Graduate Handbook
For
Mechanical Engineering

University of Pittsburgh

Revised October 2007

THE MECHANICAL ENGINEERING GRADUATE PROGRAM

The Department of Mechanical and Materials Science offers graduate studies in advanced mechanical sciences and technologies. The graduate faculty is committed to high-quality research and teaching. The curriculum is an integrated program of study in applied sciences, applied mathematics, and modern computational procedures that are relevant to the research emphasis in the department. The research is focused on three major areas: (1) **Manufacturing**: process design and modeling, tribology, composite materials, micro- and nano-scale fabrication and mechanics; (2) **Energy Technology**: fluid mechanics, heat transfer, combustion, fuel cells, gas turbines, advanced thermodynamics cycles and hybrid systems; (3) **Smart Materials and Devices**: piezoelectric sensors and actuators, micro-electro-mechanical systems (MEMS), shape memory alloys, radio-frequency energy harvesting, acoustics, and vibration control.

DEGREE PROGRAMS

An application for either the MS or PhD program is judged on the student's prior academic record, GRE scores (required for PhD applicants), the accreditation of the prior degree granting school, and the capability of the department to match the applicant's interest with the program. A foreign national student who did not receive his or her Bachelor of Science or Master of Science degree from an accredited U.S. institution is required to take the TOEFL exam and receive a score of at least 550 (213 for the computer-based exam / 79-80 internet-based exam) or the International English Language Testing System (IELTS) and receive a minimum result of Band 6.5 as well as the GRE. GRE testing may also be required for applicants of the MS program if requested by the Graduate Committee. Students with a Bachelor of Science degree in another engineering field, mathematics, or physics will also be considered for the graduate program with the possibility that prerequisite courses may be required. A part-time program is available for students who are employed in local industries. Part-time students usually carry from three to six credits per term in either day or evening classes.

Applicants who do not meet these requirements will be considered on an individual basis with strong emphasis given to academic promise, career orientation, work experience, and preparation in engineering and related disciplines. In some cases, applicants may be admitted provisionally until certain deficiencies in either coursework or academic achievement are satisfied.

Master of Science Program. Upon entering, the student plans a program of study with the aid of the faculty advisor. The course requirements can be met by either the

(1) Thesis Option (Research M.S.):
21 course credits
3 ME 2997
6 ME2999
30 Credits

Or the

(2) Non-Thesis Option (Professional M.S.): 30 course credits.

Thesis Option (Research M.S.)

Each candidate must provide a suitable number of copies of the thesis for review and use as designated by the thesis examining committee, consisting of at least three members of the faculty recommended by the major advisor and approved by the department chair. The final oral examination in defense of the master's thesis is conducted by the thesis committee, and a report of this examination signed by all members of the committee must be filed in the office of the dean. After the examination, the approved ETD must be deposited to the ETD Online System where it will be reviewed by the ETD Student Services Staff in the dean's office of the student's school and submitted for microfilming and deposit in the University Library System. A receipt for the ETD processing/microfilming fees and any necessary paperwork must be submitted to the appropriate ETD Staff in the Office of Administration.

Non-Thesis Option (Professional M.S.)

Professional master's degrees are conferred upon those students who demonstrate comprehensive mastery of their general field of study. The professional master's degrees normally require the satisfactory completion of more than 30 credits of graduate study approved by the department. No professional master's degree program may require fewer than 30 credits.

No more than one-third of the total number of required credits may be granted to a student as transfer credit for work done at another accredited graduate institution. (See Acceptance of Transfer Credits section for further detail.) At least one-half of the credits earned in a master's degree program must be at the graduate level (the 2000 or 3000 series). No courses numbered below 1000 may be applied toward graduate degree requirements.

Keep in mind, that 1000 level courses must be advanced as determined by the graduate committee. If it is determined that the course is not advanced enough. You will be informed that the class will not count.

Master's degrees are conferred only on those students who have completed all course requirements with at least a 3.00 GPA.

Professional master's degrees are conferred upon those students who demonstrate comprehensive mastery of their general field of study. Students are expected to acquire professional skills through course work, projects, internships, practica, and/or research papers as part of demonstrating their comprehensive mastery of their field of study. Thirty credits are required to graduate.

(Visit http://www.umc.pitt.edu/bulletins/graduate/index.html) for further detail.

In either case, students seeking the Master of Science degree in Mechanical Engineering must take at least one of the mathematics courses, **ME 2001 or ME 2002**, and must take Mechanical Engineering courses from at least two different subject course lists. Up to nine credits from other engineering, mathematics, or physics departments may be used in fulfilling the remaining course requirements.

Subject Course Lists

ME2005 Structure of Materials
ME2010 Nanomechanics, Materials & Device
ME2060 Numerical Methods
ME2062 Orthopaedic Engineering
ME2069 Materials Science of Nanostructures

Dynamic Systems
ME 2020 Mechanical Vibrations
ME 2027 Advanced Dynamics
ME 2045 Linear Control systems
ME 2046 Digital Control Systems
ME 2080 Introduction to MicroElectroMechanical Systems (MEMS)
ME 2082 Principles of Electromechanical Sensors & Actuators

Fluid Mechanics
ME 2003 Introduction to Continuum Mechanics
ME 2055 Computational Fluid Dynamics and Heat Transfer
ME 2070 Microfluidics
ME 2074 Advanced Fluid Mechanics

Solid Mechanics
ME 2003 Introduction to Continuum Mechanics
ME 2004 Elasticity
ME 2022 Applied Solid Mechanics
ME 2033 Fracture Mechanics
ME 2047 Finite Element Analysis

Thermal systems
ME 2050 Thermodynamics
ME 2053 Heat and Mass Transfer
ME2056 Introduction to Combustion Theory
ME 2074 Advanced Fluid Mechanics

MEMS
ME2080 Intro to MicroElectroMechanical Systems (MEMS)
ME2082 Principles of ElectroMechanical Sensors & Actuators)

Nuclear
ME 2101 Nuclear Dynamics and Control 1
ME 2102 Nuclear Dynamics and Control 2
ME 2103 Integration of Nuclear Systems & Components
ME 2104 Nuclear Operations Safety
ME 2105 Integrated Nuclear Power Plant Operations
ME 2110 Nuclear Materials
ME 2115 Heat Transfer & Fluid Flow In Nuclear Plants

Doctor of Philosophy Program. An applicant is officially classified as a PhD student if he or she has been accepted into the PhD program and:

(1) has received an accredited MS or equivalent degree; or
(2) has completed eight courses at the MS level in good academic standing and has been granted permission to bypass the additional course work required for the MS degree.

Doctoral level courses are numbered in the 3000 series, but courses numbered in the 2000 series may also be appropriate for doctoral study. Normally, courses numbered below 2000 do not meet the minimum requirements for doctoral study, although they may be taken to supplement a doctoral program.

Students must maintain a minimum cumulative QPA of 3.00 in courses to be eligible to take the preliminary and comprehensive examinations as well as to graduate.

Plan of Study. During the first term in the doctoral program the student must submit a plan of study for approval by the department. Minimum course requirements (beyond the MS or equivalent degree) include:

30	credits for M.S. degree (or equivalent)
18	course credits at an advanced graduate level (Approval is required by the student's advisor and the graduate committee. Courses may NOT include: ME 2001, ME 2002, ME 2003, ME 2004, ME 2020, ME 2022, ME 2027, ME 2047, ME 2053, ME 2060, ME 2074, and any course that is a dual graduate/undergraduate course. Non-duplicating courses from other departments may be allowed subject to approval.)
6	ME3997 – PhD Research
12	ME3999 – PhD Dissertation (after admission to PhD Candidacy)
6	additional credits approved by advisor and graduate committee
72	**total credits**

Seminar. PhD students are required to give one seminar each year, usually as part of the departmental seminar series. The seminar topic should be chosen in consultation with the student's advisor.

Preliminary Examination for PhD (Qualifying Exam). The PhD preliminary examination is a diagnostic examination based on Master of Science-level courses (or equivalent) to assess student's potential to complete the PhD program. ***It is not based on material covered in the PhD-level courses.*** The exam consists of both a closed book written test and an oral test. The student may elect to take the exam in three of the five following areas: Fluid Mechanics, Heat Transfer, Solid Mechanics, Dynamics and Vibrations, Mathematics and Numerical Methods. The student is only required to pass the exam in two areas. The student must pass both the written and oral exams.

PLEASE NOTE: If a student fails the exam on the first attempt, he or she must retake the exam the next time it is offered (retaking only the failed areas). The re-take is counted as the second attempt, if the re-take results in failing again, he/she will be dismissed from the program. A student is NOT allowed to take the exam more than two times. Each PhD student is required to take the exam before the end of his or her first year of study. A student who receives his/her MS degree in Mechanical Engineering at the University of Pittsburgh will be required to take the exam the first time it is offered after initial enrollment as a PhD student.

Comprehensive Examination for PhD. The comprehensive examination is administered by the student's advisor. This exam is given after the student has passed the preliminary examination and completed all course requirements for the doctorate with a cumulative QPA of at least 3.0. A copy of the comprehensive exam document, signed by the major advisor, must be submitted to the ME Graduate Office. **In no case may the comprehensive examination be taken in the same term in which the student is to graduate**.

Doctoral Committee. The student's major advisor proposes a dissertation committee. The doctoral committee must consist of a minimum of four current members of the graduate faculty. At least three of these graduate faculty members must be from the Mechanical Engineering Department, and at least one graduate faculty member must be from another department. Other appropriate graduate and non-graduate faculty members may also serve on the committee.

Application for PhD Candidacy. After passing the PhD comprehensive examination, the student must apply for admission to candidacy before starting on a dissertation. To do this the student must submit the blue "Application for PhD Candidacy" form to the ME Graduate Office to have the PhD committee approved at least a month before the dissertation proposal meeting. If the committee is approved by the School of Engineering, the form is returned to the department. The committee members sign the form during the dissertation proposal meeting if they approve the proposed research. The form is then submitted again to the ME Graduate Office.

PhD Dissertation Proposal. In this examination, the student presents and defends a proposal for dissertation research to the doctoral committee. The members of the doctoral committee will review the proposal and either accept, revise, or reject it. If the dissertation proposal is accepted by the doctoral committee, the student is formally admitted to Candidacy for the Doctor of Philosophy Degree. Students are allowed to take ME 3999 credits ONLY after being admitted to PhD Candidacy. **Admission to candidacy must occur at least one term before the student plans to graduate.**

PhD Dissertation. Each student must prepare a dissertation embodying an extended original, independent investigation of a problem of significance in the student's field of specialization. The dissertation must add to the general store of knowledge or understanding in that field. After the dissertation has been prepared and approved by the major advisor, the final oral examination shall be held.

