UNIVERSITY of PENNSYLVANIA

Ph.D. PROGRAM

GUIDELINES FOR GRADUATE STUDY

September 2006

Department of Mechanical Engineering
and Applied Mechanics
School of Engineering and Applied Science
297 Towne Bldg., 220 S. 33rd Street
Philadelphia, PA 19104-6315

Electronic version of this document is available at
http://www.me.upenn.edu/graduate/phdguidelines.html

Mechanical Engineering and Applied Mechanics

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1. INTRODUCTION

These guidelines are for Ph.D. students in the Department of Mechanical Engineering and Applied Mechanics (MEAM). In addition to the information presented here, students should also read and understand the following publications, which can be obtained from 111 Towne Building, (when in print):

- Current University of Pennsylvania catalog, "Graduate Study in Engineering and Applied Science."
- "The PennBook - Resources, Policies & Procedures Handbook," which contains University policies and procedures.
- "An Insider's Guide to Graduate Requirements," published by the Office of Graduate Education and Research in the School of Engineering and Applied Science (SEAS).
- "The Practical Penn: A Student Guide"- a very informative handbook distributed to all new students.

These guidelines together with the above publications will answer most of your questions. Advice and answers to special questions may be obtained from your advisor or the Graduate Group Chair[1], as well as the Graduate Chair's Program Coordinator[2], who will assist you in any reasonable manner possible.

It is the student's responsibility to be familiar with the rules, procedures, and requirements of the Department, SEAS, and the University of Pennsylvania. Your advisor and any staff member will assist you as much as possible. A continually updated version of this document is available on the web (http://www.me.upenn.edu/graduate/phdguidelines.html).

Students who matriculated before September 2006 are subject to the policies that were in effect as of their matriculation date.

2. ADMINISTRATIVE STRUCTURE

The graduate program in Mechanical Engineering and Applied Mechanics is administered by the Graduate Group in Mechanical Engineering and Applied Mechanics. The Graduate Group is comprised of the primary faculty members of MEAM as well as faculty from other departments and schools throughout the University. This unique composition gives students the opportunity to work in emerging and interdisciplinary areas that are relevant to mechanical engineering. The current members of the MEAM graduate group and their research areas are listed in Appendix E. Additional information can be obtained from the Department's website (http://www.me.upenn.edu/graduate/GGfaculty.html).

All graduate programs in SEAS are administratively under the auspices of the Associate Dean for Academic Affairs[3], whose activities with respect to graduate studies in MEAM are in conjunction with the recommendations of the MEAM Graduate Group Chair.

3. ADVISORS

The first person with whom a new student has contact is the MEAM Graduate Group Chair. A program of study is developed in collaboration with the Chair and with the research/academic advisor once the advisor has been appointed. The academic advisor is responsible from then on for monitoring the student's course plan and dissertation work.

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4. GENERAL INFORMATION

The objective of the doctoral program is to educate a cadre of highly competent researchers who will pursue careers in academia, research, and technological leadership. The centerpiece of the doctoral program is the dissertation research. You are expected to spend most of your time and energy generating high quality, original research. The courses that you will be taking during your tenure at the university will be geared mostly towards providing you with the necessary background to conduct quality research and to strengthen your core knowledge. Your professional reputation and, to some extent, that of the department depend on your success in generating a high quality dissertation. Furthermore, the research grants that faculty receive and all other funding available in the department for graduate students are closely tied to the department's research productivity.

Registration, Leaves of Absence

Graduate students in Mechanical Engineering and Applied Mechanics have a wide variety of interests, and the MEAM graduate program is designed to encourage these interests. Some students prefer to take technical courses primarily within the Department; others desire to take a number of courses in other engineering or science departments. The student must obtain his/her advisor's approval for any course selection. First year students must complete an advisor's sign-off form. This form can be found in Appendix F and should be submitted prior to registering for courses. A sample list of courses usually taken by MEAM doctoral students is available in Appendix A.

All students enrolled in a degree program are required to be continuously registered. Four courses per semester (including thesis research, such as MEAM 999) is considered to be a normal, full-time load for all students. Students must consult with the Graduate Group Chair if a deviation from the normal load is contemplated. Part-time students usually take one or, at most, two courses per semester. MEAM 999 is the course number assigned to dissertation research. Several units of this course may be taken simultaneously. The grading of MEAM 999 is done by the student's dissertation advisor. Only grades of "S" (satisfactory), "U" (unsatisfactory) or "I" (incomplete) can be earned in this course.

Continuous registration as a graduate student is required unless a formal leave of absence is granted by the dean of the student's school. A student who has reached dissertation tuition status will not be granted a leave of absence, except for military duty, medical reasons, or when the student receives a grant for dissertation research conducted abroad and the grant does not include funds to pay home institutional fees. A student not in dissertation status who desires a leave of absence must submit a request to the Graduate Group Chair and to the Graduate Division Office.

Changes in Course Program

Students may add or drop courses without penalty in any semester if it is done by the deadline listed in the current graduate bulletin. The student's advisor must be informed of the student's decision beforehand and must give his/her approval. However, international students must maintain full time status in accordance with the rules administered by the Office of International Programs.

Grades, Credits, and Academic Standing

The grading system is as follows: A (4.0), Excellent; B (3.0), Good; C (2.0), Fair; D (1.0), Below Average; F (0.0), Failure; and (I) Incomplete. A course in which an F was obtained must be taken again; however, the F remains on the student's record. Courses for which a passing grade was obtained cannot be taken again for credit.

Doctoral students in the School of Engineering and Applied Science are expected to maintain at least a B average (3.0) in their work. A student whose record falls below a minimum of a B average will be put on academic probation and may be required to withdraw; graduation requires a minimum of a B average

(exclusive of dissertation credits). Requirements cannot be satisfied by auditing courses or receiving an incomplete (I) grade.

