Energy, Environmental & Chemical Engineering

The Department of Energy, Environmental & Chemical Engineering (EECE) provides integrated and multidisciplinary programs of scientific education in cutting-edge areas, including the PhD in Energy, Environmental & Chemical Engineering. The research and educational activities of the department are organized into four clusters: aerosol science and engineering; engineered aquatic processes; multiscale and electrochemical engineering; and synthetic biology and bioproduct engineering. These overlapping clusters address education and research in four thematic areas: energy; environmental engineering science; advanced materials; and sustainable technology for public health and international development. In addition to the core faculty in the department, faculty in the schools of Medicine, Arts & Sciences, Business, Law, and Social Work collaborate to provide students with a holistic education and to address topical problems of interest.

Three master’s programs are offered through the department: Master of Science in Energy, Environmental & Chemical Engineering (MS), Master of Engineering in Energy, Environmental & Chemical Engineering (MEng) and Master of Engineering in Energy, Environmental & Chemical Engineering/Master of Business Administration (MEng/MBA). The MS degree is a research-focused master’s program for students interested in studying environmental engineering, energy systems and chemical engineering. The MEng degree provides students with critical scientific and engineering skill sets; leadership training for management, economics, and policy decision making; and the opportunity to specialize in one of five pathways. The MEng/MBA is a dual degree between the McKelvey School of Engineering and the Olin Business School that provides engineering and business approaches to issues of sustainability, energy, the environment and corporate social responsibility. Interested students must apply and be accepted to both programs before admission is provided to the MEng/MBA dual-degree program.

The department is a key participant in the university’s Center for the Environment, and it supports both the International Center for Energy, Environment and Sustainability (InCEES) and the McDonnell Academy Global Energy and Environment Partnership (MAGEEP). Major externally funded research centers in the department include the Consortium for Clean Coal Utilization, the Nano Research Facility (NRF) and Jens Environmental Molecular and Nanoscale Analysis Laboratory (Jens Lab), the Center for Aerosol Science and Engineering (CASE), the Center for Water Innovation (CWI), and the Synthetic biology Manufacturing of Advanced materials Research Center (SMARC).

Faculty

Department Chair and Professor

Joshua Yuan
Lucy & Stanley Lopata Professor
PhD, University of Tennessee
Design-based engineering to address challenges in energy, the environment and health

Endowed Professors

Richard L. Axelbaum
The Stifel & Quinette Jens Professor of Environmental Engineering Science
PhD, University of California, Davis
Combustion, advanced energy systems, clean coal, aerosols, nanoparticle synthesis, rechargeable battery materials, thermal science

Daniel E. Giammar
Walter E. Browne Professor of Environmental Engineering
Director, Center for the Environment
PhD, California Institute of Technology
Aquatic chemistry, environmental engineering, water quality, water treatment

Zhen (Jason) He
Laura and William Jens Professor of Energy, Environmental & Chemical Engineering
Director of Graduate Studies
PhD, Washington University
Environmental biotechnology, bioenergy production, biological wastewater treatment, resource recovery, bioelectrochemical systems, sustainable desalination technology, anaerobic digestion, forward osmosis, membrane bioreactors

Feng Jiao
Elvera and William R. Stuckenberg Professor
Director, Center for Carbon Management
PhD, University of St. Andrews
Electrocatalysis, carbon dioxide utilization, electrochemical devices, energy storage

Randall Martin
Raymond R. Tucker Distinguished Professor
PhD, Harvard University
Characterizing atmospheric composition to inform effective policies surrounding major environmental and public health challenges ranging from air quality to climate change

Vijay Ramani
Vice Provost for Graduate Education and International Affairs
Roma B. and Raymond H. Wittcoff Distinguished University Professor
PhD, University of Connecticut
Electrochemical engineering, energy conversion

Phone: 314-935-5548
Website: https://eece.wustl.edu/academics/graduate-programs/index.html
Jay R. Turner  
Head of the Division of Engineering Education  
Vice Dean for Education  
James McKeel Professor of Engineering Education  
DSc, Washington University  
Air quality planning and management, aerosol science and engineering, green engineering

Professors

Young-Shin Jun  
PhD, Harvard University  
Aquatic processes, molecular issues in chemical kinetics, environmental chemistry, surface/physical chemistry, environmental engineering, biogeochemistry, nanotechnology

