The purpose of this handbook is to outline the policies and procedures of the graduate program of the Department of Mechanical and Aerospace Engineering of the University of Virginia. As such it should be viewed as a supplement to the University of Virginia Graduate Record, which summarizes the rules and regulations of the University and the School of Engineering and Applied Science (SEAS).
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Message from the Chairman

Welcome to the Department of Mechanical and Aerospace Engineering (MAE) at the University of Virginia, an organization dedicated to cutting edge research and the highest quality engineering education. We are pleased that you have come to MAE to pursue your graduate studies and will make sure you have an outstanding, intellectually-challenging, and productive educational experience.

The MAE Department is committed to providing you with a superior professional education, and instilling in you a desire to explore the frontiers of science and engineering within the context of lifelong learning. Our goal is to prepare you for a leadership position in order that you may function as a valuable, productive, responsible member of society. Together with dedicated, renowned faculty responsible for your education, you will pursue scientific and technological excellence in a stimulating pedagogical environment underpinned by the power of knowledge uncovered. We believe you should possess both breadth and depth in your education and we are concerned with your intellectual and personal well-being. We seek diversity among our students and value the varied cultural backgrounds and ethnic origins with which they enrich our department.

In the MAE Department you will find a balance between a tradition of excellence and a pioneering spirit of entrepreneurship in both education and research. Periodic revisions of our curricula keep us at the forefront of what is important to teach, learn and experience. Major, funded research activities maintain us at the cutting edge in various fields including dynamics and controls, solid-, fluid- and thermo-mechanics, nanomechanics, and bioengineering. Some of these activities have their homes in major laboratories such as the Aerospace Research Lab, the Center for Applied Biomechanics, the Bio-Thermo-Fluids Lab, the Micro-Scale Heat Transfer Lab, and the Rotating Machinery and Controls Lab.

The MAE Department is home to 26-tenured/tenure track faculty, 3-research faculty, 2 general faculty, about 300 undergraduate students and 72 graduate students, and 9 technical and administrative support staff. The Department offers Master of Science, Master of Engineering and Ph.D. degrees in Mechanical and Aerospace Engineering. Our primary classrooms, laboratories and offices are housed in an independent four-story building located on the Grounds of the University. Three of the laboratories mentioned above operate from off-campus sites devoted exclusively to engineering research.

I hope you find this information helpful. Please do not hesitate to contact any one of us (fellow student, faculty, or staff member) to help make MAE a happy, interesting productive home for you over the next few years.

H. Haj-Hariri
Professor and Chair
Department Policies and Organization

Background

The Department of Mechanical and Aerospace Engineering has three fields of study:

- Continuum Mechanics
- Dynamics/Controls
- Thermomechanics

New students should select an advisor from one of these fields of study during or prior to their first semester of study. Affiliating with a specific field does not preclude taking courses in other fields; in fact, all students are required to take courses in fields in addition to their major area. (See requirements under specific degree program)

A list of MAE faculty and their areas of interest is included in Appendix II. New graduate student should use this information to choose an advisor whose research interests most closely match his or her own interests.

The MAE Graduate Office, located in MEC 327, can provide you with forms, keys, and guidance concerning the procedures, deadlines, and regulations applicable to your degree program. Any questions or problems which arise that you cannot resolve satisfactorily with your advisor should be brought to the attention of the graduate office.

Torque Converter

A Torque Converter is the heart of an automotive automatic transmission. Laser velocimetry has been used to document the 3-D flow fields, including average throughflow, periodicity, secondary flows and separated regions over a wide range of operating conditions.
Department Policies
The following policies have been established concerning the use of equipment, supplies, and materials.

KEYS
Keys to the building and to the student offices are available from the MAE Graduate Office in MEC 327, and MEC 326. A replacement fee of $5.00 will be charged for EACH lost key.

OFFICES
Your advisor will normally assign offices. The office should be kept neat and clean as we often show visitors through the Department. Remember that someone else will occupy your office after you leave, so try to keep it nice. Office space is extremely limited, and can normally only be provided to those with research or teaching assistantships.

TELEPHONES
Telephones are provided in most graduate student office areas. Necessary research related long distance calls are made with a forced authorization code (FAC). The FAC number allows the cost of the call to be directly charged to the research contract. FAC numbers may be obtained from the faculty investigator of the research project. University policy prohibits personal long distance calls to be made at University expense. Personal long distance calls must be made "collect", by calling card, by credit card, or charged to your home telephone number.

OFFICE SUPPLIES
The Department DOES NOT supply paper, pencils, pens, or other office supplies to graduate students. Research laboratories may have office supplies for use on research projects.

COPY MACHINE
The photocopy machine can only be used with the proper copy card. The Department copy card, which is only for specific teaching assignments, can be found in MEC 326. Each research group typically has its own copy card. The department photocopy machine is available from 9am-5pm Monday through Friday only. Other machines are scattered throughout the University.

MAILBOXES
Graduate student mailboxes are located in MEC 344 (the mailroom). Each student will be assigned a mailbox for departmental communications and notices, etc. University mail service is NOT to be used for personal mail. Mailboxes should be checked on a regular basis.
E MAIL, WORD PROCESSING & COMPUTING FACILITIES

The Department of Information Technology and Communication (ITC) provides general purpose computing resources for the University of Virginia. Please obtain an account (http://www.virginia.edu/comp.html) promptly and read your mail daily, as this will be primary method by which the department will communicate important information to you.

TRAVEL

Your advisor can advise and assist you concerning research or Department related travel. It is very important to keep your boarding receipts when traveling by air.

LAB SUPPLIES

Supplies must be ordered through Ms. Fredia Kennedy in MEC 325, or the appropriate research lab secretary.

ADDRESS CHANGES

Please inform the graduate secretary, as well as the University, of any changes in your address or telephone number. It is important that we have an address at which you can be reached during the holidays and summer as well as the academic year. FOR THOSE GRADUATING, PLEASE LEAVE A FORWARDING HOME OR BUSINESS ADDRESS.

BUILDING USE AND SECURITY

We need your help and cooperation in deterring would-be thieves! Please observe the following procedures:

- Keep your office door locked whenever it is unoccupied.

- Teaching assistants must not leave until all students have left the laboratory and they must then secure all doors and windows.

- If you see someone carrying equipment from the building on nights or weekends, call the University Police (dial 911) and notify the Department Chair or Assistant Chair.

- Only recognized student organizations are permitted to hold private parties or other events in the building or Darden Court. All such functions must be scheduled and approved in advance by Assistant Dean W. Thurneck.

- Personal belongings are NOT covered under the University Insurance Policies. Check your home policy to see if you are covered.

CONFERENCE ROOMS

Conference Rooms are available for oral and written exams, research meetings, and other course or research functions. The Department conference room (MEC 305) can be reserved through Ms. Karen Harper room MEC 326. All other rooms must be reserved through Cathy Dean (924-3155).
Academic Policies

**Graduate Studies Committee**
The Graduate Studies Committee is responsible for all graduate-related matters in the Department. The Committee is made up of faculty members from all the various disciplines within the Department. The Graduate Committee reviews all degree programs of study. The Graduate Chair assigns the graduate teaching assistant positions (GTA's) to the undergraduate classes. The full committee periodically reviews graduate courses and recommends new course offerings to the faculty.

**Course Load**
Students receiving financial aid from the School of Engineering and Applied Science must be registered as a full time student, defined as at least 12 credit hours of lecture-laboratory courses and/or research per semester during the academic year, must maintain a grade point average of at least 3.0, and must maintain satisfactory progress toward a degree. During the summer, graduate research assistants must register for a minimum of 6 credit hours of research. Students receiving financial aid are not permitted to have other employment without prior approval of the Office of the Assistant Dean for Graduate Programs.

**Seminar Attendance**
The Department has a strong interest in making sure that every student is an active member in our community of scholars. As a requirement for receiving a degree, students in the MAE graduate program must attend at least 10 seminars during each academic semester they are enrolled on-grounds. Of these, at least 7 should be MAE Department seminars. At the end of each semester, each student will submit a list of seminars that were attended (seminar title, date, sponsoring organization) to the Department Chair. Students who fail to satisfy this requirement will be asked to account to the Department Chair for their lack of attendance.

**Graduate Course Drop Deadline**
The last date for dropping a graduate course is nine weeks after the start of the semester. (After this date, students may petition the Dean's Office for a W or WP upon concurrence of their instructor and advisor.)

**Probation and Dismissal Policy**
A graduate student will be considered to be on probation if his/her cumulative GPA for graduate work is less than 3.0 and will be notified of this situation by the Dean's Office. Graduate students on probation are usually ineligible for financial aid. A graduate student will be subject to dismissal if the cumulative GPA is not raised to 3.0 within one semester. Undergraduate courses and courses taken on a Pass/No Credit basis may not be used to meet requirements for a graduate degree and will not be used in computing the GPA.
Financial Support

Financial support may be provided by the Department in the form of a fellowship, teaching assistantship (GTA), or research assistantship (GRA). The student should consider such support an honor and make every effort to meet the requirements specified for such support. Financial aid may be terminated at any time if the Department or the faculty investigator feels the student is not performing to the professional standards expected of a graduate engineer.

Graduate Teaching Assistants are assigned to specific courses. Some preliminary preparation may be required before the beginning of the semester. At the end of the semester, the GTA should check with the faculty member in charge of the course to make sure that all duties have been completed. Complete instructions for GTA's will be issued. Generally, first year international students are not eligible for a GTA position.

Graduate Research Assistantship (GRA) support is provided for assistance on sponsored research contracts or grants. This work not only aids the research project but also may provide a topic for the student's thesis or dissertation. This financial aid is not a gift to the student. The student is expected to complete the work specified by the Investigator in a professional manner. The Investigator and the student should discuss what is to be expected from the student during the employment period. Masters students receiving financial assistance will normally be required to be enrolled in the M.S. (thesis) program. This is particularly true for students receiving a GRA.

Financial aid is not automatically renewable from one year to the next. It is the student's responsibility to make arrangements with the Investigator of his research regarding the possibility of continued employment for the next academic year.

All students receiving financial assistance are responsible for providing withholding tax information and a social security card to the school payroll office and completing Federal Employment Eligibility Form I9. Please report to the Budget Office for the School of Engineering and Applied Science in Room A205, Thornton Hall.

Students may not have any outside employment without permission from the Dean's Office. The student would need to send written notice requesting permission for additional work. The extra work must be explained. We must also have a support letter from the faculty funding the student. This must be done before the student accepts outside employment.
Graduate Curriculum and Degree Requirements

The faculty of the department strives to offer graduate courses that will challenge the students’ capabilities, inform them of cutting-edge innovations, and develop in them an appreciation of the deep beauty and history of our discipline. Toward these ends, our curriculum has three goals:

- To ensure that all graduates possess a broad knowledge of the fundamentals that underlie Mechanical and Aerospace Engineering.
- To ensure that all graduates have a deep knowledge within one of three fields of study.
- To provide sufficient flexibility within our program for interdisciplinary students, acknowledging the great diversity within MAE and its emerging areas.

