

Applied Mathematics Graduate Handbook (2020–2021)

NOTE: The Department of Mathematics at Iowa State University contains two graduate programs: (1) Mathematics and (2) Applied Mathematics. This document only covers the Applied Mathematics Program. For the Mathematics Program, please see:

<https://iastate.box.com/s/0xavwcu48o9sj5tz3af5dnnv1lwfp715>

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1 Introduction

Graduate degree students in the Applied Mathematics Program at Iowa State University must meet requirements specified by the Graduate College, the Department of Mathematics, and the student's Program of Study (POS) Committee. The Graduate College requirements are published in the Graduate College Handbook (GCH):

<https://www.grad-college.iastate.edu/handbook/>

Each graduate student should become familiar with its contents. The requirements specified by the Department of Mathematics are described in this document. Requirements specified by the student's POS Committee are defined at the time the student's POS Committee is formed and the Program of Study is formulated.

The Department of Mathematics at Iowa State University offers two terminal degrees in Applied Mathematics: PhD (Doctor of Philosophy) § 3 and MS (Master of Science) § 4. For the MS degree either a thesis or a non-thesis (creative component) option is available. Students working towards the PhD degree can opt to obtain a concurrent MS degree. The program also allows for the option of a Co-Major PhD § 5, which is a dual PhD in Applied Mathematics and another PhD program (not all PhD programs are compatible). For graduate students from other departments, it is also possible to obtain a graduate minor in Applied Mathematics § 6.

2 Graduate Student Timeline

1. Upon arrival

- Check-in with the Department of Mathematics Office (396 Carver Hall).
(Fill out paperwork, get building and office keys, get copier codes)
- Go to University Human Resources (Beardshear Hall).
(Fill out paperwork, get ISU ID card, get email account)
- Receive an assigned Temporary Research Advisor (TERA) from the Director of Graduate Education (DOGE). This assignment is based on research interests as indicated on a student's application to ISU.
- Meet with the DOGE and/or TERA for course registration.
- International Students:
 - Check in with Office of International Students and Scholars Office (ISSO);
 - Take the English Placement Test (non-native speakers of English – see § 3.6);
 - Complete the SPEAK/TEACH Test (non-native speakers of English – see § 3.7).
- Attend all relevant university-wide, Math TA, and Math Graduate Program orientation sessions.

2. During 1st year

- Take 2–3 courses in both Fall and Spring (mostly core § 3.3 or core-prep).
- Receive and execute TA assignment in Fall, Spring, and possibly Summer.
- **[PhD only]** Take qualifying exams in January, May, and/or August (see § 3.5).

- Attend seminars and attempt to identify research interests and a potential advisor.
3. During 2nd year
- **[PhD only]**
 - Complete all 4 qualifying exams by August just before 3rd year (see § 3.5).
 - Complete the bulk of course requirements (see § 3.2). After the 2nd year, the bulk of the student's time should be spent on research related activities.
 - Find an advisor and start prep work for research.
 - **[MS only]**
 - **Fall:** Find an advisor and submit Program of Study and Committee (POSC) (see § 4.5).
 - **Fall/Spring:** Finish all course requirements (see § 4.2).
 - **Fall/Spring:** Do MS Thesis or Creative Component work (see § 4.6 and § 4.7).
 - **Spring:** Defend the MS Thesis or Creative Component (see § 4.9).
4. [PhD only] Beyond 2nd year
- NOTE:** the items listed below are only the suggested times, and most could be done earlier if the Student, Advisor, and POS Committee are in agreement.
- **3rd year:** Submit Program of Study and Committee (POSC) to the Graduate College (see § 3.8).
 - **3rd/4th year:** Complete the Preliminary Exam (see § 3.9).
 - **4th/5th year:** Write Dissertation (see § 3.10), pass the Final Defense (see § 3.12), and search for jobs.

3 PhD in Applied Mathematics

The detailed requirements as stipulated by the Department of Mathematics at Iowa State University for obtaining a PhD degree in Applied Mathematics are outlined in this section.