Xinhua Liang  
PhD, University of Colorado Boulder  
Gas-phase synthesis, surface science and catalysis, nanostructured films and devices, energy and environmental applications

Yinjie Tang  
PhD, University of Washington  
Metabolic modeling, fermentation engineering, algal bioprocesses

Jian Wang  
Director of the Center for Aerosol Science and Engineering (CASE)  
PhD, California Institute of Technology  
Aerosol properties and processes, nucleation and new particle formation, aerosols in the marine environment, effects of aerosols on cloud microphysical properties and macrophysical structure

Fuzhong Zhang  
PhD, University of Toronto  
Metabolic engineering, protein engineering, synthetic and chemical biology

Associate Professors

Peng Bai  
PhD, Tsinghua University, China  
develop next-generation batteries; probe the in situ electrochemical dynamics of miniature electrodes down to nanoscales; capture the heterogeneous and stochastic nature of advanced electrodes; identify the theoretical pathways and boundaries for the rational design of materials, electrodes, and batteries through physics-based mathematical modeling and simulation

Rajan Chakrabarty  
Harold D. Jolley Career Development Associate Professor  
PhD, University of Nevada, Reno  
Characterizing the radiative properties of carbonaceous aerosols in the atmosphere, researching gas-phase aggregation of aerosols in cluster-dense conditions

Marcus Foston  
Director of Diversity Initiatives  
PhD, Georgia Institute of Technology  
Utilization of biomass resources for fuel and chemical production, renewable synthetic polymers, development of advanced aerosol instruments

Elijah Thimsen  
PhD, Washington University in St. Louis  
Gas-phase synthesis of inorganic nanomaterials for energy applications, novel plasma synthesis approaches

Assistant Professors

Christopher Cooper  
PhD, Stanford University  
Responsive, soft materials for applications in energy storage, environmental sustainability and human health

Jenna Ditto  
PhD, Yale University  
Chemical composition of indoor and outdoor air, indoor air chemistry, health impacts of air pollution exposure

Fangqiong Ling  
PhD, University of Illinois at Urbana-Champaign  
Microbial ecosystem analysis and modelling, process modelling, machine learning, NextGen sequencing bioinformatics, environmental microbiology, bioreactor design

Kimberly M. Parker  
PhD, Stanford University  
Investigation of environmental organic chemistry in natural and engineered systems

Lu Xu  
PhD, Georgia Institute of Technology  
Air quality, climate change, atmospheric chemistry

Research Assistant Professor

Benjamin Kumfer  
DSc, Washington University  
Advanced coal technologies, biomass combustion, aerosol processes and health effects of combustion-generated particles

Senior Lecturers

Janie Brennan  
Director of Undergraduate Studies  
PhD, Purdue University  
Chemical engineering education, biomaterials

Raymond Ehrhard  
BS, Missouri University of Science and Technology  
Water and wastewater treatment technologies, process energy management
**Bulletin 2024-25**  
**Energy, Environmental & Chemical Engineering (07/02/24)**

**Trent Silbaugh**  
PhD, University of Washington  
Chemical engineering education, catalysis, carbon capture and conversion

**Kristen Wyckoff**  
PhD, University of Tennessee  
Environmental engineering education, stormwater runoff, environmental microbiology

**Lecturer**

**Kurt Russell**  
PhD, Purdue University  
Chemical engineering education, catalysis

**Affiliated Faculty**

**Gary Moore**  
Senior Lecturer for the Joint Engineering Program  
MS, Missouri University of Science and Technology  
Environmental management

**Adjunct Faculty**

**Grigoriy Yablonsky**  
PhD, Boreskov Institute of Catalysis  
Chemical reaction engineering and heterogeneous catalysis

**Emeritus Professor**

**Milorad P. Dudukovic**  
Laura and William Jens Emeritus Professor  
PhD, Illinois Institute of Technology  
Chemical reaction engineering, multiphase reactors, visualization of multiphase flows, tracer methods, environmentally benign processing

**Degree Requirements**

Please visit the following pages for information about the degrees offered:

- PhD in Energy, Environmental & Chemical Engineering (EECE)
- Master of Science (MS) in Energy, Environmental & Chemical Engineering (EECE)
- Master of Engineering (MEng) in Energy, Environmental & Chemical Engineering (EECE)
- Combined Master of Engineering/Master of Business Administration (MEng/MBA) (given jointly with Olin Business School)

**Courses**

Visit online course listings to view semester offerings for E44 EECE:

**E44 EECE 500 Independent Study**  
Independent investigation on topic of special interest. Interested students are encouraged to approach and engage faculty to develop a topic of interest. A form declaring the agreement must be filed in the departmental office. Petitions are generally considered in the semester preceding the independent study experience. Prerequisite: graduate level standing.  
Credit variable, maximum 9 units.