Final Oral Examination (Defense). This is the final examination of the PhD program, conducted by the doctoral committee, in which the student defends the validity of and the contributions made by his or her dissertation research as well as his or her ability to comprehend, organize, and contribute to the chosen field of research. The examination need not be confined to materials in and related to the dissertation. One copy of the dissertation must be submitted to each member of the doctoral committee at least two weeks before the date set for the final oral examination. Other qualified individuals may be invited by the committee to participate in the examination. This examination begins with a seminar presented by the student that is open to all members of the University. Therefore the date, place, and time of the examination should be published at least a week in advance by submitting the dissertation title and abstract to the ME Graduate Office. Only members of the doctoral committee may vote on whether the candidate has passed the examination. The student must be registered in the term in which the degree is granted.

Dissertation/Thesis Copies. After the final oral examination is successfully completed, the candidate must deposit with the department graduate office one bound copy of the approved completed dissertation or thesis in final form. An additional copy may be required along with the committee signature sheet, three copies of the title page, one original, and three copies of the abstract, and the receipt for the binding fee must be deposited in the Engineering Office of Administration. Thesis and dissertations are now accepted in electronic form. You should speak with someone in the Office of Administration and refer to the following website for additional information (http://www.pitt.edu/~graduate/etd).

GRADUATE MECHANICAL ENGINEERING COURSES

ME 2001 DIFFERENTIAL EQUATIONS 3 cr.
Ordinary differential equations; series solutions of differential equations; introduction to partial differential equations. Prerequisite: MATH 0250.

ME 2002 LINEAR AND COMPLEX ANALYSIS 3 cr.
Linear analysis including linear algebra, vector spaces and linear transformations, and vector analysis. Complex analysis including analytic functions of a complex variable, infinite series in the complex plane, and conformal mapping. Calculus of variations.
Prerequisite: MATH 0250.

ME 2003 INTRODUCTION TO CONTINUUM MECHANICS 3 cr.
The fundamental concepts of continuum mechanics necessary for studying the mechanical behavior of solids and fluids. Includes a review of vectors and tensors; stress; strain and deformation; general principles in the form of balance laws; constitutive equations and their restrictions; and specialization to the theories of linearized elasticity and fluid mechanics.
Corequisite: ME2001

ME 2004 ELASTICITY 3 cr.
Fundamental concepts of stress and strain. Linear theory: boundary value problems of elasticity including plane stress, plane strain, and torsion. Elementary variational theory of elasticity. Prerequisite: ME 2001, ME2003.

ME 2005 STRUCTURE OF MATERIALS 3 cr.
Basic crystallography of materials; symmetry; point groups and space groups; tensor properties of crystals; diffraction methods in materials science; atomic packing and structures; glassy state, polycrystalline aggregates; grain boundaries and interfaces in materials; textures; multiphase materials; quantitative stereology and microstructural characterization; thin films.

ME2010 NANOMECHANICS, MATERIALS & DEVICE 3 cr.
This course is an introduction for current nanotechnology and fundamentals for nanoengineering. It mainly contains three areas: nanomechanics, nanomaterials and nanoscaled devices. In nanomechanics, it covers nanoindentation mechanics, thin film mechanics and one dimensional nanowire mechanics, nano-crack mechanics, deformation in nanomaterials. Nanomechanical model will be emphasized. In nanomaterials, it covers carbon nanotube, one dimensional semi-conducting nanowires and nano-multilayers as well as nanostructured composites. Novel property/phenomena in the nanomaterials will be reviewed. Nano-scaled mechanical/electromechanical/optical testing on the nanomaterials will be presented. Potential application of the nanomaterials for the nanodevice such as gas/optical sensor, actuator, as well as nano-force sensor will be discussed.

ME 2020 MECHANICAL VIBRATIONS 3 cr.
Analysis of linear multi-degree of freedom systems. Lagrangian formulation, model analysis, lumped parameter analysis of discrete systems, and continuous system vibrations. Introduction to non-linear systems. Prerequisites: MATH 0250, ME1014.

ME 2022 APPLIED SOLID MECHANICS 3 cr.
Covers fundamental, classical, and advanced topics in mechanics of materials. These include but are not limited to theories and relationships of stress and strain, energy methods, elementary plasticity, thermal stresses, elasticity problems in axial, torsion, bending, and 2D problems. Prerequisites: ENGR0145 or ME 1028.

ME 2027 ADVANCED DYNAMICS 3 cr.
Kinematics and dynamics of rigid bodies, Euler's equations and Euler angles, the elementary calculus of variations, the development of Lagrange's equations and the principle of virtual work as used in Kane's equations, stability of mechanical systems as applied to a single rotating body. Prerequisite: ME1015.

ME 2033 FRACTURE MECHANICS FOR PRODUCT DESIGN & MFG. 3 cr.
Failure of manufactured products in service, implications for design. Energy release rates, toughness, evaluation of experimental tests. Fracture mechanisms in different material systems. Fracture toughness testing. Materials selection. Damage tolerance. Design studies.

ME 2040 EXPERIMENTATION 3 cr.
Study of process of planning and conducting engineering experiments. Topics include the development of hypotheses of physical phenomena, the use of uncertainty analysis, experimental design, methods of evaluating experimental results, and the construction of empirical models.
Prerequisite: ME1042

ME2041 EXPERIMENTAL MECHANICS 3 cr.
Stress determination from strain measurements, strain measuring device and system; variable resistance strain gages with emphasis on circuits, calibration, compensation, static, and dynamic application; stress analysis in Bio and MEMS system. Force measurement in the Micro- and Nano-Newton level in Bio and Micro-system by optical and piezoelectric techniques.

ME2042 MEASUREMENT & ANALYSIS OF VIBRO-ACOUSTIC SYSTEMS 3 cr.
This course will present measurement and analysis techniques for dynamic systems, with particular emphasis on mechanical vibrations and acoustics. Background on vibration of lumped and continuous parameter systems, acoustics, noise and vibration control will be given. Other concepts include FFTs, windowing, calculation of input/output relationships, test methods, transducers, instrumentation, and the use of dynamic signal analyzers. Application to system identification and modal analysis will be included, as well as hardware demonstrations.
Prerequisite: ME1020 or ME2020

ME2044 FUNDAMENTALS OF TRIBOLOGY 3 cr.
Fundamentals of friction theory and models; advanced topics in lubrication, mechanism in wear, micro-scale analysis of surface interaction.

ME 2045 LINEAR CONTROL SYSTEMS 3 cr.
Control systems analysis and design techniques are presented for wide range of dynamic systems through the use of modern control tools. Builds upon the foundation of classical feedback control theory. Tools will be developed for analyzing and designing controllers for multi-input, multi-output dynamic systems, including state space, controllability and observability, stability, and state estimation. Design problems with hands-on experience.

ME 2046 DIGITAL CONTROL SYSTEMS 3 cr.
This course provides the tools necessary to analyze and design discrete time (digital computer) control systems for real-time control of dynamic systems, using both transform and state space approaches. Topics include the z-transform, relationships between the
z-domain and Laplace domain, characteristics of sampled-data systems including sample rate and quantization effects. Emphasis is on design of digital controllers for dynamic systems.
Prerequisite: ME2045

ME 2047 FINITE ELEMENT ANALYSIS 3 cr.
Finite element method is introduced and applied to problems in two-dimensional elasticity, plates, heat transfer, and transient structural mechanics.

ME 2050 THERMODYNAMICS 3 cr.
This course introduces the basic concepts and principles of thermodynamics. Topics include the construction of tables of thermodynamic properties, the design and optimization of energy conversion devices, the elements of chemical thermodynamics, and the elements of non-equilibrium thermodynamics.
Prerequisites: ME0050, ME1051

ME 2053 HEAT AND MASS TRANSFER 3 cr.
Steady-state and transient conduction in solids; conservation laws of mass, momentum, and energy; forced and free convection heat transfer, condensation and boiling; and thermal radiation.
Prerequisite: ME 1052

ME 2055 COMPUTER-AIDED ANALYSIS IN TRANSPORT PHENOMENA 3 cr.
This course provides an introduction to implementation of some of the numerical/computational methods for solving problems in transport phenomena. Fields described by linear and non-linear ordinary differential equations (initial & boundary value problems), and partial differential equations (elliptic, parabolic and hyperbolic) will be considered by means of various examples from fluid dynamics, heat & mass transfer, and combustion. Numerical discretization techniques based on Finite Difference Methods (FDM) will be the subject of main discussions.
Prerequisites: ENGR0012, ME0051

ME 2056 INTRODUCTION TO COMBUSTION THEORY 3 cr.
This course presents an introduction to combustion theory, covering the general solution techniques associated with combustion phenomena. It covers preparatory materials such as chemical thermodynamics, heat and mass transfer, and conservation equations for multi-component reacting systems. The primary emphasis of the course is to prepare a foundation for the student who has not previously studied combustion phenomena.

ME 2060 NUMERICAL METHODS 3 cr.
Introduction to numerical techniques for the solution of linear and non-linear equations, numerical integration and differentiation, interpolation, ordinary and partial differential equations, and eigenvalue problems.

ME 2062 ORTHOPAEDIC ENGINEERING 3 cr.
This is an advanced course that applies mechanics of materials, material failure theories and rigid body dynamics to orthopaedic device design, tissue mechanical modeling and surgical procedure evaluation. The course is meant to provide an introductory background to engineering aspects of orthopaedic medicine and biomechanics for students preparing for medical school, positions in the medical device industry or graduate studies in this field.

ME 2064 INTRO TO CELL MECHANOBIOLOGY 3 cr.
The objective of this course is to provide an overview and a basic understanding of cell mechanobiology. The materials that will be covered in this introductory course include; 1) Stress, strain, and deformation: uniaxial and biaxial loading, hydrostatic pressure; 2) Fluid shear stress; 3) Cell structure and function; 4) Basic cell & molecular techniques; 5) Effects of mechanical forces on cells; 6) Mechanotransduction; and 7) Applications of cell mechanobiology to tissue engineering.

ME 2067 MUSCULOSKELETAL BIOMECHANICS 3 cr.

Course work will include the structure, function, and mechanics of the musculoskeletal system. Specific topics will include the kinematics and control of human movement and the mechanics of the musculoskeletal connective tissues, such as ligament, tendon, bone, cartilage, and muscle. Special emphasis will be placed on the relationship between function and material properties of these tissues. A research paper will be required as a term project.

