Mechanical Engineering & Materials Science

The Department of Mechanical Engineering & Materials Science offers a PhD in either Mechanical Engineering or Aerospace Engineering. The department's research strengths include biomechanics, materials, energy, fluid mechanics, and rotary-wing aerodynamics. Of the 72 semester hours needed to earn a PhD, the department requires its students to earn 36-48 through course work and 24-36 through research. A qualifying exam is given in the third semester. By the fourth semester, the student should present a dissertation proposal that outlines the scope and method of procedure for the PhD research. The dissertation is defended at the end of the research effort. A typical time to PhD after an undergraduate engineering degree is four to five years, but the length of program may vary, depending on the individual and the area of study.

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Chair
Philip V. Bayly
Lilyan and E. Lisle Hughes Professor of Mechanical Engineering
PhD, Duke University
Nonlinear dynamics, vibrations, biomechanics

Associate Chairs
Katharine M. Flores (Materials Science)
PhD, Stanford University
Mechanical behavior of structural materials

Kenneth L. Jerina (Mechanical Engineering)
Earl E. and Myrtle E. Walker Professor of Engineering
DSc, Washington University
Materials, design, solid mechanics, fatigue and fracture

Endowed Professors
Ramesh K. Agarwal
William Palm Professor of Engineering
PhD, Stanford University
Computational fluid dynamics and computational physics

Thomas G. Harmon
Clifford W. Murphy Professor
PhD, Massachusetts Institute of Technology
Reinforced and prestressed concrete, structural design, fiber reinforced polymers

Mark J. Jakiela
Lee Hunter Professor of Mechanical Design
PhD, University of Michigan
Mechanical design, design for manufacturing, optimization, evolutionary computation

David A. Peters
McDonnell Douglas Professor of Engineering
PhD, Stanford University
Aeroelasticity, vibrations, helicopter dynamics

Shankar M.L. Sastry
Catherine M. and Christopher I. Byrnes Professor of Engineering
PhD, University of Toronto
Materials science, physical metallurgy

Professor
Guy M. Genin
PhD, Harvard University
Solid mechanics, fracture mechanics

Associate Professors
Srikanth Singamaneni
PhD, Georgia Institute of Technology
Microstructures of cross-linked polymers

Jessica E. Wagenseil
DSc, Washington University
Biomechanics

Assistant Professors
Parag Banerjee
PhD, University of Maryland
Materials sciences and engineering, nanostructured materials, materials synthesis, and novel devices for storing and harvesting energy

Spencer P. Lake
PhD, University of Pennsylvania
Soft tissue biomechanics

J. Mark Meacham
PhD, Georgia Institute of Technology
Micro/Nanotechnologies for thermal systems and the life sciences

Rohan Mishra
PhD, Ohio State University
Computational materials science

Amit Pathak
PhD, University of California, Santa Barbara
Biomechanics
Professors of the Practice

Harold J. Brandon
DSc, Washington University
Energetics, thermal systems

Swami Karunamoorthy
DSc, Washington University
Helicopter dynamics, engineering education

Joint Faculty

Richard L. Axelbaum (EECE)
PhD, University of California, Davis
Combustion, nanomaterials

Elliot L. Elson
Alumni Endowed Professor in Biochemistry and Molecular Biophysics
PhD, Harvard University
Biochemistry and molecular biophysics

Kenneth F. Kelton (Physics)
Arthur Holly Compton Professor of Arts & Sciences
PhD, Harvard University
Study and production of titanium-based quasicrystals and related phases

Eric C. Leuthardt (Neurological Surgery and BME)
MD, University of Pennsylvania School of Medicine
Neurological surgery

Matthew J. Silva (Orthopedic Surgery)
PhD, Massachusetts Institute of Technology
Biomechanics of age-related fractures and osteoporosis

Larry A. Taber (BME)
Dennis and Barbara Kessler Professor of Biomedical Engineering
PhD, Stanford University
Biomechanics, mechanics of development

Simon Tang (Orthopedic Surgery, BME)
PhD, Rensselaer Polytechnic Institute
Biological mechanisms

Stavros Thomopoulos (Orthopedic Surgery)
PhD, University of Michigan
Development, healing and tissue engineering of the tendon-to-bone insertion

Senior Research Associate

Ruth J. Okamoto
DSc, Washington University
Biomechanics, solid mechanics

Senior Professors

Phillip L. Gould
PhD, Northwestern University
Structural analysis and design, shell analysis and design, biomechanical engineering

