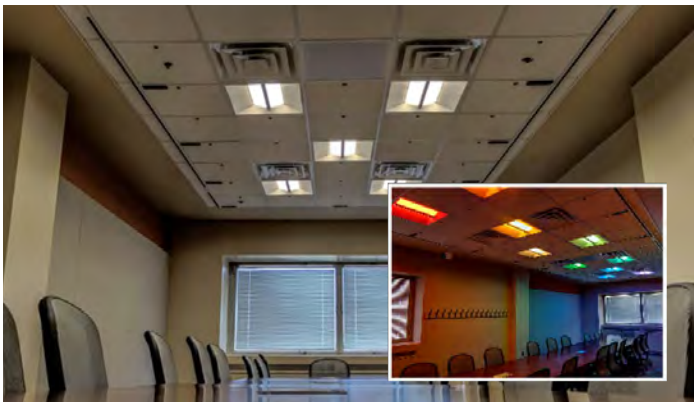
FOUNDED IN 1907,
ECSE IS ONE OF THE FIRST ELECTRICAL ENGINEERING PROGRAMS IN THE U.S.

on advanced, low-cost microchips that can perform this person sensing/counting/pose function affordably is well underway with funding from the Department of Energy.

These new applications of light for human health and building control systems are directly tied to the improvement of LED semiconductor devices, and LESA has also been involved in a broad range of research on new, sophisticated LED electronics. Professors Paul Chow and Karlicek have been using monolithic integration of GaN transistors and LED devices to develop technology for lighting communications (LiFi) and futuristic LEDs that will soon replace LCDs and OLED TVs. Variations of these LEDs can also be used to generate germicidal UV light, and Professor Shayla Sawyer has been working on developing advanced UV sensors needed to monitor UV radiation, not only for the safe use of UV germicidal devices, but also as a way to detect bacterial pathogens in the environment.

LESA has also started to transform the world of controlled environment agriculture (greenhouses and vertical farms). LESA, working together with Cornell University, is developing new lighting and plant biosensing systems to improve crop growth and crop nutritional value. In a world continually subject to climate change, water shortages, and other environmental pressures on crop production, tunable, dynamic lighting systems developed at LESA offer new approaches for efficient crop growth needed to feed the world population.

LESA trains many undergraduate and graduate students in the many novel applications of LED lighting, creating the future workforce that will further develop and commercialize new lighting, building, communications, and horticulture systems that do much more than simply illuminate.

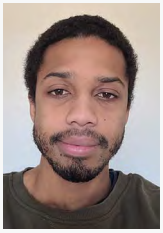


LESA Research Testbed integrating color and sensing for a wide range of new lighting applications.

Alumni Spotlight

Reid Wiseman

My career began in ECSE at Rensselaer with a degree in computer and systems engineering. After graduation in 1997, I commissioned in the Navy and spent 12 years flying from aircraft carriers and doing test work on developing aircraft. In 2009, I was selected as a member of the 20th NASA astronaut class. I am currently serving as the Chief Astronaut at NASA. It is a busy time in the astronaut office. In the past year, we launched two crews on the Space X Crew Dragon spacecraft to the International Space Station. We continue to fly on the Russian Soyuz spacecraft and operate with our international partners in Europe, Canada, Japan, and Russia. We are working on Boeing's Starliner capsule to launch humans into low earth orbit later this year. And finally, we are preparing the Space Launch System to launch the Orion capsule for the Artemis I mission around the moon in early 2022 with crewed missions soon to follow. It is an exciting time in human space exploration!



Jordan Grey

I recently graduated from Rensselaer with my master's and bachelor's degrees in electrical engineering. I enrolled after transferring from my county's community college; many of my engineering professors there recommended attending Rensselaer because it would better prepare me for working in the field. At Rensselaer, I was involved with undergraduate research and was a resident assistant. I did research under Prof. Luigi Vanfretti in the area of power measurements and hardware-in-the-loop devices. From this research I was able to learn about the modern infrastructure of the power field, and I was even able to go to Dominion Energy, an energy provider in Virginia, to see how actual power engineers work. With that research background I was able to apply for, and received, the Grainger Power Engineer Award during both my time in undergrad and grad school. I'm currently a software controls engineer for General Motors, working with software and simulations for their new line of electric vehicles. My work involves increasing the range that each vehicle can make on a single instance of charge. Due to the ECSE courses I took such as *Signals and Systems* and *Fields and Waves*, I was able to quickly understand the background information for my project and start making progress.

