THE GRADUATE STUDENT HANDBOOK

Department of Aerospace and Mechanical Engineering
University of Southern California
Los Angeles, CA 90089-1191

Tel 213 740-5353
Fax 213 740-7774
http://ame-www.usc.edu

Updated January 2005

ADMISSION REQUIREMENTS FOR GRADUATE DEGREES IN AEROSPACE ENGINEERING

Application
An application is available on-line at http://www.usc.edu/dept/admissions/grad/.

Official Transcript(s) and Admission Requirements
The University requires official transcripts from the colleges or universities the applicant has attended. The Department requires a minimum undergraduate GPA of 3.0 for admission to M.S. or Engineer program. To be considered for admission to the Ph.D. program an undergraduate GPA of 3.5 or a M.S. degree is required.

Statement of Purpose
The statement should include the reason for the applicant's desire to obtain a graduate degree in Aerospace or Mechanical Engineering.

General Record Exam
The Department requires a minimum score of 650 in the Quantitative portion of the GRE. The GRE must be taken within five years preceding the application date.

TOEFL (International Students only)
All international students are required to demonstrate their English proficiency by taking the International Student English (ISE) placement. Students that are exempt from taking the ISE are:

1. Students with an international TOEFL score of 600 or higher (250 or higher on the new computer based TOEFL) taken within the last 2 years.
2. Students with a bachelor's degree from a U.S. college or university.
3. Students with official proof of a final grade of "C-" or better in an English Composition course equivalent to Writing 130 taken at an accredited U.S. college or university.

Recommendation Letters
Please provide a minimum of two letters of reference. It is preferred that former instructors provide the letters, however, the department will accept letters from the applicant's advisors from work if the applicant has been out of school for a few years,

Please forward the application, official transcript(s), GRE report, statement of purpose and letters of recommendation to the Office of Graduate and International Admission.

Office of Graduate and International Admission
University of Southern California
Los Angeles, CA 90089
USA

The statement of purpose and letters of recommendation *may* be mailed to the Department separately to the following address.

Department of Aerospace and Mechanical Engineering
University of Southern California
854 W. 36th Place
Los Angles, CA 90089-1191
USA

Since application materials are usually mailed separately, please be sure the applicant's name is on each form. *Please note that verification and processing of materials by the Office of Graduate and International Admission may take four to six weeks.*

GENERAL INFORMATION FOR NEW GRADUATE STUDENTS

This information supplements and sometimes repeats information contained in the University Catalogue and the Graduate Assistant Handbook. In case of conflict between documents the University Catalogue always takes precedence. Consult both documents for the description of general requirements for the graduate degrees and duties of Graduate Assistants.

- **Master of Science students**: Follow program requirements in your chosen area of specialization as shown in the M.S. Curriculum.
- **Engineer students**: Total of 30 units with minimum 12 units of coursework in one area of engineering (major) and 9 units in another (minor) are required for graduation.
- **Ph.D. or prospective Ph.D. students**: A necessary condition for being in the Ph.D. program is to pass the Screening Examination (information enclosed), usually held at the end of a Fall and Spring semester. Students who enter the Graduate Program without an M.S. degree are expected to take the Screening Exam during their *third* semester at USC, while students who already hold an M.S. are expected to take the exam in their *first* or *second* semester here. It is also expected that students taking the Screening Exam have identified a general research area for a Ph.D. thesis and a potential academic advisor.
- **Students with RA/TA positions**: The department awards a limited number of Teaching Assistant (TA) and Research Assistant (RA) positions. The graduate committee evaluates applications some time in spring for the following fall semester. Decisions are made on the basis of departmental needs, available research funding, and comparison among applicants. TA positions are usually given to new graduate students for one year and sometimes extended for another year. Therefore, students interested in a Ph.D. degree, which normally takes longer than two years to complete, should identify sources of support other than a TA during their first year at USC. It is expected that after one year and not later than two years on a TA position, a Ph.D. student will have either external support or will secure an RA position in the Department. RA positions are at the discretion of individual faculty members and students are encouraged to explore possibilities of obtaining them directly with the faculty members.

Graduate Assistants are subject to the University rules described in the Graduate Assistant Handbook. The rules range from English Language Proficiency requirements to Policy on Academic Integrity and Policy Against Sexual Harassment. It is expected that all TA/RAs familiarize themselves with these rules and policies and abide by them.

Students holding RA/TA positions are required to enroll in AME 550 (Seminar).

REQUIREMENTS FOR THE M.S. DEGREE

At the Master's level, the department offers degrees in

- Aerospace Engineering
- Mechanical Engineering
- Aerospace & Mechanical Engineering (Dynamics & Control)

- Aerospace & Mechanical Engineering (Computational Fluid & Solid Mechanics)
- Product Development Engineering
- Systems Architecture and Engineering

The general M.S. programs in Aerospace and Mechanical Engineering allow for specialization in a number of topical areas, listed separately. In addition to the general M.S. degree programs the department also offers separate M.S. programs focused on single areas of Aerospace Engineering: Dynamics and Control, Computational Fluid and Solid Mechanics, Product Development Engineering, Systems Architecture and Engineering.