ME 2069 MATERIALS SCIENCE OF NANOSTRUCTURES 3 cr.

A graduate level course that reviews the theories and phenomena associated with solid structures that lie in the nano- (or meso-) scale regime from 1 to 1000 nm. Engineered structures of these dimensions have unique properties due to their size, including 1) surface and interface-dominated energy considerations governing shape and phase formation, 2) optical interactions due to confinement effects, 3) unique electronic/quantum effects due to confinement. The course will survey the issues associated with creation, analysis, and theoretical modeling of these structures-with a materials science (kinetics-thermodynamics) perspective. Some topics may vary from semester to semester.

ME2070 MICROFLUIDICS 3 cr.

The basic hypotheses in the micro-scale fluid mechanics may no longer be applicable in micro or even smaller scale. The objectives of this course are to; identify dominant forces and their effects in micro-scale fluid systems that are different from those in the macro-scale, to understand the fundamentals of microfluidic phenomena, to discuss various microfluidic applications in research and commercial levels, and to explore new possible microfluidic applications in the emerging fields.

ME 2074 ADVANCED FLUID MECHANICS 1 3 cr.

First graduate-level course in viscous fluid flow. Elementary solutions to Navier-Stokes equations, laminar and turbulent flows, boundary layers.
Prerequisites: ME 2001, 2003.

ME 2080 INTRO. TO MICROELECTROMECHANICAL SYSTEMS (MEMS) 3 cr.

Aimed to provide basic understanding of microfabrication processes, fundamentals of MicroElectroMechanical Systems (MEMS) technologies.

ME 2082 PRINCIPLES OF ELECTROMECHANICAL SENSORS & ACTUATORS 3 cr.

The objective of this course is to provide a thorough understanding of the various mechanisms that can be exploited in the design of electromechanical sensors and actuators. These transduction mechanisms include transduction based on changes: 1) in the energy stored in the electric field; 2) in the energy stored in the magnetic field; 3) piezoelectricity & pyroelectricity; 4) linear inductive transduction mechanisms; and 5) resistive transduction mechanisms. Will also discuss various transduction materials, sensors and actuators from a wide range of applications.
Prerequisites: ME1014, ME1020/2020, ME2001

ME 2085 GRADUATE SEMINAR 0 cr.

Designed to acquaint graduate students with various subjects in advanced mechanics and current graduate-level research mechanical engineering; aspects of graduate-level engineering and applied mechanics not normally encountered in classes.

ME 2094 PRACTICUM 1 cr.

This course is designed to provide students who are engaged in thesis or dissertation research an opportunity to participate in an internship with an external organization (industry or government laboratory). The internship must be related to the thesis or dissertation research. See more detailed description on the following page.
Prerequisites: Approval of advisor and Graduate Director.

ME 2095 GRADUATE PROJECTS 1 to15 cr.
A special problem or reading course of individual study guided by the student's major advisor. Topics selected from any phase of mechanical engineering not covered in the regular MS-level courses.

ME 2097 SPECIAL STUDY 3 cr.
Special topics of particular importance to an individual's plan of study.
Prerequisite: Approval of advisor.

ME2101 NUCLEAR DYNAMICS AND CONTROL 1 3 cr.
This course reviews the mathematics of nuclear reactor kinetics. Linear systems of ordinary differential equations are solved by state vector techniques, Laplace transform techniques, or finite difference techniques including the treatment of discretization errors resulting from various finite differencing approximations. A review of the physics of nuclear kinetics is followed by treatments of the kinetics equations including the effect of uncertainties, approximate solutions, and the interpretation of experiments to measure kinetics parameters. Representations and the physical basis of reactivity feedback mechanisms are treated. Lumped and distributed parameter models of fuel, coolant, fission products are derived and applied to develop quantitative static relationships and qualitative dynamic results for transient conditions. The course provides an introduction to space dependent reactor kinetics.

ME2102 NUCLEAR DYNAMICS AND CONTROL 2 3 cr.
This course provides an integrated engineering examination of a nuclear power plant from the perspective of instrumentation and control systems used to infer the condition of the nuclear plants and its systems, control its normal operation, and provide protection during transient situations as well as assess core damage during severe accident situations. Students will apply previous knowledge of analog, digital, and microprocessor electronics techniques to nuclear power plant design and operation and reactor protection and safety considerations that influence the design of the reactor plant. A major outcome of this course will be an integrated understanding of the interaction between the physics of nuclear plant control (reactivity and heat balance) and the control and protection systems. This integrated plant understanding will be essential for the successful completion of the Integrated Nuclear Power Plant Operations course.

ME2103 INTEGRATION OF NUCLEAR SYSTEMS & COMPONENTS 3 cr.
This course examines design bases for major systems and components in a nuclear plant and evaluates how the systems function in an integrated fashion. The student will examine a typical nuclear power plant and those components and systems of the nuclear plant complex that have the potential for affecting core power, and whose failure could be an initiating event for a plant transient. Dynamic relationships for the systems developed in the companion nuclear courses will be transformed into stable, numerical algorithms for computer solutions and system interactions will be illustrated using a major industry transient analysis code. Emphasis is on how operations of and faults in systems and components can influence reactivity and core behavior. Through classroom discussions the students will assess engineering problems and operational problems that have been experienced in historical nuclear plant operations. The intended outcome is an aptitude for predicting complex transient behavior of the integrated nuclear plant considering factors that are important for safe and efficient operation: reactivity management and control, coolant inventory control, and core heat removal.

ME2104 NUCLEAR OPERATIONS SAFETY 3 cr.

This course reviews the development of reactor safety concepts, the emergence of safety strategies and culture, and the perspectives of severe accidents and how they can be mitigated. Risk-influenced regulatory practices will be introduced and quantitative use of probabilistic risk assessment will be described in terms of its use as a guide to intelligent decision-making. The characteristics of accident progression in the reactor vessel and containment in the unlikely event of core melting and relocation of fuel material will be explained. Offsite impacts of such severe accidents will be introduced. Source terms, dispersion of radionuclides, and dose projections will be developed for both conservative and realistic evolutions. Protective actions and emergency preparedness will be introduced. This course will cover the regulatory aspects of nuclear operations and the roles that the NRC, INPO, WANO and the IAEA play and what impact each has on plant operations. An introduction into regulatory requirements, the Safety Analysis Report, nuclear safety and licensing, and whistle-blower rules will be provided.

ME2105 INTEGRATED NUCLEAR POWER PLANT OPERATIONS 3 cr.

This course provides a capstone hands-on-simulator and classroom experience to promote understanding how the integrated plant works and what challenges the operator faces, and to help an engineer "speak operations" with the interfacing groups. Use of the simulator is an effective way for students to understand accident control and Emergency Operating Procedures, and how the control room interfaces with the rest of the plant. Emphasis is placed on understanding plant characteristics and controls, rather than on developing control manipulation skills. Intended outcomes are an aptitude for predicting transient behavior of the integrated plant and a command of reactivity management and control that is important for efficient operation of a nuclear plant complex. The course presumes knowledge of the major systems in a nuclear power plant and will emphasize how operations of and faults in those systems and components can affect reactivity and core transient behavior.

ME2110 NUCLEAR MATERIALS 3 cr.

This course presumes that students have the knowledge base needed to understand materials issues associated with the design and operation of nuclear power plants, such as basic concepts of physical metallurgy, a mechanistic and microstructural-based view of material properties, and basic metallurgical principles. This course will cover the metallurgy and phase diagrams of alloy systems important in the design of commercial nuclear power plants. The micro-structural changes that result from reactor exposure (including radiation damage and defect cluster evolution) are discussed in detail. The aim is to create a linkage between changes in the material microstructure and changes in the macroscopic behavior of the material. Also discussed is the corrosion of cladding materials as well the effects of irradiation on corrosion performance, as well as the effects of primary and secondary coolant chemistry on corrosion. Both mathematical methods and experimental techniques are emphasized so that theoretical modeling is guided by experimental data. Materials issues in current commercial nuclear reactors and materials issues in future core and plant designs are covered.

ME2115 HEAT TRANSFER & FLUID FLOW in NUCLEAR PLANTS 3 cr.

This course provides advanced knowledge to promote understanding and application of thermal and hydraulic tools and procedures used in reactor plant design and analysis. It assumes that the student has a fundamental knowledge base in fluid mechanics, thermodynamics, heat transfer and reactor thermal analysis. The focus of the course is on physical and mathematical concepts useful for design and analysis of light water nuclear reactor plants. Applications of mass, momentum, and energy balances are combined with use of water properties to analyze the entire reactor plant complex as a whole. Principles are applied through the application of major industry codes to specific cases.

ME 2997 MS RESEARCH 3 cr.

Students prepare a literature survey on a major research problem and submit an outline for future work on the Master of Science thesis.

ME 2999 MS THESIS 1-12 cr.

ME 2094 Practicum. Having internships with industry and research laboratories provides graduate students a great opportunity to complement their studies with practical training. The course, ME 2094—Practicum, is a formal mechanism for full time graduate students who have obtained an internship with an external organization (industry or government research laboratory) to carry out that internship. The internship must be related to the student's thesis/dissertation research.

Requirements and restrictions for ME2094:

- The student must be enrolled as a full time graduate student in the Mechanical Engineering Department.
- The student cannot be holding a teaching assistantship or research assistantship in the term the internship is conducted.
- International students must obtain the appropriate employment authorization through the Office of International Services **BEFORE** they may begin paid employment.
- The student must start the internship in the term for which it is registered.
- The internship must last for at least 12 weeks.
- The student must receive approval for the internship by the Graduate Director prior to registering for ME2094.
- The student must be on the MS Thesis or PhD track. If the student switches from the MS Thesis track to the Professional MS track, the ME2094 credits will not count towards his or her MS requirements.
- A student can register for ME2094 three different times for a maximum of three credits (1 credit max per term).
- Faculty advisor must be willing to recommend and oversee the student's internship. Student must submit a report to their faculty advisor at the end of the internship and must receive a satisfactory (S) grade to receive credit.

Registration Steps for ME 2094:

1. Find a qualifying organization willing to conduct the internship.
2. Obtain Internship Agreement Form and guidelines from the graduate office.
3. Fill out the internship agreement form and have your advisor sign it and then submit it to the Graduate Director. The Agreement Form must include a statement from the employer, and for international students a certification from the Office of International Services indicating that you satisfy the requirements for practical training as set by the University and the Immigration and Naturalization Service.
4. Once the Internship Agreement Form has been approved by the Graduate Director, you can register for ME2094 for the specified term.