Curriculum:
Graduate students in our program choose one of three fields of study for a concentration:

- Continuum Mechanics
- Dynamical Systems & Control
- Thermomechanics

Students in the MS and PhD program are required to take a certain number of courses from the field chosen, with this number depending upon the degree sought. Each field of study has a Core class associated with it as well as a number of Fundamentals classes. All PhD and MS students are required to take two out of three Core classes. Within their field of study, students are required to take three Fundamentals for the PhD degree and two for the MS degree. Students must also pass courses in Engineering Analysis (one for MS, two for PhD) that cover a broad array of analytic and computational techniques. These requirements do not apply to Masters of Engineering students (see below for details regarding this program).

Each Core course provides basic knowledge that underlies investigation in one of our three fields of study. These courses are:

- MAE 602 - Continuum Mechanics With Applications
- MAE 621 - Analytical Dynamics
- MAE 610 - Thermomechanics
Fundamentals courses provide a framework for advanced study in a field of study. These courses, arranged by field of study are:

<table>
<thead>
<tr>
<th>Continuum Mechanics</th>
<th>Dynamics/ Control</th>
<th>Thermomechanics</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAE 631 Fluid Mechanics I</td>
<td>MAE 652 Linear State Space Systems</td>
<td>MAE 611 Heat &amp; Mass Transport Phenomena</td>
</tr>
<tr>
<td>MAE 622 Waves</td>
<td>MAE 624 Nonlinear Dynamics &amp; Waves</td>
<td>MAE 612 Microscale Heat Transfer</td>
</tr>
<tr>
<td>MAE 607 Elasticity</td>
<td>MAE 755 Multivariable Control</td>
<td>MAE 636 Gas Dynamics</td>
</tr>
<tr>
<td>MAE 608 Constitutive Modeling of Bio Systems</td>
<td>MAE 753 Optimal Dynamic Systems</td>
<td>MAE 613 Kinetic Theory &amp; Transport Properties</td>
</tr>
<tr>
<td></td>
<td>MAE 623 Vibrations</td>
<td></td>
</tr>
</tbody>
</table>

To accommodate interdisciplinary investigations, our curriculum also recognizes certain courses called *Foundations* as important to graduate study. These courses consist of fundamental and broadly applicable knowledge in areas related to, but transcending, Mechanical and Aerospace Engineering (e.g., chemistry, physics, biology, mathematics). Please see the web link for a list of acceptable foundations courses.

The five Engineering Analysis courses offered cover a variety of analytical and computational results useful for investigation across the departments fields of study:

- MAE 641: Engineering Analysis I
- MAE 642: Engineering Analysis II
- MAE 643: Probability & Statistics for Engineers
- MAE 644: Applied Partial Differential Equations
- MAE 671: Finite Element Analysis
# Graduate Course Offering Schedule

## Fall Semester

<table>
<thead>
<tr>
<th>Even Year</th>
<th>Odd Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAE 602  Continuum Mechanics</td>
<td>MAE 602  Continuum Mechanics</td>
</tr>
<tr>
<td>MAE 621  Analytical Dynamics</td>
<td>MAE 621  Analytical Dynamics</td>
</tr>
<tr>
<td>MAE 610  Thermomechanics</td>
<td>MAE 610 - Thermomechanics</td>
</tr>
<tr>
<td>MAE 652  Linear State Space Systems</td>
<td>MAE 652  Linear State Space Systems</td>
</tr>
<tr>
<td>MAE 612 Microscale Heat Transfer</td>
<td>MAE 636  Gas Dynamics</td>
</tr>
<tr>
<td>MAE 632  Fluids II</td>
<td>MAE 715  Combustion</td>
</tr>
<tr>
<td>MAE 685 Measurement &amp; Instrumentation</td>
<td>MAE 634  Transport in Bio Systems</td>
</tr>
<tr>
<td>MAE 641  Engineering Analysis I</td>
<td>MAE 625  Multi-Body Mechanical Systems</td>
</tr>
<tr>
<td>MAE 687  Applied Engineering Optics</td>
<td>MAE 641  Engineering Analysis I</td>
</tr>
</tbody>
</table>

## Spring Semester

<table>
<thead>
<tr>
<th>Even Year</th>
<th>Odd Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAE 607 Elasticity</td>
<td>MAE 607 Elasticity</td>
</tr>
<tr>
<td>MAE 755 Multivariable Control</td>
<td>MAE 622 Waves</td>
</tr>
<tr>
<td>MAE 631 Fluid Mechanics I</td>
<td>MAE 753 Optimal Dynamic Systems</td>
</tr>
<tr>
<td>MAE 611 Heat and Mass Transport Phenomena</td>
<td>MAE 631 Fluid Mechanics I</td>
</tr>
<tr>
<td>MAE 608 Constitutive Modeling Bio</td>
<td>MAE 611 Heat and Mass Transport Phenomena</td>
</tr>
<tr>
<td>Course Code</td>
<td>Course Title</td>
</tr>
<tr>
<td>--------------</td>
<td>--------------------------------------------------</td>
</tr>
<tr>
<td>MAE 623</td>
<td>Vibrations</td>
</tr>
<tr>
<td>MAE 672</td>
<td>Computational Fluid Dynamics</td>
</tr>
<tr>
<td>MAE 671</td>
<td>Finite Element Analysis</td>
</tr>
<tr>
<td>MAE 642</td>
<td>Engineering Analysis II</td>
</tr>
<tr>
<td>MAE 643</td>
<td>Applied Probability and Statistics</td>
</tr>
<tr>
<td>MAE 624</td>
<td>Nonlinear Dynamics and Waves</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>MAE 613</td>
<td>Kinetic Theory and Transport Properties</td>
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<td>MAE 642</td>
<td>Engineering Analysis II</td>
</tr>
<tr>
<td>MAE 643</td>
<td>Applied Probability and Statistics</td>
</tr>
<tr>
<td>MAE 703</td>
<td>Injury Biomechanics</td>
</tr>
</tbody>
</table>

Pre Impact position of a crash test dummy at the UVA Center for Applied Biomechanics.
The department offers two Master's degrees, a Master of Science, which requires a thesis, and a Master of Engineering. Students receiving financial support from the Department in the form of a GRA, GTA or a fellowship will generally be required to take the MS (thesis) option. Masters students enrolled in the MS program must obtain the agreement of an advisor to supervise an MS thesis. Degree requirements set by the Engineering School are given in the SEAS Graduate Record and are in addition to Mechanical and Aerospace Engineering Department requirements.

**Degree Requirements**

The MS degree requires completion of at least one semester in residence at UVA as a full-time student. MS degrees require **24 course hours plus a thesis**. In addition, the MS student will be required to take a final oral examination after the thesis has been submitted. This examination normally covers the research done for the thesis but may also include questions from related coursework. ME degrees require **30 course hours**. All students must have an approved plan of study.

**Course Requirements – Master of Engineering**

- 30 credits of graduate coursework
- 18 credits from Mechanical and Aerospace (MAE) graduate classes
- No more than 9 credits from 500 level classes
- No more than 6 credits from 500 level MAE classes

**Course Requirements – Master of Science**

- Two CORE classes
- Two FUNDAMENTALS classes from the students field of study
- One other CORE, FUNDAMENTALS, or FOUNDATIONS classes*
- One ENGINEERING ANALYSIS class
- Any three graduate classes, one of these must be 600 or higher level.

* Fundamentals classes from the field of study may not be used.
Time Limit for Degree Completion
The time limit for completion of the MS is five years after admission. The time limit for the ME is seven years.

Selection of Advisor
Students should select an advisor as soon as possible, but no later than the second week of graduate study. (Form G104)

Masters Degree Plan of Study
All Masters students are required to complete an approved course plan of study (form G101) with their advisor's approval and to submit to the MAE Graduate Office during the first semester. When properly completed and approved, it represents the course curriculum for the degree. For an ME degree, 30 credits of graduate courses are required. For MS degree 24 credits of coursework plus 6 credits of MAE 898, thesis research is required. A REVISED PLAN OF STUDY MUST BE SUBMITTED should the course curriculum change.

Transfer Credit
Master of Science candidates may transfer a maximum of six credits of approved graduate courses into the program. Master of Engineering candidates may transfer twelve hours. Students in the Cooperative Graduate Engineering Program may include up to fifteen hours of credit with grades of C or better from participating institutions. However, an overall GPA of 3.0 must be maintained. The student must fill out form G112 to request approval of transfer courses, along with a transcript. Students not enrolled in the Cooperative Graduate Engineering Program may only transfer courses with a grade of B or better. Requests for transfer credit should be accompanied by a plan of study, and are due by the end of the first semester of graduate study.

Application for Graduation
All students are required to complete and submit an application for degree form G113 by the following deadlines: October 1 for January graduation, February 1 for May graduation, and June 1 for August graduation.

Admission into PhD Program after the Masters Program
Masters students already enrolled at UVA who would like to be considered for admissions into the PhD program after completion of the Masters degree are required to complete form G123, along with a recommendation for admission into the PhD program.
Thesis Preparation and Examination Announcements
(MS Students Only)
Before beginning to write a thesis the student should obtain and read form G-122, Instructions for Thesis Preparation, which outlines the approved school format and requirements. Once the thesis has been written and approved by the advisor, a public oral defense of the thesis is required. The examining committee for this oral defense consists of a minimum of three faculty members. The Chair of the committee cannot be the advisor and must be from the MAE Department. This examining committee is selected by the student and the advisor and approved by the Graduate Committee Chair. (Form G105)

The format of the public oral defense is a presentation by the student followed by a question and answer period. The student presentation portion of the defense should not exceed 30 minutes.

The student is responsible for reserving a suitable conference room, and should send the abstract to the graduate coordinator at least 7 days prior to the date of the exam to announce the exam. The completed thesis should be delivered to each member of the examining committee at least 14 days prior to the date of the final oral exam. After your thesis defense your committee must complete a Report of Thesis Final Examination on form G110 (MS). This form should be accompanied by a completed MAE Course Requirements Master of Science form. These forms are due at least 4 days before graduation date.

After successfully completing any changes that need to be made to the thesis, take three copies of the final revision of the thesis on acceptable permalife paper signed by author and committee members in manila envelopes with the necessary information (see thesis check list) on the front to Tammy Ramsey, Graduate Office, Thornton Hall. This must be done at least 10 days before graduation date. She will prepare your paperwork and once all paperwork is complete you will go to Printing Services in Alderman Library and drop your thesis off to be bound. At this time you must pay to have these three official university copies bound. You will get a receipt. Your binding receipt must be given to Tammy Ramsey at least 2 days before your graduation date.

For more detailed information on preparation of the written document please refer to the section entitled “Instruction for Thesis (and Dissertation) Preparation.”