- 43RD (EE), 47TH (CSE) IN 2021 **U.S. NEWS & WORLD REPORT GRADUATE RANKINGS**
- 24TH **IN 2021 TFE TIMES BEST MASTER'S OF COMPUTER ENGINEERING RANKINGS**
- 12TH **IN COLLEGE FACTUAL BEST ELECTRICAL ENGINEERING PROGRAMS**

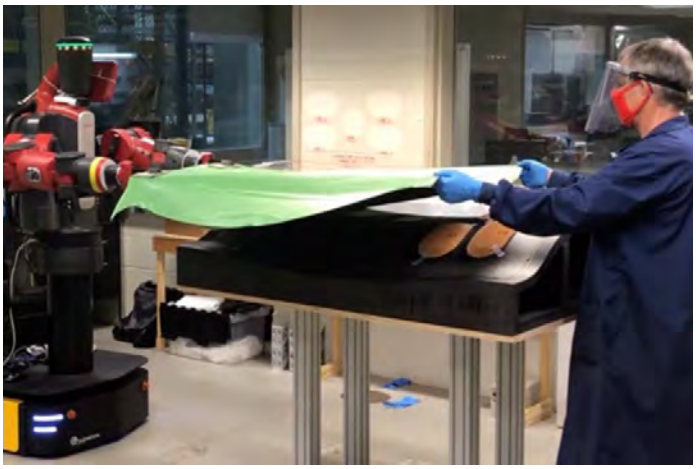
Research Highlights

Robotics in ECSE

ECSE has a vibrant robotics program in terms of both curriculum and research. Robotics is by nature a highly interdisciplinary area. ECSE faculty work with faculty in MANE, Computer Science, Cognitive Science, and other departments to ensure that our students have the opportunity to develop comprehensive s killsets related to robotics. Courses in ECSE build up the requisite skills in robotics from the first year, including programming, circuit design, sensor measurements, and signal processing in foundational courses. As electives, *Robotics I* and *Robotics II* form the core of the robotics curriculum with other related courses such as *Mechatronics*, *Control Systems Engineering*, *Computer Vision*, and *Deep Learning*. For students interested in manufacturing, courses in MANE such as *Manufacturing Processing Systems* include modules on industrial robots in manufacturing environments. For students interested in intelligent robotics and human-robot interaction, there are relevant courses in Cognitive Science on human perception and action, social robotics, and AI. We encourage early exposure and involvement in robotics at the K-12 level by sponsoring the Lego Robotics League and FIRST robotics competitions.

Faculty in ECSE are actively engaged in robotics research, in particular robotics for manufacturing applications. Prof. John Wen leads the university's participation in the Advanced Robotics for Manufacturing (ARM) Institute, which is part of the Manufacturing USA Network resulting from the Advanced Manufacturing Partnership (AMP). Our focus in this area involves sensor-guided robot motion (including vision and force), multi-robot coordinated manipulation, and human-robot collaboration. Recent projects include precision assembly of segmented wind turbine blades with vision and force guidance, robotic deep rolling of metal surface treatment, robot-human teaming for composites layup, robot-assisted fabric manufacturing, and plug-and-play robotic middleware systems. These projects are all driven by industrial needs and involve collaboration with industrial partners ranging from large corporations such as GE Global Research, Raytheon Technology Research Center, and Boeing, to small companies such as Wason Technology and Interface Technology.

Our laboratories are well equipped with multiple types of robots, including industrial robots from ABB, Yaskawa, and Staubli, collaborative robots such as Universal Robotics, Sawyer, and Baxter, assistive robots such as Kinova and Stretch, and mobile platforms such as Ridgeback and Husky. We also work with the NASA Goddard Space Flight Center for space robotics servicing research. Our focus is on addressing robot joint flexibility (as is typical of space manipulators) in manipulating large and heavy loads such as disabled satellites. We apply control theory, robot motion planning, and compliance force control to address safe load capturing, transport, and docking to the service vehicle. For assistive robotics, our focus is on helping mobility challenged individuals to manage daily activities. Specifically, we use lightweight mobile manipulators to follow high-level user commands to retrieve items from a fridge or oven. Professor Agung Julius leads research into robot task planning by using temporal logic that provides performance and safety guarantees. He also collaborates with Drexel University on manipulating motile organisms such as flagellated bacteria as miniature robots.



Internetworking of Things (IoT)

ECSE 4660 | **Taught by Hussein Abouzeid**

A new hands-on course first introduced in the curriculum in 2017 and delivered in a specially equipped laboratory for student project design. The course provides an in-depth study of the technologies and protocols involved in building the Internet of Things (IoT), with a lab-intensive hands-on experience demonstrating the application of these concepts in building networked IoT applications. Course labs focus on IoT communications, signal-strength-based localization, data aggregation, mobility, and secure communication. The course will rely on hands-on labs and group projects by sending an IoT kit to each student's home and conducting remote labs via virtual collaboration platforms. The physical lab continued to provide back-end computing infrastructure remotely to the students in an environment agnostic to their operating system.