ME 3003 THEORY OF CONTINOUS MEDIA 3 cr.
Kinematics of deformation, compatibility, material rates and relative deformation; analysis of stress; balance equations; constitutive equations for simple materials, isotropy group elastic solids, and viscous fluids. Prerequisites: ME2001, ME2003, ME2004, ME2074

ME 3004 ADVANCED ELASTICITY 3 cr.
Advanced topics in linearized elasticity including solutions of fundamental problems in three-dimensions, complex variable methods, and elastodynamics. Introduction to nonlinear elasticity including finite deformations and constitutive theory.
Prerequisite: ME2001, ME2004

ME 3006 INELASTICITY 3 cr.
Plasticity including physical and experimental foundations; notion of plastic strain; yielding and yield surfaces; loading and unloading; flow rules; perfectly plastic hardening and softening behavior; plane strain rigid-perfectly plastic slip-line theory. Viscoelasticity including methods of specifying viscoelastic properties of materials; formulation and some basic solutions in viscoelastic stress analysis; experimental methods.
Prerequisites: ME2001, ME2003, ME2004, ME3003

ME 3007 ENERGETICS 3 cr.
The objectives of this course are to understand and apply the theory of Thermodynamics and transport properties, to distinguish the thermodynamics of properties from the thermodynamics of systems, to acquire the capacity to calculate properties from a minimal set of experimental data, and to gain the ability to estimate properties based on chemical behavior. Topics include derivation of the Gibbs Equations and Maxwell relations, advanced equations of state, molecular structure and fugacity, mixing rules, and vapor-liquid equilibrium calculations.
Prerequisite: ME2001

ME 3021 MECHANICAL VIBRATIONS 2 3 cr.
Advanced analysis of discrete and continuous system vibrations; variational characterizations of eigenvalues, elements of linear operator theory, approximate methods of solution, and finite element techniques in vibrations. Prerequisite: ME2020.

ME 3023 COMPOSITES 3 cr.
Anisotropic linear elasticity, laminates; basic micromechanics of particulate and fiber reinforced materials and polycrystalline aggregates; the inclusion problem; Hashin-Shtrikman bounds and estimates of overall moduli; strength; microcracking and damage.
Prerequisites: ME2001, ME2003, and ME2004.

ME 3036 ADVANCED FRACTURE MECHANICS 3 cr.
Asymptotic crack tip fields in linear elastic fracture mechanics leading to the stress intensity factor, energy release rate, and crack tip opening displacement characterizations; elastic-plastic fracture mechanics in both small-scale yielding and large-scale yielding characterized by path independent integrals; micromechanics of fracture; fracture along bimaterial interfaces.
Prerequisites: ME2001, ME2004.

ME 3047 ADVANCED FINITE ELEMENT ANALYSIS 3 cr.
Stability and accuracy analysis of time integration methods for first- and second-order finite element systems; theory of beam and plate elements; elastic-plastic finite element analysis.
Prerequisite: ME2004, ME2047.

ME 3052 CONDUCTION HEAT TRANSFER 3 cr.
Study of conduction in continuous media by analytical and numerical methods. Analytical methods include series solution, superposition, Duhamel's theorem, and Laplace transforms. Numerical methods include finite differences, finite elements, and response factors. Prerequisites: ME2001, ME2060.

ME 3054 CONVECTION HEAT TRANSFER 3 cr.
Derivation of general governing equations using tensor notation; heat transfer in laminar and turbulent flows; incompressible and compressible thermal boundary layers; advanced solution methods for convective heat transfer. Prerequisites: ME2074.

ME 3055 MULTIPHASE FLOW 3 cr.
Study of the fluid mechanics and heat transfer processes in multiphase systems; steady-state and transient models; boiling regimes; and a variety of correlations relations for void, critical phenomena, and flow regimes. Prerequisites: ME 2053, ME2060, and ME2074.

ME 3066 MATHEMATICAL TOPICS IN FLUID MECHANICS 3 cr.
The objective of this course is to introduce the students to the mathematical theory of the Navier-Stokes initial-boundary value problem and to some of the solved and unsolved fundamental questions. In this course, after deriving the Navier-Stokes equations from the general continuum theory, we shall prove the main known results of existence, uniqueness and regularity of solutions to the corresponding initial-boundary value problem. Moreover, we shall present a number of significant open questions and explain why the current mathematical approaches fail to answer them.

ME 3075 HYDRODYNAMIC STABILITY 3 cr.
Global stability and uniqueness, Stuart-Landau theory, introduction to bifurcation theory, thermal instability, inertial instability, stability of parallel shear flow. Prerequisite: ME2001, ME2074

ME 3078 VISCOUS FLUIDS 3 cr.
Properties and exact solutions of the Navier-Stokes equation; dynamic similarity, limiting values of the Reynolds number, regular singular perturbations, Stokes and Oseen flows and boundary layer theory; stability of laminar flow. Prerequisite: ME2001, ME2003, ME2074

ME 3079 TURBULENCE 3 cr.
Definitions and equations of turbulent flow, correlations, scales of turbulence; differential equations, spectrum and decay of isotropic turbulence; non-isotropic turbulence, mathematical models and transport processes. Prerequisite: ME2001, ME2074

ME 3081 NON-NEWTONIAN FLUIDS 3 cr.
Kinetics of viscoelastic fluids, viscometric flows, motions with constant stretch history. Simple fluids, constitutive models of differential type and of integral type. Stability and uniqueness. Prerequisite: ME2001, ME2003, ME2074

ME 3090 SPECIAL TOPICS IN MECHANICAL ENGINEERING 3 cr.
Special topics of current interest to students and faculty presented by a member of the faculty. By special request only.

ME 3095 GRADUATE PROJECTS 3 cr.
A special problems or reading course of individual study guided by the student's major advisor. Topics selected from any phase of mechanical engineering not covered in the regular PhD-level courses.

ME 3997 PhD RESEARCH 1 –12 cr.
Research methods and procedures. Students are assigned a problem and are required to prepare a plan of attack including a literature survey for a research problem that can meet the dissertation requirement.

ME 3999 PhD DISSERTATION 1-15 cr.

MECHANICAL ENGINEERING FACULTY

The opportunity to work on interesting research problems under the tutelage of experienced and involved faculty is an important feature of graduate study in Mechanical Engineering at the University of Pittsburgh. Our faculty has interests in a broad range of topics.

Sung Kwon Cho, Assistant Professor of Mechanical Engineering and Materials Science
Micro-Electro-Mechanical systems (MEMS), Bio-MEMS, Microfluidics
Ph.D., Seoul National University

Minking Chyu, Leighton Orr Professor and Chairman of Mechanical Engineering and Materials Science
Heat Transfer, Gas Turbines, Microsystem Technologies
Ph.D., University of Minnesota

William W. Clark, Professor of Mechanical Engineering and Materials Science
Smart Materials & Structures, Vibration Control
Ph.D., Virginia Polytechnic Institute and State University

Daniel G. Cole, Assistant Professor of Mechanical Engineering and Materials Science
Dynamic Systems, Measurement, and Control
Ph.D., Virginia Polytechnic Institute and State University

Rory A. Cooper, Professor and Chairman, Rehabilitation Engineering
Neuromotor Control, Assistive Device Design, Medical Instrumentation, Biomechanics
Ph.D. University of California at Santa Barbara

Giovanni P. Galdi, Professor of Mechanical Engineering and Materials Science
Theoretical Fluid Mechanics, Stability
Degree in Physics, University of Naples, Italy

Peyman Givi, Professor of Mechanical Engineering and Materials Science
Turbulence, Combustion, Computational Fluid Dynamics, Propulsion, and Stochastic Processes
Ph.D., Carnegie Mellon University

Scott X. Mao, Professor of Mechanical Engineering and Materials Science
Composites, Applied Mechanics
Ph.D., Tohuku University

Mark C. Miller, Research Associate Professor of Mechanical Engineering and Materials Science
Dynamics of Human Movement
Ph.D. in Applied Mechanics, University of Michigan

Anne M. Robertson, Associate Professor and Graduate Director of Mechanical Engineering and Materials Science
Newtonian & Non-Newtonian Fluids, Computational Fluid Dynamics, Constitutive Theories, Flow in Curved Pipes, and Biofluid Dynamics
Ph.D. in Mechanical Engineering, University of California at Berkeley

Laura Schaefer, Associate Professor of Mechanical Engineering and Materials Science
Thermal-Fluid Systems
Ph.D. in Mechanical Engineering, Georgia Tech

MECHANICAL ENGINEERING FACULTY (Cont.)

William S. Slaughter, Associate Professor/Undergraduate Director of Mechanical Engineering and Materials Science
Solid Mechanics, Micromechanics, Composites, and Fracture
Ph.D. in Engineering Sciences, Harvard University

Patrick Smolinski, Associate Professor of Mechanical Engineering and Materials Science
Computational Mechanics, Biomechanics
Ph.D. in Theoretical & Applied Mechanics, Northwestern University, Illinois

Jeffrey S. Vipperman, Associate Professor of Mechanical Engineering and Materials Science
Active Microsystems (MEMS), Smart Structures, Acoustics & Vibrations, and Controls
Ph.D. in Mechanical Engineering, Duke University

James H.C. Wang, Associate Professor of Mechanical Engineering and Materials Science, Bioengineering and the Department of Orthopaedic Surgery,
Mechanical Engineering, Bioengineering
Mechano-biology and Functional Tissue Engineering
Ph.D. in Bioengineering, University of Cincinnati

Qing-Ming Wang, Associate Professor of Mechanical Engineering and Materials Science
Micro-Electro-Mechanical systems (MEMS), Microfabrication, Smart Materials, Piezoelectric and Electrostrictive Materials for Electromechanical Transducer, Actuators and Sensors
Ph.D. in Materials, Pennsylvania State University

Lisa Weiland, Assistant Professor of Mechanical Engineering and Materials Science
Smart Materials, Experimental and Computational Mechanics, Device Development
Ph.D. in Mechanical Engineering, Georgia Tech

Savio L-Y Woo, Albert Ferguson, Jr. Professor & Vice Chairman for Research, Department of Orthopaedic Surgery, School of Medicine; & Professor of Mechanical Engineering and Materials Science
Ph.D., University of Washington in Seattle

Sylvanus N. Wosu, Assistant Dean for Diversity, Associate Professor of Mechanical Engineering and Materials Science
Engineering, Dynamics of Composites
Ph.D. in Engineering Physics, University of Oklahoma

MECHANICAL ENGINEERING FACULTY (Cont.)