3.1 Checklist for PhD in Applied Mathematics

	Mandatory Tasks	Notes
<input type="checkbox"/>	Course Requirements § 3.2	≥ 72 credits (≥ 42 credits in formal courses)
<input type="checkbox"/>	Math 591 & 592 § 3.2	Orientation credits
<input type="checkbox"/>	Grade Requirement § 3.2	Overall GPA ≥ 3.33 (B+) w/ ≥ 2.00 (C) in every course
<input type="checkbox"/>	Core Courses § 3.3	≥ 18 credits w/ ≥ 3.00 (B) in every core course
<input type="checkbox"/>	Cognate Courses § 3.4	≥ 6 credits
<input type="checkbox"/>	Qualifying Exam § 3.5	Must pass 4 exams before 5 th semester
<input type="checkbox"/>	English Requirement § 3.6	For international students
<input type="checkbox"/>	Teaching Requirement § 3.7	Minimum two semesters of in-classroom teaching
<input type="checkbox"/>	Create POS and Committee § 3.8	Complete in 5 th semester
<input type="checkbox"/>	Preliminary Exam § 3.9	Complete no later than 6 months prior to Final Defense
<input type="checkbox"/>	PhD Dissertation § 3.10	Submit to POSC 2 weeks prior to PhD Final Defense
<input type="checkbox"/>	Apply for Graduation § 3.11	By 3 rd week of last semester
<input type="checkbox"/>	PhD Final Defense § 3.12	Final semester (4 th or 5 th year)
<hr/>		
	Optional Tasks	Notes
<input type="checkbox"/>	Concurrent MS Degree § 3.14	Another POSC and an MS Thesis or Creative Comp.
<input type="checkbox"/>	Minor in Another Program § 3.15	POSC member and 12 credits from other program

3.2 Course Requirements

The minimum credit requirements are as follows:

- **72** minimum total credits;
- **36** minimum earned in residence;
- **42** credits in formal courses (excluding MATH 590, 591, 592, 599, 699);
- **36** credits in 500–600 level courses (excluding MATH 590, 591, 592, 599, 699);
- **18** credits in core courses (see below in § 3.3 for more details);
- **6** credits in cognate courses (see below in § 3.4 for more details);
- **1** credit of MATH 591 and Math 592;
- **3** credits in MATH 699 (PhD research).

The minimum grade point average (GPA) requirements are as follows:

- Must obtain at least a **2.00** (C) on all graduate courses counted in the 42 credits in formal courses;
- Must obtain at least a **3.00** (B) on all graduate courses counted in the 18 credits in core courses;
- Must obtain a cumulative grade point average of **3.33** (B+) on all courses.

3.3 Core Courses in Applied Mathematics

The core course requirements for the PhD in Applied Mathematics are:

1. At least 6 core courses (18 credits);
2. At least 3 core courses must be in Applied Math or Numerical Analysis (9 credits);
3. The core courses must include MATH 519 (Applied Math I) **and** MATH 561 (Numerical Analysis I);
4. Must obtain at least a **3.00** (B) in all core courses.

3.3.1 List of All Core Courses in Math and Applied Math

Algebra	MATH 504: Abstract Algebra I (qual course) MATH 510: Linear Algebra (qual course) MATH 505: Abstract Algebra II (no qual)
Analysis	MATH 515: Real Analysis I (qual course) MATH 511: Complex Analysis (qual course) MATH 516: Real Analysis II (no qual)
Discrete Math	MATH 567: Graph Theory (qual course) MATH 568: Enumerative Combinatorics (qual course) MATH 566: Discrete Optimization (no qual)
Applied Math	MATH 519: Methods of Applied Math I (qual course) MATH 520: Methods of Applied Math II (qual course) MATH 565: Continuous Optimization (no qual)
Numerical Analysis	MATH 561: Numerical Analysis I (qual course) MATH 562: Numerical Analysis II (qual course) MATH 517: Finite Difference Methods (no qual)

3.3.2 Grade Requirement

A grade of 3.00 (B) or better must be earned in each core course used to satisfy the requirements in this section. A deficiency may be made up by any one of the following methods:

- a) Retaking the course for credit and earning a 3.00 (B) or better;
- b) A pass on the associated qualifying examination, if such examination exists.