The minimum number of units required for the M.S. degree in a program without Thesis is 27. No more than three units of Directed Research (AME 590) can be applied to the 27-unit requirement. Exceptions are the programs with a design project that can have six units of Directed Research. For a program with Thesis four of 27 units are to be thesis (594ab); however the total number of research and thesis units cannot exceed eight. The maximum number of transfer credits that may be applied towards the 27-unit requirement, subject to departmental approval, is four units. A newly admitted student to regular standing may request a credit evaluation after official transcripts have been received by the Degree Progress Department (213) 740-1335. It is advisable to submit the course work for evaluation by the end of the first semester of enrollment at USC or before filing for the Master's Degree.

M.S. degree candidates in each area of specialization must satisfy core requirements (three or six units, depending on specialization), core elective requirements (three or six units), engineering mathematics requirements (six units), and in the Aerospace Engineering a breadth requirement (three units). The core courses for each specialization are divided into required and core electives. Required core courses are usually offered every academic year. Those which may not be offered regularly are grouped as core electives. Students must take the required core courses if they are offered during the duration of their program. A core elective may replace a required course only if the latter is not being offered during that time. The remaining courses, beyond those needed to satisfy the requirements, are taken as engineering technical electives. They are selected by a student according to her/his interests but it is recommended that they are from the list of core electives from the same area of specialization. A list of required and recommended courses is provided below and their description may be found in the USC Catalogue.

Listed coursework is intended only as a guideline for students wishing to achieve a competence in a specific area of Aerospace or Mechanical Engineering. For candidates who wish to specialize in some combination of the topical areas a Graduate Advisor may approve individual M.S. programs. Note that for general MSAE and MSME degrees neither the diploma nor transcripts reflect the specialization chosen – all students receive the same degree either in Aerospace or Mechanical Engineering – but, upon request, the department will provide a student with a letter specifying area(s) pursued in his/her studies.

The majority of the specializations are available through the Distance Education Network (http://den.usc.edu/), which allows students to obtain a MSAE degree from the convenience of their home or office.

PROGRAM REQUIREMENTS FOR THE GENERAL M.S. DEGREE IN AEROSPACE ENGINEERING

The Master of Science degree in Aerospace Engineering is designed to give students exposure to at least two different areas of Aerospace Engineering through concentration and breadth

requirements, and at the same time allowing students to pursue their interests through flexibility in the selection of technical electives.

The Master of Science degree in Aerospace Engineering allows for specialization in the following topical areas:

- Aerodynamics/Fluid Dynamics
- Aerospace Controls
- Aerospace Design
- Aerospace Structures
- Astronautics
- Computational Fluid Dynamics
- Hypersonics/Kinetics of Gases and Plasmas
- Propulsion
- Space Science

The courses listed are 3 units each.

REQUIREMENTS COMMON FOR ALL AREAS OF SPECIALIZATION

Applied Math Requirements: AME 525 Engineering Analysis & AME 526 Engineering Analytical Methods

Breadth Requirement: a required core course from a different area of specialization than the one being followed.

AERODYNAMICS/FLUID DYNAMICS

Core Requirements:	AME 530a	Dynamics of Incompressible Fluids
	AME 511	Compressible Gas Dynamics
Core Electives: (choose one)	AME 530b	Dynamics of Incompressible Fluids
	AME 531	Aerodynamics of Wings and Bodies
	AME 520a	Physical Gas Dynamics
	AME 535a	Introduction to Computational Fluid Mechanics
	AME 620	Aero and Hydrodynamic Wave Theory
	AME 621	Stability of Fluids
	AME 651	Statistical Theories of Turbulence
	AME 652	Turbulent Shear Flows

AEROSPACE CONTROLS

Core Requirements:	AME 532a	Flight Vehicle Stability and Control
	AME 541	Linear Control Systems II
Core Electives: (choose one)	AME 532b	Flight Vehicle Stability and Control
	AME 552	Nonlinear Control Systems
	AME 544	Computer Control of Mechanical Systems
	AME 545	Modeling and Control of Distributed Dynamic Systems

AEROSPACE DESIGN

Core Requirement:	AME 527	Elements of Vehicle and Energy Systems Design
Core Electives: (choose two)	AME 501	Spacecraft System Design
	AME 528	Elements of Composite Structure Design
	AME 408	Computer-Aided Design of Mechanical Systems
	or	Six units of a supervised design project

AEROSPACE STRUCTURES

Core Requirement:	AME 529	Aircraft Structures Analysis
Core Electives: (choose one)	AME 546	Basic Aeroelasticity
	CE 529a	Finite Element Analysis
	CE 541a	Dynamics of Structures
	AME 509	Applied Elasticity
	or	CE 507 Mechanics of Solids I
	AME 521	Engineering Vibrations II
	AME 559	Creep
	AME 560	Fatigue and Fracture
	AME 584	Fracture Mechanics and Mechanisms