Appointment of Committee Requirements:
MS students must select an advisor and, in consultation with the advisor, and examining committee during their first semester of Master study. The advisor normally is a faculty member in the student’s primary area of interest. The examining committee should consist of at least 3 faculty. Note, the purpose of the examining committee is to provide the student with a broad base of guidance in formulating and executing a plan of study and thesis project. Should the student’s interest change, the examining committee can be reconstructed as appropriate. Selection of an advisor is completed on form G104. Selection of examining committee is completed on form G105.
Masters Degree Forms

The following is a list of required forms that must be filed with the graduate office according to SEAS deadlines. Forms may be obtained from the MAE Graduate Office or the graduate office located in Thornton Hall. A sample of each form is shown in Appendix III.

First Semester
- Appointment of Advisor G-104
- Master's Degree Plan of Study G-101
- Transfer of Credit (if applicable) G-112

Each Semester -- as Necessary
- Revised Plan of Study G-101

Final Semester
- Degree Application G-113

Final Semester -- MS ONLY
- MAE Course Requirements – Master of Science
- Appointment of Examining Committee G-105
- Announce Thesis Defense
- MS Thesis Final Examination Report G-110

Vibration Thrust
DOCTOR OF PHILOSOPHY DEGREE REQUIREMENTS

General Degree Requirements
PhD students must complete at least three years or equivalent of graduate study after the baccalaureate degree, or two years or equivalent after the Master's degree. At least two regular semesters beyond (not including summer) the Master's degree must be in full residence at the University of Virginia in Charlottesville.

Course Requirements – Doctor of Philosophy

• Two CORE classes
• Three FUNDAMENTALS classes from the students field of study
• Two other CORE, FUNDAMENTALS, or FOUNDATIONS classes*
• Two ENGINEERING ANALYSIS classes
• Any three graduate classes, one of these must be 600 or higher level.

*Fundamentals classes from the field of study may not be used.

Doctoral students must also have an approved plan of study. This must include 72 hours of research and graduate level coursework beyond the baccalaureate.

Time Limit
The time limit for completion of the PhD. is 7 years after admission into the doctoral program.

Direct Pursuit of PhD:
If a PhD candidate wishes to directly pursue a PhD without a Masters degree, they may do so by completing a request for admission to the PhD program – form G123.
Selection of Advisor and Advisory Committee

PhD students must select an advisor and, in consultation with the advisor, an advisory committee during their first semester of doctoral study. The advisor normally is a faculty member in the student's primary area of interest. The advisory committee should consist of at least 4 faculty, and one must be from outside the MAE Department. The Chair of the advisory committee must be an MAE faculty member. Note, the purpose of the advisory committee is to provide the student with a broad base of guidance in formulating and executing a plan of study and dissertation project. Should the student's interest’s change; the advisory committee can be reconstituted as appropriate. Selection of an advisor is completed on form G104. Selection of an advisory committee is completed on form G103.

PhD Plan of Study

All PhD students are required to complete and submit an approved course plan of study on form G102 by the end of the first semester of doctoral study. The student must meet with his/her advisory committee to determine a plan of study. Before this meeting the student should meet with his or her advisor and prepare a preliminary academic outline consisting of previous degrees, proposed PhD field of study, list of completed graduate courses, a copy of a transcript of graduate and undergraduate courses, and a list of proposed courses for the PhD degree. The plan of study must include at least 24 hours of MAE 999 dissertation research, and at least 12 hours of graduate level coursework beyond the master's degree. The student must satisfy the department course requirements, as previously outlined, but these are the minimum course hour requirements. The student's advisory committee may require additional courses.

While most PhD students will complete a Master's Degree before entering the PhD program, students may be admitted directly to the PhD program from a Baccalaureate program with the approval of the Graduate Studies Committee.

Transfer of Credit

Students should discuss courses acceptable for transfer of credit with their advisor at the same time the plan of study is developed. Form G112 is required for transferring courses along with a catalog statement of course level and grading systems that justifies classification of these courses as doctoral level courses. Also, an official copy of your transcript from the college where course(s) was taken is required.
PhD Qualifying Exam

Purpose:

The purpose of the comprehensive examinations shall be to evaluate the ability of the student to think and to critically evaluate research in his/her field.

General Guidelines:

- The exam will be administered once a year, in early September. The scheduling of any required reexaminations will be done by the examination committee, but must occur by the end of that same semester.
- The exam must be taken not later than the first offering occurring one year after the student begins the PhD program. An Examination Committee appointed by the Graduate Studies Committee and excluding the student’s research advisor will conduct the exam.
- The Examination Committee will consist of 4 or 5 members. The Examination Committee will contain at least one expert in the student's field of research interest. The Graduate Studies Committee must approve experts from outside the University.
- The oral exam will consist of a formal seminar during which the student will discuss an existing paper in the literature, chosen in the student's area of research by the Examination Committee. The seminar will be followed by a period of formal questioning conducted by the Examination Committee.
- Two written exams must be taken, unless exempted via the paragraphs in the section on Written Examinations below. One must come from the following list of three exams:
  - Dynamics and Control
  - Continuum Mechanics
  - Thermo-Mechanics

The second exam must come from the following list:
  - one of the other three exams listed above
  - APMA (applied mathematics)
  - an exam in an outside area

The outside area exam must be approved by the Graduate Studies Committee at least 6 months prior to the initiation of the examination and will be written and graded by faculty in the outside area. A student will be considered exempt from either, or both, of the written exams based on strong performance in a number of prescribed courses in that area. Lists of prescribed courses and levels of minimum performance for all areas are established by the Graduate Studies Committee. In order to establish a list of prescribed courses for a new outside area, the following two rules will apply:

1. The student's PhD Advisory Committee must obtain a list of fundamental
courses from faculty teaching in that area and must present this list to the Graduate Studies Committee.
2. This list of courses must be approved by the Graduate Studies Committee at least 6 months prior to the initiation of the examination.

**Written Examinations:**

Written examinations will be taken in two areas, one of which must be Dynamics & Control, Continuum Mechanics, or Thermo-Mechanics; however, the student may be considered exempt from either or both of these examinations if the prescribed courses and minimum levels of performance listed below are satisfied.

* **Dynamics & Control**

A- or better in any two of the following courses:
- MAE 621 Analytical Dynamics
- MAE 652 Linear State Space Systems
- MAE 624 Nonlinear Waves & Dynamics
- MAE 753 Optimal Dynamical Systems
- MAE 755 Multivariable Control
- MAE 623 Vibrations

* **Continuum**

A- or better in any two of the following courses:
- MAE 602 Continuum Mechanics
- MAE 631 Fluids I
- MAE 607 Elasticity
- MAE 622 Waves
- MAE 608 Constitutive Modeling of Biosystems
* Thermo-Mechanics

A- or better in any two of the following courses:
- MAE 610 Thermo-Mechanics
- MAE 611 Heat and Mass Transport Phenomena
- MAE 612 Micro-Scale Heat Transfer
- MAE 613 Kinetic Theory and Transport Properties
- MAE 636 Gas Dynamics

* Applied Mathematics

A- or better in both of the following courses:
- APMA 641, Engineering Mathematics I
- APMA 642, Engineering Mathematics II

* Written Examinations in Outside Areas: An outside area examination, including a list of courses and levels of minimum performance for exemption from that examination, must be approved by the Graduate Studies Committee at least 6 months in advance of the examination. In order to establish a list of prescribed courses for exemption from a new outside area exam, the student's PhD Advisory Committee must obtain a list of fundamental courses from faculty teaching in that area and must present this list to the Graduate Studies Committee for their approval. Lists of approved outside area exams and requirements for exemption from those exams will be maintained as attachments to this document.

  * Petitions for substitution of the above courses by courses taken outside the university will be considered by the Graduate Studies Committee.
  * The chairman for each written examination area will provide the student with the format of the written exam at the student's request.
Oral Examinations:

Guidelines for selection of the "expert" on the Examination Committee and the paper for oral presentation:

1. To determine the area for the research paper, the student should provide the Examination Committee a written statement of his/her research area, with keywords, 3 months in advance of the scheduled exam. The advisor may make suggestions for research papers to be considered for presentation at this time.

2. Candidates for the "expert" in the student's research field should be recommended by the advisor, in writing, along with credentials, 3 months in advance of the exam. The final selection of the "expert" will be made by the Examination Committee more than 2 months in advance of the exam.

3. The Examination Committee will select the paper for oral presentation by the student. The chosen paper should be often cited or referenced. The student's faculty advisor will be consulted for the suitability of the selected paper. The student will be informed of the paper selected for presentation at least 3 weeks before the scheduled oral presentation.

Format of oral presentation:

1. The oral presentation shall be a formal, public presentation of the selected research paper. The presentation will be approximately 1 hour in length and will be addressed primarily to the Examination Committee, some of whom will not be experts in the field.

2. The presentation shall include the following:

   a. Discussion of the work done in the field prior to the publication (i.e., put the paper into historical perspective).

   b. Presentation of the paper in a standard format (i.e., introduction, approach, results, conclusions, etc).

   c. Critique of the paper. This should include a discussion of any errors, incorrect or unjustified assumptions, alternative approaches, etc.

   d. Discussion of the impact/significance of the paper to the field.

   e. Review of the progress in the field since the publication of this paper.
Evaluation of oral presentation:

1. The public presentation will be followed by a closed question/answer session conducted by the Examination Committee. The faculty advisor may be present at the closed session, but may not participate in the questioning or answering.

2. Performance on the oral exam will be evaluated primarily on the technical content of the presentation and how well each of the points, 2a-2e above, were addressed; however, the quality of the presentation will also be considered in the overall evaluation.

The examining committee should be appointed and approved on Form G105 at least one week in advance of the exam, and the report on the examination, form G106, should be filed within one week after the conclusion of the exam.

![Flow Simulation](image)

The flow in the end-space of a concentric tube test section simulating the tip of a magnetically guided catheter.
**Dissertation**

After the student has been admitted to PhD study, the student should work with his/her advisor and define a dissertation topic. A dissertation proposal based on this topic must be submitted to the student's advisory committee.

After successfully defending your dissertation proposal, you apply for admission to candidacy for the PhD degree using form G108. This must be done at least one semester before you expect to receive your degree.

The department requires a public oral defense after the student has completed his or her dissertation to the satisfaction of his/her advisor. The examination committee will include the candidate's advisory committee. The complete committee should:

- Consist of a minimum of five faculty members (or outside experts within the student’s field)
- One member should represent a related field
- One member must be from outside the MAE department
- The chair of the committee must be an MAE faculty

**The examining committee is approved using form G105.**

The format of the oral defense is a presentation by the student followed by a question and answer period. The student presentation portion of the defense should not exceed 45 minutes.

Before beginning to write a dissertation, the student should obtain and read form G-122, Instructions for Thesis Preparation, which outlines the approved school format and requirements. Prior to completion of the final dissertation, typed copy should be submitted to Tammy Ramsey (complete except for minor typographical errors) to be checked for format and returned to candidate.