3.3.3 Core Courses and Research

Students are strongly encouraged to consult their advisor prior to deciding which core courses to take, since certain core course combinations may not be suitable for certain areas of research.

3.4 Cognate Courses

Applied Mathematics PhD students must complete a minimum of 6 credits of **cognate courses**. A cognate course is defined to be a course which is

1. acceptable for graduate credit,
2. taught in another department (a course cross-listed with Mathematics can count toward the cognate requirement if taught by a faculty member whose primary appointment is not in the Department of Mathematics, or if approved by the Graduate Committee), and
3. relevant to the major.

The course work for the cognate study requirement must be approved by the student's POS committee. Students are encouraged to consider a minor in another department to meet the cognate study requirement.

3.5 Qualifying Exam

A PhD student in the mathematics program must pass four written qualifying examinations before the beginning of the 5th semester of study, including:

1. at least two in Applied Math **and/or** Numerical Analysis, and
2. at least two in one area.

The 10 qualifying examinations are as follows (click on each qualifying exam name to see past exams and the official exam syllabus):

Name of Qualifying Exam	Associated Course	Mathematical Area	Offered in
Abstract Algebra	MATH 504	Algebra	Jan & Aug
Linear Algebra	MATH 510	Algebra	May & Aug
Real Analysis	MATH 515	Analysis	Jan & Aug
Complex Analysis	MATH 511	Analysis	May & Aug
Graph Theory	MATH 567	Discrete Math	Jan & Aug
Enumerative Combinatorics	MATH 568	Discrete Math	May & Aug
Methods of Applied Math I	MATH 519	Applied Math	Jan & Aug
Methods of Applied Math II	MATH 520	Applied Math	May & Aug
Numerical Analysis I	MATH 561	Numerical Analysis	Jan & Aug
Numerical Analysis II	MATH 562	Numerical Analysis	May & Aug

Additional notes:

- Students are strongly encouraged to consult their advisor prior to deciding which examinations to take.
- The qualifying examination syllabi are definitive, and not all topics on the syllabi are covered each year in the associated courses. It is the student's responsibility to be prepared to answer questions about any topic on the appropriate syllabus.

- Each qualifying examination is offered twice per year, once in August and once within a month of the conclusion of the associated course. Students must request the examination in advance via the graduate secretary by the deadline set by the Graduate Committee (such request may be cancelled without penalty until 24 hours prior to the examination).
- A student granted full admission to the PhD program is expected to pass **4** qualifying examinations (subject to the rules above) within the 1st two calendar years in the program.
- A student who has passed **3** qualifying examinations in their 1st two years may request in writing an additional year to complete the 4th; such request should be addressed to the Graduate Committee (via the graduate secretary) with support from the student's advisor. While such request is not guaranteed, a positive response from the Graduate Committee for a student otherwise in good standing this is considered a routine request. Whereas, approval of an appeal for more time to complete qualifying examinations from a student who has not passed **3** qualifying examinations will normally require extenuating circumstances.
- For a student in the PhD program not granted full admission (i.e., one who enters on restricted or provisional admission), the student will normally have two years to complete the qualifying examination requirement from the time their admission status is changed to "full". Any exception to this rule would be put in writing by the DOGE at the time the student is admitted.

3.6 Graduate English Requirements

Graduate students whose native language is not English (USA, Australia, Canada, Ireland, New Zealand, or the United Kingdom of Great Britain and Northern Ireland) must meet the Graduate College English Requirement. See the Graduate College Handbook for details (Section 4.4.3):

<https://www.grad-college.iastate.edu/handbook/chapter.php?id=4#4.4>

3.7 Teaching Requirements

Each PhD student is required to have two semesters of supervised teaching. However, if approved by the student's POS committee, equivalent supervised experience in oral mathematics communication may be substituted for teaching. In that case the POS committee must specify in writing what the equivalent experience will be.

