

Graduate Manual

Department of Mechanical and Aerospace Engineering
State University of New York at Buffalo
School of Engineering and Applied Sciences

Revised: August 24, 2021

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Chapter 1

General Academic Information

The department offers separate programs in Mechanical and Aerospace Engineering. In each program, the Master of Science, M.S., and the Doctor of Philosophy, Ph.D., degrees are granted. Students are accepted for Spring or Fall admission. Subject to certain limitations, students may undertake their program on a full- or part-time basis.

1.1 Admission Requirements

The Department of Mechanical and Aerospace Engineering offers Master of Science (M.S.) and Doctor of Philosophy (Ph.D.) degrees. A B.S. in Mechanical or Aerospace Engineering, or the equivalent, with a quality point average of at least 3.0/4.0, is normally required for admission to all programs. Prospective students may apply for either the M.S. or the Ph.D. program. Students with B.S. degree (i.e., without a M.S. degree) can apply for Ph.D. program directly or may choose to first obtain M.S. degree and then enter the Ph.D. program. Students who complete UB's M.S. program and wish to continue for Ph.D. must re-apply for admission to the Ph.D. program.

All Ph.D. students are required to have GRE's taken before admission to the program. All M.S. students who have not obtained an undergraduate degree in the United States are also required to have GRE's taken before admission to the program.

1.2 Student Classifications

- a) Degree Student: Graduate students who have been accepted by the department with an undergraduate quality point average of 3.0/4.0 or better.
- b) Non-degree Student: Students with appropriate academic qualifications who do not wish to pursue a degree program.
- c) Non-Matriculated Student: A student who has been accepted but has not yet enrolled in the academic program.
- d) Conditional Admission: Students admitted on a conditional basis do not qualify as degree students and must demonstrate their ability to perform satisfactorily at the graduate level before being admitted to

degree candidacy. A GPA of 3.0 or higher is required after completion of 9-credit hours. Otherwise, the student will be dropped automatically from the program with no further probationary period possible.

- e) Provisional Admission: Students admitted on a provisional basis must complete certain requirements before being allowed to enroll in MAE.

Graduate credit earned (4 courses or 12 credits) by non-degree students may be applied toward a degree program by petition to the Director of Graduate Studies after acceptance as a degree student. An online application must be completed and an application fee is required. An official transcript must be supplied.

1.3 Application Dates for Admission

These dates can be found at:

<http://engineering.buffalo.edu/mechanical-aerospace/graduate/admissions.html>.

1.4 Student Status

- a) Full-Time: A student who carries 12 credit hours of work is considered a full-time student by the department. Research assistants (RAs), teaching assistants (TAs) and graduate assistants (GAs) are considered full time at 9 or more credit hours. The following students must be full time: university fellows, department fellows, TAs, RAs, GAs, veterans (supported by the Veteran's Administration), and all foreign students with a student visa.

Students who are within 12 credit hours of fulfilling their Masters or Ph.D. degree requirements (9 credit hours in the case of RAs, TAs and GAs) should submit the Certification of Full-Time Status Form to the Graduate School for full-time status if registering for fewer than 12 (9 for RAs, GA and TAs) credits. All supported students and all foreign students falling into this category must file the petition. Note that an Application to Candidacy (ATC) form must be submitted and approved before a petition for full-time status will be approved by the Graduate School. Supported students should also be aware that the number of tuition scholarship credits that will be allowed will be limited to only those credit hours required for a particular degree (30 credit hours for the M.S. or 72 credit hours for the Ph.D., less any transfer credits).

- b) Part-Time: A student who carries less than that required for full-time status and has not filed a petition for full-time status is considered a part-time student by the department.

1.5 Advisement

- a) Initial Advisement and Registration: Students enrolling for graduate study for the first time should report to the Department office in 238 Bell Hall at least one week prior to the first day of classes. International students registering for the first time should report to the Office of International Education in Talbert Hall for assistance on housing, visa status, and orientation before coming to the department office.

Each student is assigned a preliminary advisor upon admission. The preliminary advisor will: (1) work with the student to decide course work that should be taken during the first year of graduate study; (2) help with any general questions a student may have about the program, opportunities for research, or

funding; and (3) help the student find an academic advisor for their MS thesis or Ph.D. dissertation. The academic advisor may or may not be the same person as the preliminary advisor. The preliminary advisor also might be of assistance to provide counsel in non-curricular matters, such as health, housing, deficiencies in English comprehension, speaking or writing.

All incoming students must attend the department's orientation where they will be introduced to their preliminary advisor. This orientation typically is held the week before Fall Semester classes start. After consultation with their preliminary advisors, new students will register for their first semester's classes.

- b) Academic Advisor: Any student interested in a project or thesis should meet with MAE department faculty members as soon as possible to find a common area of research or technical interest with the purpose of deciding a preference for a thesis/dissertation topic and advisor. Upon reaching mutual agreement with a faculty member on thesis advisement the student should so notify the department graduate office. The advisor must be a member of the Graduate School Faculty. Prior to selection of an academic advisor, student should consult with their preliminary advisor for any advisement concerning their study.

Students should discuss regularly with their advisors, who must approve all course selections as well as provide thesis or project supervision. In unusual circumstances, students may change advisors only with permission of the Director of Graduate Studies.

- c) Advisement by Non-MAE faculty: Non-MAE faculty can serve as a co-advisor or as project, thesis, and dissertation committee members, provided they have an appropriate Graduate School appointment.

1.6 Academic Grievances

All academic grievances should first be brought to the attention of the Director of Graduate Studies. If the grievance is with the Director of Graduate Studies, the issue should be brought to the attention of the MAE Chair.

A listing of policies and procedures regarding of academic grievances can be found at the following website: <https://grad.buffalo.edu/succeed/current-students/policy-library.html>.

1.7 Academic Integrity

Academic integrity is a fundamental university value. Through the honest completion of academic work, students sustain the integrity of the university while facilitating the university's imperative for the transmission of knowledge and culture based upon the generation of new and innovative ideas. When an instance of suspected or alleged academic dishonesty by a student arises, it shall be resolved according to the procedures set by the Graduate School. These procedures assume that many questions of academic dishonesty will be resolved through consultative resolution between the student and the instructor. It is recommended that the instructor and student each consult with the department chair, School or College dean, or the Graduate School if there are any questions regarding these procedures.

Examples of academic dishonesty include:

- a) Previously submitted work. Submitting academically required material that has been previously submitted – in whole or in substantial part – in another course, without prior and expressed consent of the instructor.