**E44 EECE 501 Transport Phenomena in EECE**  
The aim of the course is for students to develop skills in applying principles of momentum, heat and mass transport in an unified manner to problems encountered in the areas of energy, environmental and chemical processes. A systems approach will be followed so that the general principles can be grasped and the skills to develop mathematical models of seemingly different processes will be emphasized. This provides the students with a general tool which they can apply later in their chosen field of research. Prerequisite: graduate level standing or permission of instructor  
Credit 3 units.

**E44 EECE 502 Advanced Thermodynamics in EECE**  
The objective of this course is to understand classical thermodynamics at a deeper level then is reached during typical undergraduate work. Emphasis will be placed on solving problems relevant to chemical engineering materials science. Prerequisite: E44 EECE 205 or graduate level standing or permission of instructor  
Credit 3 units.

**E44 EECE 504 Aerosol Science and Technology**  
Fundamental properties of particulate systems - physics of aerosols, size distributions, mechanics and transport of particles: diffusion, inertia, external force fields. Visibility and light scattering. Aerosol dynamics - coagulation, nucleation, condensation. Applications to engineered systems: Nanoparticle synthesis, atmospheric aerosols, combustion aerosols, pharmaceutical aerosols. Prerequisites: E44 EECE 301, E35 ESE 318 and E35 ESE 319 or graduate level standing or permission of instructor  
Credit 3 units.

**E44 EECE 505 Aerosol Science and Technology**  
Fundamental properties of particulate systems - physics of aerosols, size distributions, mechanics and transport of particles: diffusion, inertia, external force fields. Visibility and light scattering. Aerosol dynamics - coagulation, nucleation, condensation. Applications to engineered systems: Nanoparticle synthesis, atmospheric aerosols, combustion aerosols, pharmaceutical aerosols. Prerequisites: E44 EECE 301, E35 ESE 318 and E35 ESE 319 or graduate level standing or permission of instructor  
Credit 3 units.

**E44 EECE 506 Bioprocess Engineering I: Fundamentals & Applications**  
The course covers the fundamentals and provides the basic knowledge needed to understand and analyze processes in biotechnology in order to design, develop and operate them efficiently and economically. This knowledge is applied to understand various applications and
bioprocesses, such as formation of desirable bio and chemical materials and products, production of bioenergy, food processing and waste treatment. The main objective of the course is to introduce the essential concepts and applications of bioprocessing to students of diverse backgrounds. An additional project is required to obtain graduate credit. Prerequisites: L41 Biol 2960 or E44 EECE 306 or graduate level standing permission of instructor. Credit 3 units. EN: BME T, TU

E44 EECE 507 Kinetics and Reaction Engineering Principles
The course is aimed at a modern multiscale treatment of kinetics of chemical and biochemical reactions and application of these fundamentals to analyze and design reactors. Application of reaction engineering principles in the areas related to energy generation, pollution prevention, chemical and biochemical processes will be studied and illustrated with case studies and computer models. Description of the role of mass and heat transport in reacting systems is also provided with numerous examples. Prerequisites: (E44 EECE 503 or (E5 ESE 318 and E5 ESE 319)) and E44 EECE 405 or permission of instructor. Credit 3 units.

E44 EECE 508 Research Rotation
First-year doctoral students in EECE should undertake this rotation as a requirement prior to choosing a permanent research adviser. The rotation will require the student to work under the guidance of a faculty member.

E44 EECE 509 Seminar in Energy, Environmental, and Chemical Engineering
All graduate students in EECE should attend the departmental seminar series to gain exposure in various diverse fields of research. Students are also expected to participate in journal clubs and other discussion formats to discuss topical research areas. This course is required of all graduate students every semester of residency in the program. Credit 1 unit.