Every teaching assistant must demonstrate an ability to teach effectively. To assure this, before the beginning of the 1st semester that they assume their duties, teaching assistants are required to give a short, prepared lecture to a panel of experienced teaching assistants and/or faculty that is suitable for an algebra, trigonometry, or similar class. In addition, each teaching assistant whose native language is not American English must take the SPEAK/TEACH test (the test administered by the University to screen applicants for classroom duties) unless such student is a native English speaker from Australia, Canada, Ireland, New Zealand, or the United Kingdom of Great Britain and Northern Ireland. They must pass it at the 1st or 2nd level before they are assigned a class or recitation section, and they must pass it at the 1st or 2nd level within their 1st year of residence to guarantee continued financial support.

3.8 Program of Study and Committee (POSC)

Each PhD student must officially file a Program of Study and Committee (POSC) with the Graduate College. This can be done via AccessPlus and must be completed at the beginning of the 3rd year in the PhD program.

A PhD student will complete, submit, and revise their POSC through AccessPlus. They will need to log in to AccessPlus, find the student tab in the upper right-hand corner, and then find the **MY POSC Form**.

3.8.1 Program of Study (POS)

The POS details all of the courses that will be used to cover the 72 credits required for graduation. This list of courses must meet all of the requirements as described in § 3.2. If the student takes additional courses beyond the required 72 credits, these courses **do not** need to be listed on the official POS, unless these additional credits are used to satisfy the requirements of a graduate minor in another program (see § 3.15).

3.8.2 Committee

The POS Committee for a PhD student should consist of **5** members. A list of the duties of the POS Committee may be found in the Graduate College Handbook.

- The 1st member will be the major professor, who will serve as the chair of the committee. The appointment of a major professor is by mutual agreement of the student and designated faculty member, who must have graduate faculty status in the program in which the student is enrolled.
- The remaining **4** members will be selected by the student with the aid of the major professor. **1** of these **4** members must be from a research area different from the advisor and the PhD student – this member must be officially designated as the outside member.
- Failure to select a major professor and a committee in a timely fashion impedes progress towards the degree and may lead to dismissal from the program.
- If for any reason the major professor resigns or is removed from their position, and the student is in good academic standing, then a new major professor must be selected and the corrected POSC must be resubmitted to the Graduate College.

3.9 Preliminary Exam

The oral preliminary examination of a PhD student tests a student's knowledge of the major, minor, and supporting fields of their research area. The examination is taken after a student has

- Passed four written qualifying examinations (see § 3.5);
- Satisfied the graduate English requirement (see § 3.6);
- Formed a POS committee (see § 3.8); and

- Obtained an approved POSC (must be approved in the semester **prior** to the preliminary exam) (see § 3.8).

Passing the Preliminary Exam elevates the PhD student to **PhD Candidate**.

3.9.1 How to Setup and Take the Preliminary Exam

The student with the approval of the POS Committee must find a room, a 2-hour time-slot, and date for their exam. Room requests can be obtained by emailing: mathoffice@iastate.edu. Once these have been established, the PhD student must officially submit a Preliminary Exam request from the Graduate College: <https://www.grad-college.iastate.edu/student/forms/>. The form requesting scheduling of the examination must be submitted to the Graduate College at least two weeks before the proposed date of the examination.

The total length of the exam **should not exceed 2 hours**. A typical exam would consist of the following three parts:

1. [(**40-50 minutes**)]: Oral presentation given by the PhD student consisting of
 - (a) A description of the proposed research problem that the PhD student wants to tackle;
 - (b) A description of previous results from the PhD student relating to the proposed research problem; and
 - (c) A description of future research that the PhD student plans to complete as part of their PhD research.
2. [(**10-20 minutes**)]: Question and answer session with members of the audience who are not part of the POS Committee;
3. [(**≤ 60 minutes**)]: Question and answer session with members of the POS Committee. In this portion of the exam, only the POS committee and the candidate are present. The questions may pertain to any of the student's knowledge of the major, minor, and supporting fields of their research area.