- b) Plagiarism. Copying or receiving material from any source and submitting that material as one's own, without acknowledging and citing the particular debts to the source (quotations, paraphrases, basic ideas), or in any other manner representing the work of another as one's own.
- c) Cheating. Soliciting and/or receiving information from, or providing information to, another student or any other unauthorized source (including electronic sources such as cellular phones and PDAs), with the intent to deceive while completing an examination or individual assignment.
- d) Falsification of academic materials. Fabricating laboratory materials, notes, reports, or any forms of computer data; forging an instructor's name or initials; resubmitting an examination or assignment for reevaluation which has been altered without the instructor's authorization; or submitting a report, paper, materials, computer data, or examination (or any considerable part thereof) prepared by any person other than the student responsible for the assignment.
- e) Misrepresentation of documents. Forgery, alteration, or misuse of any University or Official document, record, or instrument of identification.
- f) Confidential academic materials. Procurement, distribution or acceptance of examinations or laboratory results without prior and expressed consent of the instructor.
- g) Selling academic assignments. No person shall sell or offer for sale to any person enrolled at the University at Buffalo any academic assignment, or any inappropriate assistance in the preparation, research, or writing of any assignment, which the seller knows, or has reason to believe, is intended for submission in fulfillment of any course or academic program requirement.
- h) Purchasing academic assignments. No person shall purchase an academic assignment intended for submission in fulfillment of any course or academic program requirement.

Complete policies and procedures regarding academic integrity issues can be found at the following website: <https://grad.buffalo.edu/succeed/current-students/policy-library.html>.

1.8 Registration

Every student is required to register every semester; registration options include courses, research, thesis, or dissertation work. Schedules should be planned as early as possible at the beginning of each semester. The latter may be undertaken only under the direct supervision of a faculty member. No credit will be allowed for work done without proper registration. Proper registration is important for determination of the residence requirements. "Residence" implies the pursuit of advanced study or research while registered at UB under the supervision of the Graduate School Faculty.

Normally, a minimum registration period of one year on a full-time equivalent basis is expected for the M.S. degree, and two years on a similar basis is expected for the Ph.D. A Ph.D. candidate must also fulfill the Ph.D. residency requirement of at least two semesters as a full-time student.

It is important for all international students to maintain full-time status during their entire graduate study at the University at Buffalo. As per immigration regulations, international students must maintain full time status. All international students must register for at least one (1) credit in the semester prior to graduation.

Students are required to register continuously during their period of graduate study until all requirements for the degree are completed. Students who, for one reason or another, cannot maintain continuous registration must request a Leave of Absence before the start of the semester for which the leave is being requested. For this purpose, the student must petition the Dean of the Graduate School and obtain the approval of the Director of Graduate Studies. A leave of absence will only be granted to students in good academic standing. If the student is enrolled for less than 12 credits (less than 9 credits for TAs, GAs or RAs), the Certification of Full-Time Status form should also be completed.

Leaves of absence will normally be granted for only one (1) semester at a time. Leaves of more than one (1) semester may require additional justification and documentation from the student and the student's advisor. Documented cases of financial hardship, illness, or compulsory military service constitute valid justification. Students who leave the program after completion of some graduate work, but have not been given an approved leave of absence, must reapply and be readmitted as a new student. Continued leaves of absence beyond two (2) semesters will not be granted.

1.9 Paperwork Deadlines for M.S. and Ph.D. Conferral

It is the responsibility of the student to meet all deadlines specified by the Department and by the Graduate School. Degree conferral deadlines are available at <https://registrar.buffalo.edu/degrees/graduate.php> and are subject to change. Check at least three months before expected conferral. Allow time for internal processing. It is the responsibility of the student to check with the Graduate School prior to the various deadline dates to be sure that all the requirements and paperwork for the degree have been completed.

IMPORTANT NOTE ON APPLICATION TO CANDIDACY (ATC) FORM: To be in compliance with University policies all full-time students must submit their ATC forms at least one semester before the degree is to be conferred. Students in the M.S. program should submit their ATC form in their second semester of full time study. Students in the Ph.D. program should submit their ATC form as soon as possible after passing the Ph.D. qualifier exam but no later than the fourth semester of full-time study.

1.10 Transfer Credit

- a) From Another School: Graduate work done at other institutions may be offered in partial fulfillment of the requirements for a degree if the work is of acceptable quality and appropriate to the student's program. Transfer credit will be allowed only for graduate work with a grade of "B" or better. Courses graded S or P are eligible for consideration except when the transfer institution's grading policy equates S or P with lower than a full B grade. Credits earned in correspondence courses may not be transferred.
- b) A student desiring to transfer graduate credits should consult with his/her advisor before the end of the first semester in the program. When the student's Application to Candidacy is submitted, it must list the credits to be transferred.
- c) Information regarding limits on the number of credits able to be transferred can be found in Section 2.1.3 for the MS-degree and Section 3.3.1 for the PhD degree.
- d) From another Department within UB: Graduate work done in another department within UB may be offered in partial fulfillment of the degree requirements if the work is of acceptable quality and appropriate to the student's program and to the satisfaction of the advisor.

1.11 Graduate Credit

Graduate credit is granted only to degree students who:

- a) have been accepted into the department prior to registration in any course, seminar, research program, or other type of study.
- b) are seniors close to graduation with at least a 3.0/4.0 grade point average during their last three semesters and who do not need the course credit to complete the B.S. requirements. (Petition forms are available in the Student Advising Services office. Exception registration is done within the department, by the assistant to the chair, with instructor's permission.)

Graduate credit is earned for approved courses and registration in thesis/dissertation which is under the direct supervision of the advisor. Approved are those at the 500, 600 and 700 level, provided the advisement and registration requirements are met. Graduate courses from outside the School of Engineering and Applied Sciences or Natural Sciences and Mathematics must receive prior approval from the student's advisor and the Director of Graduate Studies. A form for this purpose is available with the department office of graduate studies.

1.11.1 Informal Courses

Informal courses usually include Individual Problems and Graduate Internship, which are taught on an informal basis. These courses require a complete narrative description on a special form designed for this purpose, which includes the signatures of the student, instructor, and the Director of Graduate Studies, and should be submitted to the MAE graduate secretary during registration time (the beginning of the semester).

A maximum of six (6) credit hours of informal courses may be applied toward the minimum 30 credit-hour requirement for the Masters degree.

A maximum of six (6) credit hours of informal course work may be applied towards the minimum 72 credit-hour requirement for the Ph.D. degree. Any informal course credits applied towards a Masters degree are included in this six credit limit for Ph.D. students.

1.11.2 Graduate Internship

Academic credit may be given for internship work performed during graduate studies. One (1) academic credit will be provided for every 90 hours of work performed during the internship, with no more than three (3) credits earned during each internship period. Internships during the Fall and Spring semesters, in addition to the 12-week Summer Session may be up to the three (3) credit limit. Internships during the Winter Session may only earn up to one (1) credit. Students must be registered for the internship course, MAE 598, during the time they hold the internship for the credits to count towards their degree. To register for a Graduate Internship students must fill out the "Internship Credit Request Form for MAE 598" located at <http://engineering.buffalo.edu/mechanical-aerospace/graduate/current-students/advising.html>. Students must have completed at least three (3) credits in their program before they are allowed to register for a Graduate Internship. A waiver for the three-credit requirement must be requested in writing to the Director of Graduate Studies *before* the Internship Credit Request Form is submitted. Students who hold a permanent position in the internship company will not be allowed to register for Graduate Internship credit. The graduate internship course will be graded as S/U.