ASTRONAUTICS

Core Requirements:	AME 501	Spacecraft System Design
	AME 585	Space Environments and Spacecraft Interactions
Core Electives: (choose one)	AME 473	Spacecraft Propulsion
	AME 477	Solar System Exploration
	AME 502	Systems for Remote Sensing from Space
	AME 511	Compressible Gas Dynamics
	AME 549a	Systems Architecting
	AME 549b	Systems Architecting
	AME 580	Orbital Mechanics I
	AME 581	Orbital Mechanics II
	AME 583	Spacecraft Attitude Dynamics

COMPUTATIONAL FLUID DYNAMICS

Core Requirements:	AME 530a	Dynamics of Incompressible Fluids
	AME 535a	Introduction to Computational Fluid Mechanics
Core Electives:	Choose two courses, each from a different category.	
	Numerical Methods	
	AME 535b	Introduction to Computational Fluid Mechanics
	AME 564	Computational Techniques in Rarefied Gas Dynamics

	Math 504ab	Numerical Solution of Ordinary and Partial Differential Equations

Fluid Mechanics

AME 530b	Dynamics of Incompressible Fluids
AME 511	Compressible Gas Dynamics
AME 520a	Physical Gas Dynamics

HYPERSONICS/KINETICS OF GASES AND PLASMAS

Core Requirements:	AME 520a	Physical Gas Dynamics
	AME 520b	Physical Gas Dynamics
Core Electives: (choose one)	AME 485	Molecular Gas Dynamics
	AME 511	Compressible Gas Dynamics
	AME 564	Computational Techniques in Rarefied Gas Dynamics
	AME 585	Space Environments and Spacecraft Interactions
	AME 586	Partially Ionized Plasmas
	AME 587	Gas-Surface Processes
	EE 539	Engineering Quantum Mechanics

PROPULSION

Core Requirements:	AME 511	Compressible Gas Dynamics
	AME 513	Principles of Combustion
Core Electives: (choose one)	AME 473	Spacecraft Propulsion
	AME 520a	Physical Gas Dynamics
	AME 436	Energy and Propulsion
	AME 514	Applications of Combustion
	ChE 530	Thermodynamics for Chemical Engineers

SPACE SCIENCES

Core Requirements:	AME 477	Solar System Exploration
	AME 520a	Physical Gas Dynamics
Core Electives: (choose one)	AME 485	Molecular Gas Dynamics
	AME 501	Spacecraft System Design
	AME 502	Systems for Remote Sensing from Space
	AME 585	Space Environments and Spacecraft Interactions
	AME 586	Partially Ionized Plasmas
	AME 587	Gas-Surface Processes

PROGRAM REQUIREMENTS FOR THE GENERAL M.S. DEGREE IN MECHANICAL ENGINEERING

For a Master's degree in Mechanical Engineering, the student should follow a coherent program of study in a chosen area of specialization. There are suggested programs that provide for focused education in four areas of concentration:

- Thermal and Fluid Sciences
- Engineering Design
- Mechanics and Materials
- Microelectromechanical Systems (MEMS)

In addition, the department also offers specialized M.S. programs: Dynamics and Control, Computational Fluid and Solid Mechanics, and Product Development Engineering. The details of the specific requirements in each specialization are given below. The courses listed are 3 units each.

REQUIREMENTS COMMON FOR ALL AREAS OF SPECIALIZATION

Engineering Analysis Requirements: AME 525 Engineering Analysis and AME 526 Engineering Analytical Methods.

THERMAL AND FLUID SCIENCES: COMBUSTION, FLUID DYNAMICS AND HEAT TRANFER

The Thermal & Fluid Sciences encompasses concentration in one of the following areas: (1) Combustion, (2) Fluid Dynamics, and (3) Heat Transfer. A coherent degree program in one of these concentrations will require four core courses (12 units), two required engineering analysis courses (6 units), two core electives (6 units), and one engineering elective (3 units) by advisement. A minimum cumulative GPA of 3.00 is required for graduation. Additional requirements may need to be met as per the University Catalogue.

Core Courses

COMBUSTION	*FLUID DYNAMICS*	*HEAT TRANSFER*
AME 436	AME 457	AME 457
AME 513	AME 511	AME 515
AME 514	AME 530a	AME 516
AME 530a	AME 535a	AME 517

Core Electives (take two courses from the following list, not duplicating the above selection)

AME 436	Energy and Propulsion
AME 457	Engineering Fluid Dynamics
AME 511	Compressible Gas Dynamics
AME 513	Principles of Combustion
AME 514	Advanced Topics in Combustion
AME 515	Advanced Problems in Heat Conduction
AME 516	Convective Processes
AME 517	Radiation Heat Transfer
AME 530a	Dynamics of Incompressible Fluids
AME 533	Multi-Phase Flows

AME 535a	Introduction to Computational Fluid Dynamics
AME 535b	Introduction to Computational Fluid Dynamics
AME 537	Microfluidics
AME 599	Spacecraft Thermal Control

Engineering Elective:
Take one 400-, 500- or 600-level graduate course by advisement

ENGINEERING DESIGN

The Engineering Design is a program concentration that focuses on engineering design process and techniques. A coherent degree program in this concentration will require two required engineering analysis courses (6 units), three core courses (9 units), two core elective courses (6 units), and two engineering electives approved by advisement (6 units). A minimum cumulative GPA of 3.00 is required for graduation. Additional requirements may need to be met as per the University Catalogue.