3.9.2 Possible Outcomes of the Preliminary Exam

Immediately following the preliminary oral examination it is the responsibility of the POS committee to decide whether the student will be recommended for admission to candidacy and may continue to work toward the PhD degree. All POS committee members must be present at the preliminary oral and sign the report form. Four options exist:

1. The student passes and the POS committee recommends to the Graduate College that the student be admitted to candidacy.
2. The student may continue their studies, but must meet other conditions specified by the POS committee on the "Report of Preliminary Oral Examination" form under "Conditional Pass" before being recommended for admission to candidacy.
3. The student fails, but is given an opportunity to repeat the examination six months after the first attempt. An explanatory letter must accompany the report form.

4. The student fails and is not permitted to continue to work toward a PhD at ISU. An explanatory letter must accompany the report form.

In a preliminary oral examination, if one member of the committee votes not to pass the candidate, the student passes, but each member of the committee must forward to the Dean of the Graduate College in writing a justification for their votes. Upon request these letters will be made available to the committee at the time of the final oral examination. If more than one member of the committee votes not to pass the student, the candidate does not pass the examination. An explanatory letter must accompany the report form.

3.9.3 Retake of the Preliminary Exam

A student who does not pass the preliminary oral examination may be allowed by the POS Committee to retake it one additional time. Six months must elapse between the 1st attempt and the 2nd. The preliminary oral examination must be passed at least six months prior to the final defense.

3.10 PhD Dissertation

The most important component of the PhD program is **original research**. The PhD Dissertation is a written document that is the culmination of the PhD student's research efforts. It is expected, although not officially required, that each PhD student's research will also lead to publications in refereed conferences, journals, or as a book.

3.10.1 Basic Format

There is no specific length requirement for the dissertation, but it should contain at least three general parts:

1. **Introduction:** This critically important portion of the dissertation outlines the rationale and context for the PhD student's research project. Somewhere in this part there should be a chapter, section, or subsection with a title similar to **Scope of This Work** that clearly explains in general terms what original research has been done as part of this work, why this work is important, and how it fits into the larger context of research being done in that field.
2. **Original Research Results:** This critically important portion of the dissertation provides all the details (e.g., methods, data, theorems, proofs, computations, figures, and tables) of the original research conducted by the PhD student. Unlike many refereed journal articles, there are no maximum page number requirements on the dissertation, which allows the PhD student to provide ample detail.
3. **Conclusions:** This critically important portion of the dissertation provides the PhD student with the space to properly summarize and draw conclusions from their research efforts. In this portion it is also advisable to briefly describe future avenues of research that could be conducted by the PhD student or others in order to extend the current work.

All PhD students are strongly urged to use the official thesis L^AT_EX style file as provided by the ISU Grad College:

https://www.grad-college.iastate.edu/thesis/thesis_template/

More information about how to format, organize, and submit your dissertation can be found here:

<https://www.grad-college.iastate.edu/thesis/>

Archived versions of past theses/dissertations can be found at the following link:

https://lib.dr.iastate.edu/math_etd/

NOTE: The PhD dissertation must be submitted to the POS committee two weeks before the PhD Final Exam.

3.10.2 Traditional vs. Journal Style Format

- **Traditional Format:** All your references and appendices are at the end of the dissertation. See Overleaf Traditional Style Format.
- **Journal Style Format:** Use this style when you have published, have submitted, or will be submitting papers for publication. Each journal paper becomes a chapter complete with abstract, introduction, tables, figures, references, and appendices. References are put at the end of each chapter rather than at the end of the paper. The first chapter is Introduction. The last chapter is Conclusion. See Overleaf Journal Style Format.