1.11.3 Auditing Courses

An audited course carries no weight and does not count as attempted or accumulated hours. A student desiring an “audit” grade in a course must officially register for the course. The student must also submit a written request to the instructor by the fourth week of class indicating the desire to receive an “audit” grade. The instructor’s decision is final and must be communicated to the student in writing in a timely manner. A student wishing to repeat a previously audited course and receive a weighted grade and academic credit must first obtain permission of both the course instructor and Director of Graduate Studies before registering for the course.

1.11.4 Distance Learning for Part-time Students

Part-time students can take 4 courses through distance learning (e.g. EngiNet).

1.11.5 Distance Learning for Full-time Students

Full time Domestic Students can take 2 courses through distance learning (e.g. EngiNet). Full time International Students can take 1 course through distance learning. In such a case, both domestic and international students must discuss this with their advisor and the Director of Graduate Studies. International students must also contact International Student Services:

<http://www.buffalo.edu/international-student-services.html>.

1.11.6 Graduate Credit from Undergraduate Courses

Students wishing to use an undergraduate course for graduate credit must submit a petition form along with a statement or syllabus from the instructor showing the additional work required for graduate credit to the MAE graduate office two business days before the University’s Add/Drop deadline for the semester the course will be taken in. Copies of these petitions must be included along with the Application to Candidacy form. Retroactive approval will not be granted.

Such courses must be limited to a maximum of 2 advanced undergraduate courses at the 400 level. This maximum limit applies to the entire M.S. or Ph.D. degree program.

Undergraduate courses which carry 4 or more semester hours of credit will receive a maximum of 3 semester hours of graduate credit. Graduate students taking a 4 credit hour course must register and pay tuition for the full 4 credits.

1.11.7 Other

The following courses may not be employed to fulfill degree credit requirements:

- a) undergraduate courses in which a grade below a B is earned. Credit for such courses will not be applied to the total program, but the grades will be counted in the overall average.
- b) a graduate course already used to fulfill the requirements of an undergraduate degree program; repeat of graduate course already taken at undergraduate level
- c) graduate courses in which a grade of D, F or U is obtained.

1.12 Scholastic Requirements (General)

- a) Grades: A minimum average of B (3.0/4.0) must be maintained during all graduate work. This requirement takes effect after nine (9) credit hours, and all work taken for graduate credit which could be applied to the degree is used in calculating the grade point average. Courses should not be taken using “S/U” grading unless approval is obtained ahead of time from the Director of Graduate Studies.

Accordingly, courses taken in excess of that which is applied toward the degree credit requirements will be included in the computation of the student’s grade point average. Students whose averages fall below 3.0 at the end of any grading period may be permitted, upon the recommendation of their advisors and approval of the Director of Graduate Studies, to make up the grade point deficiency within a specified period.

- b) Dismissal from Academic Program: A student will be considered for dismissal from the program when:

- i) the grade of F is earned in any course;
- ii) more than two grades are earned from among, C, D, and U;
- iii) probation status has not been removed;
- iv) the grade point average falls below 2.5 at the end of any grading period;
- v) multiple semesters with a GPA lower than 3.0 occur;
- vi) the student is found guilty of academic dishonesty according to existing regulations.

Incomplete grades (‘I’) are not counted in the program average while they are on the student’s record. However, after no more than two additional semesters, all requirements for such courses must be completed and a letter grade assigned. If this is not done, the ‘I’ grade will automatically be changed to a U (unsatisfactory), which cannot be used to satisfy graduation requirements. The program average is not affected by grades received for thesis, dissertation and seminar.

Graduate students are permitted to resign from a course without academic penalty if this is done prior to the last day for dropping a course without penalty. The student must resign officially by use of a Change of Registration slip which is available in the Student Response Center office. The student must consult with his/her advisor before returning the slip. Students who are required to keep full-time status must also receive approval of the Director of Graduate Studies prior to dropping a course.

It is important that the student resign officially from a course in the manner described, otherwise a grade of F will be recorded.

- c) Time limits for full-time degree students

The time limit for the M.S. degree is four years, measured from the first registration as a graduate degree student. For part-time students a time limit of 6 years from the first registration in the graduate program may be permitted. At the end of 4 years, a graduate student petition form must be submitted to request an extension beyond the fourth year.

For students entering the Ph.D. program with a M.S. degree the limit is five years from the date of the first Ph.D. registration and seven years from the date of first graduate registration. For students entering the Ph.D. program with a B.S. degree the limit is seven years from the date of the first Ph.D. registration. The time spent on an approved leave of absence is not included in these time limits.

Time limit extensions may be granted for adequate reasons by petition to the Executive Committee of the Graduate School. The petition must be forwarded with a recommendation from the Director of Graduate Studies. The extension of time limit is normally granted for a maximum period of one year.

d) Other requirements

Any general requirements of the Graduate School or SEAS must also be satisfied. See the UB Graduate School Policy Library at <https://grad.buffalo.edu/succeed/current-students/policy-library.html>.

1.13 Financial Assistance and Tuition Scholarships

All students are automatically considered for financial aid upon application for admission to graduate studies. There are three main types of financial support: Teaching or Graduate Assistantships, provided by state funds for lines allotted to the department; Research Assistantships, provided by research grants held by individual faculty members; and Graduate Fellowships provided by state funds administered by the Graduate School. In addition to Research Assistantships, potential new graduate students applying for admission are also eligible for Teaching Assistantships on which the decisions are made by the Graduate Studies Committee of the department. For TAs, the general policy of the department is to limit them to two semesters. Ph.D. students as TAs are eligible for support beyond the first two semesters; however the expectation is that the bulk of the support of Ph.D. students is to be provided by Research Assistantships and Graduate Fellowships based on satisfactory performance.

The duties of TAs, which are assigned by the Department Chair after consulting the Director of Graduate Studies, typically require twenty (20) hours per week and consist of conducting undergraduate laboratories, assisting faculty in recitations, the grading of problems, or the holding of office hours. The stipend and duties of RAs are decided by the Principal Investigator or grant holder. Usually the work of RAs contributes directly to their thesis study or at least is closely related. Graduate or University Fellowships are awarded annually to new students, by the Graduate School on a University-wide competitive basis. The department proposes several of its most promising candidates for these Fellowships every February when applications are solicited by the Graduate School.

Assistantships and fellowships normally include a full or partial tuition scholarship. Tuition Scholarship credit hours will be limited only to those credits required for the degree (M.S. or Ph.D.) being pursued. Continuing students who are eligible for tuition scholarships must complete and submit the necessary forms before the beginning of the Fall semester each year.

In cases of late appointments, tuition scholarship forms may be filed until the middle of the second week of classes each semester. Failure to do this could result in the loss of the tuition scholarship regardless of the initial appointment terms. Students should also note that tuition scholarships are not granted for courses or thesis/dissertation work undertaken during the summer months. It is therefore necessary that all graduate students register for adequate thesis or project credit during the fall and/or spring semesters in order that tuition scholarships are received for such study. This should be done even though most of the thesis or project work might actually be delayed until a later period. Registration for up to 19 credit hours per semester is permitted without petition.

