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. Research and educational activities of the department are organized into four clusters: aerosol science & engineering; engineered aquatic processes; multiscale engineering; metabolic engineering & systems biology. 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.

The department is a key participant in the university's Energy, Environment & Sustainability initiative (http://ees.wustl.edu) and supports both I-CARES (http://i-cares.wustl.edu) and MAGEEP (http://mageep.wustl.edu). Major externally funded research centers in the department include the Consortium for Clean Coal Utilization (http://cleancoal.wustl.edu), the National Nanotechnology Infrastructure Node (http://nano.wustl.edu), and the Photosynthetic Antenna Research Center (http://parc.wustl.edu), a USDOE Energy Frontier Research Center.

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Chair and Endowed Professor

Pratim Biswas
Lucy and Stanley Lopata Professor
PhD, California Institute of Technology
Aerosol science and engineering, air quality and pollution control, nanotechnology, environmentally benign energy production

Endowed Professors

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

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

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

Professors

William P. Darby
PhD, Carnegie Mellon University
Environmental planning and management

Paigghat A. Ramachandran
PhD, University of Bombay
Chemical reaction engineering, applied mathematics, process modeling, waste minimization, environmentally benign processing

Associate Professors

John T. Gleaves
PhD, University of Illinois
Heterogeneous catalysis, particle chemistry

Young-Shin Jun
Harold D. Jolley Career Development Associate Professor
PhD, Harvard University
Aquatic processes, molecular issues in chemical kinetics, environmental chemistry, surface/physical chemistry, environmental engineering, biogeochemistry, nanotechnology

Yinjie Tang
Francis Ahmann Career Development Associate Professor
PhD, University of Washington in Seattle
Metabolic engineering, bioremediation

Jay R. Turner
DSc, Washington University
Air quality planning and management; aerosol science and engineering, life cycle assessments

Assistant Professors

Rajan Chakrabarty
PhD, University of Nevada, Reno
Characterizing the radiative properties of carbonaceous aerosols in the atmosphere; and researching gas phase aggregation of aerosols in cluster-dense conditions
John Fortner
I-CARES Career Development Assistant Professor
PhD, Rice University
Environmental engineering, aquatic processes, water treatment, remediation, and environmental implications and applications of nanomaterials

Marcus Foston
PhD, Georgia Institute of Technology
Utilization of biomass resources for fuel and chemical production, renewable synthetic polymers

Cynthia Lo
PhD, Massachusetts Institute of Technology
Solar energy conversion, materials, environmental interfaces, catalysis, computational chemistry and molecular modeling

Tae Seok Moon
PhD, Massachusetts Institute of Technology
Metabolic engineering and synthetic biology

Elijah Thimsen
PhD, Washington University
Gas-phase synthesis of inorganic nanomaterials for energy applications, and novel plasma synthesis approaches

Brent Williams
Raymond R. Tucker Distinguished I-CARES Career Development Assistant Professor
PhD, University of California
Aerosols, global climate issues, atmospheric sciences

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

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

Joint Faculty
Steven George
Elvera and William Stuckenber Professor and Chair
PhD, University of Washington in Seattle
Tissue engineering; microphysiological systems; vascularizing engineered tissues

Himadri Pakrasi
PhD, University of Missouri-Columbia
Systems biology, photosynthesis, metal homeostasis

Nathan Ravi
PhD, Virginia Polytechnic Institute
Cataract, ocular biomaterials

Adjunct Faculty
Robert Heider
MME, Washington University
Process control and process design

Timothy Michels
MA, Washington University
Energy economics, building construction and equipment sciences

Nicholas J. Nissing
BS, Washington University
Product development and process design

Research Associate
Raymond Ehrhard
BS, University of Missouri-Rolla
Water and wastewater treatment technologies, process energy management

Professor Emeritus
Rudolf B. Husar
PhD, University of Minnesota
Environmental informatics, aerosol science and engineering

Lecturer
Janie Brennan
PhD, Purdue University
Biomaterials, synthetic biology, engineering education

Professor of Practice
James Harlan
PhD, Harvard University, Kennedy School of Government
Technology development economics and venture finance

Degree Requirements

Academic Requirements
Candidates for this degree must complete a total of 72 credits beyond the bachelor’s degree. Of these, a minimum of 36 must be graduate course work and a minimum of 30 must be doctoral thesis research units. To be admitted to candidacy, students must have completed at least 18 credits at Washington University, have an overall GPA equal to or greater than 3.25 and pass the qualifying examination. The student must also have completed the research rotations and have selected a permanent adviser.

Transfer Credits: At most, 9 graduate credits in a master’s program from another university may be counted as transfer credits toward the required 36 units of course work.

Maximum Research Units per Semester: At most, 9 units of research units may be taken in a semester.
Seminar Credits: The 1-unit EECE seminar course may be taken for graduate course work credit in up to six semesters for a total of 6 units.

Independent Study Credits: At most, 3 units of course work may be taken as graduate independent study. An independent study must be entirely separate from work done as part of the graduate thesis research. The student should prepare a proposed plan of study to be completed, and this plan must be described on the Independent Study Petition Form approved by the independent study instructor, student's adviser, Graduate Program Coordinator, and Department Chair for the independent study credits to count toward the 36 required units of course work. This credit will not be counted toward the cumulative GPA for a qualification exam requirement.

400-level Courses: Courses must be 500-level graduate courses, except for up to three 400-level courses, provided that they are approved by the Graduate Program Coordinator and Department Chair.