5. DEGREE REQUIREMENTS

Detailed regulations and requirements concerning the degree are described in the current University of Pennsylvania Bulletin on Graduate Studies in Engineering and Applied Science and the Graduate Academic Bulletin Rules and Regulations. It is the responsibility of the Ph.D. student to become familiar with all of the degree requirements in addition to those discussed in this document.

The Ph.D. requirements include the completion of a minimum of 20 course units of graduate level work beyond the undergraduate program with a grade-point average of at least 3.0 (as indicated in Section 4), satisfactory performance in the Ph.D. related exams, presentation of a departmental seminar, completion of the teaching practicum, and the submission and successful defense of an original and significant dissertation. The required 20 course units may include research units (i.e., MEAM 999). The milestones in the Ph.D. program are noted in Appendix B and described in detail in this document.

Core Requirements

All doctoral students are required to take the following:

- Three mathematics courses. The three mathematics courses must be selected from the following: ENM 510, ENM 511, ENM 600, ENM 601, and ENM 603. A student may take any graduate Engineering Mathematics (ENM) course or any graduate course offered by the Math Department with a petition approved by the Graduate Group Chair. It is recommended that ENM 510 and 511 be taken in the first and second semesters as they lay the necessary mathematical foundation for other MEAM/SEAS graduate courses.
- One course in continuum mechanics (MEAM 530 or 630)
- One in dynamics (MEAM 535)
- One in transport processes (MEAM 570)
- Six seminar course units (MEAM 699)

Note: MEAM 530/630, 535, and 570 may be taken anytime in the first three years of the Ph.D. program.

Course Selection Approval

No courses shall be taken without the prior approval of the student's advisor. Each student must prepare a tentative course plan and obtain the approval of his/her advisor and the Graduate Group Chair before the end of the second semester after his/her matriculation. A copy of the course plan will be maintained in the student's file. Any deviations from the course plan must be documented and approved by the Graduate Group Chair.

6. POLICY ON TRANSFER OF CREDIT UNITS EARNED AT OTHER INSTITUTIONS

A maximum of eight graduate-level course units (out of the 20 required) taken at another university may be accepted provided that the grade received in each course was at least a B, and subject to approval by the Graduate Group Chair and the Associate Dean for Academic Affairs, and in accordance with the rules of the University at the time of admission, as found in the current SEAS catalog. The student who wishes such credit transfer must petition to the Graduate Group Chair and enclose with the petition the documents and information stated in Appendix D. In order to obtain credit for courses taken at other institutions the following procedure must be followed:

- For each transfer course, obtain the course description and the title of the textbook prescribed for the course.
- Identify a professor who teaches a similar course at Penn. If a similar course is not offered at Penn,

identify a professor whose areas of expertise are in the general area of the course to be transferred. The professor should certify that the course is of similar level to a graduate course offered at Penn or, if a similar course is not offered at Penn, that the course qualifies for Penn students to take if it were offered here.

- Submit a petition on a standard form (appendix D) to the Graduate Group Chair. Attach to the petition a copy of the transcript, the professor's certification, and documents and information noted in Appendix D.

7. INDEPENDENT STUDY

Independent study courses are important vehicles to accommodate special interests of the students, which are not served through the regular courses. They create opportunities for mini-projects and a mentoring relationship between the student and the faculty. Independent study also can serve as a means for the student and advisor to appreciate each other's interests and get started on dissertation work prior to making a long-term commitment. The student should identify the topic and scope of the independent study in the semester prior to the one in which s/he intends to take on the independent study.

Since independent studies are less structured than regular courses and typically do not come with strict deadlines, occasionally students tend to fall behind in their work. There is also the possibility a miscommunication between the student and the faculty on the objectives, extent, scope, and the grading method for the independent study.

The purpose of this policy is to set the rules for an independent study with the objectives of maintaining academic rigor and minimizing any potential for miscommunication.

- An independent study course should require an effort comparable to that of a regular course, about 9 hours a week or a total of 126 hours per semester.
- The student should meet the faculty member administering the independent study (the advisor) on a regular basis, at least once a week. It is the student's responsibility to schedule these weekly meetings. Past experience indicates that failure to maintain regular contact with the student's advisor often has led to a less than satisfactory performance in the independent-study course. In the absence of regular contact, the student stands the risk of not being focused leading to an impression of dereliction. The key to a successful independent study is a steady effort throughout the semester. The student should not expect to be able to cram a semester's work into a few days of intensive work at the end of the semester.
- Prior to the beginning of the semester in which the student contemplates taking the independent study, the student and his/her advisor should develop a brief document. The first paragraph of the document should describe the objectives, scope, and content of the independent study. The second paragraph should state how the independent study will be evaluated and how the student will be graded. The document should be signed by both the student and his/her advisor, and it should be submitted to the graduate group chair for approval before the beginning of the semester.
- At the conclusion of the independent study, the student should prepare a brief report specifying what material was covered during the independent study, those objectives that were met and those that were not. In the event that objectives were not met, a clear explanation should be provided as to why such objectives were not met. This document should also be signed by the student and his/her advisor, and it will form a part of the student's file.
- It is the student's responsibility to make sure that these guidelines are followed. Failure to follow these guidelines may result in the student not receiving credit for the independent study.

8. RESIDENCY REQUIREMENT

A Ph.D. candidate, unless s/he already has a Master's degree from the University, must spend at least one year in residence with the associated graduate group. This rule is interpreted to mean a program of at least two course units per semester achieved within two successive terms exclusive of the summer terms. Also, following matriculation, no courses may be taken for a MEAM degree credit at any place other than at the University of Pennsylvania.