3.11 Application for Graduation

Application for graduation should be made by the end of the 3rd week of the semester in which the student expects to receive the degree. Instructions for how to complete this form can be found here:

<https://www.grad-college.iastate.edu/student/forms/graduation-application/>

3.12 PhD Final Defense

The most important component of the PhD program is **original research**. The PhD Final Defense is an oral exam in which the PhD student presents a portion of their original PhD research to their POS Committee and answers questions about this research. The PhD Final Defense cannot be taken until at least 6 months have elapsed since the Preliminary Exam has been completed (see § 3.9).

3.12.1 How to Setup and Take the Final Defense

The student with the approval of the POS Committee must find a room, a 2-hour time-slot, and date for their exam. Room requests can be obtained by emailing: mathoffice@iastate.edu. Once these have been established, the PhD student must officially submit a Final Exam request from the Graduate College: <https://www.grad-college.iastate.edu/student/forms/>. The form requesting scheduling of the examination must be submitted to the Graduate College at least two weeks before the proposed date of the examination.

The total length of the exam **should not exceed 2 hours**. A typical exam would consist of the following three parts:

1. [(**40-50 minutes**)]: Oral presentation given by the PhD student consisting of a description of (a portion) of the original research carried out by the PhD student.
2. [(**10-20 minutes**)]: Question and answer session with members of the audience who are not part of the POS Committee;
3. [(**≤ 60 minutes**)]: Question and answer session with members of the POS Committee. In this portion of the exam, only the POS committee and the candidate are present. The questions are usually limited to a defense of the dissertation.

3.12.2 Possible Outcomes of the Final Defense

The “Report of the Final Oral Examination” form must be submitted to the Graduate College immediately after the examination. On this form the POS committee has four possible options:

1. The student passes and may be granted the degree sought.
2. The student must meet some conditions before the degree may be granted. These conditions are specified on the report form and will remain in effect until the major professor and/or committee, if specified, submits the “Preliminary or Final Oral Exam Conditions Met” form to the Graduate College. This form notifies the Graduate College that conditions have been satisfied and the degree may be granted.
3. The student has not passed, but the exam may be retaken. Two months must elapse before the exam may be retaken (a written explanation should be provided with the report form).
4. The student has not passed and the exam may not be retaken at a future date. The degree is denied (a written explanation should be provided with the report form).

In a final oral examination, if one member of the committee votes not to pass the candidate, each member of the committee must forward to the Dean of the Graduate College in writing a justification for their vote. If more than one member of the committee votes not to pass the student, the candidate does not pass the examination.

3.13 Satisfactory Progress

Starting in year 2 of the PhD program, every student will receive a yearly **progress memo** from the DOGE and the Graduate Committee. This memo will contain a brief assessment as to whether or not the PhD student is making **satisfactory progress**, which is defined below.

3.13.1 Students Admitted with a Previously Completed MS Degree

- A student who already possesses a Master of Science (MS) degree or its equivalent, in Mathematics or a closely related field, and from an accredited US institution, should complete all requirements for the PhD degree in four years.
- Under special circumstances, the student and their advisor may request one additional year of support. This request must be made in writing at the beginning of the 4th year to the Graduate Committee.

- The student should take at least one qualifying examination upon arrival on campus, pass two examinations by the beginning of the 3rd semester, and pass four examinations by the beginning of the 4th semester.
- The POS committee should be formed by the beginning of the 4th semester. The oral preliminary examination should be taken no later than the end of the 6th semester.
- The student must maintain a cumulative grade point average of at least 3.33 (B+) in graduate level mathematics courses and of at least 3.00 (B) in all course work, exclusive of research credit.