Emeritus Professors

James L. S. Chen, **Emeritus Professor** of Mechanical Engineering
Heat Transfer, Non-Newtonian Fluids, Suspension Flows
Ph.D. in Mechanical Engineering, The University of Illinois

Richard S. Dougall, Emeritus Professor of Mechanical Engineering
Heat Transfer, Multiphase Flow, Flow in Porous Media
Sc.D., Massachusetts Institute of Technology

Charles C. Hwang, Emeritus Professor of Mechanical Engineering
Combustion, Fluid Mechanics & Heat Transfer
Ph.D. in Engineering, Harvard University

Michael J. Kolar, Professor of Mechanical Engineering
Design & Manufacturing
Ph.D. in Engineering, Case Western Reserve University

Norman Laws, Emeritus Professor of Mechanical Engineering
Composites, Applied Mechanics
Ph.D., University of New Castle-upon-Tyne, England

Roy D. Marangoni, Associate Professor and Undergraduate Coordinator of Mechanical Engineering
Vibrations, Biomechanics
Ph.D. in Mechanical Engineering, University of Pittsburgh

Tse-Chien Woo, Emeritus Professor of Mechanical Engineering
Viscoelasticity, Thermal Stresses
Ph.D. in Applied Math, Brown University

EXPERIMENTAL & COMPUTATIONAL FACILITIES

Artificial Heart & Lung Laboratory - This laboratory provides bioengineering support for the development of improved artificial organ systems. Blood flow in these systems is studied both through flow visualization and by Computational Fluid Dynamics. Computer optimization is used in the design of next-generation artificial hearts and lungs. Research is also conducted on blood rheology, magnetic levitation, hemodynamic control, and alternative power sources for artificial organs. The laboratory has equipment capability ranging from microscopy to prototyping of artificial organs. The laboratory also has computer capabilities ranging from PCs to workstations, which connect to the Pittsburgh Supercomputing Center. State-of-the-art surgical facilities for in-vivo evaluation of organ systems are also available.

Computational Mechanics Laboratory - The primary research focus of this lab is the development of computational software as well as the use of commercial software packages to simulate and visualize the physical behavior of fluids, bio-fluids, solids and structural materials. Research is carried out using commercial Computational Fluid Dynamics (CFD) program, linear and non-linear Finite Element Programs (FEA), generic analysis programs, scientific, mathematical software packages and several programming languages. The laboratory consists of Hewlett-Packard and Digital alpha workstations, several Pentium II class workstations and student work space.

Computer Aided Design (CAD) Laboratories – One laboratory contains more than 60 workstations that have both ProEngineer (3-d solid modeling design software) and ANSYS (Finite element software). A second laboratory contains twenty 486 computers with advanced graphics capabilities which use AUTOCAD and ANSYS software. Printers and plotters are available as output devices.

Energy Systems Laboratory – Thermal-fluid processes are the foci of this laboratory. These processes are examined through both experimental and computational approaches. Areas of research include heat pumps, fuel cells, and single- and dual-phase fluid flow characterization/heat and mass transfer in single- and multi-component fluids. This research addresses issues faced both on the microscale and in large-scale HVAC&R applications. Equipment includes a DAQ system, a flow loop, and measurement and visualization equipment.

Fluid Mechanics Laboratory – This laboratory is devoted to basic research investigating the relationship between convective heat transfer and turbulence. Equipment includes a 20 x 28 inch open loop wind tunnel, a PC controller, a high speed voltage recorder, an orthogonal triple wire probe, date acquisition system, computers/w laser printer, probe positioning system, DC power supplies, hot wire anemometer system, and heat transfer surfaces.

Gas Dynamics Laboratory – This facility contains a heat transfer apparatus, wind tunnel, parallel pump apparatus, and an air compressor in addition to space for project work.

Fluids Laboratory - The Fluids Laboratory is the center for experimental research in fluid mechanics and rheology at the University of Pittsburgh. Much of the research in this laboratory examines the behavior complex fluids, such as polymeric solutions, suspensions, and biological fluids in processing-like flows. We seek to better understand the link between flow behavior and the material properties so that materials can be processed more efficiently to yield the desired characteristics. In obtaining this goal, this laboratory develops and applies many cutting edge technologies to obtain precise, in situ measurements of fluid velocity, stress, pressure, and temperature. These measurements are compared with direct numerical simulations to model, understand, and predict the flow behavior.

Heat Transfer Laboratory – In this laboratory, basic research on heat conduction is performed. Thermal conductivity of various materials is measured using transient heat conduction methods. Equipment includes data acquisition system, DC power supplies, a vacuum chamber, and a spectrometer.

Human Engineering Research Laboratory – This laboratory contains the following apparatus. Smart Wheel: A wheelchair wheel that can measure the forces and torque which the wheelchair rider exerts on the push-rim. Also included is a motion analysis system that records the position of the hand, wrist, elbow, and shoulder of the wheelchair rider. This information is converted into forces and torques at the joints. The objective is to develop a workstation that a therapist can use to evaluate a wheelchair user while the individual is pushing. Wheelchair dynamic Loads: International and National Standards work is performed to improve the reliability and comfort of wheelchairs.

Measurement Laboratory – The equipment in this laboratory includes most of the basic sensors (accelerometers, thermocouples, strain gages, microphones, photocells, potentiometers, analytical 2-pan balance) and their associated recording devices (function generators, analog and digital oscilloscopes, digital plotters, strain indicators, universal counters, sound recorder, multi-meters, sound level meters). There is also a complete supply of signal conditioners (power supplies, amplifiers, filters, oscillators) and a vibration tester.

Mechanical Vibrations Laboratory – Experimental test facilities for rotor-dynamics testing and vibration or motion control are housed in these laboratories. Integral test equipment includes real time frequency analyzers, FFT analyzers, digital plotters, accelerometers and impact hammers for dynamic model analysis of structures. Also included in these laboratories is a complete compliment of acoustic equipment for sound pressure measurement, sound intensity measurement and noise frequency analysis.

MicroElectromechanical Systems (MEMS) Laboratory – With a recent gift from Dr. John Swanson (founder of ANSYS, Inc.) a MEMS laboratory will be created equipped with a clean room of class 1,000/10,000 and the state-of-art microfabrication facilities that are suitable for thin and thick film, silicon-based MEMS processing. The primary research focus of this lab include (1) piezoelectric/electrostrictive thin and thick film based micro-actuators and micro-sensors for industrial, medical and military applications, (2) micro power generation system research and (3) thin film transducer materials and transducer research.

Micromechanics and Nano-science laboratory - This mechanical engineering laboratory is a modern facility with cutting edge technology for the study of micromechanics and physics of micrometer and nanometer scaled structures and materials. The laboratory contains atomic force microscopes and a nano-indentation testing facility, which provide a capability of measuring load vs. displacement at scales of 10^{-9} Newton vs nanometer, nano-scaled adhesion and micro-mechanical behavior for advanced materials including semiconductors and biosystems.

Microprocessor Control Laboratory – This laboratory houses 24 microprocessor based workstations for controlling mechanical devices from robots to anti-lock braking systems. There is a software development system for project and thesis work. The lab also contains an industrial programmable controller, which has a simulator of motors, slides, and belts.

Musculoskeletal Research Center – The Musculoskeletal Research Center of the Department of Orthopedic Surgery is a collection of researchers, scientists, physicians, and students exploring innovative applications of bioengineering principles and technologies to orthopedics, particularly synovial joint and tissue biomechanics and biomaterials. The facility is composed of seven laboratories including areas for anatomy and tissue measurement, Biomaterials, Kinematics and Robotics; as well as Cartilage, Ligament, and Tendon Biomechanics.

The center is well equipped with three Instron Testing Machines, (one has biaxial servo-hydraulics capability), two advance video Motion Analysis Systems with Sun Workstations for three-dimensional motion measurements, laser micrometer measurement system, Silicon Graphics Workstation, Articulated Robotic Manipulator with two universal force-moment sensors, and extensive other computer support for data acquisition and analysis.

The laboratories also have a variety of specialized, custom-built equipment to facilitate testing. Research projects include the evaluation of healing in ruptured ligaments and tendons; shoulder dynamics; determination of lengths and forces in tendons and ligaments and tendons; and ligaments *in situ;* and evaluation of cartilage and meniscal viscoelastic properties. New areas of interest include wrist and finger biomechanics, spine biomechanics, and biomaterials.

Solid Mechanics/Biomechanics Laboratory – The solid mechanics and biomechanics laboratory contains space and equipment for materials testing and the development of apparatus for biomechanical measurements. An Instron uniaxial testing device offers low and mid-level loading capabilities with computer data acquisition. A fume hood connection allows the study of the interaction of volatile chemicals with material properties. The laboratory has a workstation used for finite element modeling of biological systems and the processing of data from human motion tests.

Sound, Systems, and Structures Laboratory – (a member laboratory of the Swanson Center for Micro and Nano Systems) **-** This mechanical engineering laboratory is dedicated to development, modeling, and experimental characterization of active systems at the micro and macro scales. The diverse range of projects typically blend the related fields of acoustics, noise control, hearing loss prevention, vibrations, structural-acoustic interaction, controls, and analog/digital signal processing. A 1,000 ft^2 laboratory equipped with state of the art equipment is complemented with an ancillary 250m^3 anechoic chamber facility. Past and current projects include the development of microvalves for gas flow management in fuel cells (US Dept. of Energy), vibro-acoustic modeling and characterization of novel composites for the Air Force, development of metrics for estimating hazards posed by occupational impulse noise (NIOSH), fabrication and testing of multifunctional MEMS acoustic sensors, development of a noise classifier for military impulse noise (SERDP), and thermoacoustic refrigeration for electronics cooling (NSF).

Vascular Mechanics Research Laboratory – This laboratory is equipped with several devices used in vascular surgery research. These include a state-of-the-art vascular testing apparatus that allows simultaneous, controlled application of internal pressure, torque, and longitudinal force to perfused, intact tubular specimens. Concurrently, the deformation response (strain) is measured by monitoring gage length changes, diameter changes, and induced twist. This device is an ideal model for coronary arteries (which undergo such complex loading and motion due to the beating heart), or for studying the effects of different steady or cycle deformation on either vascular prostheses or cells response of vascular segments to these loads (i.e., biomechanical modeling and materiel blood flow through vascular segments. This apparatus allows study of the effect of different hemodynamic variables (flow, “blood pressure”, etc.) on the mechanics and biological response of blood vessels and vascular prostheses. A uni-axial testing apparatus that allows the mechanical testing of soft tissue specimens is currently being used for the mechanical characterization of aortic aneurysms.