9. TEACHING PRACTICUM

Participation of graduate students in the teaching mission of the department will help to develop teaching, presentation, leadership, and interpersonal skills while assisting the department in discharging its teaching responsibilities. All doctoral students who matriculated in September 1998 or later are required to participate under faculty guidance in the teaching mission of the department. This requirement will be satisfied by completing three 0.5 course unit of teaching practicum (MEAM 895). Each 0.5 course units of teaching practicum will consist of the equivalent of 10 hours of effort per week for one semester. As a part of the preparation for and fulfilling the teaching practicum requirement, the students will attend seminars emphasizing teaching and communication skills; lead recitations; lead tutorials; supervise laboratory experiments; develop instructional laboratories; develop instructional material; and grade homeworks, laboratory reports, and exams. A teaching training seminar typically will be conducted the day before the first day of classes of the fall semester. Attendance is mandatory to all second year students. As much as possible, the grading aspect of the teaching practicum course will be such as not to exceed 50% of the usual teaching assistant commitment time. Some of the recitations will be supervised, and feedback and comments will be provided to the student by the faculty responsible for the course. At the completion of every 0.5 course unit of teaching practicum, the student will receive a Satisfactory/Unsatisfactory grade and a written evaluation signed by the faculty member responsible for the course. The evaluation will be based on comments of the students taking the course and the impressions of the faculty in charge.

10. OBSOLETENESS

The Ph.D. program, culminating in a successful defense of the doctorial dissertation, must be completed within a period of 10 years from the year of matriculation as a graduate student in the School of Engineering and Applied Science of the University of Pennsylvania.

11. THE MEAM Ph.D. QUALIFYING EXAMINATION POLICY

All students who are working towards the Ph.D. degree must take and pass an exam, which serves as an important component of determining their ability to independently conduct research of high quality. M.S.E. students who think that they may continue on for the Ph.D. in MEAM may also take this exam.

The qualifying examination is administered in the following manner:

1. By the end of his/her first semester, each full-time doctoral student will elect an independent study in the general area in which s/he wishes to pursue dissertation research. The independent study will be carried out during the second semester, and it will be research oriented and mentored by a willing faculty advisor chosen by the student. The advisor must be a member of the MEAM graduate group. While the advisor need not be the student’s Ph.D. dissertation advisor, students are advised to choose faculty advisors who are likely to serve as their dissertation supervisor in the future. The independent study will consist of either a critical review of a body of literature or a mini research project. The scope of the independent study will be consistent with at least 9 hours of work per week for the duration of the semester. The independent study should afford the student the opportunity to carry out independent work.

2. The independent study course will follow the guidelines outlined in Section 7, Independent Study. The student will receive a grade for the independent study given by the faculty advisor. This grade will be independent of the outcome of the qualification process.

3. The independent study proposal should be brief and no more than two pages in length. It should be written in a way that is comprehensible to individuals other than you and your advisor. The first paragraph of the proposal should state the scope and the objectives of the study. The second paragraph should state how you will go about achieving your objectives. For example, your study may include a critical review of a body of literature (supplementing any missing details in the reviewed work), a formulation and possibly a solution of a new mathematical model, an experimental study or a combination of the above. At the conclusion of the study, you will need to summarize your results in a report. In the third paragraph of your proposal, you should state what the deliverables are going to be at the end of the study. Finally, provide a list of the relevant references.

4. Only students in good academic standing will be allowed to go through the qualification process. "Good academic standing" implies that the student has a minimum grade point average of 3.0 at the time of taking the qualifying examination.

5. In addition to the independent study faculty advisor, a Ph.D. Candidacy Committee will monitor the student's progress. By the end of the first semester, in consultation with the student and faculty, the Graduate Group Chair will appoint the Ph.D. Candidacy Committee and its chair.

6. Before the end of his/her first semester, the student will submit to his/her committee for approval and to the Graduate Group Chair for information, a brief description of the proposed independent study. The committee will convene by the end of January to discuss each student's proposal and make suggestions and recommendations as appropriate. These suggestions and recommendations should be documented with a copy to be included in the student's file. The committee may request changes/modifications in the plan of study. If such changes are required, the committee shall establish a timetable for these changes to be implemented.

7. By the end of the spring break, the student will submit to his/her committee a written progress report and make a brief oral presentation to his/her research advisor and any members of the student's committee who wish and can be present. After the submission of the written midterm report, the committee will review the student's progress and make recommendations to the student as appropriate.

8. By the date of the last final examination of his/her second semester, the student will submit to his/her committee and to the Graduate Group Chair a paper summarizing his/her independent study work. The paper should be written in the format of a journal paper, and it should be understandable by an educated audience who are not necessarily expert in the field. The due date of the papers will not be extended.

9. No later than a month after the last day of finals, the student will make a presentation of his/her paper to the committee and respond to questions. The committee may ask additional questions related more broadly to the independent study and on material covered in the student's courses (including the mathematics courses). A committee member will be designated as the "math examiner", and s/he and any other committee members may ask questions on mathematics relevant to the broad area of the independent study.

10. The Ph.D. Candidacy Committee will review the student's record in coursework, his/her performance in the independent study, and his/her performance in the oral examination. Then, the chair of the committee, in consultation with other members of the committee, will make a recommendation to the Graduate Group Chair on the outcome of the qualifying examination. The Committee may also recommend a course plan that can help the student deal with any weaknesses in his/her background. The

Graduate Group will make the final decision. The Graduate Group Chair will inform the student about the result.

11. The qualifying examination must be completed no later than two months after the last day of final examinations in the spring semester. In exceptional cases, the committee may recommend the submission of a revised paper and/or another presentation. The Graduate Group Chair will specify the deadline for the revised paper/presentation.

12. Part-time students shall take the Qualifying Exam after they have completed six courses, at the first time it is offered.

13. It is the student's responsibility to coordinate the dates for the various presentations, reserve a room for the presentation of the material (with the assistance of the MEAM office staff) and notify his/her committee members of the time and place of the various presentations. If the deadlines stated here are not adhered to, an explanatory letter signed by the student and the advisor must be submitted to the Graduate Group Chair for approval.

12. THE DIRECT PATH TO THE Ph.D. FOR STUDENTS WITHOUT AN M.S.E. DEGREE.

Students who have only a bachelor's degree and wish to study for the Ph.D. are encouraged to register as Ph.D. candidates. However, they may obtain a Master's degree if they so desire during their Ph.D. program. The students must inform the Graduate Group Chair, in writing of their intent with respect to the receiving of the Master's degree.