E44 EECE 510 Advanced Topics in Aerosol Science & Engineering
This course will be focused on the discussion of advanced topics in aerosol science and engineering and their applications in a variety of fields, including materials science, chemical engineering, mechanical engineering, and environmental engineering. Prerequisite: EECE 504 or permission of instructor. Credit 3 units. EN: BME T, TU

E44 EECE 512 Combustion Phenomena
This course provides an introduction to fundamental aspects of combustion phenomena, including relevant thermochemistry, fluid mechanics, and transport processes as well as the interactions among them. Emphasis is on elucidation of the physico-chemical processes, problem formulation and analytic techniques. Topics covered include non-premixed and premixed flames, deflagrations and detonations, particle combustion, flame extinction, flame synthesis, pollutant formation and methods of remediation. Contemporary topics associated with combustion are discussed throughout. Prerequisite: Senior or graduate standing or permission of instructor. Credit 3 units. EN: BME T, TU

E44 EECE 514 Atmospheric Science and Climate
This course will cover current research topics in atmospheric chemistry and climate change. Topics include atmospheric composition, chemistry, transport, dynamics, radiation, greenhouse gases, natural and anthropogenic primary pollution sources and secondary aerosol production, and measurement techniques. Focus will be placed on how our atmosphere and climate are altered in a world of changing energy production and land use. Suggested prerequisites: 1 year of general chemistry (Chem 11A/112A or 105-106) and 1 year of general physics (191/19L-191/19L). Prereqs: Junior, senior or graduate level standing or permission of instructor. Credit 3 units. EN: BME T, TU

E44 EECE 516 Measurement Techniques for Particle Characterization
The purpose of this course is to introduce students to the principles and techniques of particle measurement and characterization. Practical applications of particle technology include air pollution measurement, clean manufacturing of semiconductors, air filtration, indoor air quality, particulate emission from combustion sources, and so on. The course will focus on the following: (1) integral moment measurement techniques; (2) particle sizing and size distribution measuring techniques; and (3) particle composition measurement techniques. Related issues such as particle sampling and transportation, instrument calibration, and particle standards will also be covered. Prerequisites: E44 EECE 504 or graduate level standing or permission of instructor. Credit 3 units. EN: BME T, TU

E44 EECE 520 Special Topics: Plasma Science and Engineering
This course will focus on a select set of fundamentals and technology related to nonequilibrium plasmas, which are partially ionized gases. Fundamental discussion will focus on the set of state variables that define the plasma and the interaction of the plasma with surfaces, suspended dust particles, and chemically reactive molecular species. The technology used to generate and sustain plasma will be discussed. Diagnostic probes that can be used to ascertain key aspects of the discharge will be covered. Envisioned application areas for the knowledge include semiconductor processing and electrified chemical processing (e.g., advanced oxidation processes). Students enrolling in this course should have a knowledge of chemical engineering thermodynamics; the physics of electricity and magnetism and electrical circuits; aerosol science and technology; chemical reaction engineering and reactor design; and physical chemistry. Prerequisites: Graduate level standing or permission of instructor. Credit 3 units. EN: BME T, TU

E44 EECE 521 Air Quality Engineering with Lab
Introduction to air quality and pollution control. Pollutant emissions, atmospheric chemistry, and fate. Air pollution meteorology and atmospheric dispersion. Application of chemistry, thermodynamics, and fluid mechanics in the selection and design of air pollution control equipment. Labs to measure air quality and demonstrate control principles. Prerequisite: E44 EECE 205 or permission of instructor. Same as E44 EECE 314. Credit 4 units. EN: TU

E44 EECE 531 Environmental Organic Chemistry
This course covers the fundamental physical-chemical examination of organic molecules (focused on anthropogenic pollutants) in aquatic (environmental) systems. Students learn to calculate and predict the chemical properties that are influencing the partitioning of organic chemicals within air, water, sediments and biological systems. This knowledge will be based on understanding intermolecular interactions and thermodynamic principles. Mechanisms of important thermochemical, hydrolytic, redox, and biochemical transformation reactions are also investigated, leading to the development of techniques (e.g., structure-reactivity relationships) for assessing environmental fate or human exposure potential. Prerequisites: (E44 EECE 210 or E44 EECE 205) and L07 Chem 261, or graduate level standing or permission of instructor. Credit 3 units. EN: BME T, TU
E44 EECE 533 Physical and Chemical Processes for Water Treatment

Water treatment is examined from the perspective of the physical and chemical unit processes used in treatment. The theory and fundamental principles of treatment processes are covered and are followed by the operation of treatment processes. Processes covered include gas transfer, adsorption, precipitation, oxidation-reduction, flocculation, sedimentation, filtration, and membrane processes. Prerequisite: E44 EECE 205 Corequisite: E44 EECE 210 or graduate level standing or permission of instructor
Credit 3 units. EN: BME T, TU