The completed dissertation must be delivered to each member of the examining committee at least 14 days prior to the defense. The student is responsible for reserving a suitable conference room, and should send the abstract to the graduate coordinator at least 7 days prior to the defense for public announcement.

After your dissertation defense your committee must complete a Dissertation Final Exam (oral defense) Report on form G-111. This form should be accompanied by a completed MAE Course Requirements – Doctor of Philosophy form. These forms are due at least 4 days before graduation date.

After successfully completing any changes that need to be made to the thesis, take three copies of the final revision of the thesis on acceptable permalife paper signed by author and committee members in manila envelopes with the necessary information (see thesis check list) on the front to Tammy Ramsey, Graduate Office, Thornton Hall. This must be done at least 10 days before graduation date.
She will prepare your paperwork and once all paperwork is complete you will go to Printing Services in Alderman Library and drop your thesis off to be bound. At this time you must pay to have these three official university copies bound. You will get a receipt. Your binding receipt must be given to Tammy Ramsey at least 10 days before graduation date.

**Application for Graduation**
All students are required to complete and submit an application for degree form G113 by the following deadlines: October 1 for January graduation, February 1 for May graduation, and June 1 for August graduation.

**Publications**
Regular publication and presentation of scholarly work is an expected part of any graduate level research program.

Picture of artificial heart demonstrating "squeezing" action of left ventricle with pressure gauges attached; used in mock human circulatory loop testing.
PhD Forms and Announcement Requirements
The following is a list of requirements and forms that must be submitted to the graduate office according to SEAS deadlines. See page 37 of this handbook. Forms may be obtained from the MAE Graduate Office (MEC 327) and the Graduate Office located in Thornton Hall. (A108.)

First Semester (Revise as necessary)
Appointment of Advisor G-104
Appointment of Doctoral Advisory Committee G-103
Doctoral Degree Plan of Study G-102

Comprehensive Exam (one year after being admitted to PhD program.)
Appointment of Examining Committee G-105
Report of Comprehensive Exam G-107

Dissertation Proposal (minimum of one semester before graduation)
Appointment of Examining Committee G-105
Announcement of Proposal to Faculty
Report on Dissertation Outline/Admission to Candidacy G-108

Final Semester
MAE Course Requirements – Doctor of Philosophy
Degree Application G-113
Appointment of Examining Committee G-105
Announcement of Defense to Faculty G-105
Dissertation Final Exam (Oral Defense) Report G-111
Dissertation Submission and Binding Receipt

Please note: all forms should be submitted to the MAE Graduate Office.

Airfoil Heaving
INSTRUCTIONS FOR THESIS (AND DISSERTATION) PREPARATION

These instructions apply to candidates for both the Master's and Doctor's degrees. The term thesis as used here refers to both the Master's thesis and the Doctor's dissertation. The term advisor refers to both the Master's faculty advisor and the Doctor's advisory committee.

I. Writing and Submission:
Three major steps should be observed in reporting the research completed for a graduate degree: submission of the research proposal and thesis outline (for Ph.D. students only), defense of the thesis, and the final thesis copies submitted for binding.

1. A typed copy of the detailed proposal and outline must be submitted to the Office of the Dean by the specified date. An individual copy of the proposal must also be given to each advisory committee member. (This requirement is for Ph.D. students ONLY).

2. Prior to your final defense, bring a copy of your thesis/dissertation to A-108, Thornton Hall (Graduate Records) for a format check.

3. Three copies of the final revision of thesis, signed by the author and the thesis advisor or advisory committee chairman, in manila envelopes, must be submitted to the Graduate Records Office, A-108, Thornton Hall by the specified date. This date will be different for each graduating session.

II. Form:
The specifications stated therein are acceptable to the School of Engineering and Applied Science unless stated otherwise below. Samples of engineering thesis are available in the University of Virginia Libraries or Departmental Offices. In addition to these general requirements, there are certain special requirements of the School of Engineering and Applied Science.

1. A standard type with 10 or 12 characters per inch must be used throughout the thesis. If there are any questions, a sample of type may be submitted to the Graduate Records Office for approval before typing of the thesis is started. All theses must be typed, double space, on a good grade of white bond paper, 8 1/2" x 11" sheets. Copies that are not clear and readable will be rejected. It is preferable that all photos are original prints unless reproductions with a resolution equal to the original print can be supplied.

2. All copies must be on thesis quality paper. A listing of acceptable papers can be obtained from the Graduate Office, A-108, Thornton Hall.
3. A margin of 1 1/2" inches must be maintained on the left side. A margin of 1" inch must be maintained on the top, right side, and bottom of each page. The text and footnotes should be kept within these margins. The page numbers are to be placed in the top right hand corner of the page.

4. The thesis should start with a title page, immediately followed by an approval page. Samples of both special pages are attached.

5. A complete list of Symbols should be given following the list of figures. These symbols should be listed in alphabetical order, and if both Arabic and Greek letters are used, all the Arabic Symbols should be listed first and these followed by the Greek (and others in order, if used).

6. References should be numbered consecutively throughout the text of the thesis. These numbers will refer to a numbered bibliography, which should immediately follow the thesis text. Reference by name of author and date of publication is also acceptable. However, footnotes (as distinguished from references) should be placed at the bottom of the page of which they occur.

7. Figures should be inserted in the text of the thesis so each figure follows its text reference as closely as possible. They should not be collected in a separate section at the end of the thesis. Figures and graphs should be centered within the margins specified above. In any authorized deviation the binding margin must be wide enough to permit binding without obscuring any part of the figures, graph or text.

8. Both Master’s and Doctoral students must prepare a thesis abstract of not more than 600 words and submit this abstract with their thesis. The abstract should follow the signature page.

9. Doctoral students must also fill out a Survey of Earned Doctorate Form and a Microfilm Agreement. These forms may be obtained from the Graduate Records Office.

III. Deposit of Official Copies:
Three bound copies of the final thesis are necessary, one for preservation in the archives of the University of Virginia, one for the department, and one for the technical reference use in the Library of the School of Engineering and Applied Science. Current information on procedures and costs for binding and microfilming may be obtained from the Graduate Records Office.
A fourth copy of the final thesis, either bound or unbound, may be required by the thesis advisor for personal use. If the author wishes one or more bound copies for personal use, these arrangements can be made with Printing Services in Alderman Library. Titles of all accepted theses will be listed in the appropriate volume of the University's Publications and Research record. Thesis material which is published as a report or in scientific journals should have proper credit given the University of Virginia.

**IV. Joint Efforts:**
When thesis research involves the joint efforts of two or more persons, it becomes the responsibility of the degree candidate to show responsible charge of the work covered by the thesis. For such material to be acceptable the candidate must have performed work demonstrating ability to carry out an investigation and the analysis of the results must be done by the candidate. For such joint work the tentative thesis should include an inserted sheet (not a part of the final thesis and hence not carrying a page number) clearly explaining to what extent others participated in the work and how the candidate's experimental work and analysis meet the requirements for an acceptable demonstration of ability.

Problems which arise in planning or preparing the thesis may be taken first to the student's thesis advisor; if uncertainty still remains, the student or advisor is required to contact the Graduate Records Office, A-108 Thornton Hall.

**THESIS / DISSERTATION APPROVAL CHECK-LIST**
1. The Engineering School requires three (3) copies of dissertations and theses. An original is not required.

2. IT IS EXTREMELY IMPORTANT THAT ALL COPIES BE ON ACCEPTABLE BOND PAPER. (Any bond paper that is 25% cotton is acceptable).

3. Each copy must be submitted in a labeled manila envelope with the following information on the front of each:
   a). Your name
   b). Shortened theses/dissertation title of no more than 36 characters including spaces
      This shortened title appears on the spine of the binding.
   c). Degree date i.e., January 2000, May 2000, August 2000
   d). Your degree and school

4. DISSERTATIONS
   a). A microfilm agreement must accompany your dissertation when it is taken to Alderman Library. Please be sure to sign this form where it asks for “Author’s Signature”. An extra copy of title page and abstract must accompany the microfilm agreement. The microfilm agreement is obtained from the Graduate Office.
b). A survey of earned doctorate form is required and placement form is required of all persons receiving their Ph.D. degree. These forms are obtained from the Graduate Office.

c). Copyright is optional; if desired, a copyright sheet must be included in each copy of the dissertation, with the following information: (Must use c symbol ©, NOT @).

© Copyright by
Your Name
All rights reserved
Date (Month and Year of Graduation)

5. Your abstract must be 600 words or less. A guide for this is 2 ½ pages, double-spaced.

6. MARGINS; The left hand margin must be 1 ½ inches – all others 1 inch. This is proper for both the theses and dissertations.

7. PAGE NUMBERS; The correct pagination is to place page numbers in the upper right corner, within the one inch margin.

8. SUGGESTED PAGE ORDER:
   a). Dissertations:
      1) Title Page
      2) Copyright Page (if applicable)
      3) Signature page
      4) Abstract
      5) Acknowledgements (optional)
      6) Body of text
   b). Theses:
      1) Title page
      2) Signature page
      3) Abstract
      4) Acknowledgements (optional)
      5) Body of text

Flapping Wing Experiment
TITLE OF THESIS (OR DISSERTATION)

___________________________________

A Thesis (or Dissertation)
Presented to
the faculty of the School of Engineering and Applied Science
University of Virginia

_______________________________________

In Partial Fulfillment
of the requirements for the Degree
Master of Science (_______________)
or Doctor of Philosophy (__________________)

by

( Name )

( Date )* 

*The "date" must be the month and year your degree is awarded, i.e., August, January or May, not the date on which you complete your work.
APPROVAL SHEET

The thesis (or dissertation) is submitted in partial fulfillment of the
Requirements for the degree of
Master of Science (______________________________)
or Doctor of Philosophy (______________________________)
______________________________

AUTHOR

This thesis (or dissertation) has been read and approved by the examining committee:

______________________________
Thesis (or dissertation) advisor

______________________________
______________________________
______________________________
______________________________
______________________________

Accepted for the School of Engineering and Applied Science:

______________________________
Dean, School of Engineering and
Applied Science

( Date )*

*The "date" must be the month and year your degree is awarded, i.e., August, January or May, not the date on which you completed your work.
Appendix I

Faculty Modifier Numbers

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<thead>
<tr>
<th>Name</th>
<th>Modifier Number</th>
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<tbody>
<tr>
<td>Allaire, P.E</td>
<td>1130</td>
</tr>
<tr>
<td>Barrett, L.E.</td>
<td>4575</td>
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<tr>
<td>Bart-Smith, H.</td>
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<td>Bass, C.R.</td>
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<td>Beard, J.</td>
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<td>McDaniel, J.C.</td>
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<td>Wood, H.G.</td>
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# Appendix II