Supported students in the Ph.D. program must take the Ph.D. qualifying exam, at the first opportunity as described in Sec. 3.6 and complete the annual review form every year. Failure to observe these requirements

may result in the termination of financial support.

In the department's view the main purpose of assistantship or fellowship support is to assist the student in completing the objectives and requirements of the degree program. It is mutually advantageous for the student to complete his/her program in the shortest period of time consistent with high academic performance. All assistantship appointments are subject to continuous departmental review and require satisfactory progress towards the program objectives as well as satisfactory performance of any assigned assistantship duties.

The granting of a teaching assistantship to a continuing student first requires a nomination by a tenure-track faculty member. Students are not permitted to nominate themselves.

Teaching and Research Assistants, as well as Fellows, are expected to pursue their programs vigorously and as a continuing full-time commitment. During the various recesses and periods without classes which occur in the 10-month academic year (September through June) all Teaching and Research Assistants are expected to be present and actively engaged in thesis, project work, or assigned duties. Leaves of absence for time away from the campus must have the prior approval of the student's advisor.

Unfortunately, the department does not have sufficient financial resources to assist all students deserving of support. In fact, only a fraction can be supported. For this reason students should consult the following websites:

- a) <http://ed.buffalo.edu/admission/scholarships.html>
- b) <http://financialaid.buffalo.edu/aid/scholarships/graduate/>
- c) <https://engineering.buffalo.edu/mechanical-aerospace/graduate/admissions/scholarships.html>

Students are also encouraged to search for competitive awards available from sources outside the department or outside the University.

1.14 Seminar Requirement

All full-time students should register for and attend the departmental seminar series (MAE 503). In cases where courses or formal assignments preclude regular attendance at the seminar, students may be excused.

- a) M.S. Students: All students in the M.S. program will be required to successfully complete at least one (1) semester of the seminar.
- b) Ph.D. Students Entering with a M.S. Degree: Students who enter the Ph.D. program with a M.S. degree are required to successfully complete at least one (1) semester of the seminar.
- c) Ph.D. Students Entering without a M.S. Degree: Students who enter the Ph.D. program without a M.S. degree are required to successfully complete at least two (2) semesters of the seminar.

A waiver for the seminar requirement or a request to change the mandatory semester for M.S. students can be made to the MAE Director of Graduate Studies. Waivers and change requests will only be granted if the request has sufficient justification.

Chapter 2

Masters Program Information

For Master of Science degrees in Mechanical Engineering or Aerospace Engineering the credit requirement is a minimum of thirty (30) semester credit hours. Three options exist in each program: a three (3) to six (6)-credit Thesis plus at least eight courses of three credits each; a three (3) credit Project plus at least nine courses of three credits each; or, the all-course option which consists of at least ten approved graduate courses of three credits each, plus a final comprehensive examination. Students receiving financial support (TA, RA or GA) through the department are required to do the Thesis option, except if they enter the Ph.D. program by passing the Ph.D. qualifying exam and do a dissertation.

The Mechanical Engineering and Aerospace Engineering Master of Science program requires that at least 21 credits, including research credits, be from within the MAE department. To aid in course selection, all MAE classes have been split into six tracks. These tracks might contain courses from different research areas:

- BIO: Bioengineering
- CAM: Computational and Applied Mechanics
- DC: Dynamics and Control
- DM: Design and Manufacturing
- FTS: Fluid and Thermal Sciences
- MAT: Materials

Appendix B provide a suggested first semester course list in each area. A full list of currently offered classes can be found at the following link: <http://engineering.buffalo.edu/mechanical-aerospace/graduate/courses.html>.

The remaining 9 credits (3 courses) shall be taken from MAE, another engineering department, or hard-science department such as Chemistry, Physics, Mathematics, Geology, MDI, or Biology. Requests to use credits from any other department must be made to the Graduate Director before the semester in which that course will be taken.

It is suggested that students should take 9 MAE credits from two or three of the different tracks to broaden their knowledge in the general area of MAE. The remaining 12 MAE credits will be free electives and can be chosen among any combination of tracks. However, students are advised to take these 12 credits among one particular track to get specialization in one particular area. For example, a student could take

seven courses within FTS to get a specialization in Fluid and Thermal Sciences and can take one course in Materials and two courses in Design and Manufacturing to broaden their knowledge scope in MAE. Students are not required to declare their specialization track.

2.1 Master Degree Programs

There are three Master Degree programs/tracks available to students:

- a) Master of Science Degree with Thesis: The minimum requirements consist of at least eight approved graduate courses (24 to 27 credit hours) and 3 to 6 credit hours of thesis registration (MAE 560), for a total of 30 credit hours. The thesis may cover a variety of activities, including theoretical and experimental investigations, practical design projects, and the like. The nature of these activities may vary greatly, but no essential difference should exist in equality and significance as a contribution to engineering. The thesis should be carefully prepared as indicated below.

Three people, qualified to render judgment in the area involved, constitute the thesis examination committee: the advisor plus two other graduate faculty members. Non-MAE faculty can serve as a co-advisor or committee members, provided they have a Graduate School appointment. Two of the thesis examination committee members must hold MAE appointments. A waiver for this requirement may be requested from the MAE Director of Graduate Studies.

The candidate is required to hold a public oral presentation at which the examination committee is present in addition to other interested faculty and students. Advance notice of the oral defense must be sent to all department members at least one week prior to the presentation. Any changes in the thesis examination committee should be approved by the graduate committee. The department must approve and notify the Graduate School in writing when major changes in the program, such as a change in Thesis title, are made.

Following a successful oral defense, the examination committee certifies approval of the thesis by signing the Graduate School “M” form, and the advisor reports the thesis grade (if it needs to be changed).

The typing and detailed format and arrangement of the M.S. thesis are to be the same as prescribed for the Ph.D. dissertation in Sec. 3.12. After final corrections have been made, the student must submit the thesis electronically to the graduate school; see <http://grad.buffalo.edu/study/graduate/etd.html> for details. The department sends the signed “M” form to the Graduate School. All materials must be in the Graduate School Office on or before the degree conferral deadlines established each year by the Graduate School.

- b) Master of Science Degree with Project: The minimum requirements consist of nine approved graduate courses (27 credit hours) and 3 credit hours of project registration (MAE 560) for a total of 30 credit hours. The project should be carefully prepared, and must be typed as indicated below. Two people, qualified to render judgment in the area involved, constitute the project examination committee: the advisor plus one other faculty member. Non-MAE faculty can serve as committee member, provided they have a Graduate School appointment. The candidate makes an oral presentation at which the examination committee is present in addition to other interested faculty and students. Advance notice of the oral defense must be sent to all department members at least one week prior to the presentation.