12.1 Obtaining An M.S. E. Degree

The master and doctoral programs have different objectives. An M.S.E. degree will not be automatically granted to a Ph.D. candidate upon the completion of 10 course units. Doctoral students who desire to obtain an M.S.E. degree at some point along their doctoral studies must petition the Graduate Group. The Graduate Group or its designee will review the petitioner's records and determine whether the granting of the M.S.E. degree is appropriate. Typically, M.S.E. degrees are awarded to Ph.D. candidates at the end of their third year at Penn.

13. DISSERTATION

Several recognized paths are available to the student when choosing a dissertation topic. Often the topic will be the natural result of sponsored research the student may be working on. Sometimes a particularly challenging problem at the student's place of employment will form the foundation for a dissertation. Regardless of the route by which a dissertation topic is chosen, a student must have a faculty member willing, by mutual agreement, to act as a dissertation advisor. It is essential that the student realize that the dissertation is the culmination of years of study and is the distinguishing feature of the Ph.D. degree. Clearly, dissertation topics and advisors should be chosen with care and deliberation. The student should feel free to discuss possible topics and dissertation supervision with any and all MEAM faculty members.

When requested by the advisor, the Graduate Group Chair will appoint a Dissertation Committee composed of at least three members. The advisor(s) is/are member(s) of the committee, while the other members may be from related disciplines. The Committee may include members who are not on faculty of the University of Pennsylvania, subject to approval by the Graduate Group Chair, as long as at least three members of the Committee are faculty of the University of Pennsylvania. The Chair of the Committee may be any of the committee members exclusive of the student's dissertation advisor(s). The Chair will be appointed by the Graduate Group Chair, in consultation with the advisor(s). The Dissertation Committee Chair will call a dissertation proposal meeting, at which time the candidate will present the proposed research topic, scope and method of research, and partial results (if any). This preliminary meeting is intended to be helpful in

discussing the student's planned program, scope of work, and method of approach, and in providing proper guidance. The committee often makes constructive suggestions for strengthening the research and the eventual dissertation. The Dissertation Committee Chair will inform the Graduate Group Chair and the student, in writing, on whether the Dissertation Committee has approved the proposal and what its recommendations are on further work. To avoid any misunderstanding, it is emphasized that the dissertation itself is not approved at the preliminary meeting; only the area of research topic and a general plan of the dissertation are approved at this meeting. Furthermore, the advisor and the student may ask the committee to reconvene at other times if they feel that there is further benefit to be gained from discussing the research topic. The student is also encouraged to frequently consult with the Dissertation Committee members and inform them of the progress.

A full-time Ph.D.-track graduate student should prepare and present his/her Ph.D. dissertation proposal preferably before the end of the second year of study. A copy of this proposal should be submitted to the MEAM office to be kept on file. If the proposal was not approved by the Dissertation Committee, the student must make the necessary improvements, resubmit and present the new proposal, and earn its approval. The proposal must be completed at least six to twelve months prior to the final defense.

When the dissertation advisor is satisfied with the dissertation presented to him/her by the student, copies of the dissertation are given to the members of the Dissertation Committee for study and critique. Normally, the Dissertation Committee members require three or four weeks to examine a dissertation, and the student should recognize this when attempting to meet deadlines. The Dissertation Committee may declare itself sufficiently satisfied with the dissertation to permit the scheduling by the dissertation advisor of the dissertation defense. Where the committee feels that major modifications are in order, additional work by the student and revision of the dissertation may be required before a defense can be scheduled.

The dissertation presentation by the doctoral candidate is given at a meeting open to the public. The announcement of the presentation to the public must be submitted to the graduate assistant and the seminar coordinator for posting at least three weeks prior to the presentation. As much as possible, the thesis presentation will be scheduled during the seminar period to enable the attendance of a broad audience. After the presentation by the candidate, the Dissertation Committee will question him/her on several aspects of the work. Additional questions or comments from others attending the presentation will then be solicited. The general public will then be asked to leave the room prior to a final session at which more questions may be asked by the Dissertation committee. The Dissertation Committee will decide on acceptance or the non-acceptance of the dissertation at the conclusion of this meeting.

Once the dissertation has been accepted by the thesis committee, the student will submit the final version of the thesis with the advisor's signature for the approval of the Graduate Group Chair. The student will submit the thesis to the Chair at least two weeks prior to the university's deadline for Ph.D. theses. After examining the thesis, the Graduate Group Chair may either approve and sign on the thesis or return the thesis to the student requesting additional modifications.

It is noted and emphasized that the dissertation must be prepared and submitted in accordance with the rules and schedules of the School of Engineering and Applied Science of the University of Pennsylvania. The format is explained in the booklet "Doctoral Dissertation Manual" available from the Office of the Associate Dean for Academic Affairs. In addition to the two unbound copies of the dissertation and other items, which need to be submitted to the Office of the Associate Dean for Graduate Education and Research, two or more hardbound copies must be submitted to the Graduate Group Chair and advisor(s) as stated in Appendix C. Failure to follow the above schedule and requirements will result in a delay in awarding the degree.

All dissertations must be freely publishable and the contents cannot be restricted from dissemination to the community at large by the candidate's place of employment or the sponsoring agency, government, or any person. Any computer source code which constitutes a portion of the thesis (with the exception of

readily-available commercial software) must be available to the community at large. It is the responsibility of the student to insure that the above requirements are duly considered in the planning and execution of the research program and in the presentation of the final document.

14. SEMINAR PRESENTATION REQUIREMENT

As a part of their degree requirements, all doctoral students will present a departmental seminar on their research prior to their dissertation presentation. This seminar must be given at least one semester before the anticipated graduation date.