Advanced Computer Systems

ECSE 4961 | **Taught by Tong Zhang**

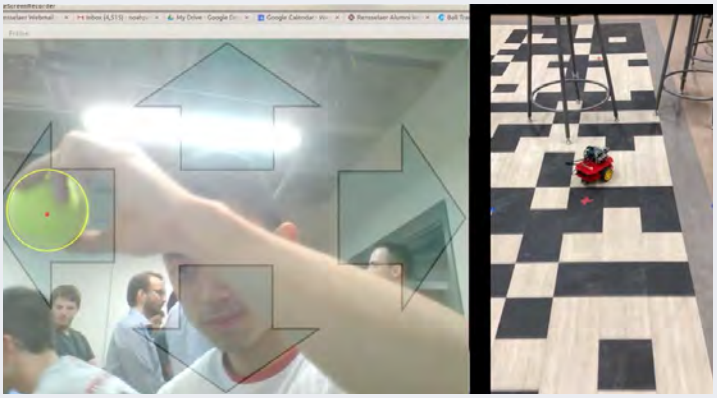
Covers advanced topics and current industrial trends in modern computer systems from both hardware and software aspects. The course first presents key design principles of modern computing hardware platforms, including instruction/data/thread-level parallelism in CPUs and GPUs, cache and memory hierarchy, DRAM and non-volatile memory technologies, and heterogeneous and disaggregated computing architectures. It then discusses software design techniques and methodologies including memory management, consistency, concurrency control, transaction, indexing data structures, key-value storage, and data storage in distributed systems.

Students work on a set of design projects that span SIMD and multi-threaded programming, computer system performance profiling, column-store compression libraries, and in-memory key-value stores. Through the design projects, students gain hands-on experience in implementing software optimized for modern computing hardware, attaining valuable software development experience highly relevant to today's computing industry.

Introduction to Machine Learning

ECSE 4840 | **Taught by Tianyi Chen**

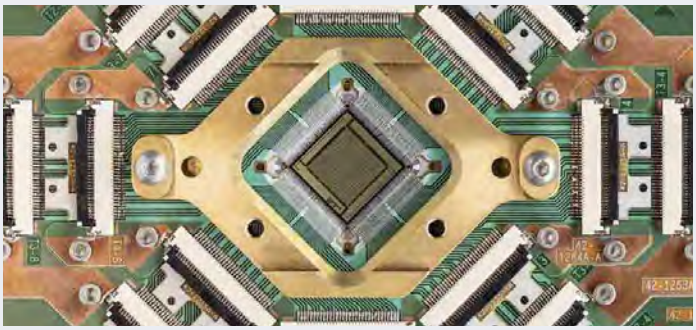
A new senior-level course that gives a broad introduction to statistical machine learning. Topics include (1) supervised learning (generative/discriminative learning, parametric/non-parametric learning, neural networks, support vector machines), (2) unsupervised learning (clustering, dimensionality reduction, kernel methods) and (3) learning theory (bias/variance tradeoffs, practical advice; online learning, and reinforcement learning). To reinforce students' understanding of fundamental knowledge, the course also integrates homework and projects that cover machine learning applications in data mining, robot navigation, smart grids, image processing, and signal processing.



Quantum Computer Programming

ECSE-4964 | **Taught by Randolph Franklin**

A new topics course that describes how quantum computers are implemented and programmed, presents the major algorithms, and includes exercises on three major platforms: transmon qubit, trapped ion, and quantum annealing. The use of quantum superposition and entanglement to search massive parameter spaces for solutions, such as the factors of large integers may revolutionize computer engineering domains such as cryptography and communication, protein folding for drug design, and financial engineering. This course continues the century-old ECSE tradition of teaching our graduates tomorrow's ideas to solve tomorrow's problems.



Student Spotlights

Avani Saggi

Class of 2021

Major: Electrical Engineering

Minor: Psychology

Work Experience: I have been working for IBM since January 2020 as a product engineering co-op in their mainframe division. My job is to help develop automation tools that improve diagnostic efficiency of high-level mainframe problems. I also mentor new interns.

Projects: Last semester, I completed my capstone project where my team and I developed an IoT (Internet of Things) vase. I was responsible for the development and programming of the input system and output lighting system circuit.

On-campus: I am involved with the Bhangra (Indian dance) team and am a former director of professional development for the Women's Mentorship Program. I was an RA in the Quad and was the lead RA for Davison last semester.

My Future Plans: I plan to join IBM as a full-time power product engineer this summer. I plan to also get my master's in either electrical engineering or data science.

Fun Facts About Me: I love baking and cross-stitching; over quarantine, I made a baby Yoda cross-stitch!

Rahul Jain

Class of 2022

Major: Electrical/Computer Systems Engineering Dual

Work Experience: I was a software engineering intern at Northrop Grumman on a project involving communications software used for military applications. I also worked at Verizon developing an application using Internet of Things (IoT) technologies and digital signs that could be used for public safety purposes.

Projects: I worked with Professor Radke's research group to help design a tabletop device that uses cameras, microphones, and range sensors to automatically understand group meetings.

On-campus: I'm the current President of the HKN (Eta Kappa Nu) Honor Society, and was a part of the Rensselaer annual hackathon and the Rensselaer Center for Open Source (RCOS).