The three-credit Project must be done under the supervision or advisement of a Mechanical and Aerospace Engineering Department graduate faculty member, although it can be initiated by a student. A typed report of substantial length is required, written to a satisfactory standard as judged by the faculty advisor. An electronic copy of the report must be submitted to the MAE graduate office (for retention). The detailed format and arrangement of the report should be the same as prescribed for the M.S. thesis. Following a successful oral presentation, the advisor certifies approval of the project by signing the Graduate School “M” form.

- c) All-Course Master of Science Degree with e-Portfolio: The requirements of this option are at least ten approved graduate courses of three credits each, plus an electronic portfolio (e-Portfolio). The general regulations and guidelines governing program course content are the same as for the M.S. Thesis and Project options.

The e-Portfolio will require that you prepare materials that many graduates create and post on LinkedIn. The e-Portfolio itself highlights the expected key skills and abilities of MAE graduates. You will be asked to reflect on all of your experience in the program and ascertain your knowledge and experience you gained.

The Ublearns site for the e-Portfolio will be made available to students by the end of their first month in the program. The deadline for submission of the e-Portfolio will be announced near the beginning of each semester. This portfolio will then be reviewed by a MAE faculty member.

A summary of different requirements for each Master’s degree:

M.S. Degree Option	Minimum Course work Credits	Culminating Experience	Expected Time to Completion
All-Course	30	e-Portfolio	2 to 3 semesters
Project	27	3 credit project and presentation	3 to 4 semesters
Thesis	24 to 27	3 to 6 credits M.S. Thesis and defense	3 to 4 semesters

2.1.1 Changing to Project or Thesis Track

All M.S. students enter the program in the All-Course track. A student wishing to complete the M.S. degree in the Project or Thesis track must first come to a mutual agreement with a MAE faculty member, who will serve as the student’s advisor. This faculty member will then inform the department of the agreement, at which point the student will be in the new track.

The Project and Thesis tracks both require students register for MAE 560: Masters Research Guidance under their advisor’s section. To register for MAE 560 the advisor must first inform the department of the agreement. Every semester a student wishes to register for MAE 560 they must submit the appropriate request form to the MAE department, at which point the student will be registered for the course.

2.1.2 Dual M.S. Degrees

It is possible for a student to complete a program leading to two M.S. degrees, for example, the Mechanical Engineering and Aerospace Engineering degrees described, or one of those and a second degree from another

engineering discipline and department. The guideline governing such a program is that the integrity of each degree must be observed. This will usually mean that a minimum of 24 semester hours of credit must be completed for each degree and that 6 semester hours may be applied to both programs. In some cases the curriculum will contain prescribed courses which are common to both programs. Such common courses may be counted for both degree programs. See also information on the Graduate School site at <https://grad.buffalo.edu/succeed/current-students/policy-library.html>.

2.1.3 Transfer Credit Limits

No more than six (6) credit hours may be comprised of non-UB graduate credits. Up to nine (9) non-MAE graduate credit hours earned at UB may be counted towards the MS degree.

2.1.4 Deadlines

In order that students receive their degrees when expected it is necessary that certain deadlines be met in their programs. It is the student's responsibility to be cognizant of these deadlines and ensure that they are met.

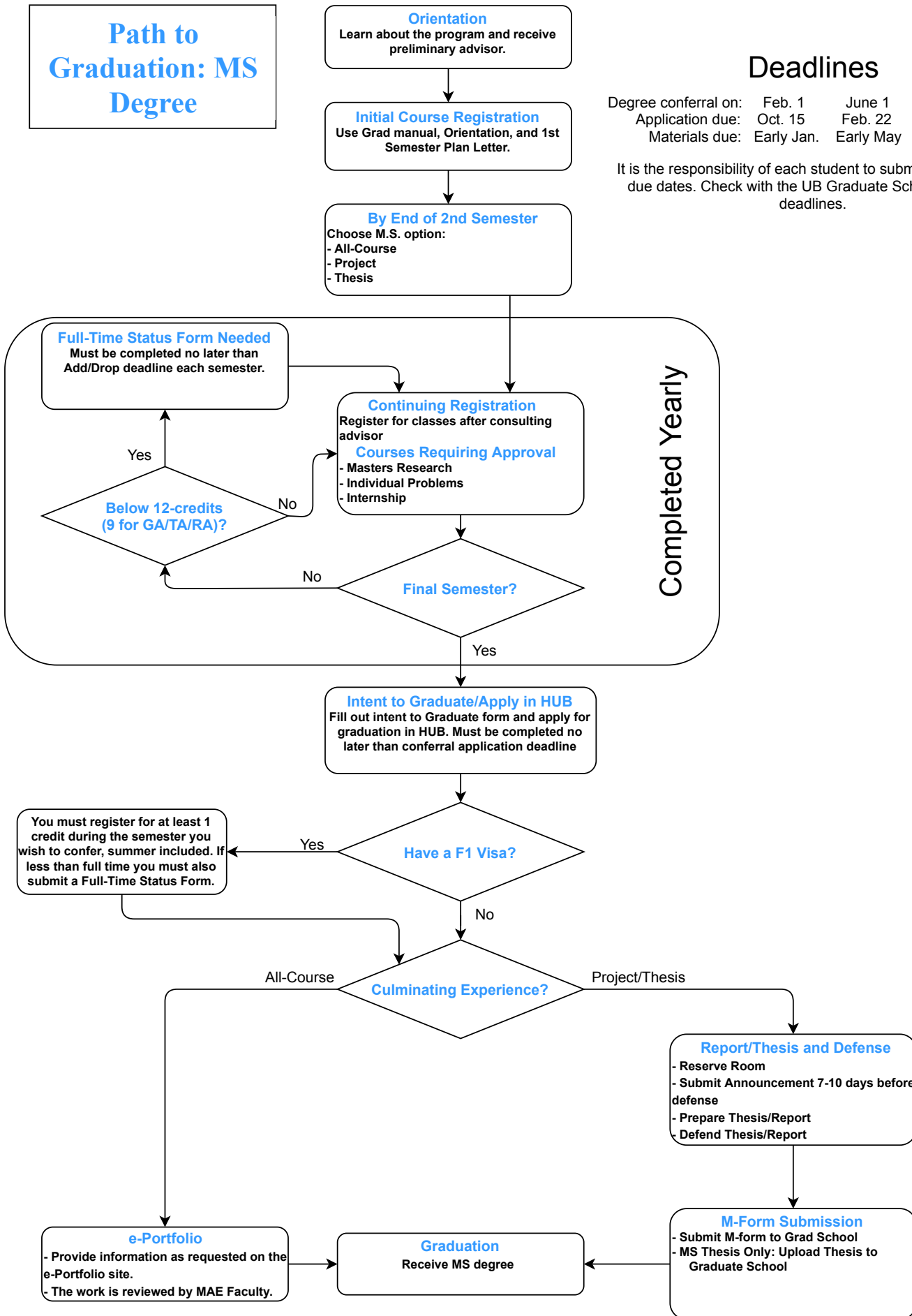
2.2 Summary of M.S. Degree Requirements and Timeline

Path to Graduation: MS Degree

Deadlines

Degree conferral on: Feb. 1 June 1 Sept. 1
 Application due: Oct. 15 Feb. 22 July 15
 Materials due: Early Jan. Early May Early Aug.