## Faculty Areas of Interest

<table>
<thead>
<tr>
<th>Name</th>
<th>Areas of Interest</th>
</tr>
</thead>
<tbody>
<tr>
<td>HOSSEIN HAJ-HARIRI</td>
<td>Stability, fluid dynamics, mechanics, applied mathematics.</td>
</tr>
<tr>
<td>Paul E. Allaire</td>
<td>Magnetic bearings, rotor dynamics, fluid bearings, controls.</td>
</tr>
<tr>
<td>Lloyd E. Barrett</td>
<td>Rotating machinery, lubrication, magnetic bearings.</td>
</tr>
<tr>
<td>Hilary Bart-Smith</td>
<td>Mechanics of ultralight materials, morphing structures, and nano structured polymer composites.</td>
</tr>
<tr>
<td>Cameron R. Bass</td>
<td>Impact and allistic biomechanics.</td>
</tr>
<tr>
<td>Edward J. Berger</td>
<td>Transient interface mechanics, Friction and friction damping</td>
</tr>
<tr>
<td>Matthew R. Begley</td>
<td>Nano-to-microscale material science theory and experiments</td>
</tr>
<tr>
<td>Silvia S. Blemker</td>
<td>Neuromuscular biomechanics, movement disorders, musculoskeletal modeling &amp; simulation, medical imaging, and constitutive modeling.</td>
</tr>
<tr>
<td>Harsha K. Cheilliah</td>
<td>Combustion.</td>
</tr>
<tr>
<td>Jeff A. Crandall</td>
<td>Auto safety and biomechanics.</td>
</tr>
<tr>
<td>George T. Gillies</td>
<td>Precision measurements, medical physics, gravitation.</td>
</tr>
<tr>
<td>Joseph A.C. Humphrey</td>
<td>Experimental and computational flow, heat and mass transfer, flow instabilities, transition and turbulence, analysis and modeling of biological systems, sensors and sensing.</td>
</tr>
<tr>
<td>Tetsuya Iwasaki</td>
<td>Control theory, neural systems.</td>
</tr>
<tr>
<td>Richard W. Kent</td>
<td>Injury biomechanics, automobile safety.</td>
</tr>
<tr>
<td>Name</td>
<td>Title</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>------------------------</td>
</tr>
<tr>
<td>CARL R. KNOSPE</td>
<td>Associate Professor</td>
</tr>
<tr>
<td>GABRIEL LAUFER</td>
<td>Associate Professor</td>
</tr>
<tr>
<td>ERIC H. MASLEN</td>
<td>Professor</td>
</tr>
<tr>
<td>JAMES C. MCDANIEL</td>
<td>Professor</td>
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<tr>
<td>PAMELA M. NORRIS</td>
<td>Professor</td>
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<tr>
<td>WALTER D. PILKEY</td>
<td>Professor</td>
</tr>
<tr>
<td>ROBERT J. RIBANDO</td>
<td>Associate Professor</td>
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<tr>
<td>LARRY G. RICHARDS</td>
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<tr>
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<td>TIMOTHY C. SCOTT</td>
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<td>PRADIP N. SHETH</td>
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<tr>
<td>JOHN G. THACKER</td>
<td>Professor</td>
</tr>
<tr>
<td>Marcel Utz</td>
<td>Assistant Professor</td>
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<tr>
<td>HOUSTON G. WOOD, III</td>
<td>Professor</td>
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</table>
Appendix III
Sample Forms

Form G101: Master's Degree Plan of Study

Form G102: Doctoral Degree Plan of Study

Form G103: Recommendation and Certification of Appointment of Doctoral Advisory Committee

Form G104: Recommendation and Certification of Advisor for Master's/Doctoral Students

Form G105: Request for Appointment of Examining Committee

Form G107: Report on Comprehensive Examination for the Doctor of Philosophy Degree

Form G108: Report on Dissertation outline and Admission to Candidacy

Form G110: Report on Master of Science Thesis Final Examination

Form G111: Report on Dissertation Final Examination

Form G112: Transfer of Graduate Courses for Master's/Doctoral Graduate Degrees

Form G113: Application for Graduate Degree

Form G123: Request for Admission to the Ph.D. Program

MAE Course Requirements – Master of Science

MAE Course Requirements – Doctor of Philosophy
# MASTER'S DEGREE PLAN OF STUDY – FORM G101

**Name:** ___________________________________________________________________________________

(last) (first) (middle)

<table>
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<th>Credit Hours</th>
<th>Grade</th>
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<td>1. __________________________________________</td>
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<td>9. __________________________________________</td>
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<td>10. _________________________________________</td>
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**Thesis and/or Project Research**

| 1. __________________________________________| ______     | ______       | ______|
| 2. __________________________________________| ______     | ______       | ______|

Total Hours Required: ______

**Thesis Title (if applicable):** ___________________________________________________________________________

_____________________________________________________________________________________________

Student’s Signature ______________________________________ Advisor’s Approval ____________________

Approved by the Office of the Dean, Assistant Dean ____________________________________________

** Please attach Transfer of Credit Form (G112) for courses to be transferred and list under “Degree Credit.”
DOCTORAL DEGREE PLAN OF STUDY – FORM G102

Name: _____________________________________________________________________________________________________

(last) (first) (middle)

Research Area: __________________________________________ Anticipated Date of Graduation: ________________________

List All Graduate Work:

<table>
<thead>
<tr>
<th>Course Number</th>
<th>Course Title</th>
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<th>Credit Hours</th>
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Date: ____________________________
Title of Masters thesis (if applicable) ________________________________________________________________

Student’s Signature ______________________________________________________ Date _______________________________

Advisory Committee Signatures

Chairperson ____________________________________________________________ Department or Curriculum

Minor Representative ____________________________________________________ Minor Department or Curriculum

Committee Member ______________________________________________________ Department or Curriculum

Committee Member ______________________________________________________ Department or Curriculum

Committee Member ______________________________________________________ Department or Curriculum

Approved by Department or Curriculum Chairperson ________________________________

Approved by the Office of the Dean, Assistant Dean ________________________________

Date ________________________________

** Please attach Transfer of Credit Form (G112) for courses to be transferred.
Office of the Dean/Graduate Studies
School of Engineering and Applied Science
University of Virginia Date: ______________________________

Recommendation and Certification of Appointment of Doctoral Advisory Committee – FORM G103

Name: ______________________________________________________________________________________________
(last) (first) (middle)

Major: ____________________________________________ Minor(s): __________________________________

Expected Date of Graduation: ___________________________________________________________________________

The above named student is studying for the Doctor of Philosophy degree and the following committee
(New ____ Changed ____ ) is recommended to supervise work for that degree. At least four committee members
are required.

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<th>Name (please type or print)</th>
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Date _____________________________________
Office of the Dean/Graduate Studies
School of Engineering and Applied Science
University of Virginia

Recommendation and Certification of Advisor for Master’s/Doctoral Students – FORM G104

Student’s Name: ______________________________________________________________________________________
(last) (first) (middle)

Student Identification Number: __________________________________________________________________________

Major Curriculum: _______________________________________ Minor: ____________________________________

Expected Date of Graduation: ___________________________________________________________________________

The above named student is studying for the degree of ______________________________________________________

and Professor _________________________________________________________ is recommended to advise the student.

His/her faculty modifier number is _______________________________.

Approved by Department or Curriculum Chairperson ________________________________________________________

Approved by the Office of the Dean, Assistant Dean _________________________________________________________

Date _______________________________
Office of the Dean/Graduate Studies
School of Engineering and Applied Science
University of Virginia

Student’s Name: ______________________________________________________________________________________
(last) (first) (middle)

Appointment of an examining committee for (check one as appropriate):

_____ Master of Science Final Examination (3 members minimum)
_____ Master of Engineering Final Examination (3 members minimum)
_____ Ph.D. Preliminary Examination (4 members minimum)
_____ Ph.D. Comprehensive Examination (4 members minimum)
_____ Ph.D. Dissertation proposal presentation (4 members minimum)
_____ Ph.D. Final Examination (5 members minimum)

This examination will be held __________________________________________________________________________

Recommended Faculty members:

____________________________________________________________, Examining Committee Chairperson
____________________________________________________________, Thesis/Dissertation Director (if any)
____________________________________________________________, Minor Department or curriculum representative

____________________________________________________________
____________________________________________________________
____________________________________________________________

Approved by Department or Curriculum Chairperson ________________________________

Approved by the Office of the Dean, Assistant Dean ________________________________

Date ________________________________

It is the duty of the Examining Committee to administer such examinations as are required by the regulations of the School and to report in writing the results of such examinations to the Assistant Dean.
Report on Comprehensive Examination for the Doctor of Philosophy Degree – FORM G107

Student’s Name: ______________________________________________________________________________________

(last) (first) (middle)

Curriculum or Department: _____________________________________________________________________________

Degrees now held, where received and when:
____________________________________________________________________________________________________
____________________________________________________________________________________________________

was given the written comprehensive examination for the Ph.D. on ________________________________________ (date)
and the oral examinations on ________________________________________ (date).

The Examining Committee has declared performance on the comprehensive examination satisfactory/unsatisfactory (strike out one) and recommends/does not recommend (strike out one) that the student be encouraged to prepare a dissertation outline for public defense prior to being admitted to candidacy.

Special Conditions (if any):
____________________________________________________________________________________________________
____________________________________________________________________________________________________
____________________________________________________________________________________________________
____________________________________________________________________________________________________

Examining Committee Signatures:
____________________________________________________________, Examining Committee Chairperson
____________________________________________________________, Advisor and Dissertation Director
____________________________________________________________
____________________________________________________________

Approved by Department Chairperson or Representative: ______________________________________________________

Approved by the Office of the Dean, Assistant Dean: _________________________________________________________

Date: ____________________________________
Report on Dissertation Outline and Admission to Candidacy – FORM G108

Degree: _______________________________________
Curriculum or Department: ___________________________

Major: _______________________________________
Minor(s): _______________________________________

Student’s Name: ______________________________________________________________________________________
is hereby certified as having met all the requirements for admission to candidacy for the degree named above. Included among these requirements are the following (please check or answer as required):

1. Plan of study completed: Yes _____ No _____ Date submitted: _____________________________
2. Preliminary examination: Date passed: ____________________________________________________________
3. Comprehensive examination: Date passed: ____________________________________________________________
4. Public defense of dissertation outline: Date passed: _____________________________________________________
5. Title of Dissertation: ________________________________________________________________________________

Anticipated date of degree (month and year): _______________________________________________________________

Statement of any necessary changes in student’s program or of special conditions:
__________________________________________________________________________________________________
__________________________________________________________________________________________________
(use extra page as needed)

Signatures of examining committee:* Names of faculty representatives attending dissertation outline presentation:*

___________________________________________________________________________________________
Examiner Committee Chairperson

___________________________________________________________________________________________
Advisor and Dissertation Director