The Ph.D. seminar requirement will serve the following purposes:

- The seminar will give the student an opportunity to practice presenting technical material and "think on his/her feet" while responding to questions from the audience. Similar seminars are often required by prospective employers both in academia and industry as a part of the interviewing process.
- The seminars will help inform other students and faculty about ongoing research. These should be of particular interest to first year graduate students who are trying to identify relevant research areas.
- The seminars may help foster intellectual interactions in the department and the formation of a scholarly community. Comments and questions during the presentation may provide constructive suggestions to the presenter regarding how to improve his/her thesis while there is still time to do so.
- The presenters may include in their CV the fact that they have given a seminar at Penn.

No Ph.D. student will be able to graduate without fulfilling the Ph.D. seminar requirement. To the extent possible, the Ph.D. seminar should be scheduled as part of the departmental seminar series, and it will receive public notice similar to that of other departmental seminars. It is the responsibility of the student to schedule a date for his/her seminar with the MEAM seminar coordinator. Students should be aware that the seminar calendar is typically finalized before the beginning of each semester. Ph.D. students who wish to give a talk during any given term will need to fix the date at least a month prior to the beginning of the semester. Typically, the seminar should be presented no later than the end of the fourth year after matriculation.

The presenter should prepare his/her seminar carefully, keeping in mind that he/she is going to talk to an intelligent audience with diverse backgrounds, some of whom may not be familiar with the speaker's specific research area. The student should have his/her advisor(s) critique the visuals and the presentation before the public presentation. A good introduction which gives background information, context, and motivation is a good idea. To allow ample time for discussion, the talk should not exceed 40 minutes. The presenter should anticipate and be ready to answer questions from the audience. During the discussion period, in order to encourage student questions, students in the audience will have be given a chance to ask questions before the faculty members do so. After the presentation, the student’s dissertation committee will discuss the presentation and provide the student with a written evaluation including comments on both strengths and areas for possible improvement. The chair of the student’s dissertation committee will develop this evaluation. The presentation may be videotaped to give the student an opportunity to see himself/herself the same way the audience have seen him/her.

15. ATTENDANCE AT DEPARTMENTAL SEMINARS AND THESIS PRESENTATIONS

The attendance of all full-time graduate students at departmental seminars is mandatory. There are many

good reasons why students should attend departmental seminars even when the seminars are not directly linked to their area of research. For example:

- The seminar provides an opportunity to learn about the state-of-the-art in mechanical engineering and applied mechanics.
- The seminar provides an opportunity for the student to get acquainted with people from other institutions and companies and get a birds-eye view of the culture at other institutions. On more than one occasion, during job interviews, interviewers have been known to mention a visit to Penn and delivering a seminar. The student would like to be in a position to comment on that particular seminar and state how enjoyable it was.
- The departmental seminars are one of the few opportunities there are to get together as a department. It is hoped that a full attendance at these seminars will help create departmental spirit and cohesiveness.

Seminar course

The seminar course has been established so that students get recognition for their seminar attendance as well as to encourage students to attend. There will be however, no quizzes, tests, or homeworks. The course will be graded S/U. In order to obtain a satisfactory (S) grade, the student will need to attend more than 70% of the departmental seminars. For example, in a term in which 12 seminars are given, the student will need to attend at least 9 seminars to obtain a satisfactory grade. Participation in the seminar course will be documented and recorded in the student's transcript. In order to obtain their degree, doctoral candidates will be required to accumulate 6 seminar courses (beginning in the fall of 2001). Under special circumstances, i.e., in a case of a conflict with a course, the student may waive the seminar requirement for a particular semester by petition to the Graduate Group chair. Part-time students are exempted from the seminar attendance requirement although they are encouraged to attend the seminars.

16. SUMMER STUDIES

There are several possibilities for scholarly activities by graduate students at the University during the summer which include:

- Independent study and research (MEAM 899 or 999) with an instructor willing to act as a supervisor during the summer.
- Course work outside SEAS, as well as a limited number of regular courses occasionally offered by some SEAS departments. The advisor, in consultation with the Graduate Group Chair, must approve summer school courses.

Full-time students supported by research grants are expected to be in residence for the summer. Students who wish to take summer courses must obtain approval from their faculty advisor prior to registration. Questions on summer session registration should be referred to the Graduate Group Chair.

17. RECORDS

The official graduate student records are kept in 111 Towne Building and transcripts can be viewed on Penn InTouch at https://sentry.isc.upenn.edu/intouch/. Graduate students are encouraged to periodically check the accuracy of their records and to bring any discrepancies to the attention of the Graduate Group Chair.

18. FINANCIAL SUPPORT

Financial support for graduate students is made available through a number of sources such as funds from the School, the Department, research grants of the faculty, and industrial sources, where research support is

the predominant among all. A given faculty member plays the primary role in selecting a student for a research fellowship supported by his/her grant. Appropriate committees will choose students for other scholarships and fellowships. The Graduate Group Chair formally makes all fellowship appointments. Most sources of funding, research grants in particular, include support for the summer months. Students are expected to work full time on research in the summer months during which they are supported.

19. THE GRADUATE ENVIRONMENT

The spirit and size of the Department of Mechanical Engineering and Applied Mechanics fosters a close interaction between the graduate students and the entire faculty. This enhances the quality of student-faculty communications and enriches the academic environment, to benefit both learning and discovery.

Apart from offering advising, seminars and meetings to introduce incoming students to faculty research, and informal meetings with the Department Chair and Graduate Group Chair to solicit student input and exchange information, the Department strongly supports the Mechanical Engineering Graduate Association (MEGA). MEGA is a student-run association that represents the entire graduate student community in MEAM, and organizes both social and technical events. A chosen representative of MEGA becomes a member of the Graduate Group of the department, with voting rights, and serves as a communication channel for information between the Graduate Group and students.

Every effort is made to create an environment of scholarship, creativity and learning, which is the very essence of graduate study.