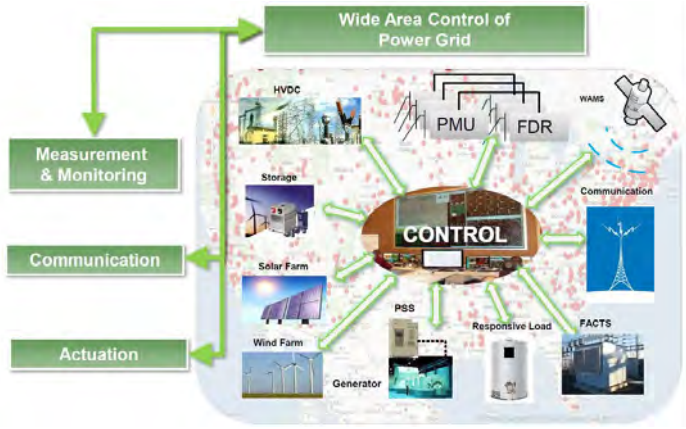
My Future Plans: This summer, I will be a student research assistant at MIT Lincoln Labs. I'm also planning on pursuing graduate studies to gain a deeper understanding of ML, AI, networking, and communications.

Fun Facts About Me: I like to create small projects with Arduinos or Raspberry Pis such as remotely controlled toy cars. When I'm not studying, you can find me cooking, playing table tennis, or watching *Star Wars*.

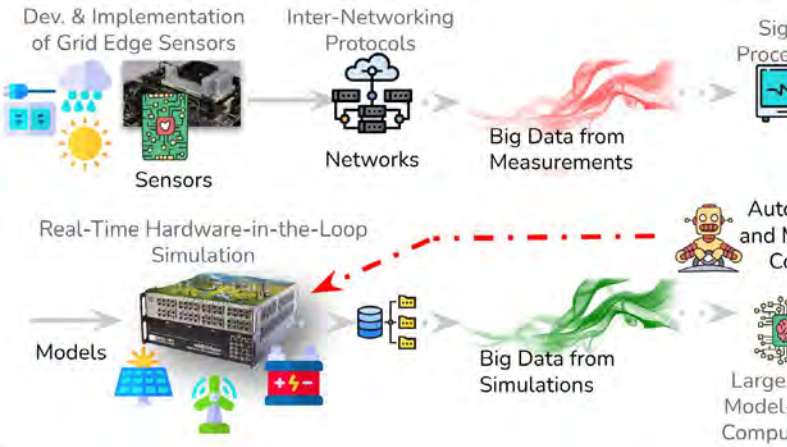
Research Highlights

Power and Energy

ECSE research in Power and Energy involves multiple research centers and labs, including the NSF/DOE Center for Ultra-wide-area Resilient Electric Energy Transmission Network (CURENT), the Center for Future Energy Systems (CFES), and the Analysis Laboratory for Synchrophasor and Electrical Energy Technology (ALSET). Students in the Power and Energy area are trained through courses in power system analysis, power generation, transmission and distribution, power electronics, and electromechanical machines. They have won prestigious scholarships, including the NSF Graduate Research Fellowship, Chateaubriand Fellowship, and Grainger Scholarship.



CURENT, directed by Prof. Joe Chow in partnership with the University of Tennessee, Knoxville, advances the state-of-the-art utilization of phasor measurement unit (PMU) data, control of renewable resources, and enhancement of power system stability. The center research also includes the ARPAe PERFORM project *Risk Segmentation and Portfolio Analysis for Pareto Dominance in High Renewable Penetration and Storage Reserves*.



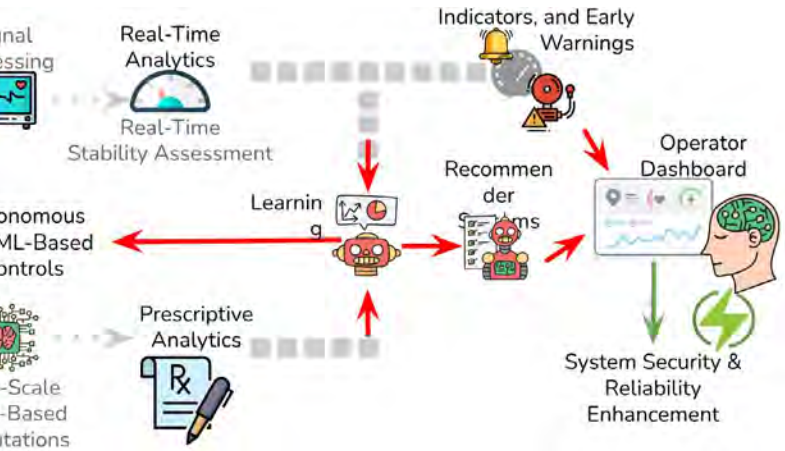
785 **UNDERGRADUATES**

32 **MASTER'S STUDENTS**

90 **DOCTORAL STUDENTS**

CFES, directed by Prof. Jian Sun, emphasizes collaboration with industry and conducts research on a wide range of topics, including renewable generation, efficient energy utilization, energy storage, and power system modeling and control. The center collaborates with faculty across campus in related disciplines, including the development and characterization of new batteries, fuel cells, wind turbines, photovoltaics, and data analytics. The research in Prof. Sun's group is devoted to power electronics and its application in information technology, aerospace, and power systems. The particular emphasis is on renewable energy and its integration into the power grid, with the goal of enabling a decarbonized power system powered 100% by renewables. Power electronics plays a critical role in achieving this goal because electricity generated from renewable sources must be conditioned and controlled before it can be transmitted and distributed through the grid to reach loads.