___________________________________________________________________________________________

___________________________________________________________________________________________

Approved by Department or Curriculum Chairperson: _____________________________

Approved by the Office of the Dean, Assistant Dean: _____________________________

Date: _____________________________

* For the doctoral candidate, no fewer than four faculty members shall be present for the dissertation outline presentation, but only the official members of the Examining Committee are required to sign this form. One copy of the dissertation outline, modified as a consequence of the oral presentation, must accompany this form.
Report on Master of Science Thesis Final Examination – FORM G110

Student’s Name: ______________________________________________________________________________________
(last) (first) (middle)

has submitted in partial fulfillment of the requirements for the degree of __________________________________________
in the Curriculum or Department of __________________________________________________________, a thesis entitled
____________________________________________________________________________________________________
____________________________________________________________________________________________________
____________________________________________________________________________________________________

The committee examined the candidate on __________________________________________ (date) in accordance with the
regulations governing the Final Examination and has judged the candidate’s performance satisfactory/unsatisfactory (delete
one). Exceptions or qualifications are noted as follows: _______________________________________________________
____________________________________________________________________________________________________
____________________________________________________________________________________________________

Signatures of thesis advisor and members of examining committee:*

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Approved by Department or Curriculum Chairperson: __________________________________________________________

Approved by the Office of the Dean, Assistant Dean: _________________________________________________________

Date: ____________________________________

* No fewer than three faculty members shall be present for a master’s examination but only the members of the official
Committee are required to sign this form.
Report on Dissertation Final Examination – FORM G111

Student’s Name: ______________________________________________________________________________________

(last) (first) (middle)

has submitted in partial fulfillment of the requirements for the degree of __________________________________________
in the Curriculum or Department of _____________________________________________________, a dissertation entitled
____________________________________________________________________________________________________
____________________________________________________________________________________________________
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This dissertation has been examined by the dissertation director, advisor and by all members of the candidate’s Examining
Committee, as appropriate, and has been approved/rejected (delete one). The committee examined the candidate on
______________________________ (date) in accordance with the regulations governing the Final Examination and
has judged the candidate’s performance satisfactory/unsatisfactory (delete one). Exceptions or qualifications are noted as
follows: _____________________________________________________________________________________________
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Signatures of members of examining committee:*

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<td>Minor Representative</td>
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Names of faculty representatives attending final examination:*

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Approved by Department or Curriculum Chairperson: _________________________________________________________

Approved by the Office of the Dean, Assistant Dean: _______________________________________________________

Date: __________________________

* No fewer than five faculty members shall be present for the final doctoral examination.
Transfer of Graduate Courses for Master’s/Doctoral Graduate Degrees – FORM G112

Name: ____________________________________________________________________________
(last) (first) (middle)

Major curriculum or department ______________________________________________________________________________________

Credit recommended for transfer to degree of ____________________________________________________________________________
(Attach official transcript(s) from other colleges/universities.)

Name of institution ______________________________________________________________________________________

Name of equivalent degree offered ________________________________________________________________

Name and number of equivalent U.Va. course ____________________________________________________________

Course Number Course Title Credit Grade Date

_____________________________________________________________________________________________

_____________________________________________________________________________________________

_____________________________________________________________________________________________

_____________________________________________________________________________________________

_____________________________________________________________________________________________

Catalogue statement of course level and grading system that justified classification of these courses a equivalent to
500 level or above courses at this University. These courses must be ones that you can use for credit towards a
graduate degree at the institution at which they were taken. (Please attach a copy of the course description to this
form.)

_____________________________________________________________________________________________

_____________________________________________________________________________________________

Official classification of student when courses were taken: (graduate), (undergraduate), (if other, specify)

_____________________________________________________________________________________________

Recommended by Supervisory Committee Chairperson or Faculty Advisor ________________________________

Approved by Assistant Dean, Office of the Dean _____________________________________________________
APPLICATION FOR GRADUATE DEGREE – FORM G113

I hereby apply for the degree of:

_____________________________________________________________(_______________________________)

Curriculum

To be awarded in ______________________________________________________________________________

(Month and Year)

Final correct title of thesis or dissertation: (M.S. and Ph.D.)

_____________________________________________________________________________________________

_____________________________________________________________________________________________

_____________________________________________________________________________________________

Dissertation Director: ___________________________________________________________________________

Previous degrees and where received (Full name of University or College and complete degree title)

_____________________________________________________________________________________________

_____________________________________________________________________________________________

_____________________________________________________________________________________________

Hometown and State: ___________________________________________________________________________

(For Use in Finals Program)

To apply for admission into the Doctoral Program, please complete Form G123.

STUDENT’S SIGNATURE

_____________________________________________________________________________________________

Print Full Name and Student ID Number

YOUR FULL NAME WILL APPEAR ON YOUR DIPLOMA AND ON YOUR PERMANENT RECORD IN THE
OFFICE OF THE REGISTRAR.

Date: ________________________________ Department Chairperson Recommendation

____________________________________________________

Do not file this form unless you will be registered as a student when you intend to receive your degree and all other
requirements for your degree are completed or will be completed by the graduation day.

After obtaining the signature of your department chairperson, please submit this form to:
Office of Graduate Studies, School of Engineering and Applied Science, Thornton Hall, Rm. A-108.

NOTE: Before receiving your diploma you must complete and submit the form:
“Placement Status of Graduates” to Thornton Hall, Rm. A-108.
You may access this form online and submit it via the web at http://128.143.168.30:591/placement/default.htm
REQUEST FOR ADMISSION TO THE Ph.D. PROGRAM – FORM G123

I hereby apply for admission to the doctoral program in:

_____________________________________________________________________________________________

in the ___________________ semester (fall, spring, summer) __________ year.

_____________________________________________________________________________________________

Student’s name

_______________________________________________ __________________________________________

Student’s signature

Approved by Doctoral Advisor: ________________________________ ________________________________

_______________

Approved by Other Departmental Designees:
(if required by Department)

___________________________________ _____________________

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Approved by Department Chair: ________________________________ ________________________________

_______________

Approved by Assistant Dean: ________________________________ ________________________________

_______________
### MAE Course Requirements - Masters of Science

Name: _________________________________  
Email address: ___________________________  
Advisor: ________________________________

#### Core Course Requirement
Two Core courses must be taken. Please check appropriate boxes:

- [ ] MAE 602 - Continuum Mechanics With Applications  
- [ ] MAE 621 - Analytical Dynamics  
- [ ] MAE 610 - Thermomechanics

#### Fundamentals Course Requirement
Two Fundamentals courses from the student’s field of study must be taken.

**Field of Study (select one)**

| ☐ Continuum Mechanics | ☐ Dynamical Systems and Control | ☐ Thermomechanics |

Check boxes for Fundamentals courses under the selected field of study

| ☐ MAE 631 Fluid Mechanics I | ☐ MAE 652 Linear State Space Systems | ☐ MAE 611 Heat & Mass Transport Phenomena |
| ☐ MAE 622 Waves | ☐ MAE 624 Nonlinear Dynamics & Waves | ☐ MAE 612 Microscale Heat Transfer |
| ☐ MAE 607 Theory of Elasticity | ☐ MAE 755 Multivariable Control | ☐ MAE 636 Gas Dynamics |
| ☐ MAE 608 Constitutive Modeling Bio Systems | ☐ MAE 753 Optimal Dynamical Systems | ☐ MAE 613 Kinetic Theory & Transport Properties |
| ☐ MAE 623 Vibrations |

#### Engineering Analysis Requirement
One Engineering Analysis course must be taken. Please check the appropriate box:

- [ ] MAE 641: Engineering Analysis I  
- [ ] MAE 642: Engineering Analysis II  
- [ ] MAE 643: Statistics for Engineers  
- [ ] MAE 644: Applied Partial Differential Eqns  
- [ ] MAE 671: Finite Element Analysis

#### Other Requirements
1) All Masters of Science students must take one other Core, Fundamentals, or Foundations course.  
   (Fundamentals classes from the student’s field of study may not be used.)

   Course: ________________________________________________

2) Each student must take two additional graduate courses:

   Course: ________________________________________________  
   Course: ________________________________________________
MAE Course Requirements – Doctor of Philosophy

Name: _________________________________

Email address: ___________________________

Advisor: ________________________________

Core Course Requirement
Two Core courses must be taken. Please check appropriate boxes:

☐ MAE 602 - Continuum Mechanics With Applications
☐ MAE 621 - Analytical Dynamics
☐ MAE 610 - Thermomechanics

Fundamentals Course Requirement
Three Fundamentals courses from the student’s field of study must be taken.

Field of Study (select one)

☐ Continuum Mechanics ☐ Dynamical Systems and Control ☐ Thermomechanics

Check boxes for Fundamentals courses under the selected field of study

☐ MAE 631 Fluid Mechanics I ☐ MAE 652 Linear State Space Systems ☐ MAE 611 Heat & Mass Transport Phenomena
☐ MAE 622 Waves ☐ MAE 624 Nonlinear Dynamics & Waves ☐ MAE 612 Microscale Heat Transfer
☐ MAE 607 Theory of Elasticity ☐ MAE 755 Multivariable Control ☐ MAE 636 Gas Dynamics
☐ MAE 608 Constitutive Modeling Bio Systems ☐ MAE 753 Optimal Dynamical Systems ☐ MAE 613 Kinetic Theory & Transport Properties

☐ MAE 623 Vibrations

Engineering Analysis Requirement
Two Engineering Analysis courses must be taken. Please check the appropriate boxes:

☐ MAE 642: Engineering Analysis II ☐ MAE 671: Finite Element Analysis
☐ MAE 643: Statistics for Engineers

Other Requirements
1.) All PhD students must take two other Core, Fundamentals, or Foundations courses.
   (Fundamentals courses from the student’s field of study may not be used.)

   Course: __________________________________________
   Course: __________________________________________

2) Each student must take three additional graduate courses (one must be 600 or higher level):

   Course: __________________________________________
   Course: __________________________________________
   Course: __________________________________________
Appendix IV
Mechanical/Aerospace Graduate Course Listings & Description

HOW TO READ COURSE LISTINGS:
EX: (3) - number of credits which will be earned upon successful completion of the course.
(Y) - code for frequency with which the course is offered. Variations are:
  S offered fall and spring semesters
  Y offered at least once every academic year (fall or spring)
  E offered every other year, in the academic years when the fall semester occurs in an even year (e.g. 1998-99)
  O offered every other year, in academic years when the fall semester occurs in an odd year (e.g. 1997-98)
  IR offered irregularly

MAE 602 - (3) (Y)
Continuum Mechanics With Applications
Introduction to continuum mechanics and mechanics of deformable solids. Topics include Vectors and cartesian tensors, stress, strain, deformation, equations of motion, constitutive laws, introduction to elasticity, thermal elasticity, viscoelasticity, plasticity, and fluids. Cross-listed as AM 602, APMA 602, and CE 602.

