RESEARCH IN ELECTRICAL AND COMPUTER ENGINEERING (ECE)

WHAT IS ECE?
Electrical and Computer Engineers (ELECs) create, innovate and design technologies in robotics, computing, and microwave and radiofrequency engineering. They are at the forefront of science and technology, applying the latest techniques to a wide range of products, from smart phones to cars, from health care to entertainment. Rice is a leader in digital signal processing, signal transmission, and wireless networking.

WHAT DO WE DO?
ELECs are a diverse, smart, creative group of problem-solvers who make cool things that change the world. Our research covers the full stack of systems, from integrated circuits to signal processing, and signal processing to communication networks. Our work impacts every aspect of our society, from health care to entertainment to transportation to national security.

COMPUTER ENGINEERING (CE)
Computer Engineering is about designing, realizing and evaluating computing, communication and storage systems: making them fast, secure, reliable, and efficient. Our research covers the full stack of systems, from integrated circuits to signal processing, and signal processing to communication networks. Our work impacts every aspect of our society, from health care to entertainment to transportation to national security.

NEUROENGINEERING (NEURO)
The brain is essentially a circuit. Neuroengineering is a discipline that exploits engineering techniques to understand, repair, and manipulate the brain. Rice is uniquely positioned to lead this field thanks to the broad, interdisciplinary research performed in conjunction with the world’s largest medical center (Texas Medical Center), steps away from the Rice University campus.

PHOTONICS, ELECTRONICS, & NANODEVICES (PEN)
This field strives to improve understanding of the interaction of light and matter, and to develop innovative devices and technologies. PEN has applications in energy, healthcare, communication, and more. Rice is a leader in optical computing, optical communications, and optical sensors.

DATA SCIENCE (DS)
Data Science is a growing field that integrates the tools and techniques involved in data acquisition, data analysis, and data storage to enable extraction of meaningful information from data. Rice is a leader in data science thanks to the research of our faculty and the resources of our campus.

DSP/WIRELESS NETWORKING
Rice is a leader in Digital Signal Processing. Signal Processing is the analysis and transformation of signals in order to understand, simplify, or recast their structure. The understanding of how to analyze and recast signals is applied to a wide range of areas, including wireless communication systems, Internet of Things (IoT), machine learning, and healthcare.

RESEARCH AREAS OF RICE ECE:

NOTES:
Kaiyuan Yang, Assistant Professor, Electrical and Computer Engineering
kyang@rice.edu
Research areas: Computer Engineering
Dr. Yang’s research focuses on designing low-power digital and mixed-signal circuits for future secure and low-power applications, especially the Internet of Things (IoT). He is also interested in hardware security and circuit/system design with emerging devices.

Gary Woods*, Professor in the Practice, Electrical and Computer Engineering (Computer Technology)
gary.woods@rice.edu
Research areas: Photonics, Electronics & Nanodevices
Dr. Woods is interested in mobile health, semiconductor failure analysis, and optical probing and debugging of advanced integrated circuits. He has advised groups who’ve gone on to: develop a vest to help the deaf hear; develop a dynamic radar and digital imaging system; and create an automated monitoring and control system for water waste reduction in oil fields.

Lin Zhong, Professor, Electrical and Computer Engineering (Sabattical Spring 2019)
lzhong@rice.edu
Research areas: Computer Engineering; Data Science
Dr. Zhong’s team recently developed RIO, which allows an application on one mobile system to utilize I/O from another. He’s interested in mobile and embedded systems, human-computer interaction, and nanoelectronics. REU opportunities available.

*Denotes VIP leading Faculty

HOW TO use THIS GUIDE

This guide is organized alphabetically by faculty member with a brief description of their research. News from the Electrical and Computer Engineering Department (ECE) is interspersed throughout the booklet.

Many faculty’s work is interdisciplinary and covers multiple areas. Each faculty member has listed the area(s) that most pertains to her/his research and lists an email where you can contact them and communicate your interest.

Useful information

• You can request to attend one of the regularly scheduled research group meetings held by a particular faculty member;

• Some faculty have summer Research Experiences for Undergraduates (REU) available; and

• Continuing undergraduates and graduate students may take one 3-credit research course in the summer tuition free. This applies to courses like ELEC 490, 491, 590 and 591)

RESEARCH THROUGH: Vertically Integrated Projects

The Vertically Integrated Projects (VIP) Program at Rice unites undergraduate education and faculty research in a team-based context. Undergraduate Rice VIP students earn academic credits, while faculty and graduate students benefit from the design/discovery efforts of their teams.

VIP at Rice extends the academic design experience beyond a single semester. Rice VIP teams are comprised of students from freshmen to graduate students, with a variety of majors and backgrounds.

VIP provides the time and context to learn and practice professional skills, to make substantial contributions, and experience different roles on large multidisciplinary design/discovery projects. Participation is through ELEC 491 and 591.

vip.rice.edu
Dr. Aazhang’s research interests are signal processing, information theory, and their applications to neuroengineering, including closed-loop stimulation of neuronal systems to mitigate disorders such as epilepsy, Parkinson’s disease, depression, and obesity.

**Research Experiences for Undergraduates.** Research Experiences for Undergraduates (REUs) are competitive summer research programs in the United States for undergraduates studying science, engineering, or mathematics.
Xaq Pitkow, Assistant Professor, Electrical and Computer Engineering  
Assistant Professor, Computational Neuroscience, Baylor College of Medicine  
xaq.pitkow@rice.edu  
Research areas: Data Science; Neuroengineering  
Dr. Pitkow’s research includes theories of neural computation in animal brains. Topics include: probabilistic inference, control theory, nonlinear dynamics, and population codes. Current projects include analyzing behaviors of animals playing video games; designing animal virtual reality environments; stimulating and analyzing computation in neural networks.