ALSET, established by Prof. Luigi Vanfretti with funding and contribution from CURENT, GE, and Dominion Energy, focuses on the modeling and simulation of the power grid as a cyberphysical system. ALSET is part of a team winning the "Future Grid Challenge" of the New York State Energy Research and Development Authority (NYSERDA) for developing a better understanding of smart inverter functions and control and communications capabilities and how they impact grid stability, voltage regulation, and system losses in the Orange & Rockland's Advanced Distribution Management System (ADMS). Other projects in ALSET include a NYSERDA collaboration with the New York Power Authority to develop a modeling interpreter tool and a machine learning-based recommender system for grid operations decision support. Prof. Vanfretti is expanding ALSET research to include multi-carrier energy systems and transport electrification in partnership with the University of Illinois and the University of Colorado.



Student Spotlights

Connor Duncan

Class of 2021

Major: Computer and Systems Engineering

Work Experience: I worked for HP Inc. as a software engineering intern focused on predictive analysis of hardware failures. In my Arch away semester, I worked as a software engineering intern for an aerospace startup called SpinLaunch.

Projects: Most of my project experience has come through my internships and co-ops, providing me with a wide variety of technical skills.

On-campus: In my first year, I worked in Professor Kim Lewis' research lab in the Physics Department, focused on molecular electronics. I also was heavily involved in Greek Life, as well as participating in the club lacrosse team.

My Future Plans: I will be moving to Washington, D.C., to work for Leidos as an offensive software engineer.

Fun Facts About Me: I am a huge advocate for students being able to pursue "alternative" success strategies that embrace experiential learning as opposed to the traditional college classroom. Rensselaer has given me a great support network for pursuing these goals and I am incredibly thankful!

Meaghan Podlaski

B.S. Class of 2019, Current ECSE Ph.D. Student

Major: Electrical Engineering

Work Experience: I was an intern with ERCOT, studying the effects of planned wind plant projects in western Texas on the grid dynamics. I also spent two summers at ISO New England, where I helped develop models to forecast the amount of solar power generated by residential rooftop solar panels.

Projects: I work with the Center for High-Efficiency Electrical Technologies for Aircraft (CHEETA), a university/industry collaboration funded by NASA with the goal of developing fully electric aircraft. I'm also funded through the NSF Graduate Research and Chateaubriand Fellowships to conduct research on system identification and parameter estimation for power systems, working with the École Centrale de Lyon.

On-campus: I'm part of the ECSE mentor program, and I competed on the cross country and track teams throughout my undergrad years.

My Future Plans: I hope to enter industry to either continue working with electric aircraft modeling and development, or work on the bulk electric grid in transmission planning.

Fun Facts About Me: I used to be nationally ranked and competed for Team USA in race walking, the Olympic sport for speed walking. It's a small subset of track and field that has races that span from 1500m to 50km.

Alumni Initiatives

Industry Adviser Program

The ECSE Industry Adviser Program helps undergraduate ECSE students connect with an alumni adviser in industry as they prepare to look for an internship, find an away opportunity, or look for a job. The Industry Adviser provides unique insight into the workforce and how to connect academics to students' job search. The Industry Adviser Program has supported over 100 students since fall 2020. This program is intended as a complement to students' academic advising and provides a space for individual mentoring as students begin their job search.

Alumni Contact Sheet

The Alumni Contact sheet provides alumni contact information and career journeys to our current ECSE students, and gives them a chance to connect with alumni who have careers they are interested in. The contact sheet is updated every semester, and shared weekly in our events and opportunities newsletter.

Alumni Student Engagement

ECSE Alumni Panel: Job Search for International Students, Nov. 4, 2020

ECSE Alumni Jingyu Su (Wells Fargo) and Yiyang Li (Google) discussed their own experiences searching for jobs and internships as international students, and gave tips and advice for current students. Attendees had the opportunity to ask questions and engage with our alumni during this conversational panel.