It is the responsibility of each student to submit forms by the due dates. Check with the UB Graduate School for exact deadlines.



Chapter 3

Doctoral Program Information

3.1 Application to the MAE Ph.D. Program

Effective Fall 2007, all PhD students must have taken the Graduate Record Exam (GRE).

3.1.1 Students Entering Ph.D. Program With M.S. degree

Students who already have a Masters degree, an outstanding academic background and are highly interested in research can pursue his/her Ph.D. degree by entering the Ph.D. program.

3.1.2 Students Entering Ph.D. Program Without M.S. degree

Students with outstanding undergraduate studies and a high level of interest in research can pursue his/her Ph.D. degree by directly entering the Ph.D. program. During this pursuit, if the student wishes to earn an M.S. instead of Ph.D. for special reasons, they need to first seek for the approval from his/her advisor, see Sec 3.5. The request needs to be submitted by the advisor to the Graduate Studies Committee for final approval.

3.1.3 Ph.D. Program for Continuing Students

Students completing the M.S. program in UB's MAE department who wish to proceed to the Ph.D. program must re-apply following the standard admission procedure. All applicants to the Ph.D. program must take the GRE before his/her application to the program. This requirement holds even if the applicant previously earned an M.S. degree or equivalent at UB or elsewhere and was not required to take the GRE.

3.2 Ph.D. Advisor

All incoming Ph.D. students will have an advisor. If at any point during during their studies a student does not have a Ph.D advisor that student will have until the end of the following academic semester to come to an advisement agreement with a MAE Graduate Faculty member. If a student is unable to do so they may be dismissed from the program.

3.3 Credit Hour Requirements

The Mechanical Engineering and Aerospace Engineering Ph.D programs both require a total of seventy-two (72) credit hours be completed past the baccalaureate degree. The following are the credit distribution requirements:

- Regular Course Credits: 36 to 60
- Minimum Regular Course Credits in MAE: 12
- Maximum Informal Course Credits: 6
- Research Credits: 12 to 36.
- Minimum PhD Dissertation (MAE 660) Credits in MAE: 12

Regular courses are those graded on a letter-scale with a syllabus. Informal courses include Graduate Internship (MAE 598) and Individual Problems (MAE 501, MAE 601). Research credits include Masters Research Guidance (MAE 560) and Dissertation (MAE 660). A waiver for the minimum of 12 Regular Course MAE credits may be requested in writing to the Director of Graduate Studies through the end of the student's first semester. Each request will be considered on an individual basis.

Normally, at least three academic years of full-time graduate study, beyond the baccalaureate degree, are required to complete the Ph.D. degree requirements. The selection of the program of courses and the student's dissertation research are under the supervision of a Ph.D. program committee chaired by the student's advisor.

3.3.1 Transfer Credits

A student entering the Ph.D. program may transfer up to thirty-six (36) total credit hours of previous graduate work. Regular courses with a grade of B (or equivalent) or higher will be considered as Regular Course Credits. Research or Informal Courses that meet the minimum grade requirement will be considered as Research Credits.

Before submitting a transfer-credit request all students must obtain the approval of their faculty advisors. Written approval from the faculty advisor must be provided to the MAE Department before any request will be approved by the Director of Graduate Studies.

3.4 Ph.D. Academic Course Plan

Within three (3) semesters of beginning the Ph.D. program, students must consult with their Ph.D advisor and form a 72-credit course work plan. This plan must be filed with the MAE department by the end of the student's third semester. Any changes to this plan must be approved by the student's Ph.D advisor and filed with the MAE department. Failure to submit this plan may result in the dismissal of the student from the MAE Ph.D. program.

3.5 Earning a Masters Degree as a Ph.D. Student

Students who do not already hold a M.S. degree in their chosen area are eligible to earn a M.S. degree while completing their Ph.D. program. To do so, students must inform the department of their intent, satisfy all

requirements of the particular M.S. track chosen, and submit all paperwork according to the M.S. deadlines required by the department, School of Engineering and Applied Sciences, and University at Buffalo Graduate School.

3.6 Qualifying Examination

Each student desiring to become a Ph.D. candidate in the department must take the Ph.D. Qualifying Examination, which consists of written and oral components. The written examination consists of three (3), 1.5-hour sessions given at the end of the Spring Semester. The exact time and dates for the examination will be announced by March, while the oral examination follows after the written examination.

All Ph.D. students must pass the Qualifying Examination within the first three (3) years of the Ph.D. program if they enter with a B.S. degree and within two (2) years of the Ph.D. program if they entered with an M.S. degree. The academic advisor of a student may require, at the advisor's discretion, that a student pass the Qualifying Examination within the first two (2) years of the Ph.D. program, regardless if they entered with a B.S. or M.S. degree.

For students entering with an M.S. degree, the PhD Qualifying Examination time limit will begin at the start of the student's first Fall semester, unless the student's academic advisor requires that the time limit begin from the student's first semester.

All students will have two (2) opportunities to pass the Qualifying Examination. Failure to take the examination during the second year for students who enter with a B.S. degree or during the first year for students with an M.S. degree will be counted as a failed attempt. For any students whose academic advisor requires that they pass the Qualifying Examination during the first two years of the Ph.D. program, failure to take the examination during the first year will be considered a failure.

Any requests for deferment of a qualifying exam must be provided in writing by the Ph.D. advisor of the student at least four (4) weeks prior to the scheduled exam date. These will be considered by the Graduate Studies Committee on a case-by-case basis. If a student is not able to take the examination on the scheduled date due to medical reasons, documentation must be provided to the Graduate Studies Committee regarding the medical condition.

The Qualifying Examination consists of both a written and oral examination. The examination consists of seventeen (17) topics covering seven (7) areas:

1. Bioengineering:
 - (a) Biomechanics of the Musculoskeletal System (MAE 520)
 - (b) Cardiovascular Biomechanics (MAE 578)
2. Computational and Applied Mechanics:
 - (a) Advanced Solid Mechanics (CIE 511)
 - (b) Finite Elements (MAE 529)
 - (c) Continuum Mechanics (MAE 555)
3. Design and Manufacturing:
 - (a) Probability (MAE 509)

- (b) Optimization (MAE 550)
 - (c) CAD Applications (MAE 577)
4. Dynamics and Controls:
- (a) Controls (MAE 543)
 - (b) Dynamics (MAE 562)
 - (c) Systems Analysis (MAE 571)
5. Fluid and Thermal Sciences:
- (a) Fluid Mechanics (MAE 515)
 - (b) Thermodynamics (MAE 532)
 - (c) Heat Transfer (MAE 545)
6. Materials:
- (a) Smart Materials (MAE 538)
 - (b) Thermodynamics of Materials (MAE 570)
 - (c) Modern Theory of Materials (MAE 587)
7. Mathematics (Written Examination Only):
- (a) Engineering Analysis (MAE 507)

For each topic, the associated MAE course covering the topic is also provided. While not required, it is suggested that students register and successfully complete the associated courses before sitting for the Qualifying Examination.