Vibration and Control Laboratory – The Vibration and Control Laboratory has been developed for studying smart materials and structures concepts, particularly in the area of vibration control. The laboratory is well equipped for experimental research in smart structures including a number of pc-based workstations for real-time control; digital signal processing capability; a variety of transducers for actuating and measuring vibrations; function generators; oscilloscopes; dynamic signal analyzer; a work center for computations, presentation, and publication.

GENERAL INFORMATION

Admission – Applications for admission are encouraged from all persons with a genuine interest in advanced engineering study. Each application will be judged on its own merits. For the applicant who is a recent graduate of an Accreditation Board for Engineering and Technology (ABET) accredited school, admission will be granted on the basis of the undergraduate scholastic record. Usually an applicant with a B average (cumulative quality point average of 3.0/4.00) or better will be granted admission. The Graduate Record Examination (GRE) is required by the Mechanical Engineering Department. Applicants should check each program's specific requirements. Applicants who do not meet these requirements may be considered on an individual basis with strong emphasis given to academic promise, career orientation, work experience, and preparation in engineering and related disciplines. In some cases, these applicants will be required to correct deficiencies in preparation for the graduate program.

Admission Procedures

(1) United States citizens or permanent residents should follow this procedure.

a. Write or telephone the departmental graduate coordinator for the application material.

b. Return the completed application material with a check or money order (not cash) in the amount of $50 payable to the University of Pittsburgh (The fee for a Special Student application is $50.00). The application fee is not returnable.

c. Ask the registrars of all undergraduate and graduate schools attended to send transcripts of records to the School of Engineering Office of Administration, 253 Benedum Engineering Hall, University of Pittsburgh, Pittsburgh, PA 15261. An official transcript of the undergraduate record is required even though the applicant may not intend to work towards a degree. A graduate of the University of Pittsburgh need not request the University registrar to send a transcript of the undergraduate record.

Action will be taken after receipt of the completed application materials, including the application fee, and complete transcripts of work done in previous undergraduate and graduate curricula. The deadline for the fall term is March 1; the spring term deadline is July 1; and the summer term deadline is February 1. We ask that International Students send in their application materials at least two months before the posted deadlines.

(2) All international student applications are processed for academic qualifications by the School of Engineering and for non-academic qualifications by the Admissions Officer, Office of International Services (OIS). The document needed to apply for a non-immigrant visa will be issued only after the applicant has been admitted and has provided evidence of adequate financial support and English language proficiency. International applicants should follow this procedure:

a. Direct preliminary inquiries concerning graduate programs, research, and financial aid to the departmental graduate coordinator. Applications for graduate study are available from the graduate coordinator and the School of Engineering Office of Administration, 253 Benedum Hall, Pittsburgh, PA 15261.
The non-refundable application fee for international students is $50.

b. The applicant will receive notification from the Engineering Office of Administration concerning the evaluation of academic qualifications.

c. If the academic evaluation by the department is favorable, the International Student Admissions Officer will review non-academic qualifications to determine eligibility for a visa document.

This procedure is also for any international applicants who are already in U. S. A.

The University reserves the right, even after the arrival and enrollment of a student from another country, to require, at his or her own expense, individual curricular adjustments whenever particular deficiencies or needs are found. This could include enrollment without credit in additional course work in English as a foreign language or in courses prerequisite to his or her regular plan of study. New students from abroad are encouraged to use the services of OIS to help them in their own adjustment to the United States and to facilitate their total educational experience.

English Language Proficiency – Graduate students must possess sufficient knowledge of English to study without being hindered by language problems, to understand lectures, and to participate successfully in class discussions. The determination that the applicant has sufficient proficiency is made by the admitting department or school, subject to University-wide minimum standards determined by the University Council on Graduate Study.

The Test of English as a Foreign Language (TOEFL) must be taken if the applicant's native language is not English. A minimum score of 550 (213 on the computer-based test / 79-80 on the internet-based test) or higher on the TOEFL is required for admission to graduate study. The International English Language Testing System (IELTS) may now be substituted for the TOEFL. A minimum result of Band 6.5 is required on the IELTS. The requirement to take the TOEFL may be waived if the applicant has achieved a satisfactory score on other tests of English proficiency such as the IELTS or has received a degree from an accredited institution in the United States.

In special cases, a school or department may admit a student who has not demonstrated minimum proficiency in English. Upon arrival, students with TOEFL scores less than 550 (213 on the computer-based test / 79-80 on the internet-based test) or IELTS scores less than Band 6.5 **will not be permitted to register** until they have taken the on-campus administered Michigan Test of English Proficiency.

If remedial courses in English as a foreign language are recommended as an outcome of the Michigan Test of English Proficiency, the department or school must ensure that the recommendations are followed. All students with a TOEFL score less than 600 (250 on the computer-based test / 100 on the internet-based test) or less than Band 7 on IELTS must take the Michigan Test of English Language Proficiency upon arrival. Although the registration of only those with TOEFL scores less than 550 and IELTS scores less than Band 6.5 will be blocked.

In keeping with the University policy on Certification of English Language Fluency for Teaching, students who are not native speakers of English and are appointed as teaching assistants or teaching fellows are required to take a test of their spoken English **upon arrival**. Individuals are given non-teaching assignments and are required to take special course work until they attain passing scores. An unsatisfactory score at the time of reappointment is sufficient cause for non-renewal.

Original results of the Test of English as a Foreign Language (TOEFL) should be sent directly to the University of Pittsburgh by the Educational Testing Service. Copies of TOEFL test results are not acceptable. For information or an application for the TOEFL, you may contact the Educational Testing Service, P.O. Box 6151 Princeton, New Jersey 08541-6151, USA. (E-mail: toefl@ets.org; website: www.toefl.org). The institutional code for the University of Pittsburgh is 2927 and the department code for the School of Engineering is 69. International English Language Testing System (IELTS) is jointly managed by: University of Cambridge ESOL Examinations, British Council, and IDP: IELTS Australia. For more on IELTS , please visit the website: http://www.ielts.org.

Financial Aid – Admission to the graduate program does not imply the granting of financial aid. This is done separately, and an applicant interested in obtaining financial aid should request information directly from the department. The following types of aid may be available:

(1) Fellowships are awarded to students of outstanding ability. The financial aid is usually an unrestricted grant.

(2) Teaching Assistantships and Teaching Fellowships are awarded to exceptionally well-prepared students in return for assistance in laboratories, recitation sections, and other teaching duties. Partial or full tuition scholarships are also provided.

(3) Research Assistantships are awarded to students for assistance on research programs. Partial or full tuition scholarships are also provided.

When an award for financial aid is made by the department, the terms and conditions are specified. Applications for financial aid should be received as early as possible.

For information on student loans, contact the University Office of Admissions and Financial Aid, Alumni Hall – 4227 Fifth Avenue, University of Pittsburgh, Pittsburgh, PA 15260 (624-7488).

Tuition Costs and Fees

Note: ***The University reserves the right to change the tuition rates and fees at any time without notice in advance.***

Tuition rates vary with each school within the University. Graduate students are invoiced per credit for the first one to eight credits and the full-time flat rate for nine to 15 credits. No student is permitted to register for more than 15 credits without specific permission from the dean of the school in which the student is pursuing a degree. If granted, the student will be assessed the flat rate plus a per-credit charge for each credit over 15.

Graduate School Tuition – Graduate students registered for 9 to 15 credits in the Fall and Spring Terms are regarded as **full-time**, and are assessed the current "flat" tuition rate for the School of Engineering.

Resident Tuition, Per Term:	**$ 8,540.00**
Non-Resident Tuition, Per Term:	**$15,454.00**

Additional Fees that are applicable to students regardless of Pennsylvania or Out-of-State Residency include:

Student Activity Fee	**$ 20.00**
Student Health Fee	**$ 65.00**
Computing and Network Services Fee	**$ 150.00**
Security, Safety, and Transportation Fee	**$ 90.00**
	$ 325.00

Graduate Students registered for fewer than 9 credits are considered **part-time** and are billed on a per-credit basis.

Resident Tuition, Part-Time Per Credit	**$ 813.00**
Non-Resident, Part-Time Per Credit	**$1,465.00**

Additional Fees that are applicable to students regardless of Pennsylvania or Out-of-State Residency include:

Student Activity Fee	**$ 10.00**
Student Health Fee	**$ ------**
Computing and Network Services Fee	**$ 75.00**
Security, Safety, and Transportation Fee	**$ 90.00**
	$ 175.00

Summer Term/Summer Sessions – Students registered during the summer term and/or summer sessions will be billed on a **per-credit basis only**, **regardless of the number of credits taken.**

Graduate Housing – There is no residence hall on campus for graduate students for the fall and spring terms. Accommodations are available throughout the summer term. Rates are available upon request from the University Housing and Food Services Office, which is located in the Litchfield Towers, Tower A, (412) 648-1100. The University has established a meal plan for which any registered student is eligible. Students may obtain board-plan information by contacting the Housing and Food Services Office.

Housing Resource Center, 127 North Bellefield Avenue (412) 624-6998, provides community listings of private rooms and apartments for rent continually throughout the year. The Housing Resource Center is open between 8:00 am and 4:30 pm, Monday through Friday.
HRC website: http://www.pitt.edu/~property/contact.html, e-mail: hrc@bc.pitt.edu
HRC lists University-owned efficiencies and one- and two-bedroom apartments for rent.
As well as informative information concerning housing outside of University-owned property.

Student Status – Continuing Student is a student who was registered in the same academic center at the same level for any term within the last calendar year.

New Student is a student who is registering for the first time, or one who is registering in a different academic center (including regional campuses) or level from his/her last registration, regarding the registration process.

Re-Admitted Student is a student who has previously registered but not within the last calendar year. The student shall be considered the same as a new student registering for the first time, regarding the registration process.

Provisional Status – Students who are admitted to the program under provisional status must satisfy the conditions of his/her provisions to remove certain deficiencies in either coursework or academic achievement before being changed to full status.

Special Student Status – Students who are seeking advanced degrees but who are unable to meet the deadline for filing all required credentials for admission may be granted temporary admission provided they present acceptable evidence concerning their qualifications for graduate study. Regular admission must be accomplished within the first term of registration.