3.13.2 Students Admitted without a Previously Completed MS Degree

- A student who does not possess a Master of Science (MS) degree or its equivalent, in Mathematics or a closely related field, and from an accredited US institution, should complete all requirements for the PhD degree in five years.
- Under special circumstances, the student and their advisor may request one additional year of support. This request must be made in writing at the beginning of the 5th year to the Graduate Committee.
- The student should take at least two qualifying examinations by the beginning of the 3rd semester, pass two examinations by the beginning of the 4th semester, and pass four examinations by the beginning of the 5th semester.
- The POS Committee should be formed by the beginning of the 5th semester.
- The oral preliminary examination should be taken no later than the end of the eighth semester.
- The student must maintain a cumulative grade point average of at least 3.33 (B+) in graduate level mathematics courses and of at least 3.00 (B) in all course work, exclusive of research credit.

PhD students admitted without an MS or equivalent degree will be required to transfer to the MS program under any of the following circumstances:

- They have failed to pass three qualifying examinations by the beginning of their 5th semester;
- Their cumulative grade point average in graduate level mathematics courses does not exceed 3.32 by the beginning of their 5th semester; or
- They have failed to constitute a PhD POS committee by the beginning of their 6th semester.

Such students are expected to complete all requirements for the MS degree within one year of the transition to the MS program (see § 4).

3.13.3 Students Admitted to the PhD Program from the ISU Applied Math MS Program

- For a student entering the PhD program from the ISU Applied Math MS program, the timeline for completion of the PhD for a student entering without an MS is applied to the student's entire tenure in the ISU Mathematics Department. Thus, the student should complete all requirements for the PhD degree within five years of admission to the MS program.
- Under special circumstances, the student and their advisor may request one additional year of support.
- The student should pass four qualifying examinations by the beginning of the 3rd year in the PhD program.
- A POS Committee for the PhD should be formed by the beginning of the 3rd semester in the PhD program.
- The oral preliminary examination should be taken by the end of the eighth semester in the department.
- The student must maintain a cumulative grade point average of at least 3.33 (B+) in graduate level mathematics courses and of at least 3.00 (B) in all course work, exclusive of research credit.

3.13.4 Failure to Maintain Academic Standing

If a graduate student does not maintain a cumulative 3.00 (B) grade point average on all course work taken, exclusive of research credit, they will be placed on probation by the Dean of the Graduate College. The Graduate College places a hold on future registrations by a student on probation; see the GCH for more details. Before a student on probation registers for each term, there must be a review of their record by the POS committee. Further registration will not then be permitted without recommendation in writing by the Graduate Committee to the Graduate College.

It is the purpose of the yearly review to anticipate any problems that a student may have in making satisfactory progress toward a degree. Generally, failure to meet the time limits or maintain the grade point averages specified above is considered the main evidence of unsatisfactory academic progress. If the student fails to meet any of the time limits under extenuating circumstances, they may petition the Graduate Committee for extension of one or more of those limits.

Under certain circumstances it may be necessary to terminate a graduate student's enrollment in a program because of lack of satisfactory academic progress, or for other reasons as specified in the GCH. The procedures of dismissal are spelled out in the GCH.

3.13.5 Grievance Procedures

If dismissal is based on failure to make satisfactory progress, the graduate student may appeal to an ad hoc grievance committee that is appointed for this purpose by the Chair of the Department of Mathematics. Details of the constitution of the grievance committee, and the procedures it will follow, are given in the GCH.

3.14 Concurrent MS Degree

Applied Mathematics PhD students have the option to obtain a concurrent Applied Mathematics MS degree. This can be done at any time upon the completion of the course requirements for the MS degree (see § 4.2). **NOTE:** the same courses can be used to fulfill both the MS and PhD course requirements (i.e., no additional courses are required).

PhD students seeking a concurrent MS must complete the following steps:

- File a request with the Graduate College:

https://www.grad-college.iastate.edu/documents/forms/Pursue_Two_Concurrent_Graduate_Degrees.pdf

- Once the Graduate College has approved the concurrent MS, a new tab will appear on the PhD student's AccessPlus. The next step is for the student to select an MS POS Committee (minimum of **3** members) and fill out the POS form on AccessPlus (see § 4.5).