ECSE, HKN, & IEEE Professional Development Week – March 1-5, 2021

ECSE, HKN, & IEEE's Professional Development Week was held the first week of March 2021! The week was a time to get feedback and advice specific to our ECSE students from our alumni on their resumes, interview skills, and online presence. During this week, students could sign up for resume review and mock interviews with ECSE alumni, as well as attend the Online Presence Workshop

The Online Presence Workshop was an event for students to learn more about how to market themselves online to potential employers through platforms like LinkedIn and GitHub, hosted by ECSE alumni Saied Seghatoleslami, Olin Lathrop, Janet Xu, and Emile Anderson.

Video: What Is ECSE?

Our alumni shared their experiences as ECSE students to show prospective students what earning a degree in electrical or computer and systems engineering entails, and what it can lead to after graduation.

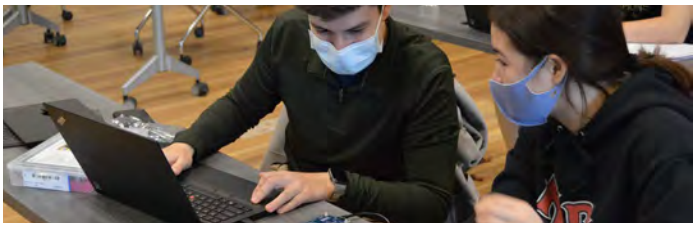
Visit our YouTube channel and watch "Electrical, Computer, and Systems Engineering at Rensselaer"

ECSE Course Highlights

ECSE 1010: Balancing Hands-on Learning and COVID-19 Safety Measures

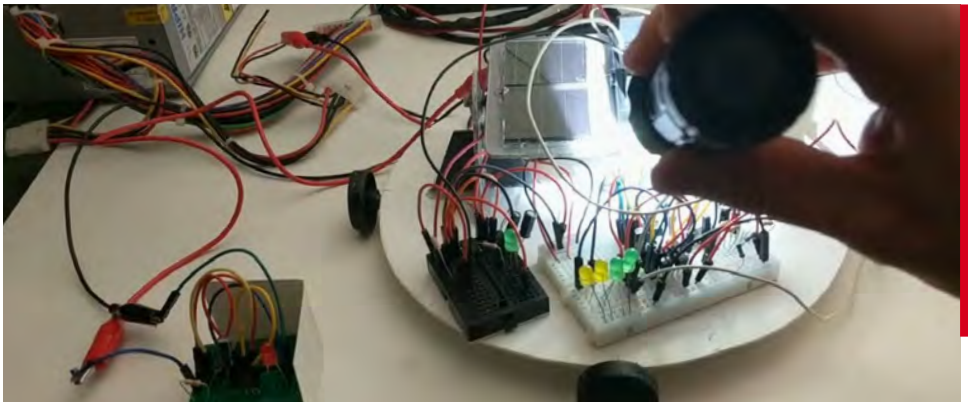
The COVID-19 outbreak resulted in a major disruption to college education, with institutions across the country switching from in-person classes to remote instruction. Transitioning to the online format was not the only challenge faced by *Introduction to Electrical, Computer, and Systems Engineering*, taught by Mahmood Hameed. This is the gateway course to the ECSE department taken by all EE and CSE majors, usually during their first semester, with an enrollment of 100 to 200 students across multiple sections. The course topics include basic circuit analysis, linear algebra, statistics, and electric power, explored through hands-on experiments.

Prior to COVID, the course used the Digilent Analog Discovery 2 instrumentation board, which allows students to measure, visualize, generate, record, and control mixed-signal circuits of all kinds. However, the pandemic resulted in lead times of over 12 weeks and the cost of each board sharply rose to $399. A generous donation from Douglas Mercer '77, a pioneer in analog-digital conversion and a longtime supporter of Rensselaer and ECSE, allowed the department to switch to the Analog Devices ADALM1000 (M1K) Active Learning Module for the fall semester. The M1K board is small enough to fit inside a pocket and allows students to explore the fundamentals of electrical engineering from anywhere. *Every incoming ECSE first-year student received a personal M1K instrumentation board because of this timely gift.*



Due to classroom capacity rules, students from each section were split into three roughly 24-person teams: Teams Monday, Thursday, and Remote. On-campus teams were invited to the classroom on their respective days and participated via Webex on other days. Remote students attended online only using Webex. These students had the option to watch recorded lectures and attend virtual open shop hours in the evenings to get additional help.

Before each class, students watched short pre-recorded videos that provided the background information for the day's experiment. During class, students worked on bite-sized experiments and reported their results using Gradescope, an online tool for submitting assignments. The professor, teaching assistants, and students all worked in the same Webex Teams space during class time, which allowed course material to be shared to everyone and smaller breakout groups to work on individual projects. The course received positive feedback from students, who appreciated learning fundamental ideas through hands-on experiments and were excited to be invited back to the classroom.