Students who are not seeking an advanced degree but who have specific qualifications for one or more courses, including courses required for learning or certification, may register for such courses subject to review by the department and the dean of the school. If a student should apply for admission to a degree program, a maximum of 6 credits may be applied toward a graduate degree.

Inactive Status - Students who have not registered for at least three (3) credits (eligible doctoral students at least one (1) credit of full-time dissertation study) during a 12-month period will be transferred automatically to inactive status and must file an application for readmission to graduate study (application fee required) before being permitted to register again. Students on inactive status cannot apply to graduate or take preliminary or comprehensive examinations. Also, students on inactive status are not eligible to use University facilities and should not expect to receive counseling from the faculty or active supervision by their advisor and committee.

Readmission – Readmission is not automatic nor does it necessarily reinstate the student to the academic status enjoyed prior to becoming inactive. When readmitted, the student must be prepared to demonstrate proper preparation to meet all current admission and degree requirements.

Registration Process – After being admitted to a graduate program, students may register for classes with their academic advisor. The registration period for a term or session is published in the University's Schedule of Classes (see www.pitt.edu/~srfsweb/crinPgCrsInfo.htm), in course descriptions, on calendars (including the University's Academic Calendar at (www.pitt.edu/~provost/calendar.html), and in numerous other publications.

Students registering for the first time are advised to complete registration well before the beginning of the term. Typically, the first day of classes is the last day for students to register. After the start of classes, registration for new and continuing students is permitted only in unusual circumstances and only with the written approval of the dean and the payment of a late registration fee.

Your registration will be processed in the Office of Administration, 253 Benedum Hall. Students are required to have the signature of their academic advisor on the registration form. The student's signature on the registration form creates a financial obligation to the University of Pittsburgh. Once students have registered, they may view their class schedules online at http://student-info.pitt.edu.

Registering for Full-Time Dissertation Study – Doctoral students who have completed all credit requirements for the degree, including any minimum dissertation credit requirements, and are working full-time on their dissertations may register for Full-Time Dissertation Study, which carries no credits or letter grade but provides students full-time status. Students so enrolled are assessed a special tuition fee but are still responsible for the full-time computer and network, security/transportation, student health, and activity fees. Students must consult with the dean's office of their school for permission to register for full-time dissertation study.

Registering for Two Independent Degree Programs Simultaneously – Students may pursue two independent graduate degrees simultaneously in two different schools within the University (joint degree) or two different departments within the same school (dual degree). Normally, such students should be enrolled for no more than a total of 15 credits per term. Special approvals and regulations apply before a student is allowed to register for courses in pursuit of two independent graduate degrees. See discussion in Special Academic Opportunities for further detail.

Registering for Cooperative, Dual-Degree, and Joint-Degree Programs – Dual- and joint-degree programs result in two degrees being awarded. Requirements for these programs include all or most of the requirements of two distinct academic degree programs. Dual programs exist within a single school; joint programs exist between two or more schools; cooperative programs are administered by two or more institutions. Before registering for courses in pursuit of a cooperative, dual-degree, or joint-degree program, a student must be admitted to both programs. See discussion in Special Academic Opportunities for further detail.

Cross-Registration – Carnegie Mellon University, Duquesne University, the Pittsburgh Theological Seminary, Robert Morris University, and the University of Pittsburgh offer graduate students the opportunity for cross-registration in graduate programs in the five institutions in the fall and spring terms. Credits earned by cross-registration in graduate courses at Carnegie Mellon, Duquesne University, the Pittsburgh Theological Seminary, and Robert Morris University, when approved in advance by the student's graduate advisor, are accepted as University of Pittsburgh credits for the purpose of the calculation of the quality point average and the completion of degree requirements. Each department at each institution retains the authority to establish the prerequisites for admission and the maximum enrollment in its own courses and to grant priority in registration to its own graduate students.

Cross-registration is only available in the fall and spring terms. Only full-time students may cross-register. Students who cross-register do not pay tuition to the host institution; however, they are responsible for any additional fees associated with the course such as laboratory fees, books, and the like. During the summer, students may attend one of the above colleges as guest students, but they must pay that institution's tuition and fees. Students are discouraged from cross-registering during their term of graduation to avoid any delays in the receipt of course credit needed to graduate. Students should meet with their advisor before they cross-register. See also Cross-Registration Credit or visit the Pittsburgh Council of Higher Education (PCHE) (http: www.pchepa.org) for organization history and available program information.

Auditing Courses – With the consent of the school and instructor, students may audit a course and receive an N grade with the consent of the instructor and school offering the course. However, to audit a course, a student must register and pay tuition for the course. The N grade is not counted toward graduation or the QPA.

Adding and Dropping Courses – Students may add and drop courses only during the add/drop period. The dates for the add/drop period are listed in the University's Schedule of Classes, in course descriptions, on calendars (including the University's Academic Calendar at www.pitt.edu/~provost/calendar.html), and in numerous other publications. Students who no longer wish to remain enrolled in a course after the add/drop period has ended may resign from the University or withdraw from the course.

Resigning from the University for a Specific Term – If students decide to drop all of their courses after the add/drop period has ended and before 60 percent of the term or session has been completed, they must resign from the University for that term. Official resignation from the University requires students to contact the Student Appeals Office. Students have several options. They may resign in person, by mail, or by calling 412-624-7585, where students may leave a message 24 hours a day, including weekends and holidays. An R grade will appear on the student's academic transcript. Tuition is prorated from the date of the student's notification to the Student Appeals Office of the student's desire to resign, **unless 60 percent of the term has been completed**, in which case there is no refund.

After the 60 percent point of the term or session has passed, students who wish to terminate their registration may process withdrawal from all classes only with the permission of their academic dean. If the reason for withdrawal is medical or psychological in nature, the academic dean may consult with the director of the Student Health Service prior to making a determination. There is no financial adjustment associated with this procedure, which results in the assignment of W grades for the courses.

Monitored Withdrawal from a Course - After the add/drop period has ended, students may withdraw from a course that they no longer wish to attend by completing a Monitored Withdrawal Request form in the office of the school offering the course. Students must process the Monitored Withdrawal Request form within the first nine weeks of the term in the fall and spring. Because summer sessions vary in length, students should check the summer Schedule of Classes for those deadlines. Students should check with the school offering the course for the last day to submit a Monitored Withdrawal Request form. The grade W will appear on the student's grade report and transcript. **There is no financial adjustment to students' tuition or fee obligations involved in withdrawing from courses**, but withdrawing may jeopardize satisfactory academic progress, financial aid, and assistantships or fellowships.

Transfer Procedure – The application of a graduate student from another graduate school is treated in the same way as a new application, and the same procedure for application is followed. This includes the transfer into an engineering graduate program from another school in the University of Pittsburgh. After a transfer application is formally accepted, the student may apply for transfer of graduate credits from another accredited institution to the University with the major adviser's recommendation and the dean's approval. **However, no transfer credit will be accepted for courses in which grades lower than B, or its equivalent, has been received or which are no longer considered as graduate-level courses by the department.** A graduate student may apply for a maximum of six (6) transfer credits toward the MS degree. No more that 30 credits may be accepted for a master's degree awarded by another institution to meet the minimum credit requirement for the Ph.D. degree. However, in recognition of graduate study beyond the master's degree successfully completed elsewhere, up to twelve (12) additional credits may be accepted at the time of admission to meet the minimum credit requirement. Thesis and dissertation credits are not transferable.

Grading – Quality Point Average (QPA) and Grade Point Average (GPA) are numerical indications of a student's academic achievement. QPA is the average of letter grades earned toward a degree. GPA is the average of total letter grades earned.

Academic Standards – An average of at least B (QPA=3.00) is required in the courses that make up the program for any graduate degree. Students with full graduate status are automatically placed on probation whenever their cumulative QPA falls below 3.00. Each school determines the restrictions placed on a student on probation.

A student on provisional or special status or on probation is not eligible to take the PhD preliminary evaluation or the MS or PhD comprehensive examination, or to be graduated.

Grading System – The University of Pittsburgh has a standard letter grade system (see Letter Grades below). Some additional grading options are available in some courses as determined by the school and the instructor (see sections below on University Grading Options and Other Grades). Students are subject to the grading system of the school in which they are taking the course.

University Grading Options

Individual schools may elect to offer one of the following grade options for its courses:

LG	Letter Grade
H/S/U	Honors/Satisfactory/Unsatisfactory
S/N	Satisfactory/Audit
LG and H/S/U	Letter Grade and Honors/Satisfactory/Unsatisfactory
LG and S/N	Letter Grade and Satisfactory/Audit

From among the grading options approved by the school, each department identifies those it deems acceptable for its courses. Furthermore, course instructors may specify, within the grading options approved by the school and department, which grading options may be selected by students taking their course.

Students should choose a grading option from those listed with the course in the Schedule of Classes. Grade Option/Audit Request forms for graduate courses are required by the School of Engineering. Forms are available in Mechanical Engineering, 648 Benedum Hall and the Office of Administration, 253 Benedum Hall.

Students receive the grade H or S for satisfactory work and U for unsatisfactory work. The grades H and S are counted toward graduation but not the student's QPA. The grades N and U are not counted toward graduation or the QPA. The S grade indicates adequate graduate attainment; in evaluating thesis or dissertation research, an instructor may only use the S/N grading option. All thesis/dissertation credits remain Incomplete, “I” grade until the student successfully defend his/her thesis/dissertation.

Letter Grades

The University's letter grade system for graduate courses is as follows:

Grade		Quality Points
A+	=	4.00
A	=	4.00 Superior Attainment
A-	=	3.75
B+	=	3.25
B	=	3.00 Adequate graduate-level attainment
B-	=	2.75
C+	=	2.25
C	=	2.00 Minimal graduate-level attainment
C-	=	1.75
D+	=	1.25
D	=	1.00
D-	=	0.75
F		0.00 Failure

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Other Grades: Incomplete, Withdraw, Resign – Upon a student's completion of a course, one of the grades listed below may appear on the student's transcript in lieu of one of the options selected by the student and/or instructor under University Grading Options. None of these grades carries quality points. Students should consult with their individual school for information on any school-specific regulations regarding these grades.

G Grade – The G grade signifies unfinished course work due to extenuating personal circumstances. Students assigned G grades are required to complete course requirements no later than one year after the term in which the course was taken. After the deadline has passed, the G grade will remain on the record, and the student will be required to reregister for the course if it is needed to fulfill requirements for graduation.

I Grade – The I grade signifies incomplete course work due to nature of the course, clinical work, or incomplete research work in individual guidance courses or seminars.