At the beginning of the Spring semester, each student taking the the Ph.D. Qualifying Exam must declare three (3) topics for the written examination and one area for the oral examination. No more than two (2) topics from a single area can be taken for the written examination. Students are also not allowed to select Mathematics as an area for the oral examination. Once declared, the student's PhD advisor will be notified of the selection for final approval. If the student does not have an advisor, the Director of Graduate Studies will review the student's choice. Not all suggested courses may be offered every year. If a student wishes to take a course before sitting for the specific topic, please review the course offerings for the current academic year before selecting.

The written examination will consist of three, 1.5-hour sessions in each of the three declared topics. The oral examination will be held after the written examination and may be on any topic in the selected area.

Following the completion of both the written and oral components of the Qualifying Examination, the Graduate Studies Committee, in consultation with the student's Ph.D. advisor, will reach a decision as to whether the student has passed or failed. Candidates who fail twice will be dismissed from the program.

At the discretion of the Graduate Studies Committee and in consultation with the student's Ph.D advisor, additional work, including but not limited to additional written examinations, oral examinations, or class work, may be required for passage of the Qualifying Examination.

3.7 Ph.D. Dissertation Committee

Within 12 months of successful completion of the MAE Ph.D. Qualifying Examination a Ph.D. Program Committee is formed. This committee must consist of at least three MAE members who hold Full Graduate School membership plus one outside reader. The chair of this Ph.D. committee, who must be a member of MAE and hold a Full Graduate School appointment, is the primary advisor of the student. Non-MAE UB Faculty can serve as co-chairs, as long as three Ph.D. committee members are MAE faculty who hold Full Graduate School appointments. The Ph.D. committee may consist of additional members. If the additional member is affiliated with UB, they must hold either an Associate or Full Graduate School appointment. Additional members outside of UB require the approval of the MAE Director of Graduate Studies.

The outside reader, who can not hold an appointment in MAE, is selected by the student and their advisor/s, and could consist of non-MAE UB faculty who hold a Full Graduate School appointment, a tenured or tenure-track position at another university, or hold a Ph.D. degree and work in an industrial setting.

A waiver for these requirements may be requested from the MAE Director of Graduate Studies, and any changes in the Ph.D. program committee after the initial selection must be approved by the Ph.D. Program Committee and the Director of Graduate Studies.

3.7.1 Ph.D. Dissertation Committee Responsibilities

It is the responsibility of the Ph.D. Program Committee to provide guidance to the candidate. The selection of the Ph.D. Program Committee members is primarily the responsibility of the candidate and their dissertation advisor/s. All Ph.D. Program Committee members are required attend the Ph.D. Dissertation Proposal Defense, Sec. 3.8, review the Annual Evaluation, Sec. 3.9, read and approve of the Dissertation, Sec. 3.12, and sign any other paperwork which might be required. The outside reader is required to submit their approval of the Dissertation, Sec. 3.12, in writing to the MAE graduate director.

3.8 Ph.D. Dissertation Proposal Defense

The student shall prepare a Ph.D. Dissertation Proposal Defense presentation to his/her Ph.D. Program Committee which will include a literature review, research plan, and any preliminary results. This presentation must be presented within 12 months of successful passage of the MAE Ph.D. Qualifying Examination. The student may include this proposal defense as part of the MS-Project or MS-Thesis defense if they are earning the M.S. degree while working on their Ph.D. After this presentation, the Ph.D. Program Committee will offer written and/or oral comments on the presentation and advise the student for the proposed future work.

3.9 Annual Evaluation

During the course of the student's program, annual progress evaluations should be carried out by the Ph.D. Program Committee and should be reported to the director of graduate studies. A review form for this purpose is available with the office of MAE graduate studies. This annual review will take place during the spring semester. In the progress evaluation the candidate's course performance will be considered as well as progress made on the candidate's dissertation research. If the committee finds the candidate's progress

unsatisfactory, it may recommend corrective action. If the candidate's progress continues to be unsatisfactory, the committee may recommend withdrawal from the University to the Department Chair.

3.10 Advancement to Candidacy

Continuation in the Ph.D. program requires that student advance to candidacy. When considering a student's advancement to candidacy, the Graduate Studies Committee will consider the following components:

1. Result of Qualifying Examination,
2. Result of Ph.D. Dissertation Proposal Defense,
3. Graduate GPA/Transcript,
4. Advisor LOR/Annual Reviews,
5. Curriculum Vitae/CV,
6. TA Evaluations (if available).

Successful advancement to candidacy requires formal review by the Graduate Studies Committee and Director of Graduate Studies. If the Graduate Studies Committee or Director of Graduate Studies do not support a student's advancement to candidacy, the student will be dismissed from the program.

To advance to candidacy, a student must submit an Application to Candidacy (ATC) form to the department. This ATC form must include evidence of full-time residency for at least two semesters, itemization of at least seventy-two (72) credit hours beyond the baccalaureate, including any proposed course work, and any additional information required by the Graduate Studies Committee. Courses for transfer credit must be indicated as such on the Application for Candidacy. The program is then filed for approval by the Executive Committee of the Graduate School. Approval by the Executive Committee constitutes admission to candidacy. The student notifies the Graduate School by petition when minor changes in the program, such as changes in the dissertation title, or deletion/addition of one or two courses, occur. Major changes in the program, such as research abstract revision, adding or deleting more than two courses or change in major advisor require a petition to be filed through the department graduate office.

3.11 Responsible Conduct of Research

All students initially admitted to a Ph.D. program for the Fall 2009 semester or thereafter are required to document successful completion of "Responsible Conduct of Research" (RCR) training when they submit his/her Application to Candidacy (ATC) for his/her Ph.D. degree. This training requirement may be fulfilled by either (1.) enrolling in and passing PHI 640 Graduate Research Ethics or RPN 541 Ethics and Conduct of Research or (2.) completing the Collaborative Institutional Training Initiative (CITI) online Responsible Conduct of Research course with an average score of 80% or higher. Students opting to complete the CITI online course must supply documentation of its successful completion with his/her Application to Candidacy.

3.12 Dissertation

Each Ph.D. student is required to complete an original dissertation and orally defend his/her work before the program committee and any other interested parties. Upon completion of the dissertation a draft is submitted to the advisor for comments, corrections, and approval. Upon the advisor's approval the student submits copies of the dissertation to the remaining members of the program committee for his/her approval.

The oral defense consists of a presentation during which the candidates outline the highlights of his/her work, followed by questions from the program committee or any other interested persons present. This oral defense can not occur earlier than six (6) months after the Ph.D. Dissertation Proposal Defense date. Following a successful dissertation defense, the program committee certifies approval of the dissertation by signing the Graduate School M form. The M form must be signed by the Director of Graduate Studies or the Department Chair before being forwarded to the Graduate School.