APPENDIX A

A Sample Ph.D. Program in Mechanical Engineering & Applied Mechanics

Thermo/Fluids	Mechanics of Materials	Mechanical Systems	Bio mechanics
1st Year - Fall			
ENM 510-Applied Mathematics I (R)			
MEAM 530 Continuum Mechanics (R)	**MEAM 530 Continuum Mechanics (R)**	**MEAM 535 Advanced Dynamics (R)**	MEAM 555 Membranes and Polymers in Biology (E)
MEAM 570 Introduction to Transport Phenomena (R)	MEAM 519 Introduction to Elasticity (E)	MEAM 540 Optimal Design of Mechanical Systems (E)	**MEAM 570 Introduction to Transport Phenomena (R)** or MEAM 554 Mechanics of Materials (E)
MEAM elective or MEAM 899 Independent Study (E)			
Departmental Seminars (R)			
1st Year - Spring			
ENM 511-Applied Mathematics II (R)			
MEAM 527 – Finite Element Analysis (E)	MEAM 527 – Finite Element Analysis (E)	MEAM 513 Linear Control Systems (E)	MEAM 527 – Finite Element Analysis (E)
MEAM 665 – Intermediate Transport Phenomena (E) or MEAM 642 Fluid Mechanics I (E)	MEAM 632 – Plasticity (E)	MEAM 520 Robotics and Automation (E) Or MEAM 527 Finite Element Analysis (E)	Upper Level (>300) or Grad Course in the Bio-Sciences
MEAM 899 Independent Study (R)			
Departmental Seminars (R)			

E → elective
R → required

A Sample Ph.D. Program in Mechanical Engineering & Applied Mechanics (continued)

Thermo/Fluids	Mechanics of Materials	Mechanical Systems	Bio mechanics
2nd Year - Fall			
MEAM 535 Advanced Dynamics (R)	**MEAM 535 Advanced Dynamics (R)**	**MEAM 570 Introduction to Transport Phenomena (R)**	**MEAM 535 Advanced Dynamics (R)**
MEAM 643 Fluid Mechanics II (E)	**MEAM 570 Introduction to Transport Phenomena (R)**	**MEAM 530 Continuum Mechanics (R)**	**MEAM 530 Continuum Mechanics (R)**
MEAM 999 (2 units) Thesis Research			
MEAM 895 Teaching Practicum (R)			
Departmental Seminars (R)			
2nd Year - Spring			
ENM 601 Mathematics (R)			
MEAM 644 Fluid Mechanics III (E)	MEAM 635 – Composite Materials (E)	MEAM 527 Finite Element Analysis (E)	Upper Level or Grad Course in the Bio-Sciences
MEAM 999 (2 units) Thesis Research			
MEAM 895 Teaching Practicum (R)			
Departmental Seminars (R)			

A Sample Ph.D. Program in Mechanical Engineering & Applied Mechanics (continued)

Thermo/Fluids	Mechanics of Materials	Mechanical Systems	Bio mechanics
3rd Year - Fall			
MEAM 645 Fluid Mechanics IV (E)	MEAM 633 Fracture Mechanics (E)	MEAM 550 Modeling and Design of MEMS (E)	Upper Level (>300) or Grad Course in the Bio-Sciences (E)
MEAM 550 Design and Modeling of MEMS (E)	MEAM 540 Optimal Design of Mechanical Systems (E)	MEAM 613 Nonlinear Control Theory (E)	MEAM 550 Design and Modeling of MEMS (E)
MEAM 999 (2 units) Thesis Research			
MEAM 895 Teaching Practicum (R)			
Departmental Seminars (R)			
3rd Year Spring			
MEAM 561 Thermodynamics (E)	MSE 660 Atomistic Modeling (E)	MEAM 635 Composite Materials (E)	Upper Level (>300) or Grad Course in the Bio-Sciences (E)
MEAM 540 Optimal Design of Mechanical Systems (E)	MEAM 550 Design and Modeling of MEMS (E)	OPIM 654 – Product Design & Development (E)	Upper Level (>300) or Grad Course in the Bio-Sciences (E)
MEAM 999 (2 units) Thesis Research			
Departmental Seminars (R)			

APPENDIX B

Time Line for Ph.D. Students

By the End of Semester	Objectives
1	Define an Independent Study Course
2	Submit A Paper Summarizing The Independent Study By The Last Day Of Finals
2+one month	Make An Oral Presentation of The Independent Study Paper
2+two months	Submit and Obtain Approval for a Course Plan
2	Register for First Teaching Practicum
3	Select a Thesis Committee
3	Register for Second Teaching Practicum
4	Present and Obtain Approval for a Thesis Proposal
4	Register for Third Teaching Practicum
8	Present a Departmental Seminar
	Submit a Dissertation Draft to your Advisor
	Submit a Revised Dissertation Draft to Your Dissertation Committee
TD-3weeks	Publicize for Thesis Presentation
TD	Defend Thesis
	Make Corrections and Modifications to Thesis
GD-4 weeks	Submit a Copy of the Thesis to the Graduate Group Chair for Approval
GD	Submit Final Thesis to the Graduate School
GD	Graduate

TD → thesis-defense date
GD → graduation date

APPENDIX C

Hard Cover Instructions
for M.S.E. and Ph.D. Thesis

Guidelines:

In addition to the two unbound copies that must be given to the Office of the Associate Dean for Graduate Education and Research, one hard-bound copy of each M.S.E. thesis and Ph.D. dissertation must be submitted to the Graduate Group Chair and one hard-bound copy must be submitted to the student's advisor. If the student has more than one advisor (co-advisors) then the student is required to submit one hard-bound copy to each advisor.

There is a charge of $25.00 per copy. Please check with the Graduate Assistant for more information about hard-binding your thesis.

Ph.D. dissertations are to be bound in a black cover with gold letters.

The lettering on the front should follow this example:

Alfred E. Neuman

Design Optimization and Control of a Multi-robot System to Study the Size-Dependent Effects in the Mechanics of Muscle Cells Flowing Through Heated Micro Conduits

Ph.D. Dissertation
Mechanical Engineering and Applied Mechanics
University of Pennsylvania
2006

And on the spine (from top to bottom):
Neuman Design Optimization and Control of a Multi-robot System (etc., as much as space will allow, use ... at end if space is insufficient) MEAM Ph.D. 2006.