Thesis Proposal

(must be completed within 18 months after qualifying exam)

Following successful completion of the qualifying examination, the students will select a research area and a permanent mentor/adviser. The student and adviser will decide on a suitable problem whereupon the student will prepare a comprehensive written research proposal that includes a thorough survey of the field, a discussion of those areas needing further research, and a tentative but clear definition of the proposed research. Results of preliminary studies or feasibility studies should be included. The format and guidelines of the PhD thesis proposal are included in the last portion of this section. This proposal will be submitted to the Thesis Committee at least one week prior to a Thesis Proposal Examination consisting of an oral presentation and questions before the committee. For students entered since Fall 2012, four of the five must be tenured or tenure-track Washington University faculty; one of these four may be a member of the emeritus faculty. The fifth member must have a doctoral degree and an active research program, whether at Washington University, at another university, in government, or in industry. Three of the five must come from the student's degree program; at least one of the five must not.

The committee is appointed by the Dean of the Graduate School upon the request of the Department Chair or Graduate Program Coordinator. Any exceptions to the normal composition of the committee should be discussed with the Graduate Program Coordinator and be approved by the Dean of the Graduate School. The thesis proposal should be successfully presented within 18 months of passing the Qualifying Examination and at least 12 months prior to graduation.

Completion of annual meetings or reports with thesis committee: The annual report can consist of one to two pages of the student's research progress summary.

A student who has passed the Thesis Proposal Examination, completed 30 units of required course work toward the PhD degree and published or submitted at least one peer-reviewed manuscript from the thesis research is eligible to receive an MS degree. The publication and submission of the manuscript must be with the approval of the research adviser. Students must submit their request to receive the MS degree at least one year before the thesis defense.

The following guidelines are recommended for the PhD Thesis Proposal:

1) The main body of the proposal should include:
   • Executive summary (no more than one page)
   • Introduction (no more than five pages)
   • Research objectives (no more than two pages)
   • Preliminary work (no more than five pages in the body of the proposal; additional preliminary data or papers can be included in the Appendices)
   • Research plan (no more than 15 pages)
   • Timeline (no more than one page)
   • References (as needed)

2) The following Appendices should be included at the end of the proposal:
   • List of courses taken and to be taken with grades
   • TA experience
   • A short CV of the student highlighting conference presentations and journal papers (published/submitted/to be submitted)
   • Copies of papers (optional)

3) Font: Times New Roman
   • Font size: no less than 11 points
   • Line spacing: single-spaced
   • Page margin: one-inch margin around the pages

PhD students are referred to the National Science Foundation (NSF) Guidelines for Proposal Writing Document as a reference.

Teaching Assistant Requirement

All students must serve as a teaching assistant or assist in some teaching activity in the department for at least two semesters prior to graduation; in some cases, a student may be required to serve as a teaching assistant in more than two semesters. The department has in place a fair process to assign students as teaching assistants. This will normally be done after the first year and after having passed the Qualifying Examination. In serving as a teaching assistant, students should meet the Graduate School-wide Teaching Requirement for PhD Candidates;
details of fulfilling teaching requirements are described in the
Teaching Requirement Form with Policy Statement on http://
graduateschool.wustl.edu.

The TA duties may include, but are not limited to: giving an
actual lecture in an undergraduate class with the instructor in
attendance, introducing/interpreting laboratory exercises, or
conducting formal help sessions before exams. TAs will also
be expected to hold one-on-one office hours and participate in
grading homework assignments and exams. Both the students
and the instructor will evaluate each TA’s performance, and
the Graduate Studies Committee will use these evaluations to
determine whether the teaching requirement has been fulfilled
for that semester. All the PhD candidates are also required to
attend one of the TA-training workshops offered by the Teaching
Center for the formal pedagogical training prior to or during their
first semester as TAs in EECE.

PhD candidates shall also accumulate teaching experience at
the advanced level. Presenting one’s research in formal settings
to other graduate students and faculty is the best way to fulfill
the requirement at this level. Therefore, all PhD candidates
who entered the program since Fall 2011 shall give at least
two formal presentations, whether at the local level (in the
department, the university, or the St. Louis area) or at a national
or international conference organized by a professional society.
For students entered before Fall 2011, four formal presentations
are required. Among the presentations, at least one presentation
should be oral at a national or international conference (this
last requirement may be waived upon approval of the Graduate
Studies Committee).

During the semester, doctoral students will perform teaching
assistant duties in addition to the normal course work and
research duties that are expected by the research adviser.

**Thesis Defense**

Upon completion of the thesis, candidates must present the
thesis in a public forum and successfully defend the thesis
before their Thesis Committee. Students must submit their
completed thesis to the committee at least two weeks prior to
the defense. Without the approval of the committee members
two weeks in advance, the defense process cannot proceed
and the room will not be reserved. The student should also
have submitted at least one paper to a peer-reviewed journal
prior to defending his or her thesis. Normally students are
expected to have at least one paper accepted in a peer-reviewed
journal, and at least another paper submitted prior to graduation.
Presentation at national conferences is also encouraged. At
least four committee members must be present at the defense
(including the chair). Members of the Dissertation Defense
Committee normally attend in person, but one of the five (or, in
case of an emergency, one of the four) members may attend
virtually instead. Otherwise, the student must reschedule the
proposal/thesis defense. This is based on students who entered
the program in/after Fall 2012. Students who entered before

Fall 2012 need one more committee member compared to the
requirement of a student who entered Fall 2012.