Salvatore P. Sutera
PhD, California Institute of Technology
Viscous flow, bioengineering

Barna A. Szabo
PhD, State University of New York-Buffalo
Numerical simulation of mechanical systems, finite-element methods

Senior Lecturer

Jerry W. Craig
MS, Pittsburg State University
Computer aided design

Lecturers

Emily J. Boyd
PhD, University of Texas at Austin
Thermo fluids

H. Shaun Sellers
PhD, Johns Hopkins University
Mechanics and materials

Adjunct Instructors

Ricardo L. Actis
DSc, Washington University
Finite element analysis, numerical simulation, aircraft structures

Carl A. Baggett
BS, University of Missouri-Columbia
Design

Thomas L. Bever
BS, Washington University
Design, mechanical systems

John D. Biggs
MEng, Washington University
Thermal science

Andrew W. Cary
PhD, University of Michigan
Computational fluid dynamics

Richard S. Dyer
PhD, Washington University
Propulsion, thermodynamics, fluids

John M. Griffith
BS, Washington University
Manufacturing
Degree Requirements

Policies & Regulations

A key objective of the doctoral program is to promote cutting-edge multidisciplinary research and education in the areas of Mechanical Engineering & Materials Science. The doctoral student works in conjunction with his or her adviser in designing their program of study and research project. Students are selected for admission to the program by a competitive process, and they typically start in the fall semester. On arriving at Washington University in St. Louis (WUSTL), the student will be advised by the temporary adviser on all procedural issues. The student will choose a permanent adviser by the end of the first year of residency in the program.

The following is a brief summary of the requirements for doctoral students:

1) Pass the qualifying exams. Qualifying exams should be taken by the end of the third semester.
2) Prepare and defend a research proposal. The research proposal should be defended by the end of the fifth semester.
3) Write and successfully defend the doctoral dissertation.
4) Complete a minimum of 36 credits of course work, and a minimum of 24 credits of doctoral research; total of 72 credits to earn the PhD degree.
5) Satisfy the applicable teaching requirements of the Graduate School.

Qualifying Examination

The qualifying examination should be taken no later than the third semester of the doctoral program.

Thesis Proposal

The thesis proposal should be defended within one year of the qualifying examination. The student will submit a comprehensive written research proposal to his or her doctoral committee. The requirements for the doctoral committee are listed (under Dissertation) and on the Graduate School website (http://graduateschool.wustl.edu). The presentation will include a thorough survey of the field, a discussion of those areas in need of further research and a tentative but clear definition of the problem on which the student intends to focus the dissertation.

Degrees Offered

The Department of Mechanical Engineering & Materials Science offers the following doctoral degrees:

- PhD in Mechanical Engineering
- PhD in Aerospace Engineering
- DSc in Mechanical Engineering, Aerospace Engineering, or Materials Science

The Doctor of Science (DSc) has similar requirements to the PhD but without the teaching requirement. For a list of differences, visit http://mems.wustl.edu/graduateprograms/Documents/DoctoralComparisonSection.pdf.

- One may also pursue a PhD in Materials Science — through the Institute of Materials Science & Engineering (IMSE) — but work with professors from the Department of
Mechanical Engineering & Materials Science. For details on this program, visit: http://ime.wustl.edu/program. For more information on MEMS PhD degrees, visit: http://mems.wustl.edu/graduateprograms.

Requirements for PhD Degree

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 24 must be doctoral thesis research units. To be admitted to candidacy, students must have an overall GPA greater than 2.75 and pass the Qualifying Examination.

The normal load for full-time graduate students in engineering is 9-12 units per semester including research credits. The course content and load must be discussed with and approved by the student's adviser. Students who are employed full time, either on or off campus, are limited to a maximum of 6 units per semester, except during their doctoral residency when they must register for 9 units.

Transfer Credits: At most, 24 graduate credits in a master's program from another university may be counted as transfer credits toward the required 36 units of course work. All transferred credit must be approved by the department chair as appropriate engineering or science courses, not used to complete the BS degree of the student, and be completed with a grade B or better.

Maximum Research Units per Semester: At most, 9 units of research units may be taken in a semester.

Seminar Credits: The zero-unit MEMS 501 seminar course must be taken every semester.

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, Director of Graduate Studies, and department chair for the independent study instructor, student's adviser, Director of Graduate Studies, and department chair for the independent study credits to count toward the 36 required units of course work.