W Grade – The W grade signifies that a student withdrew from the course. See Monitored Withdrawal from a Course for more information.

R Grade – The R grade indicates that a student has resigned from the University.

Z Grade – The Z grade indicates that an instructor has issued an invalid grade.

Repeating Courses – A student may repeat any course in which a grade of B- or lower is received if an authorization to repeat the course is given by the student's advisor and/or department. A school may restrict the type and/or number of different courses that may be repeated during one degree program. The grade earned by repeating a course is used in lieu of the grade originally earned, although the original grade is not erased from the transcript. No course may be repeated more than twice. No sequence course may be repeated for credit after a more advanced course in that sequence has been passed with a B or higher grade. The repeated course must be the same as that in which the original grade was earned. In extenuating circumstances, a department chair, with the dean's approval, may substitute another course of similar content. Grades of W, R, or N reported for the repeated course will not be counted as a course repeat. To initiate only the last course grade being computed in the QPA, a Course Repeat form must be filed with the dean's office.

Changing Grades – The instructor of a course may change a student's grade by submitting a Change of Grade Card. All grade changes require the authorization of the dean of the school from which the original grade was issued. While each school may determine a time limit for grade changes, they should be processed no later than one year after the initial grade was assessed. Changes in I grades are exempt from this one-year policy.

Grade Report – At the end of each term, a grade report is prepared by the Office of the University Registrar and mailed to the student, provided that all charges have been paid. This report shows credits carried, the grade received in each course, and quality points earned. Shortly after the term ends, students can also access their grades online via the secure server at http://student-info.pitt.edu.

Grade Access - Grades are available through the University Portal at approximately 10:00 am the morning after the day grades are due in the Registrar's Office. Grade information, including grade changes, will continue to be available online using the Student Services *Community* in my.pitt.edu. If one of your instructors submits grades after the established deadline, your record will not reflect a grade for that course until the next posting date. Questions about the actual grade awarded should be directed to the individual instructor or the department chairperson. Once grades have been posted, update requests must be submitted via Grade Change Request forms and processed through the proper Deans Office. Changes will appear as they are received and processed in the Office of the University Registrar.

To access your record on the web, log on to Student Self Service through my.pitt.edu and follow the menu path: **My Communities>Student Self Service>View my Grades**

If grade verification is needed for employer reimbursement, or for any other reason, you can obtain a copy of your transcript in G-3 Thackeray Hall. You can also visit the University Registrar's Office website for more information on how to obtain a transcript by mail.

If you have any outstanding financial obligations to the University, you will not be able to view your record online, or obtain a transcript until payment arrangements are completed.

Probation, Suspension, and Dismissal – Students who fail to make satisfactory progress may be subject to academic probation and/or suspension and dismissal. Students who have completed at least 9 quality point credits and whose QPA falls below 3.00 will be placed on academic probation by the dean of the school. After a certain period of time on academic probation (the period is determined by the School of Engineering), a student is subject to academic suspension and restricted from registering for classes in that school. Students on probation are not eligible to take the PhD preliminary evaluation or the MS or PhD comprehensive examination, or to be graduated.

Effect on Financial Aid and Scholarships – Conditions for loan eligibility and many scholarships (including those for teaching assistants, teaching fellows, graduate student assistants, and graduate student researchers) usually require students to complete a specified number of credits each year and maintain a specified quality point average (QPA: credits counted toward the degree). Questions about the effect of unsatisfactory academic standing on loans should be directed to the Office of Admissions and Financial Aid in Alumni Hall (4227 Fifth Avenue) at 412-624-7488. Questions about the effect of unsatisfactory academic standing on scholarships, including teaching and research assistantships, should be directed to the department.

Statute of Limitations – The purpose of the statute of limitations is to ensure that a graduate degree from the University of Pittsburgh represents mastery of current knowledge in the field of study. Individual schools within the University may adopt policies that are more stringent, but not less, than those stated here.

All requirements for MS degrees must be completed within a period of four consecutive calendar years from the student's initial registration for graduate study; all professional master's degrees, within five years. Dual degrees and joint degrees that require course work in excess of 50 credit hours may be granted a longer statute of limitations by the University Council on Graduate Study.

From the student's initial registration for graduate study, all requirements for the PhD degree must be completed within a period of 10 years, or within eight years if the student has received credit for a master's degree appropriate to the field of study. A student who is unable to complete all degree requirements within a five-year period after passing the comprehensive examination may be re-examined at the discretion of the department or school. Programs for professional doctoral degrees, for which the majority of candidates pursue part-time study while working full-time within their chosen disciplines, may be granted a longer statute of limitations by the schools offering the degrees.

Under exceptional circumstances, a candidate for an advanced degree may apply for an extension of the statute of limitations. The request must be approved by the department or departmental committee (master's or doctoral) and submitted to the dean for final action. Requests for an extension of the statute of limitations must be accompanied by a departmental assessment of the work required of the student to complete the degree as well as documented evidence of the extenuating circumstances leading to the requested extension. Students who request an extension of the statute of limitations must demonstrate proper preparation for the completion of all current degree requirements.

Leave of Absence – Under special conditions, graduate students may be granted one leave of absence. A maximum leave of two years may be granted to doctoral students or one year to master's students. The length and rationale for the leave of absence must be stated in advance, recommended to the dean by the department, and approved by the dean. If approved, the time of the leave shall not count against the total time allowed for the degree being sought by the student. Readmission following an approved leave of absence is a formality.

Registration Status at Graduation – All graduate students must register for at least 1 credit or full-time dissertation study during the 12-month period preceding graduation (that is, must be on active status) and must be registered for the term in which they plan to graduate. In exceptional circumstances, students who complete all the degree requirements at the end of a term but graduate in the next term may petition the dean of the school for a waiver of this registration requirement. Waivers may be obtained by submitting a written request to the Office of Administration. The request should be based on extenuating circumstances, e.g., inability of the student's dissertation committee to meet during the final term when a student has given reasonable notice or the student has completed all degree requirements in a previous term. Waivers will not be granted to students who are inactive. The requirement that a student be on active status cannot be waived.

Application to Graduate – Students must file an application for graduation in the department or the Office of Administration (253 Benedum) early in the term in which graduation is expected. Each school establishes its own deadline by which students must apply for graduation. Students should check with the graduate secretary for the deadline. As noted above, students must be active.

Prior to the end of the term in which they graduate, all doctoral candidates must submit to the dean's office a completed Survey of Earned Doctorates.

If your graduation is postponed, you must reapply through the department or the Office of Administration (253 Benedum) by completing another Graduation Application.

Certification for Graduation – The Graduate Faculty of the department or program evaluates the performance of the student. If that performance is satisfactory, a report should be submitted to the dean certifying that the candidate has satisfactorily completed all departmental requirements for a graduate degree. The dean, after confirming that the overall school and University requirements have been met, certifies the candidate for graduation.

Commencement

The University of Pittsburgh holds one annual commencement. It usually occurs on the last Sunday in April and is held at the Petersen Events Center. Students who graduate within a graduation year are invited to attend. A graduation year encompasses June, August, December of one year and April and May of the following year. (Example: June through December of 2002 and April and May of 2003 graduates will be invited to the 2003 Annual Commencement.) The Office of Special Events makes all of the arrangements for commencement. A "Graduation Central" is held approximately two weeks prior to commencement. Students are able to pick up their regalia, tickets, and other information regarding Commencement during this two-day event. You should contact the Office of Special Events, if you have any questions concerning commencement. Their address is 1200 Bruce Hall; their telephone number is (412) 624-7100.

Transcripts – An academic transcript serves as a permanent record of a student's academic progress. The transcript is a cumulative record of the student's QPA, as well as a record of the department, title, and grade for each course in which the student has enrolled. Students may request an official transcript that bears the seal and the signature of the University registrar. Upon graduation, the transcript reflects a student's degree and date; major; and, if applicable, honors, area of concentration, and minor.

Official Transcripts – Official transcripts are available from the Transcript and Certification Office in G-3 Thackeray Hall. Each page of your entire University of Pittsburgh transcript is included. The transcript is printed on security paper and bears the seal and signature of the University Registrar.

There will no longer be a $3.00 fee for transcripts for students and alumni. However, current fees for services will still be assessed to all other groups and individuals. There is a fee of $20.00 for overnight delivery within the continental United States (This fee is subject to change). International fees vary. If express fees are not paid within ten working days, there is an additional $10.00 service fee. **Transcripts cannot be faxed.**

If you have an outstanding financial obligation to the University, your transcript will be withheld until your account is paid in full.

REQUEST IN PERSON – To request a copy of your official transcript in person, you must complete and sign a Transcript Request form available in the Transcripts and Certification area in G-3 Thackeray Hall. You may use this form to designate the address to which your transcript should be sent. All transcript requests submitted in person **require photo identification**.

REQUEST BY MAIL - To order a copy of your transcript, please fill-out and mail the printable Transcript request form available on (http://www.pitt.edu/~registrar/tranFrmTranReq.htm). If you are requesting overnight service, please make your check or money order payable to the ***University of Pittsburgh***. Transcripts cannot be accepted by telephone or e-mail.

Unofficial Transcripts – As a currently registered student, you are entitled to a copy of your unofficial transcript. Your unofficial transcript contains the same information as the official transcript, but it is printed on white paper and does not bear the seal and signature of the University Registrar. To obtain your unofficial transcript, **you must make your request in person** in G-3 Thackeray Hall and present your valid University ID card at the time.

Diplomas – Your diploma, along with a complimentary official copy of your final transcript, will be mailed to you at no charge approximately four weeks after the end of your term of graduation. We will use the address on your Graduation Application unless you change it. See the online printable Address Change Form available on (http://www.pitt.edu/~registrar/regFrmChgAdd.htm). Check your transcript carefully. Any discrepancies should be brought to the attention of the appropriate office immediately.

Additional copies of your diploma may be purchased any time after graduation. Requests for additional diplomas can be made by completing the online printable Diploma Reorder Form available on (http://www.pitt.edu/~registrar/gradFrmDiplReq.htm), print it, and deliver it to G-3 Thackeray Hall or mail it, with required payment, to:

Diplomas
Office of the University Registrar
G-3 Thackeray Hall
University of Pittsburgh
Pittsburgh, PA 15260

The fee for each diploma, including mailing, is $10.00. The fee for Professional or University Honors College diplomas is $40.00. The reorder process takes approximately four weeks. Diplomas will be in the current style and font and bear the signatures of the current administrators.