- 27 **TENURED/TENURE-TRACK FACULTY**
- 5 **LECTURERS**
- 9 **IEEE FELLOWS**
- 6 **NSF CAREER AWARD WINNERS**
- $10 MILLION **ANNUAL RESEARCH EXPENDITURES**

ECSE 2020: Pedagogy Innovation and Impact in Electric Circuits

Electric Circuits, taught by Shayla Sawyer, provides fundamental prerequisite knowledge for other courses in the department. The course has historically been a testbed for innovative pedagogy, first with the Studio format and later with Mobile Studio technology, both of which impacted engineering education worldwide. In recent years, Professor Sawyer made strategic enhancements to the course centered around improving overall efficiency, data collection, feedback mechanisms, and accessibility to students. A blended format now provides short, introductory course videos for every lecture. The discussion forum Piazza is effectively a 24/7 online, crowdsourced teaching assistant. The online grading platform Gradescope promotes consistency and transparency in grading, and makes assessments at the course and curriculum level much easier.

The most fundamental change, the Alpha-Omega Lab Design Continuum, was designed to challenge and inspire students to explore how fundamental course concepts relate to societal challenges. Omega Labs are a design-based alternative to the traditional procedure-based labs (now called Alpha Labs). In Omega Labs, students have the freedom to design their own circuit based on concepts learned in the course and applied toward NAE Grand Challenges or UN Sustainability Goals. Students must iteratively update documentation, including a project plan, proof of concept, and project manual. Brainstorming design activities are given during the lecture for the entire class. The intention of these collaborative activities is to expand on fundamentals and guide students toward connecting concepts while encouraging creativity and community. ABET Evaluators cited the Omega Labs as a strength of the ECSE department: "The program provides an innovative collaborative student experience and electrical circuits design by posing Grand Challenge societal problems that students tackle in the lab. Students benefit by connecting their lab exercises to meaningful 'world-improving' problems by applying bottom-up or top-down design at the choice of each student."

These enhancements proved to be pandemic-proof and well-suited to the remote teaching environment. However, the pandemic required additional pedagogical innovation. The pandemic introduced the use of online technologies like Webex Teams, which enabled live in-class discussion, non-audible responses within the chat feature, and breakout rooms for additional conversations. As with the *Introduction to ECSE* course, we sent personal instrumentation kits to homes across the country to enable fully remote labs.

Circuits exams have always been challenging for young students because for the first time they must apply rigorous mathematics to conceptual understanding in written form. The pandemic forced us to redesign exams to have more open-ended or choose-your-own-adventure style questions with multi-answer solutions, in order to mitigate academic dishonesty. Students were given unique exam questions, which made copying easy to track. We also had to recognize accessibility issues and unexpected interference in disparate home environments, resulting in new Exam Reworks. In Exam Reworks, students are challenged to design a new problem, based on the problem they missed the most points on, and then explain their solution process as they rework the problem via video or audio recording. This method provides two modes of evaluation, design and analysis, to assess comprehension, while providing students the opportunity to shore up any misunderstandings after an exam and get a few points back. Focusing the evaluation on the correct process, rather than just the correct answer, not only reinforces ethical engineering practices in students' future careers, but also gives them positive reinforcement that understanding how and why a procedure is used is valuable.

Electric Circuits is now an interactive learning community with engaged undergraduate student assistants as active mentors, as well as live online open hours held by both undergraduate and graduate teaching assistants. The remote labs now have video- or audio-based individual check-ins that give undergraduate student assistants a look into how each student is doing in their remote labs. These innovations enable individually tailored mentorship based on students' experiences in a new and exciting way, following our long tradition of pedagogical innovation and setting best practices for the rest of our department and university.

Interview with Dr. Nariman Farvardin

Dr. Nariman Farvardin received his B.S. ('79), M.S. ('80), and Ph.D. ('83) degrees from the Electrical, Computer, and Systems Engineering (ECSE) Department at Rensselaer Polytechnic Institute.

He joined the University of Maryland as a faculty member in electrical engineering in 1984, and served as the department chair, dean of engineering, provost, and acting president until 2011, when he became the president of the Stevens Institute of Technology. He sat with ECSE head John Wen on Zoom for an interview on April 1, 2021. The following is an abbreviated excerpt of the interview. The full version may be found at ecse.rpi.edu/news/farvardin.

John Wen: You received your bachelor's, master's, and Ph.D. degree all from the ECSE department. We are proud to count you as a distinguished alumnus. Could you describe the path that led you to Rensselaer?

Nariman Farvardin: I was born and raised in Iran. I went to college in 1974 in Iran and I was scheduled to graduate in 1978. My academic adviser in Iran was a graduate of RPI, and highly recommended RPI. I received admission from all the universities I applied to, including RPI. But in 1979, there was a revolution in Iran. For about a year prior to that, the whole country was in chaos. The university in which I was studying was physically shut down and I was unable to finish my studies. I contacted all of the universities that had given me admission for graduate programs to inform them that I was unable to come with an undergraduate degree because my university is closed, so was it possible for me to transfer as an undergraduate student? All the universities said yes. But RPI was the only university that said yes AND that I could join them in the middle of the academic year in January as an undergraduate transfer student.

John Wen: I'm so grateful to whomever at Rensselaer at the time for offering the flexibility.