E44 EECE 534 Environmental Nanochemistry

This course involves the study of nanochemistry at various environmental interfaces, focusing on colloid, nanoparticle, and surface reactions. The course would also (1) examine the thermodynamics and kinetics of nanoscale reactions at solid-water interfaces in the presence of inorganic or organic compounds and microorganisms; (2) investigate how nanoscale interfacial reactions affect the fate and transport of contaminants; (3) introduce multidisciplinary techniques for obtaining fundamental information about the structure and reactivity of nanoparticles and thin films, and the speciation or chemical form of environmental pollutants at the molecular scale; (4) explore connections between environmental nanochemistry and environmental kinetic analysis at larger scales. This course will help students attain a better understanding of the relationship between nanoscience/technology and the environment—specifically how nanoscience could potentially lead to better water treatments, more effective contaminated-site remediation, or new energy alternatives. Students enrolling in this course should have a knowledge of general chemistry. Prerequisites: Senior or graduate level standing or permission of instructor
Credit 3 units. EN: BME T, TU

E44 EECE 535 Environmental Data Science

Many of the grand challenges that we face today require understanding and manipulation of processes at the interface of natural and manmade environments. Oftentimes, such knowledge is acquired through data. Skills to effectively visualize and analyze data and build predictive models are valued across different sectors of the society. This is an application-driven course. Prerequisites: L24 Math 217, E35 ESE 318 and (E35 ESE 326 or E60 ENGR 328) or graduate level standing or permission of instructor
Credit 3 units. EN: BME T, TU

E44 EECE 537 Environmental Resource Recovery

This course will focus on key concepts of resource recovery from wastes. Topics include energy, water, nutrient, and value-added compounds. The course will discuss technological advancements, environmental impacts, and techno-economic assessment of environmental resource recovery. The cutting-edge recovery technologies in full-scale applications or laboratory studies will be introduced. Students will be trained for critical thinking and review of literature information, practice technical analysis and writing, and conduct a concept design of recovery systems using the data from local wastewater treatment facilities. The course is valuable as a prerequisite to more advanced research in environmental engineering, as a technical education to stimulate graduate students’ interest in environmental sustainability, and as an introduction to environmental constraints that are increasingly important to other engineering disciplines. Prerequisites: E44 EECE 210 and E44 EECE 409 or graduate level standing or permission of instructor
Credit 3 units. EN: TU

E44 EECE 551 Metabolic Engineering and Synthetic Biology

Synthetic Biology is a transformative view of biology from “observation approach” to “synthesis approach.” It is new “engineering” discipline and aims to make the engineering of new biological function predictable, safe, and quick. It will pave a wide range of applications to transform our views on production of sustainable energy and renewable chemicals, environmental problems, and human disease treatments. The field intersects with Metabolic Engineering in areas such as the design of novel pathways and genetic circuits for product generation and toxic chemical degradation. In this course, the field and its basis are introduced. First, relevant topics in biology, chemistry, physics, and engineering are covered. Second, students will participate in brain-storming and discussion on new biology-based systems. Last, students will design and present new synthetic biology systems to solve real-world problems. No prerequisite. Both undergrad and graduate students can take this course.
Credit 3 units. EN: BME T, TU

E44 EECE 552 Biomass Energy Systems and Engineering

This course offers background in the organic chemistry, biology and thermodynamics related to understanding the conversion of biomass. In addition includes relevant topics relating to biomass feedstock origin, harvest, transportation, storage, processing and pretreatment along with matters concerning thermo- and bio-chemical conversion technologies required to produce fuels, energy, chemicals, and materials. Also, various issues with respect to Biomass characterization, economics and environmental impact will be discussed. The main objective of the course is to introduce concepts central to a large-scale integrated biomass bioconversion system. Prerequisites: Senior or graduate level standing or permission of instructor
Credit 3 units. EN: BME T, TU