APPENDIX D

GRADUATE TRANSFER OF CREDIT PETITION

TO: SEAS Associate Dean for Academic Affairs

FROM: _____ _____
Name of Student PENN ID #:

DEPT: _____

DATE: _____

Include with this petition, course numbers and descriptions from the appropriate bulletin listing and a final transcript. A maximum of **two** courses may be transferred to the Master's program or a maximum of **eight** to the Ph.D. program if approved. Courses counted towards an undergraduate degree will not be considered for graduate credit unless in an approved submatriculation program.

TRANSFER OF CREDIT TO: ☐ Master's program ☐ Ph.D. program

FROM WHICH UNIVERSITY: _____

Please list courses to be transferred and SEAS equivalent if applicable:

	COURSE	SEAS EQUIVALENT	# CUS
1)			
2)			
3)			
4)			
5)			
6)			
7)			
8)			

_____
Adviser's Approval Date

_____
Graduate Group Chairman Date

☐ Approved ☐ Disapproved

_____
Associate Dean for Academic Affairs Date

APPENDIX E

MEAM Graduate Group Members

Primary Faculty

P. S. Ayyaswamy, Asa Whitney Professor of Dynamical Engineering and Graduate Group Chair. Phase change heat and mass transfer processes, bioheat/mass transfer, arc-plasma heat transfer, and thermal aspects in MEMS.

John L. Bassani, Richard H. and S. L. Gabel Professor in Mechanical Engineering. Plastic deformation of crystals, atomic/continuum property relationships, interface mechanics, fracture mechanics, material stability at large strains, mechanics of living cells.

Haim H. Bau, Professor. Micro and nano fluidics, nanotechnology, fluid and particle motion under the action of electric and magnetic fields, and bifurcation and instability phenomena in and feedback control of flows.

George Biros, Assistant Professor. Computational science and engineering, optimization algorithms, inverse problems, computational fluid mechanics, integral equations, fast multipole methods, parallel and scientific computing.

Robert W. Carpick, Associate Professor. Experimental nanomechanics and nanotribology (friction, adhesion, lubrication, wear). Development, characterization, and applications of nanostructured materials. Application and development of advanced scanning force microscopy tools.

Howard H. Hu, Associate Professor. Modeling of complex flows with multiphase or polymeric fluids, computational fluid dynamics, hydrodynamic stability.

Katherine J. Kuchenbecker, Skirkanich Assistant Professor of Innovation. Design and control of haptic interfaces, virtual reality, teleoperation, and medical robotics (September 2007).

Vijay Kumar, UPS Foundation Professor and Chair. Robotics, dynamics of systems with frictional contacts, actively coordinated mobility systems, mechanism design and control.

Noam Lior, Professor. Energy conversion, advanced power generation, global warming alleviation, solar energy, combustion, water desalination, destruction of hazardous wastes by photocatalysis and supercritical oxidation, materials processing.

Jennifer R. Lukes, William K. Gemmill Term Assistant Professor. Nanoscale thermal, fluid, and mass transport; molecular dynamics simulation; laser-based materials characterization; field-directed patterning for nanofabrication; flow measurement in confined geometries; micro- and nanoscale engineering.

Pedro Ponte Castañeda, Professor. Nonlinear composite and polycrystalline materials, fracture mechanics, microstructure evolution and localization in manufacturing processes, mechanics of polymers, nonlinear variational principles in mechanics.

Prashant Purohit, Assistant Professor. Rod theories for DNA and biopolymers, Mechanics of sub-cellular organelles, Mechanics at the bio-nano interface, Martensitic phase transitions in solids.

Mark Yim, Associate Professor, Gabel Family Term Junior Professor of Mechanical Engineering and Undergraduate Curriculum Chair. Modular Self-reconfigurable Robotics, Virtual reality (haptics), meso-scale devices (typically larger than MEMS).

Affiliated Faculty

G. K. Ananthasuresh, Adjunct Associate Professor of Mechanical Engineering and Applied Mechanics. Compliant mechanisms, microelectromechanical systems (MEMS), design optimization, kinematics of mechanisms.

Michael Carchidi, Senior Lecturer, Mechanical Engineering and Applied Mechanics. Engineering Mathematics, Vibrations, Nonlinear Dynamics, Vector Dynamics, Operations Research: Simulation and Optimization.

Thomas A.V. Cassel, Professor of Practice, Mechanical Engineering and Applied Mechanics. Engineering Entrepreneurship.

Stuart Churchill, Carl V. S. Patterson Professor Emeritus of Chemical Engineering. Combustion, rate processes and correlation, the prediction of turbulent flow and convection.

Ira M. Cohen, Professor, Emeritus. Basic problems in fluid mechanics and heat transfer as applied to microelectronic processing. Plasmas in combustion and manufacturing.

Dennis E. Discher, Professor of Chemical and Biomolecular Engineering. Mechanics and structural assemblies of biomolecules, mechanochemistry of cells, mechanics and statistical mechanics of networks and complex fluids.

David M. Eckmann, Associate Professor of Anesthesia. Experimental and computational biofluid dynamics, interfacial fluid mechanics, molecular mechanics of cellular activation and biological adhesion to vascular tissue and biomimetic materials.

Dawn M. Elliott, Associate Professor of Orthopaedic Surgery and Bioengineering. Orthopaedic biomechanics of the intervertebral disc; anisotropic, nonlinear, and viscoelastic biomechanics; models of disc degeneration; structure-function of the disc.

Robert L. Jeffcoat, Adjunct Professor of Mechanical Engineering and Applied Mechanics.

Daniel E. Koditschek, Alfred Fitler Moore Professor and Chair of Electrical and Systems Engineering. Robotics, computational neuromechanics, dynamical systems theory applied to design of intelligent machines and their control.

Charles J. McMahon, Jr., Professor Emeritus of Material Science and Engineering. Mechanisms of intergranular embrittlement and fracture in high-strength structural materials, especially as related to environmental effects. Current interests are dynamic embrittlement in nickel and copper-based alloys and in steels.