After the student has made final corrections to the dissertation, the student must submit the dissertation electronically to the graduate school; see the MAE Graduate Coordinator for details. This must be done prior to your designated conferral date. All materials must be in the Graduate School office on or before the degree conferral deadlines established each year by the Graduate School.

The typing, arrangement, and submission of Ph.D. dissertations must meet the requirements of the Graduate School. More details regarding the formatting and ETD submission dates of the dissertation can be found at <http://grad.buffalo.edu/study/graduate/etd.html>.

Since theses and dissertations represent the joint effort of students and his/her advisors (if not also other members of the faculty), the student should make no arrangements for publication without consulting his/her advisor. Electronic submission of Ph.D. dissertations, as required by the Graduate School, does not preclude publication by other methods later.

It should be noted that the primary responsibility for the quality of the presentation, organization, grammar and readability of the dissertation, thesis or project lies with the student. Extra effort and outside editorial assistance may be required when the student does not write fluently in the English language.

3.13 Summary of Ph.D. Degree Requirements and Timeline

Path to Graduation: PhD Degree

Coursework & Paperwork Flowchart

Acceptance into PhD Program

Orientation

Research Flowchart

CITI-Responsible Conduct of Research
All PhD students must complete this.

Do you have a M.S. degree?

Pass Qualifying by end of Year 3

Pass Qualifying by end of Year 2

After Passing Qualifying Exam:
Submit Application to Candidacy Form

Dissertation Committee Formation & Preliminary Defense
Should be completed within 12 months of passage of Qualifying Exam

Dissertation Credits
Must complete 12-24 credits

Outside Reader Selection
Must be completed at least 6 weeks prior to Final Defense date.

Write PhD Dissertation

Prepare for Final Defense
- Reserve room
- Submit Defense Announcement form 7-10 days before defense

Final Defense

Submit Dissertation to University

Initial Course Registration:
Use Grad manual, Orientation, 1st Semester Plan Letter, and advisor.

Transfer non-UB Credits:
Fill out form in 1st semester.

Full-Time Status Form Needed
Must be completed no later than conferral application deadline

Submitted ATC Form?

Below 12-credits (9 for GA/TA/RA)?

Continuing Registration:
Register for classes after consulting advisor
Courses Requiring Approval:
- Dissertation
- Individual Problems
- Internship

Annual Review Due August 31st

Final Semester?

Intent to Graduate/Apply in HUB:
Fill out intent to Graduate form and apply for graduation in HUB. Must be completed no later than conferral application deadline

Have a F1 Visa?

You must register for at least 1 credit during the semester you wish to confer, summer included.

M-Form Submission
- Submit M-form to Grad School
- Complete Exit Survey

Graduation
Receive PhD degree

Completed Yearly

Deadlines

For degree conferral on:	Sept. 1	Feb. 1	June 1
Application to candidacy due:	Early July	Early Oct.	Early March
All required materials due:	Early Aug.	Early Jan.	Early May

It is the responsibility of each student to submit forms by the due dates. Check with the UB Graduate School for exact deadlines.

Credit Requirements

- Total Credits: 72
- Minimum Course Credits: 48
- Minimum Dissertation Credits: 12
- Up to 30 course credits can be used from prior M.S. degree.

Appendix A

Forms

- University required forms: <https://grad.buffalo.edu/succeed/current-students/forms.html>
- MAE forms: <http://engineering.buffalo.edu/mechanical-aerospace/graduate/current-students/advising.html>

Appendix B

Suggested First Semester Courses

All students can see a current listing of courses at <http://engineering.buffalo.edu/mechanical-aerospace/graduate/courses.html>. It is recommended that no student register for more than 12 credits per semester. MAE reserves the right to dis-enroll from courses a student who has registered for more than 15 credits before the first day of the semester. All PhD students should confirm their course selections with their advisor prior to registration. All courses are subject to the availability of the instructor or may be offered every other year. If a course is not offered the student is free to choose a replacement course.

Fall Semester Matriculation

<p style="text-align: center;">Bioengineering</p> <ol style="list-style-type: none"> 1. MAE 607: Biomat Cell-Surface Phen 2. MAE 608: Polymeric Biomaterials 3. Elective 4. Elective 	<p style="text-align: center;">Computational and Applied Mechanics</p> <ol style="list-style-type: none"> 1. MAE 507: Engineering Analysis 1 2. MAE 529: Finite Element Struct. Analysis 3. MAE 555: Continuum Mechanics 4. MAE 609: High Performance Computing 1
<p style="text-align: center;">Dynamics and Controls</p> <ol style="list-style-type: none"> 1. MAE 543: Continuous Control System 2. MAE 567: Vibration & Shock 1 3. MAE 571: Systems Analysis 4. Elective 	<p style="text-align: center;">Design and Manufacturing</p> <ol style="list-style-type: none"> 1. MAE 509: Probability And Random Process 2. MAE 550: Optimization in Eng. Design 3. MAE 564: Manufacturing Automation 4. MAE 609: High Performance Computing 1
<p style="text-align: center;">Fluid and Thermal Sciences</p> <ol style="list-style-type: none"> 1. MAE 515: Fluid Mechanics 1 2. MAE 532: Advanced Thermodynamics 3. MAE 542: Eng. App. in CFD 4. Elective 	<p style="text-align: center;">Materials</p> <ol style="list-style-type: none"> 1. MAE 538: Smart Materials 2. MAE 570: Thermodynamics of Materials 3. MAE 587: Modern Theory of Materials 4. Elective

Spring Semester Matriculation

<p style="text-align: center;">Bioengineering</p> <ol style="list-style-type: none"> 1. MAE 520: Biomechanics of the Musculoskeletal System 2. MAE 578: Cardiovascular Biomechanics 3. MAE 584: Nano/Microtechnologies for MEMS 4. Elective 	<p style="text-align: center;">Computational and Applied Mechanics</p> <ol style="list-style-type: none"> 1. CIE 511: Advanced Mechanics of Solids 2. MAE 524: Elasticity 3. Elective 4. Elective
<p style="text-align: center;">Dynamics and Controls</p> <ol style="list-style-type: none"> 1. MAE 525: Space Dynamics and Control 2. MAE 562: Analytical Dynamics 3. MAE 568: Vibration & Shock 2 4. Elective 	<p style="text-align: center;">Design and Manufacturing</p> <ol style="list-style-type: none"> 1. MAE 552: Heuristic Optimization 2. MAE 577: CAD Applications 3. MAE 610: High Performance Computing 2 4. Elective
<p style="text-align: center;">Fluid and Thermal Sciences</p> <ol style="list-style-type: none"> 1. MAE 539: Computational Fluid Dynamics 1 2. MAE 545: Heat Transfer 1 3. Elective 4. Elective 	<p style="text-align: center;">Materials</p> <ol style="list-style-type: none"> 1. MAE 581: Advanced Materials Science 2. MAE 589: Materials Experimental Methods 3. Elective 4. Elective