E44 EECE 554 Molecular Biochemical Engineering

This course is set for junior level graduate students to bridge the gap between biochemical engineering theory and academic research in bioengineering. It will cover common molecular biotechnologies (molecular biology, microbiology, recombinant DNA technology, protein expression etc), biochemical models (enzyme catalysis, microbial growth, bioreactor etc) and bioengineering methodologies (protein engineering, expression control systems etc). These theories and technologies will be introduced in a manner closely related to daily academic research or biochemical industry. Areas of application include biofuel and chemical production, drug discovery and biosynthesis, bioremediation, and environmental applications. This course also contains a lab section (20~30%) that requires students to apply the knowledge learned to design experiments, learn basic experimental skills and solve current research problems. Prerequisites: (E44 EECE 101 or E44 EECE 103), (L41 Biol 2960 or E44 EECE 306), L41 Biol 4810, or graduate level standing or permission of instructor.
Credit 3 units. EN: BME T, TU

E44 EECE 572 Advanced Transport Phenomena

Analytical tools in transport phenomena: Scaling, perturbation and stability analysis. Numerical computations of common transport problem with MATLAB tools. Low Reynolds number flows and applications to microhydrodynamics. Turbulent flow analysis and review of recent advances in numerical modeling of turbulent flows. Convective heat and mass transfer in laminar and turbulent flow systems. Introduction to two phase flow and multiphase reactors. Pressure-driven transport and transport in membranes, electrochemical systems, double layer effects and flow in microfluid devices. Prerequisites: E44 EECE 501 or (E44 EECE 301 and E44 EECE 307), or permission of instructor
Credit 3 units. EN: BME T, TU
E44 EECE 573 Polymers for Energy, Sustainability, and Human Health
Polymeric materials are critical to solving global challenges related to energy (e.g., batteries, membranes, and energy harvesting devices), sustainability (e.g., upcycling, compatibilizers, water purification, and bio-based plastics), and human health (e.g., wearable and implantable bioelectronics, stimuli-responsive soft robots, and hydrogels for drug delivery). This course covers how polymers are designed and processed across many length and time scales to achieve specific target properties for applications in energy, sustainability, and human health. Ideal and real chain conformations, persistence length, polymer architectures, scaling and blob theories, dispersity, networks and defects, and programmed interactions in heteropolymers will be covered. Analysis of polymer structure and dynamics will include: macroscopic and microscopic phase separation, crystallization and melting, glass transition behavior, rouse dynamics, linear viscoelasticity, processing methods, and network elasticity. Key polymer characterization methods including rheology and small- and wide-angle x-ray scattering will be introduced. The course will emphasize individual problem sets, in-class journal club participation, and team-based project work. Prerequisites: EECE 204 or MEMS 301 or equivalent; EECE 301 or MEMS 3410 or equivalent Credit 3 units.

E44 EECE 574 Electrochemical Engineering
This course will teach the fundamentals of electrochemistry and the application of the same for analyzing various electrochemical energy sources/devices. The theoretical frameworks of current-potential distributions, electrode kinetics, porous electrode and concentrated solution theory will be presented in the context of modeling, simulation and analysis of electrochemical systems. Applications to batteries, fuel cells, capacitors, copper deposition will be explored. Prerequisites: E44 EECE 501 or (E44 EECE 301 and E44 EECE 307) or permission of instructor Credit 3 units.

E44 EECE 576 Chemical Kinetics and Catalysis
This course reflects the fast, contemporary progress being made in decoding kinetic complexity of chemical reactions, in particular heterogeneous catalytic reactions. New approaches to understanding relationships between observed kinetic behaviour and reaction mechanism will be explained. Present theoretical and methodological knowledge will be illustrated by many examples taken from heterogeneous catalysis (complete and partial oxidation), combustion and enzyme processes. Prerequisite: senior or graduate student standing, or permission of instructor. Credit 3 units. EN: BME T, TU

E44 EECE 597 EECE Project Management
An introduction to the theory and practice of engineering project management, with an emphasis on projects related to environmental protection and occupational health and safety. Topics include: project definition and justification; project evaluation and selection; financial analysis and cost estimation; project planning, including scheduling, resourcing, and budgeting; project oversight, auditing, and reporting; and effective project closure. Students will be introduced to commonly used project management tools and systems, such as work breakdown structures, network diagrams, Gantt charts, and project management software. Topics will also include project management in different organizational structures and philosophies; creating effective project teams; and managing projects in international settings. Prerequisites: Enrolled in MEng program; senior or graduate level standing or permission of instructor. Credit 3 units.

E44 EECE 599 Masters Research
Credit variable, maximum 9 units.

E44 EECE 600 Doctoral Research
Credit variable, maximum 9 units.