George J. Pappas, Associate Professor of Electrical and Systems Engineering. Hybrid systems, hierarchical control systems, embedded systems, nonlinear systems, geometric control theory, robotics, unmanned aerial vehicles.

Gianluca Piazza, Assistant Professor of Electrical and Systems Engineering. Micro/NanoElectroMechanical Systems (MEMS/NEMS), Piezoelectric Materials, Wireless Transducers, Sensors and Actuators, Biochemical Detectors, Micro/Nanofabrication Techniques.

Harvey Rubin, Professor of Infectious Diseases, School of Medicine. Modeling complex biological behavior using a hybrid systems approach that combines continuous and stochastic modalities, enzymology and genetics of dormancy in Mycobacterium tuberculosis, enzymology and cell biology of serine proteases and serine protease inhibitors.

Irving M. Shapiro, Professor of Orthopaedic Surgery, Jefferson Medical College. Cellular mechanism of bone and cartilage formation; effects of microgravity on bone; the structure and function of the intervertebral disc; orthopaedic implant design and tissue integration.

Louis J. Soslowsky, Professor of Orthopaedic Surgery and Bioengineering and Director of Orthopaedic Research. Orthopaedic biomechanics and functional tissue engineering; structure-function studies of tendons and ligaments; models of tendon injury, repair, and healing; shoulder joint mechanics.

Camillo J. Taylor, Associate Professor of Computer and Information Science. Reconstructing and rerendering 3D scenes from 2D images and vision guided robotic systems.

Karl T. Ulrich, CIBC Professor of Operations and Information Management (Wharton School) and Chairperson. Product design, product development, technology development, personal transportation, environmental issues.

Vaclav Vitek, Professor of Materials Science and Engineering. Computer modeling of the structure and properties of grain boundaries, metal-metal and metal-ceramic interfaces, dislocations and other lattice defects.

Beth A. Winkelstein, Assistant Professor of Bioengineering and Neurosurgery. Spine biomechanics; modeling & experimental methods in subfailure mechanics; joint mechanics; mechanical modulation of pain and cellular dysfunction; models of ligament & nerve injury.

APPENDIX F

Mechanical Engineering and Applied Mechanics Worksheet for Course Registration

Name: _____

Year Matriculated:_____ Degree program:_____(Ph.D./M.S.E.) Status: _____(Full-time/Part-time)

Concentration Area: _____

Proposed Thesis Topic and/or Title (if applicable):

PROPOSED COURSES OF STUDY FOR (TERM/s) _____ and _____

	Course	Section	CUs	Title	Comments
1					
2					
3					
4					
5					

Have you met the appropriate milestones for your program at this point? If not, please discuss with your faculty advisor.

Additional notes (if any):

_____ _____
Student's Signature Date

Required only for first-year Masters and Ph.D. students

"I have met with the student and discussed the course plan for the term(s) indicated above."

_____ _____
Advisor's Signature Date

M.S.E. Degree Requirements

- 10 CUs = 5 MEAM (3 in area of concentration) + 2 ENM/Math + 3 free preapproved electives.
- An optional masters thesis may be counted up to 3 CUs.
- Up to two CUs may be transferred from another institution subject to approval by the Graduate Group.
- Two seminar (MEAM 699) CUs are required of full-time students only.

Ph.D. Degree Requirements

- A total of 20 CUs (including 899/999). MEAM 530, 535, and 570; three ENM classes (choose from: 510, 511, 600, 601, 603) are required.
- Up to eight CUs may be transferred from another institution subject to approval by the Graduate Group.
- Teaching Practicum in three semesters, Thesis Proposal, Departmental Seminar, and Thesis research, defense, and submission are required.
- Six seminar (MEAM 699) CUs are required.

Recommended Time Line for Ph.D. Students

By the End of Semester	Milestones
1	Define an independent study course topic and choose a faculty advisor
2	Submit a paper summarizing the independent study by the last day of finals
2+one month	Make an oral presentation of the independent study paper (Qualifying examination)
2+two months	Submit and obtain approval for a course plan
2	Register for first teaching practicum
3	Choose an area for thesis research
3	Register for second teaching practicum
4	Register for third teaching practicum
6 or 7	Present and obtain approval for a thesis proposal
8 or 9	Present a departmental seminar
TD – 2 months	Submit a dissertation draft to your Advisor
TD - 3 weeks	Submit a revised dissertation draft to your dissertation committee
TD - 3 weeks	Submit abstract to Graduate Administrative Assistant for publicizing thesis presentation
TD	Defend thesis
	Make corrections and modifications to the thesis
GD - 4 weeks	Submit a copy of the thesis to the Graduate Group Chair for approval
GD	Submit final thesis to the Graduate School
GD	Graduate!

TD → thesis-defense date **GD → graduation date**

MEAM 899/999 Section Numbers

Fall & Spring	
002	Ayyaswamy
003	Bassani
004	Bau
010	Biros
005	Carpick
006	Discher
017	Elliott
007	Hu
001	Kuchenbecker
008	Kumar
009	Lior
012	Lukes
018	Piazza
011	Ponte Castañeda
001	Purohit
014	Soslowsky
016	Taylor
015	Vitek
017	Yim
019	Winkelstein

Summer 1	
911	Ayyaswamy
912	Bassani
913	Bau
930	Biros
914	Carpick
915	Discher
935	Elliott
916	Hu
910	Kuchenbecker
917	Kumar
918	Lior
919	Lukes
937	Piazza
931	Ponte Castañeda
910	Purohit
932	Soslowsky
936	Tylor
933	Vitek
936	Yim
938	Winkelstein

Summer 2	
921	Ayyaswamy
922	Bassani
923	Bau
940	Biros
924	Carpick
925	Discher
945	Elliott
926	Hu
920	Kuchenbecker
927	Kumar
928	Lior
929	Lukes
947	Piazza
941	Ponte Castañeda
920	Purohit
942	Soslowsky
944	Taylor
943	Vitek
946	Yim
948	Winkelstein

Last Updated 9/06