Core Courses

AME 503	Advanced Mechanical Design
AME 505	Engineering Information Modeling
AME 509	Applied Elasticity

Core Electives (take two courses from the following)

AME 404	Mechanical Engineering Problems
AME 501	Spacecraft System Design
AME 506	Design of Low Cost Space Missions
AME 527	Elements of Vehicle and Energy Systems Design
AME 541	Linear Control Systems II
AME 549a	System Architecting
CE 529a	Finite Element Analysis

Engineering Electives (take two courses from the following)

Approved (by advisement) 400-, 500-, or 600-level engineering courses.

MECHANICS AND MATERIALS

A coherent degree program in Mechanics of Materials will require two required engineering analysis courses (6 units), four core courses (12 units), one core elective course (3 units), and two engineering electives approved by advisement (6 units). A minimum cumulative GPA of 3.00 is required for graduation. Additional requirements may need to be met as per the University Catalogue.

Core Courses

AME 509	Applied Elasticity
AME 559	Creep
AME 560	Fatigue and Fracture
AME 584	Fracture Mechanics

Core Elective (take one course from the following)

AME 542	Theory of Plates (CE 542)
AME 588	Materials Selection
CE 529a	Finite Element Analysis

Engineering Electives (take two courses from the following)

Approved (by advisement) 400-, 500-, or 600-level engineering courses

MICROELECTROMECHANICAL SYSTEMS (MEMS)

Core Courses

AME 455	Introduction to MEMS
AME 537	Microfluidics
EE 607	Microelectromechanical Systems
BME 551	Introduction to Bio-MEMS & Nanotechnology

Core Electives: Take one courses from the following

AME 535a	Computational Fluid Dynamics
AME 520a	Physical Gas Dynamics
AME 564	Computational Techniques in Rarefied Dynamics

Engineering Electives: Take two courses from the following

Approved (by advisement) 400, 500 or 600 level engineering courses

SPECIALIZED DEGREE OPTIONS IN AEROSPACE AND MECHANICAL ENGINEERING

The department offers several specialized M.S. degrees that differ from general M.S. degrees by imposing stricter coursework requirements. While graduating students receive the same diploma as those following the general M.S. program, the specialization appears on a student's transcript.

MASTER OF SCIENCE IN AEROSPACE AND MECHANICAL ENGINEERING (COMPUTATIONAL FLUID AND SOLID MECHANICS)

The program prepares students for professional careers in engineering companies that develop products using computational tools of fluid and solid mechanics. The program also provides the necessary background for pursuing higher degrees, Engineer and Ph.D., in aerospace and mechanical engineering with specializations in computational fluid mechanics, computational solid mechanics and computational heat transfer. The degree course-work provides a necessary background in basic aerospace and mechanical engineering disciplines (solid mechanics, fluid mechanics, heat transfer), engineering mathematics and numerical methods. The capstone project courses, AME 535b and CE 551, provide practical examples using existing numerical programs to simulate structures, heat transfer and fluid flows as well as commercial mathematical packages for analyzing data.

Admission requirements follow the general admission rules for aerospace and mechanical engineering graduate programs. The program requires completion of a minimum of 27 units and a cumulative GPA of at least 3.0 for graduation. The program with a thesis requires 28 units, four of which are to be thesis.

Required Core Courses (24 units)

AME 404	Mechanical Engineering Problems
AME 509	Applied Elasticity, or
CE 507	Mechanics of Solids I
AME 525	Engineering Analysis
AME 526	Engineering Analytical Methods
AME 530a	Dynamics of Incompressible Fluids
AME 535a	Introduction to Computational Fluid Mechanics
AME 535b	Introduction to Computational Fluid Mechanics, or
CE 529a	Finite Element Analysis
CE 551	Computer-Aided Engineering Project

Selected technical electives from the following list or other electives approved by a graduate advisor: 3 units.

Technical Electives		**units**
AME 511	Compressible Gas Dynamics	3
AME 516	Convection Processes	3
AME 564	Computational Techniques in Rarefied Gas Dynamics	3
AME 590	Directed Research	1-12
AME 599	Special Topics	2-4, max 9

MASTERS OF SCIENCE IN AEROSPACE & MECHANICAL ENGINEERING (DYNAMICS & CONTROL)

The Master of Science with emphasis in Dynamics and Control educates and trains multidisciplinary professionals in the modeling, analysis, simulation and control of complex time-evolutionary systems. It is a program of study that encompasses advanced analytical dynamics, nonlinear dynamical systems, linear and nonlinear dynamics and vibrations, and linear and nonlinear control. The program equips students to apply their knowledge to a variety of complex systems encountered in nature and society, especially those in civil, mechanical and aerospace engineering and applied mechanics.