400-level Courses: A maximum of 6 units of 400-level courses are allowed, and these must be from courses not required for the BS degree.

Residency: The residency requirements for the PhD are:

(1) that each student must earn at least 48 semester hours of the required 72 at Washington University and

(2) that each student must spend at least one academic year registered for full-time credits (9-12 units in the fall followed by 9-12 units in the spring) at Washington University. Any exceptions to these requirements must be approved by the Dean of the Graduate School. All PhD programs prefer that students remain full-time and in residence throughout their work toward the degree.

Teaching Requirement

All students must assist in some teaching activity in the department for at least two semesters prior to graduation. If specified as a condition for financial support, a student may be required to serve as a teaching assistant in more than two semesters. Students should accumulate 14 hours of teaching experience at the basic level. This can be accomplished in many ways including: giving an actual lecture in an undergraduate class; conducting discussion sections; introducing/interpreting laboratory exercises; or conducting formal help sessions. Students will also need to accumulate four hours of teaching experience at the advanced level. An example of this would be presenting a paper at a conference or teaching one's research at a regularly-scheduled colloquium or seminar that is attended by other graduate students and faculty.

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 on the Graduate School website (http://graduateschool.wustl.edu).

Dissertation

The candidate must submit a satisfactory dissertation that involves independent, creative work in an area of specialization and that demonstrates ability for critical and constructive thinking. It must constitute a definite contribution to knowledge in some field of engineering or applied science. The research used as a subject of the dissertation must have been performed under the supervision of a member of the faculty of the School of Engineering & Applied Science. A copy of the rules governing off-campus research may be obtained from the student's adviser.

The candidate must defend the dissertation during a final oral examination by an examining committee to be nominated by the adviser and approved by the Director of Graduate Studies. The committee will consist of five members all with doctoral degrees:

- 4 from WUSTL
- 3 from MEMS
- 1 from outside MEMS

Financial Assistance

Research Assistants

Research assistantships are funded directly from grants and contracts. They are normally awarded to students who have made a commitment to a particular research area and who, by virtue of their academic background and record, will contribute significantly to the research project. The department strives
to place all full-time students on research projects as early as possible. For this reason, students must choose a research area and a research adviser before the end of their first year of residence.

Research assistants are paid a regular monthly stipend. During the academic year, a research assistant is considered to be employed half-time on a research project and, as such, is normally not permitted to register for more than 9 hours of graduate credit per semester after the first year. A minimum of 20 hours of work per week is required on the research project. However, research assistants are typically expected to devote more than this minimum effort to research; the student's diligence and productivity are important factors in renewal of research assistantships. The research adviser may terminate a research assistantship for unsatisfactory performance.

Research assistantships are continued during the summer and are renewable for the next year at the discretion of the research adviser. Summer appointments are paid at the same rate as during the academic year, but full-time effort (a minimum of 40 hours per week) is expected.

Tax Liability
The taxability of the various types of awards described above is determined by current policy of the U.S. Internal Revenue Service (IRS). It is prudent to assume that all stipends are fully taxable and that tax will be withheld. Questions concerning an individual's tax liability must be referred to the IRS.

Outside Employment
Holders of fellowships, traineeships and assistantships are required to devote full-time effort to graduate studies. They are not permitted to engage in any outside employment without permission of the adviser and department chair.

Time Off
Graduate students receiving financial support are expected to commit themselves fully to their studies and research. Intersession periods listed in the University academic calendar denote time when classes are not in session, and graduate students are expected to devote themselves full-time to their research during these periods.

Students on full support are permitted to take off a maximum of two weeks during the calendar year for holidays, interview trips, etc. Additional time off can be arranged in discussion with the research adviser, but it may result in a reduction of the student's stipend. During the first year in the program when students do not have a permanent adviser, they should consult their first-year adviser to schedule any time off. Absence of research assistants must be scheduled so as not to impede the progress of an ongoing research project and should be approved by the research adviser.

Full-time summer appointments do not include paid vacation. An appointment may be prepared for periods of less than three months to allow for planned vacations.

Other Policies

Seminars
Each year the department sponsors or participates in a series of seminars by visiting lecturers and WUSTL faculty and students. All full-time graduate students are required to enroll in MEMS 501-Graduate Seminar, which is a pass/fail course carrying 0 units. A passing grade is required for each semester for all full-time students and is earned by regular attendance at these events.