MAE 603 - (3) (IR)
Computational Solid Mechanics
Prerequisite: MAE 602.
Analyzes variational and computational mechanics of solids; potential energy; complementary energy; virtual work; Reissner's principle; Ritz and Galerkin methods; displacement; force and mixed methods of analysis; finite element analysis including shape functions, convergence, and integration. Applications in solid mechanics. Cross-listed as AM 603 and CE 603.
MAE 604 - (3) (IR)
Plates and Shells
Prerequisite: APMA 641, AM 601 or AM 602.
Topics include the classical analysis of plates and shells; plates of various shapes (rectangular, skew) and shells of various shapes (cylindrical, conical, spherical, hyperbolic, paraboloid); closed-form numerical and approximate methods of solution governing partial differential equations; and advanced topics (large deflection theory, thermal stresses, orthotropic plates). Cross-listed as AM 604 and CE 604.

MAE 607 - (3) (O)
Theory of Elasticity
Prerequisite: AM 602 or instructor permission.
Review of the concepts of stress, strain, equilibrium, compatibility; Hooke's law (isotropic materials); displacement and stress formulations of elasticity problems; plane stress and strain problems in rectangular coordinates (Airy's stress function approach); plane stress and strain problems in polar coordinates, axisymmetric problems; torsion of prismatic bars (semi-inverse method using real function approach); thermal stress; and energy methods. Cross-listed as AM 607 and CE 607.

MAE 608 - (3) (O)
Constitutive Modeling of Biosystems
Prerequisite: MAE 602
The course covers state-of-the-art mechanical models to describe the constitutive behavior of hard and soft tissues with emphasis on biological form following physiological function. The course will cover linear and nonlinear elasticity, viscoelasticity, poroelasticity, and biphasic constitutive relations in the context of biological systems and will include the dependence of macroscopic behavior and properties on material microstructure.

MAE 610 - (3) (Y)
Thermomechanics
Prerequisite: Graduate standing.
Review of classical thermodynamics; introduction to kinetic theory; quantum mechanical analysis of atomic and molecular structure; statistical mechanical evaluation of thermodynamic properties; chemical thermodynamics and equilibria.

MAE 611 - (3) (Y)
Heat and Mass Transport Phenomena
Prerequisite: Undergraduate fluid mechanics or instructor permission.
MAE 612 - (3) (E)
Microscale Heat Transfer
Prerequisite: MAE 610
This course will begin with a study of the fundamental microscopic energy carriers (definitions, properties, energy levels and disruptions of photons, phonons, and electrons.) Transport of energy will then be investigated with an emphasis on both radiated and microscale effects in space and in time. Radiation heat transfer analysis will include consideration of gray, diffuses, and specular surfaces. The approaches used to describe microscale heat transportation differ significantly from the macroscopic phenomenological approaches and include new physical mechanisms. They often involve solution of the Boltzman transport equation and the equation of phonon radiative transfer. These approaches will be introduced with an emphasis on ultra-short time scale heating and ultra-low temperatures.

MAE 613 - (3) (O)
Kinetic Theory and Transport Properties
Prerequisite: MAE 610 or instructor permission.
Boltzmann equation: Dynamics of molecular collisions; Chapman-Enskog solution of non-equilibrium flows; transport properties; application to shock structure; and shear and mixing layers with chemical reactions.

MAE 616 - (3) (IR)
Advanced Thermodynamics
Prerequisite: Instructor permission.
Analyzes basic concepts, postulates, and relationships of classical thermodynamics; thermodynamics potentials and derivatives; energy minimum and entropy maximum principle; generalized Maxwell relations; stability considerations; phase transitions; application to perfect and imperfect systems; and extension to chemically reacting and solid systems.

MAE 617 - (3) (IR)
Microscopic Thermodynamics
Prerequisite: Instructor permission.
Topics include the thermodynamics of gases developed from a microscopic point of view; kinetic theory derivation of equilibrium thermodynamic and transport properties of gases; introduction to advanced non-equilibrium kinetic theory; quantum mechanical treatment of atomic and molecular energy level structure; statistical mechanics derivation of the thermodynamic properties of equilibrium gases; chemical thermodynamics and chemical equilibrium of reacting gas mixtures; applications of the theory of high temperature gas behavior, gas-phase combustion and equilibrium and non-equilibrium gas dynamics.
MAE 620 - (3) (IR)
Energy Principles in Mechanics
Prerequisite: Instructor permission.
Analyzes the derivation, interpretation, and application to engineering problems of the principles of virtual work and complementary virtual work; related theorems, such as the principles of the stationary value of the total potential and complementary energy, Castigliano's Theorems, theorem of least work, and unit force and displacement theorems. Introduces generalized, extended, mixed, and hybrid principles; variational methods of approximation, Hamilton's principle, and Lagrange's equations of motion; and approximate solutions to problems in structural mechanics by use of variational theorems. Cross-listed as AM 620 and CE 620.

MAE 621 - (3) (Y)
Analytical Dynamics
Prerequisite: Undergraduate physics, ordinary differential equations.
The topics covered are: Newtonian mechanics: Newton's laws, energy, work, conservation principles; Reference frames: transformations, Euler angles, kinematics; Rotational motion: rigid bodies, inertia tensors; constraints and generalized coordinates; Other equations of motion: Kane's equations, Lagrange's equations, Gibbs-Appell equations; Variational principles. Cross-listed as AM 621.

MAE 622 - (3) (E)
Waves
Prerequisite: MAE/AM 602 or equivalent.
The topics covered are: plane waves; d'Alembert solution; method of characteristics; dispersive systems; wavepackets; group velocity; fully-dispersed waves; Laplace, Stokes, and steepest descents integrals; membranes, plates and plane-stress waves; evanescent waves; Kirchhoff's solution; Fresnel's principle; elementary diffraction; reflection and transmission at interfaces; waveguides and ducted waves; waves in elastic half-spaces; P, S, and Rayleigh waves; layered media and Love waves; slowly-varying media and WKBJ method; Time-dependent response using Fourier-Laplace transforms; some nonlinear water waves. Cross-listed as AM 622.

MAE 623 - (3) (Y)
Vibrations
Prerequisite: Instructor permission.
Topics include free and forced vibrations of undamped and damped single- and multi-degree-of-freedom systems; modal analyses; continuous systems; matrix formulations; finite element equations; direct integration methods; and eigenvalue solution methods. Cross-listed as AM 623 and CE 623.
MAE 624 - (3) (O)
Nonlinear Dynamics and Waves
Prerequisite: Undergraduate ordinary differential equations or instructor permission.
Introduces phase-space methods, elementary bifurcation theory and perturbation theory, and applies them to the study of stability in the contexts of nonlinear dynamical systems and nonlinear waves, including free and forces nonlinear vibrations and wave motions. Examples are drawn from mechanics and fluid dynamics, and include transitions to periodic oscillations and chaotic oscillations. Cross-listed as APMA 624.

MAE 625 - (3) (O)
Multibody Mechanical Systems
Prerequisite: Engineering degree and familiarity with a programming language.
Analytical and computational treatment for modeling and simulation of 3-Dimensional multibody mechanical systems. Provide a systematic and consistent basis for analyzing the interactions between motion constraints, kinematics, static, dynamic, and control behavior of multibody mechanical systems. Applications to machinery, robotic devices and mobile robots, biomechanical models for gait analysis and human motions, and motion control. Matrix modeling procedures with symbolic and numerical computational tools will be utilized for demonstrating the methods developed in this course. Focus on the current research and computational tools and examine a broad spectrum of physical systems where multibody behavior is fundamental to their design and control.

MAE 631 - (3) (Y)
Fluid Mechanics I
Prerequisite: MAE 602 and APMA/MAE 641.
The topics covered are: dimensional analysis; physical properties of fluids; kinematic descriptions of flow; streamlines, path lines and streak lines; stream functions and vorticity; hydrostatics and thermodynamics; Euler and Bernoulli equations; irrotational potential flow; exact solutions to the Navier-Stokes equation; effects of viscosity - high and low Reynolds numbers; waves in incompressible flow; hydrodynamic stability. Cross-listed as AM 631.

MAE 632 - (3) (E)
Fluid Mechanics II
Prerequisite: MAE 631.
The topics covered are: thin wing theory; slender-body theory; three-dimensional wings in steady subsonic and supersonic flows; drag at supersonic speeds; drag minimization; transonic small-disturbance flow; unsteady flow; properties and modeling of turbulent flows. Cross-listed as AM 632.
MAE 633 - (3) (IR)
Lubrication Theory and Design

Prerequisite: Instructor permission.
Topics include the hydrodynamic theory of lubrication for an incompressible fluid; design principles of bearings: oil flow, load-carrying capacity, temperature rise, stiffness, damping properties; influence of bearing design upon rotating machinery; computer modeling methods; and applications to specific types.

MAE 634 - (3) (O)
Transport Phenomena in Biological Systems

Prerequisite: Introductory fluid mechanics and/or heat or mass transfer, or instructor permission.
Fundamentals of momentum, energy and mass transport as applied to complex biological systems ranging from the organelles in cells to whole plants and animals and their environments. Derivation of conservation laws (momentum, heat and mass), constitutive equations, and auxiliary relations. Applications of theoretical equations and empirical relations to model and predict the characteristics of diffusion and convection in complex biological systems and their environments. Emphasis placed on the bio-mechanical understanding of these systems through the construction of simplified mathematical models amenable to analytical, numerical or statistical formulations and solutions, including the identification and quantification of model uncertainties.

MAE 636 - (3) (O)
Gas Dynamics

Prerequisite: MAE 610.
Analyzes the theory and solution methods applicable to multi-dimensional compressible inviscid gas flows at subsonic, supersonic, and hypersonic speeds; similarity and scaling rules from small-perturbation theory, introduction to transonic and hypersonic flows; method-of-characteristics applications to nozzle flows, jet expansions, and flows over bodies one dimensional non-steady flows; properties of gases in thermodynamic equilibrium, including kinetic-theory, chemical-thermodynamics, and statistical-mechanics considerations; dissociation and ionization process; quasi-equilibrium flows; and introduction to non-equilibrium flows.
MAE 637 - (3) (IR)

Singular Perturbation Theory

*Prerequisite:* Familiarity with complex analysis.

Analyzes regular perturbations, roots of polynomials; singular perturbations in ODE's, periodic solutions of simple nonlinear differential equations; multiple-Scales method; WKBJ approximation; turning-point problems; Langer's method of uniform approximation; asymptotic behavior of integrals, Laplace Integrals, stationary phase, steepest descents. Examples are drawn from physical systems. Cross-listed with APMA 637.

MAE 641 - (3) (Y)

Engineering Mathematics I

*Prerequisite:* Graduate standing.