Students will be given advisement in the first semester of their study. In addition to AME 525 and AME 526, students are required to take the following core courses: AME 521, AME 522, AME 524, AME 541, AME 552. Elective courses can be chosen in areas of specific interest to the student such as orbital dynamics, spacecraft control, aircraft dynamics and control, chaos and chaotic dynamics, random vibrations, computer control of mechanical systems and robotics. The program provides the graduate student with a broad, well-rounded, advanced education that can be applied to many specific, technologically advanced fields in which dynamics and control play a pivotal role.

MASTER OF SCIENCE IN PRODUCT DEVELOPMENT ENGINEERING

The AME department offers this program as 'Product Development Technology,' and a similar program in 'Product Development Systems,' is available through the Industrial and Systems Engineering Department (ISE). A minimum of 27 units of course-work are required for this degree. This includes two required program core courses, two required "area of specialization" (AOS) courses, two AOS elective courses, and three general elective courses approved by an advisor. A minimum cumulative GPA of 3.0 is required for graduation. In addition to classroom lectures, emphases are placed on case studies and team projects. Students can choose a thesis option to develop new technology products or services of their choice as part of their degree program requirements.

Core Courses

AME 503	Advanced Mechanical Design
ISE 545	Technology Development and Implementation

Required AOS Courses

AME 505	Engineering Information Modeling
AME 525	Engineering Analysis
OR	
AME 526	Engineering Analytical Methods

AOS Technical Electives (select two)

AME 501	Spacecraft Systems Design
AME 506	Design of Low-Cost Space Missions
AME 549ab	Systems Architecting
AME 599	Advanced Topics in Product Development

Engineering Electives: Take three courses from the following

Approved (by advisement) 400, 500 or 600 level engineering courses

Students interested in Product Development Systems program are referred to the ISE Department (go to **http://mspde.usc.edu/** for details).

FILING FOR THE MASTER'S DEGREE

Please file for the Master's Degree in order to have your academic program approved and verified for ***completion*** of degree requirements. The application is available online at http://www.usc.edu/dept/engineering/ms_app_instructions, or to request a hard copy, please call 213 740-7755. Students should file this form by September 1 for December graduation, December 1 for May graduation, or April 1 for August graduation. Please return the form to the following address.

School of Engineering
Engineering Academic Affairs
330I Olin Hall
University Park Campus 90089-1454

REQUIREMENTS FOR THE PH.D. DEGREE IN AEROSPACE AND MECHANICAL ENGINEERING PROGRAMS

General Requirements for the Doctor of Philosophy

This degree is granted under the jurisdiction of the USC Graduate School. Students should also refer to the **Requirements for Graduation** section and the **Graduate School** section of the University Catalogue for general regulations. All courses applied toward the degree must be courses accepted by the Graduate School.

Course Requirements

Satisfactory completion of at least 60 units of approved graduate level coursework beyond baccalaureate, with a cumulative grade point average of at least 3.0 is required of all Ph.D. students in engineering. The 60 units minimum include research courses (590, 690, 790) and four units of 794ab Doctoral Dissertation. Ph.D. students in the AME department typically take at least 45 lecture units, i.e. regular, non-research courses. Students with a completed graduate degree from an accredited institution, e.g. an M.S. degree, can be admitted to a Ph.D. Program with Advanced Standing. For such students a minimum of 36 units of course work beyond that graduate degree, exclusive of 794 Doctoral Dissertation, will be required for the degree. The number of units taken at USC can be reduced by transferring graduate credits from another institution, as long as transfer work has not been counted towards student's previous degree. A maximum of six units can be transferred for students admitted with Advanced Standing and four for those without. Transfer units are subject to approval by the Degree Progress Department (for course-work taken at institutions in the U.S.) or by International Admission (for course-work taken at institutions outside the U.S.) and by the guidance committee.

Guidance Committee

The Ph.D. student's program of study is supervised by the guidance committee, consisting of five tenure-track faculty members, four from the major department and one from outside the department. The students are encouraged to select as early as possible the primary advisor, who will chair the guidance committee. Having a Ph.D. advisor is critical for the student's success. The advisor assists in the selection of the research topic, appropriate course-work, and monitors progress toward meeting degree requirements.

Screening Procedure

The initial admission decision admitting a student to the Ph.D. program is based on the student's previous academic records, Graduate Record Examinations scores and other evidence of scholastic abilities indicating promise for completing graduate studies. It is also a prerequisite that all Ph.D. students successfully complete the screening procedures designated by the department and described separately below. The screening exam must be taken before completion of 24 units, including research courses. Students who fail the screening procedure will be advised that they are not recommended to continue in the Ph.D. program and that any additional work may not be counted toward the degree.