Jacob T. Robinson, Assistant Professor, Electrical and Computer Engineering & Bioengineering  
jacob.t.robinson@rice.edu  
Research areas: Data Science; Neuroengineering; Photonics, Electronics & Nanodevices  
Dr. Robinson uses nanotechnology to interact with the brain and to treat neurological disorders. He uses nanotechnology to measure and manipulate neural activity. REU opportunities available.

Akane Sano, Assistant Professor, Electrical and Computer Engineering  
akane.sano@rice.edu  
Research areas: Data Science; Systems  
Dr. Sano is interested in affective computing, particularly mobile and personalized health. Currently, she is lead investigator on the SNAPSHOT study measuring sleep, stress, and ambulation in everyday living.

Ashutosh Sabharwal*, Professor, Electrical and Computer Engineering  
ashu@rice.edu  
Research areas: Data Science; Systems  
Dr. Sabharwal is interested in mobile health – using smart devices to diagnose and treat patients in more scenarios, to measure medicine adherence, and to impact health behaviors. He’s also interested in wireless networks, information theory, multiple antenna systems, coding and computation.

Santiago Segarra, Assistant Professor, Electrical and Computer Engineering  
santiago.segarra@rice.edu  
Research areas: Data Science  
Dr. Segarra is interested in network theory, data analysis, machine learning, and graph signal processing. His focus is to develop tools to better process and understand network data, and apply these tools to real-world problems.

ECE is Mobile Health  
In partnership with IBM, ECE researchers have developed a prototype Multi-Purpose Eldercare Robot Assistant (MERA). The Watson-enabled robot is designed to help assist the elderly and their caregivers in an “aging in place” environment.

ECE is Solar Desalination  
Rice’s Center for Nanotechnology Enabled Water Treatment (Newt) has developed an off-grid technology that uses energy from sunlight alone to turn salt water into fresh drinking water.

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santiago.segarra@rice.edu  
Research areas: Data Science  
Dr. Segarra is interested in network theory, data analysis, machine learning, and graph signal processing. His focus is to develop tools to better process and understand network data, and apply these tools to real-world problems.
Edward W. Knightly, Chair, Electrical and Computer Engineering, Lindsay-Sheafor Professor, Electrical and Computer Engineering, Professor, Computer Science
knightly@rice.edu
Research areas: Systems
Dr. Knightly is the founder of Technology for All, bringing tech to underserved areas. He is interested in wireless networks, multi-antenna systems, high-performance protocol design, security, and performance evaluation.
REU opportunities available.

Junichiro Kono, Professor, Electrical and Computer Engineering & Physics & Astronomy
kono@rice.edu
Research areas: Photonics, Electronics & Nanodevices
Dr. Kono's research results in increased understanding of quantum states. He's interested in condensed matter physics, including electron transport, quantum computing, and topological insulators.
REU opportunities available.

ECE is Engineering the Brain
The Kemere lab designs systems to interact with complex neural circuits to explore how information is processed, stored, and retrieved in both healthy brains and those with disorders, focusing on memory and cognitive processes; model-based signal processing; and low-power embedded systems.

Yingyan Lin, Assistant Professor, Electrical & Computer Engineering
yingyan.lin@rice.edu
Research areas: Computer Engineering; Data Science
Dr. Lin's research interests include analog and mixed-signal circuits, error-resilient techniques, and VLSI circuits and architectures for machine learning systems on resource-constrained platforms. REU opportunities available.

Caleb Kemere, Assistant Professor, Electrical and Computer Engineering
caleb.kemere@rice.edu
Research areas: Neuroengineering
Dr. Kemere is researching memory manipulation for the greater good (treating PTSD) and Deep Brain Stimulation for treatment of diseases like PD. He's interested in building interfaces with memory and cognitive processes.

Kevin Kelly, Associate Professor, Electrical and Computer Engineering
kkelly@rice.edu
Research areas: Photonics, Electronics & Nanodevices
Dr. Kelly is interested in imaging and spectroscopy at the nanoscale, and understanding the role of mathematics in image acquisition and interpretation. Other interests include Scanning Probe Microscopy, Electronic Materials, and Nanoelectronics.

Gururaj Naik, Assistant Professor, Electrical & Computer Engineering
research@rice.edu
Research areas: Photonics, Electronics & Nanodevices
Dr. Naik is interested in light and heat management for clean energy: thermovoltaics and photovoltaics; materials for plasmonics and metamaterials; and large-area nanofabrication and integration. REU opportunities available.

Guru Naik's method to 'upconvert' light could make solar cells more efficient and disease-targeting nanoparticles more effective.

ECE is Research in Education
The Baraniuk lab researches how the brain perceives depth and 3D vision. They are interested in machine learning and neural information processing.

Ankit Patel, Assistant Professor, Electrical & Computer Engineering
abp4@rice.edu
Research areas: Data Science; Neuroengineering; Systems
Dr. Patel is interested in probabilistic theories of deep learning from first principles; neurally-inspired learning and computation; medical imaging diagnostics; reverse-engineering neuroanatomy; and deep learning for particle physics.

Michael T. Orchard, Professor, Electrical & Computer Engineering
orchard@rice.edu
Research areas: Data Science; Systems
Dr. Orchard researches image and video modeling and compression.

ECE is ‘Upconverted’ Light