Review of ordinary differential equations. Initial value problems, boundary value problems, and various physical applications. Linear algebra, including systems of linear equations, matrices, eigenvalues, eigenvectors, diagonalization, and various applications. Scalar and vector field theory, including the divergence theorem, Green's theorem, and Stokes theorem, and various applications. Partial differential equations that govern physical phenomena in science and engineering. Solution of partial differential equations by separation by variables, superposition, Fourier series, variation of parameter, d'Alembert's solution. Eigenfunction expansion techniques for non-homogeneous initial-value, boundary-value problems. Particular focus on various physical applications of the heat equation, the potential (Laplace) equation, and the wave equations in rectangular, cylindrical, and spherical coordinates. Cross-listed as APMA 641.

MAE 642 - (3) (Y)

Engineering Mathematics II

*Prerequisite:* Graduate standing and APMA/MAE 641 or equivalent.


MAE 643 - (3) (Y)

Statistics for Engineers and Scientists

*Prerequisite:* Admission to graduate studies or instructor permission.

Role of statistics in science, hypothesis tests of significance, confidence intervals, design of experiments, regression, correlation analysis, analysis of variance, and introduction to statistical computing with statistical software libraries. Cross-listed as APMA 643.
MAE 644 - (3) (IR)
**Applied Partial Differential Equations**
*Prerequisite:* APMA/MAE 641 or equivalent.
Includes first order partial differential equations (linear, quasilinear, nonlinear); classification of equations and characteristics; and well-posed-ness of initial and boundary value problems. Cross-listed as APMA 644.

MAE 651 - (3) (IR)
**Linear Automatic Control Systems**
*Prerequisite:* Instructor permission.
Studies the dynamics of linear, closed-loop systems; mechanical, electrical, hydraulic, and other servo systems. Analysis of transfer functions; stability theory. Considers compensation methods. Cross-listed as ECE 621.

MAE 652 - (3) (Y)
**Linear State Space Systems**
*Prerequisite:* Graduate standing.
A comprehensive treatment of the theory of linear state space systems, focusing on general results which provide a conceptual framework as well as analysis tools for investigation in a wide variety of engineering contexts. Topics include vector spaces, linear operators, functions of matrices, state space description, solutions to state equations (time invariant and time varying), state transition matrices, system modes and decomposition, stability, controllability and observability, Kalman decomposition, system realizations, grammians and model reduction, state feedback, and observers. Cross-listed as SYS 612 and ECE 622.

MAE 662 - (3) (IR)
**Mechanical Design Analysis**
*Prerequisite:* Undergraduate mechanical design or instructor permission.
Topics include the design analysis of machine elements subject to complex loads and environments; emphasis on modern materials and computer analysis; theory of elasticity, energy methods; failure theories, fracture, fatigue, creep; contact, residual, and thermal stresses; experimental stress analysis; and corrosion.

MAE 671 - (3) (Y)
**Finite Element Analysis**
*Prerequisite:* MAE/AM 602 or equivalent.
The topics covered are: review of vectors, matrices, and numerical solution techniques; discrete systems; variational formulation and approximation for continuous systems; linear finite element method in solid mechanics; formulation of isoparametric finite elements; finite element method for field problems, heat transfer, and fluid dynamics. Cross-listed as AM 671.
MAE 672 - (3) (O)
Computational Fluid Dynamics I
*Prerequisite:* MAE 631 or instructor permission.
Includes the solution of flow and heat transfer problems involving steady and transient convective and diffusive transport; superposition and panel methods for inviscid flow, finite-difference methods for elliptic, parabolic and hyperbolic partial differential equations, elementary grid generation for odd geometries, primitive variable and vorticity-steam function algorithms for incompressible, multidimensional flows. Extensive use of personal computers/workstations, including interactive graphics. Cross-listed as APMA 672.

MAE 685 - (3) (E)
Measurement Theory and Advanced Instrumentation
*Prerequisite:* Undergraduate electrical science.
Studies the theory and practice of modern measurement and measurement instrumentation; statistical analysis of data; estimation of errors and uncertainties; operating principles and characteristics of fundamental transducers and sensors; common electrical circuits and instruments; and signal processing methods.

MAE 687 - (3) (E)
Applied Engineering Optics
*Prerequisite:* PHYS 241E.
Analyzes modern engineering optics and methods; fundamentals of coherence, diffraction interference, polarization, and lasing processes; fluid mechanics, heat transfer, stress/strain, vibrations, and manufacturing applications; laboratory practice: interferometry, schlieren/shadowgraph, and laser velocimetry.

MAE 692 - (3) (Y)
Special Topics in Mechanical and Aerospace Science: Intermediate Level
Study of a specialized, advanced, or exploratory topic relating to mechanical or aerospace engineering science, at the first-graduate-course level. May be offered on a seminar or a team-taught basis. Subjects selected according to faculty interest. New graduate courses are usually introduced in this form. Specific topics and prerequisites are listed in the *Course Offering Directory*.

MAE 693 - (3) (Y)
Independent Study in Mechanical or Aerospace Science: Intermediate Level
Independent study of first-year graduate level material under the supervision of a faculty member.
MAE 694 - (Credit as arranged) (Y)
Special Graduate Project in Mechanical or Aerospace Engineering: First-Year Level
A design or research project for a first-year graduate student under the supervision of a faculty member. A written report must be submitted and an oral report presented. Up to three credit hours from either this course or MAE 794 may be applied toward the master's degree.

MAE 703 - (3) (O)
Injury Biomechanics
Prerequisite: MAE 608.
This is an advanced applications course on the biomechanical basis of human injury and injury modeling. The course covers the etiology of human injury and state-of-the-art analytic and synthetic mechanical models of human injury. The course will have a strong focus on modeling the risk of impact injuries to the head, neck, thorax, abdomen and extremities. The course will explore the biomechanical basis of widely used and proposed human injury criteria and will investigate the use of these criteria with simplified dummy surrogates to assess human injury risk. Brief introductions to advanced topics such as human biomechanical variation with age and sex, and the biomechanics of injury prevention will be presented based on current research and the interests of the students.

MAE 715 - (3) (O)
Combustion
Prerequisite: Undergraduate thermodynamics and MAE 631 or instructor permission.
Reviews chemical thermodynamics, including conservation laws, perfect gas mixtures, combustion chemistry and chemical equilibrium; finite-rate chemical kinetics; conservation equations for multicomponent reacting systems; detonation and deflagration waves in premixed gases; premixed laminar flames; gaseous diffusion flames and droplet evaporation; introduction to turbulent flames; chemically-reacting boundary-layer flows; ignition; applications to practical problems in energy systems, aircraft propulsion systems, and internal combustion engines. Projects selected from topics of interest to the class.

MAE 753 - (3) (IR)
Optimal Dynamical Systems
Prerequisite: Two years of college mathematics, including some linear and vector calculus. Classical and state-spaced controls and undergraduate design courses are not required, but would help.
Introduces the concept of performance metrices for dynamical systems and examines the optimization of performances over both parameter and function spaces. Discusses both the existence of optimal solutions to dynamic problems and how these may be found. Such results provide via limits to performance of dynamic systems, which delineate what can and cannot be achieved via engineering. Constitutes a basis for more advanced study in design synthesis and optimal control. Cross-listed as ECE 723.
**MAE 755 - (3) (O)**  
*Multivariable Control*  
*Prerequisite:* MAE 652.  
State space theories for linear control system design have been developed over the last 40 years. Among those, H2 and Hinf control theories are the most established, powerful, and popular in applications. This course focuses on these theories and shows why and how they work. Upon completion of this course, student will be confident in applying the theories and will be equipped with technical machinery that allows them to thoroughly understand these theories and to explore new control design methods if desired in their own research. More importantly, students will learn a fundamental framework for optimal system design from a state perspective. Cross-listed as ECE 725.

**MAE 756 - (3) (IR)**  
*Nonlinear Control Systems*  
*Prerequisite:* ECE 621 or instructor permission.  
Studies the dynamic response of nonlinear systems; approximate analytical and graphical analysis methods; stability analysis using the second method of Liapunov, describing functions, and other methods; adaptive, learning, and switched systems; examples from current literature. Cross-listed as ECE 726.

**MAE 758 - (3) (IR)**  
*Digital Control Systems*  
*Prerequisite:* MAE 652 or instructor permission.  
Topics include sampling processes and theorems, z-transforms, modified transforms, transfer functions, stability criteria; analysis in both frequency and time domains; discrete-state models for systems containing digital computers; and applications using small computers to control dynamic processes. Cross-listed as ECE 728.

**MAE 772 - (3) (IR)**  
*Computational Fluid Dynamics II*  
*Prerequisite:* MAE 672 or instructor permission.  

**MAE 791 - (0-1) (S)**  
*Research Seminar, Mechanical and Aerospace Engineering: Master's Students*  
Required one-hour weekly seminar for master's students in mechanical and aerospace and nuclear engineering. Students enrolled in MAE 898 or 694/794 make formal presentations of their work.
MAE 792 - (3) (Y)
Special Topics in Mechanical or Aerospace Engineering Science: Advanced Level
A specialized, advanced, or exploratory topic relating to mechanical or aerospace engineering science, at the second-year or higher graduate level. May be offered on a seminar or team-taught basis. Subjects selected according to faculty interest. Topics and prerequisites are listed in the Course Offering Directory.

MAE 793 - (Usually three credits) (S)
Independent Study in Mechanical or Aerospace Engineering Science: Advanced Level
Independent study of advanced graduate material under the supervision of a faculty member.

MAE 794 - (Credit as arranged) (S)
Special Graduate Project in Mechanical or Aerospace Engineering: Advanced Level
A design or research project for an advanced graduate student under the supervision of a faculty member. A written report must be submitted and an oral report must be presented. Up to three credits of either this course or MAE 694 may be applied toward the master's degree.

MAE 897 - (Credit as arranged) (S)
Graduate Teaching Instruction
For master's students.

MAE 898 - (see below regarding credit) (S)
Master's Thesis Research, Mechanical and Aerospace Engineering
Formal documentation of faculty supervision of thesis research. Each full-time, resident Master of Science student in mechanical and aerospace engineering is required to register for this course for the number of credits equal to the difference between his or her regular course load and 12.

MAE 991 - (0-1) (S)
Research Seminar, Mechanical and Aerospace Engineering: Doctoral Students
Required one-hour weekly seminar for doctoral students in mechanical, aerospace, and nuclear engineering. Students enrolled in MAE 999 may make formal presentations of their work.

MAE 997 - (Credit as arranged) (S)
Graduate Teaching Instruction
For doctoral students.
MAE 999 - (see below regarding credit) (S)
Dissertation Research, Mechanical and Aerospace Engineering
Formal documentation of faculty supervision of dissertation research. Each full-time resident doctoral student in mechanical and aerospace engineering is required to register for this course for the number of semester-hours equal to the difference between his or her regular course load (not counting the one-hour MAE 991 seminar) and 12.

Professor Pamela Norris in the Microscale Heat Transfer Lab using transient thermoreflectance technique to determine properties of thin metallic films.