Qualifying Examinations

The qualifying examinations are taken during the last semester of the second year of graduate study or, at the latest, in the fifth semester or equivalent. The Request to take the Qualifying Examinations must be filed in the semester prior to taking the examinations and at least 30 days before beginning the examinations. The examinations, administered by the guidance committee, are intended to determine the extent of the student's knowledge in basic science and engineering areas as well as the ability to do original and scholarly research. The format of the qualifying exam in the department of Aerospace and Mechanical Engineering is described separately below. The committee examines the candidate's overall scholarly ability as well as the ability to complete the proposed research together with its originality and potential for archival publication. The examinations may be scheduled at any time during the semester provided that all members of the committee are available to administer them. All portions of the examinations must be completed within 60 days.

After passing the qualifying examinations the Ph.D. student is admitted to candidacy by the Dean of Graduate Studies and the guidance committee becomes the dissertation committee. The dissertation committee may be reduced to three members, with at least one member being a tenured faculty member in the student's home department, and one must be a faculty member from outside the major department. After this step students will normally engage in at least one year of full-time graduate study and research on campus.

Doctoral Dissertation

An acceptable dissertation based on original investigation and supervised directly by the dissertation committee is required. The dissertation must show mastery of a special field, capacity for independent research and a scholarly result. Candidates are expected to keep all members of the dissertation committee informed of their progress at all stages of the dissertation. The department offers the opportunities for research experience in a variety of areas, representing state-of-the-art activity in the frontiers of science and engineering.

Defense of the Dissertation

After satisfactorily meeting all other requirements and after the research and writing of the dissertation are substantially complete, the Ph.D. candidate must pass a general final oral

examination devoted to the major field and to the topic of the dissertation. The examination will be conducted in such a manner as to determine to the satisfaction of the dissertation committee that the candidate has attained the stage of scholarly advancement and power of investigation demanded by the university for final recommendation to the doctorate. In the Aerospace and Mechanical Engineering the dissertation defense has a form of a technical seminar open to the general university community, followed by an optional closed examination session at the discretion of the committee. Only members of the dissertation committee have the authority to recommend the acceptance of the dissertation. The recommendation must be unanimous and all members of the committee must be present during the oral defense.

If the defense is satisfactory, the committee will sign the Approval for Final Typing Card; if additional work is required, the committee may postpone signing the Card to a later date, when the additional work is completed to the satisfaction of the committee.

THE Ph.D. SCREENING EXAMINATION

The screening exam is one component of the overall screening procedure that involves each student's complete academic/research record. The exam is offered twice a year, at the end of a Fall and a Spring semester. A Pass/Fail decision will be made for each student at the AME faculty meeting. The general policy is that the screening exam can be taken only once. Individual exceptions to this policy may be approved by the faculty on the basis of other significant indicators of research potential.

The screening exam must be taken before completion of 24 units, including research courses. Students must register for the exam in advance. *To register a student must be in a good standing, i.e., must be admitted to the Graduate Program (with all conditions cleared in case of a conditional admission) and must have a M.S. degree or at least 12 units of graduate work with GPA of 3.0 or greater.* The sign up deadline and the exact date of the exam are in the announcement usually posted about two months before the exam. For instance, the registration **Deadline** in Fall 2004 was October 29 and the exam was held on December 3. Students should sign up in person or by email with Ms. Marrietta Penoliar in the AME office: RRB-101, tel. 213-740-5353, email: marriett@spock.usc.edu. A sample exam copy can be obtained at that time. At the time of registration a student must declare his or her major and minor in which he/she wishes to be examined and provide information about current GPA and most recent GRE scores.

The exam is closed book. Candidates are expected to solve a total of four problems. One problem must be in Applied Mathematics and two problems in the chosen major. The fourth problem is chosen from the student's selected minor area. *The major and minor must be selected from the list of research areas enumerated in bold below. Note that some areas on the list are subdivided but the subdivisions cannot be selected, e.g. neither Classical Dynamics nor Orbital Mechanics is a correct choice but Dynamics is*. To facilitate preparation, the material covered in the screening exam, for some research areas, is identified below by a relevant AME course number and a typical textbook and/or names of the AME faculty members, who may be contacted for further information.

1. Applied mathematics

1.1 Complex variables (AME 525, Profs. Newton and Udwadia; ``Complex Variables and Applications" by Churchill and Brown)

1.2 Linear algebra (AME 525, Profs. Newton and Udwadia; ``Linear Algebra" by Shilov)

1.3 Differential equations (AME 526, Profs. Newton and Sadhal)

2. Combustion (AME 513 and AME 514, Profs. Egolfopoulos, Ronney, and Wang; ``Combustion" by Glassman or ``An Introduction to Combustion" by Turns)

3. Control theory (AME 451, ``Modern Control Engineering" by K. Ogata; AME 541, ``Linear Systems and Theory" by C.-T. Chen)

4. Design and Manufacturing (AME410/AME503 and AME505, Profs. Jin and Lu)

5. Dynamics

5.1 Classical dynamics (AME 524; Profs. Udwadia and Newton)

5.2 Orbital mechanics (Prof. Gruntman)

6. Elasticity and solid mechanics (Prof. Dravinski; AME 509, ``Deformation of Elastic Solids" by A.K. Mal and S.J. Singh)