Nariman Farvardin: When I came from Iran, I didn't even have my full transcript because of the circumstances, so I only had an unofficial transcript. You remember Bruce Carlson? I have an enormous amount of respect for Bruce. Because when I came to this country, and I knew nothing, I was kind of homeless. He gave me the benefit of the doubt. He held my hand, and he gave me the guidance that I needed and the flexibility that I needed. If RPI had not been the first to give me that benefit, I would not have been where I am today. When I came to RPI, I didn't know what is a private university, what is a public university. I was completely unfamiliar with the American system. I didn't know the culture. I didn't know the language. I didn't have a support system. I didn't have a friend, nothing. I came to the United States with $3,000, and I ran out of money by the end of August. I had received admission for the master's program from RPI. But I did not have any financial aid. And I was quickly running out of funds. If they were not going to give me some financial aid, I would not have been able to stay. I would have had to go back. But it was Bruce Carlson, again, who arranged for me to become a teaching assistant for this course in linear systems, which was a self-paced course. That's actually how I survived in the United States. That's what gave me the resources to stay in graduate school and be able to buy some food. In that first semester, I took a class in stochastic processes from Jim Modestino. And that was a very demanding class. I loved it. I had heard a lot of good things about Jim Modestino. I would have liked to be one of his students. But I didn't have any relationship until I took that course. In that course, I did very well. I was by far number one in the class. And when I had my first conversation with Jim Modestino about becoming his student, he immediately accepted me. That was the beginning of a new era.

John Wen: Do you have any other special memories about your experience at Rensselaer?

Nariman Farvardin: My four and a half years at RPI were total dedication to my studies. My undergraduate program was very tumultuous because of the revolution and I had lost about a year and a half. I was determined to make up for it. I really enjoyed my interactions with Modestino and my graduate program at RPI because from an educational point of view it was a very rich experience, so my best memories are the memories of interacting with my advisor, with my fellow Ph.D. classmates, and with a couple of other professors that I really loved. In particular I remember Bill Pearlman. I had a tremendous amount of admiration for him, and I learned a lot from him, and John Anderson. These two people were very close to me. I had some math professors that I took classes with and I really liked working with them also.

John Wen: Do you have any advice for our students, the young minds coming through today?

Nariman Farvardin: I have only one piece of advice. And that's the advice that I have used in my own personal life. We as human beings all have strengths and weaknesses. I have found one trick that helps me to compensate for my weaknesses. And that's by working hard. I always try to capitalize on my strengths. And I always compensate for my weaknesses by working hard. That combination has worked for me, and I think it will work for others.

2020-2021 ECSE Awards

Faculty

Birsen Yazici: Elevated to Fellow of IEEE

Joe Chow: Part of Team To Receive 2020 R&D 100 Award

Tianyi Chen: IEEE Signal Processing Society (SPS) Best Ph.D. dissertation award, NSF CAREER Award

Ali Tajer: 2021 James M. Tien '66 Early CAREER Award and Grant for Faculty (Rensselaer Commencement Award)

John Wen: 2020 *International Journal of Intelligent Robotics and Applications* Best Paper Award

Shayla Sawyer: 2020 Trustee's Outstanding Teacher Award (Rensselaer Commencement Award)

Tong Zhang: Elevated to Fellow of IEE

Students

2021 Grainger Power Engineering Awards

Taite R. Clark
William Kachidurian
Kunj Shah

The Allen B. Dumont Prize

Gourav Saha
Shuai Zhang

The Harold N. Trevett Award

Aiden Chen
Andrew Nguyen

Charles M. Close '62 Doctoral Prize

Saurabh Sihag

Dr. Alireza Seyedi '99, '04 Teaching Assistant Award

Lauren Brady

Lt. Charles D. Dyce Award

Thomas Moe
Ajeet Parmer

The Henry J. Nolte Memorial Prize

Taite Clark
Eric Segerstrom

The Ricketts Prize

Matthew Dennerlein
Patrick Donelan

Graduate Student Service Award

Amelia Peterson
Waleed Mansha

The Wynant James Williams Prize

Hao Zhang
Emmanuel Sylvester

4.0 GPA Award

Nikhilas Krishna Murthy
Ningyuan Lu

ECSE Graduates and Students Enjoy Outstanding Placements in 2020-2021

Graduates and students of the ECSE program enjoyed another year of outstanding industry placements during 2020-2021 for post-graduation employment, as well as co-ops and internships. Marquee corporate names appearing on this year's placement list including IBM, Intel, SpaceX, Raytheon, NASA, Phillips, M&T Bank, Facebook, GLOBALFOUNDRIES, and many other recruiters representing an impressively broad range of industries and economic sectors.

Make a contribution to ECSE's future:
ecse.rpi.edu/donate

Newsletter Committee:
Rich Radke (Chair), Rama Hamarneh,
Shayla Sawyer, and Ali Tajer

Rensselaer
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