7. Fluid Dynamics

7.1 Incompressible flow (AME 530a, ``Incompressible Flow" by Panton)

7.2 Compressible flow (AME 511, ``Modern Compressible Flow" by Anderson)

7.3 Computational Fluid Dynamics (AME 535a, ``Computational Techniques for Fluid Dynamics, Vol. I" by Fletcher)

8. Heat transfer

8.1 Conduction (AME 515; ``Heat Conduction" by Ozisik, Ch. 1-4,7-8)

8.2 Convection (AME 516; ``Convective Heat Transfer" by Burmeister, Ch. 5.3, 6.1-6.7, 7.1-7.6, 8.1-8.3, 12.1-12.2.)

8.3 Radiation (AME 517; ``Radiation Heat Transfer" by Siegel & Howell)

9. Materials (AME 559, AME 560; Profs. Langdon and Kassner)

10. Molecular and optical physics

10.1 Molecular physics (Prof. Kunc; ``Physical Gas Dynamics"
by Walter G. Vincenti and Charles H. Kruger, Chapters I-V)

10.2 Optics (Prof. Erwin; ``Laser Spectroscopy:
Basic Concepts and Instrumentation" by W. Demtroeder)

10.3 Rarefied gas dynamics (AME 485; Prof. Muntz)

11. Planetary and space science (AME 477 and AME 587; Prof. Shemansky)

12. Vibrations (AME 420 and AME 521; Profs. Flashner and Yang)

THE PH.D. QUALIFYING EXAMINATION

It is expected that the Qualifying Exam will be taken no later than one semester following completion of graduate courses or after the completion of 60 units of graduate work, whichever comes first.

The written portion of the examination consists of a research proposal and literature search on a topic chosen by the graduate student with the agreement of the potential Ph.D. advisor. The subject of the proposal may or may not be the same as the topic of the Ph.D. dissertation. The graduate student should expect to spend approximately two months to prepare the report; it should not exceed the equivalent of one semester's effort. It is suggested that the student aim at producing a report consisting of 30--50 pages of standard-sized typing, including figures. The typed document should include:

- a statement of the problem under consideration;
- a critical survey of the literature;
- the research goals of the project;
- a research plan;
- a discussion of preliminary results (if applicable).

The student is expected to write the report independently with the minimal input from the advisor. The typed document will be given to the members of the guidance committee at least one week before the scheduled date of the oral examination.

The oral portion of the Ph.D. Qualifying Examination consists of a formal defense of the written report in the presence of the guidance committee. The candidate first makes an oral presentation with appropriate visual aids (slides, viewgraphs, etc.). It is recommended that the candidate plan for a 30--40 minute presentation emphasizing a clear definition of the problem, pertinent related contributions from the literature, proposed problem area to be researched, and proposed approaches to be used in the research. The candidate should give careful attention to the formulation of the research problem and to the scientific bases which motivate various choices underlying the research plan. The presentation is followed by a discussion and question period on the topic of the proposal conducted by the members of the guidance committee. The discussion is aimed at assessing the ability of the candidate to do original research work and to think critically about the implication of results. It is not a defense of a significant fraction of the dissertation research. In the course of the discussion, members of the guidance committee may also choose to test the student's knowledge in his/her major area of research interest. The guidance committee may choose, in individual cases and based on perceived weaknesses in the student's performance, to conduct an oral examination testing mainly the student's knowledge of fundamentals.

FACULTY

All faculty members have Ph.D. degrees in science or engineering. Three are members of the National Academy of Engineering, one is a Fellow of the Royal Academy of Engineering, and twelve are Fellows of major professional societies.

Ron Blackwelder, Professor; Fellow of APS; experimental fluid mechanics, flight aerodynamics, turbulence

Fred Browand, Professor; Fellow of APS; experimental fluid mechanics, environmental and geophysical fluid mechanics, flight and transportation aerodynamics, turbulence

Charles Campbell, Professor; Two-phase flow, flow of granular material, heat transfer, slurry flows, fluidized beds, comminutron, particle fracture

Julian Domaradzki, Professor; computational fluid mechanics, environmental and geophysical fluid mechanics, turbulence

Marijan Dravinski, Professor; Propagation, and diffraction of elastic waves, geophysical wave propagation, earthquake engineering

Fokion Egolfopoulos, Professor; Combustion and propulsion

Henryk Flashner, Professor; Dynamics and control of systems, control of structurally flexible systems, analysis of nonlinear systems

Yan Jin, Associate Professor; Collaborative engineering, design theory and methods, knowledge-based design and manufacturing systems, intelligent agents for engineering support

Roger Ghanem, Professor; Stochastic and Computational Mechanics, Multiscale Modeling, Dynamical Systems

Michael E. Kassner, Professor; Fellow of ASM; Metal plasticity theory, creep, fracture, phase diagrams, fatigue, and semi-solid forming.

Terence G. Langdon, William E. Leonhard Professor of Engineering, Professor of AME, Materials Science and Earth Sciences, Fellow of RAE, Fellow of ASM; Fellow of ACeramS; Fellow of Inst. Phys; Fellow of Inst. Mater.; Mechanical properties of metals and ceramics, creep, superplasticity, ultrafine-grained materials, processing using severe plastic deformation

Stephen C.-Y. Lu, David Packard Chair in Manufacturing Engineering (Industrial and Systems Engineering, Computer Science); Collaborative design, innovative product development, manufacturing systems, concurrent engineering, knowledge-based expert systems, AI-based machine learning technologies.

Tony Maxworthy, Smith International Professor; Member of NAE; Fellow of APS; Fellow of the American Academy of Arts and Sciences; experiments in aerodynamics, environmental and geophysical fluid mechanics, turbulence, convection, and solidification, bio-fluid dynamics

E. Phil Muntz, Arthur B. Freeman Professor; Member of NAE; Fellow of AIAA; Fellow of APS; hypersonics, gas kinetics and plasmas, high performance materials, micro-mechanical devices, space science

Paul Newton, Professor; theoretical fluid mechanics, nonlinear dynamical systems, waves and stability

Denis Phares, Assistant Professor; Aerosol Mechanics, Aerosol Mass Spectrometry, Atmospheric Aerosols, Microscale Fluid Flow

Larry Redekopp, Professor; Fellow of APS; theoretical fluid mechanics, nonlinear waves and stability, geophysical fluid dynamics

Paul Ronney, Professor; Combustion, microscale thermal sciences, fluid mechanics, internal-combustion engines, low-gravity phenomena, radiative heat transfer

Satwindar Singh Sadhal, Professor, Fellow ASME; Drops and bubbles in acoustic fields, ther-mocapillary flows with drops in low gravity, levitation studies, non-contact thermophysical property measurement, fluid flow and heat transfer in microchannels.

Don Shemansky, Professor; astrophysics, space science, surface phenomena

Geoffrey R. Shiflett, Associate Professor; Kinematics and dynamics of mechanical systems, computer-aided design, optimal design techniques, microelectromechanical systems (MEMS)

Geoff Spedding, Associate Professor; geophysical fluid dynamics, animal aero- and hydro-dynamics, turbulence

Firdaus Udwadia, Professor (Civil Engineering, Mathematics, and Information and Operations Management); Dynamics and control, mechanics and mathematics, collaborative engineering, engineering management, structural dynamics, system identification

Bingen Yang, Professor; Fellow ASME; Dynamics, vibration and control of mechanical systems, distributed-parameter systems, modeling and control of space structures, computational mech-anics

Hai Wang, Associate Professor; Combustion chemistry, high-temperature chemical kinetics, soot formation and its effects on climate forcing, nano-material synthesis, characterization and modelling, transport theory of nanomaterials.

ADJUNCT PROFESSORS

Robert Brodsky,	Fellow of AIAA; Fellow of IAE; aerospace systems design.
Gerald Hintz,	Fellow of IAE; orbital dynamics.
John McIntyre,	Aerospace structures, orbital dynamics, control.
M. Oussama Safadi,	Structural Dynamics, finite element, stress analysis, fracture mechanics.
Eugene H. Trinh,	Director, Physical Sciences Research Division, NASA Headquarters, Washington DC.
James Wertz,	Fellow of AIAA; low-cost space missions, autonomous orbit control systems.

ASSOCIATED FACULTY WITH PRIMARY APPOINTMENTS IN OTHER DEPARTMENTS

Daniel Erwin, Associate Professor (Astronautics and Space Technology Division); advanced propulsion, hypersonics, gas kinetics and plasmas.

Mike Gruntman, Professor (Astronautics and Space Technology Division); Astronautics, spacecraft design and space missions, propulsion, space science and instrumentation, gas kinetics and plasmas.

Joseph Kunc, Professor (Astronautics and Space Technology Division); Fellow of APS; hypersonics, gas kinetics and plasmas, space science, molecular and radiative processes.

Sami Masri, Professor (Civil Engineering); Modeling and control of nonlinear systems, structural health monitoring .

Steven R. Nutt, Professor (Materials Science); Fellow of ACeramS; Composite materials, deformation and damage mechanisms of metal- and ceramic-matrix composites, interface structures and defects, electron microscopy

Costas Synolakis, Professor (Civil Engineering); computer tomography, free surface hydrodynamics.

DISTINGUISHED EMERITUS FACULTY

H.K. Cheng, Distinguished Professor Emeritus; Member of NAE; Fellow of APS; Fellow of AIAA; theoretical and computational fluid mechanics, flight aerodynamics, hypersonics, geophysical fluid mechanics, bio-fluid dynamics.

Abbreviations

AIAA: American Institute of Aeronautics and Astronautics
ACeramS: American Ceramic Society
APS: American Physical Society

ASM: American Society for Materials
ASME: American Society of Mechanical Engineers
IAE: Institute for Advancement of Engineering
Inst. Mater.: Institute of Materials (U.K.)
Inst. Phys.: Institute of Physics (U.K.)
NAE: National Academy of Engineering
RAE: Royal Academy of Engineering (U.K.)