NOTE 1: the MS POS and Committee is separate from the PhD POS and Committee. Typically there would be strong overlap between these two committees, but they could in principle be completely different. The MS POS Committee has a minimum of **3** members, while the PhD POS Committee has a minimum of **5** members.

NOTE 2: the MS POS and Committee must be approved in the semester before the MS Final Defense.

- Complete the required work for either the MS Thesis § 4.6 or the MS Creative Component § 4.7.
- Complete the MS Final Defense § 4.9.

3.15 Graduate Minor in Another Program

A PhD student in Applied Mathematics has the option to get a **Graduate Minor** in another graduate program at ISU. This graduate minor should be closely connected to the student's PhD research. The graduate minor can be declared on the POS form in AccessPlus. The PhD student must add a graduate faculty member from this graduate program to their POS Committee (see § 3.8). Additionally, the PhD student must take an additional 12 credits from this graduate program. **NOTE:** the specific requirements will vary by program and can be found by consulting the appropriate program-specific graduate handbook:

<https://www.grad-college.iastate.edu/program-handbook/>

4 MS in Applied Mathematics

The detailed requirements as stipulated by the Department of Mathematics at Iowa State University for obtaining an MS degree in Applied Mathematics are outlined in this section.

4.1 Checklist for MS in Applied Mathematics

	Mandatory Tasks	Notes
<input type="checkbox"/>	Course Requirements § 4.2	≥ 30 credits (≥ 21 credits in mathematics courses)
<input type="checkbox"/>	Math 591 & 592 § 4.2	Orientation credits
<input type="checkbox"/>	Grade Requirement § 4.2	Overall GPA ≥ 3.00 (B) w/ ≥ 2.00 (C) in every course
<input type="checkbox"/>	Core Courses § 4.3	≥ 12 credits with ≥ 3.00 (B) score in every core course
<input type="checkbox"/>	English Requirement § 4.4	For international students
<input type="checkbox"/>	Create POS and Committee § 4.5	Complete in 3 rd semester
<input type="checkbox"/>	Thesis § 4.6 or Creative Comp. § 4.7	Submit to POSC 2 weeks prior to MS Final Defense
<input type="checkbox"/>	Apply for Graduation § 4.8	By 3 rd week of last semester
<input type="checkbox"/>	Final MS Defense § 4.9	Final semester (2 nd year)
<hr/>		
	Optional Tasks	Notes
<input type="checkbox"/>	Minor in Another Program § 4.11	POSC member and 6 credits from other program

4.2 Course Requirements

The minimum credit requirements are as follows:

- **30** minimum total credits;
- **22** minimum earned in residence;
- **21** credits in 500–600 level mathematics courses (excluding MATH 590, 591, 592, 599, 699);
- **12** credits in core courses (see below in § 4.3 for more details);
- **1** credit of MATH 591 and Math 592;
- Choose one of the following:
 - Thesis Option: **6** credits in MATH 699 (MS thesis); or
 - Non-Thesis Option: **3** credits in MATH 599 (MS Creative Component).

The minimum grade point average (GPA) requirements are as follows:

- Must obtain at least a **2.00** (C) on all courses counted in the 21 credits in mathematics courses;
- Must obtain at least a **3.00** (B) on all courses counted in the 12 credits in core courses;
- Must obtain a cumulative grade point average of **3.00** (B) in all courses.

4.3 Core Courses in Applied Mathematics

The core course requirements for the MS in Applied Mathematics are:

1. At least 4 core courses (12 credits);
2. At least 2 core courses in Applied Math **or** at least 2 core courses in Numerical Analysis;
3. Must obtain at least a **3.00** (B) in all core courses.

4.3.1 List of All Core Courses in Math and Applied Math

Algebra	MATH 504: Abstract Algebra I (qual course) MATH 510: Linear Algebra (qual course) MATH 505: Abstract Algebra II (no qual)
Analysis	MATH 515: Real Analysis I (qual course) MATH 511: Complex Analysis (qual course) MATH 516: Real Analysis II (no qual)
Discrete Math	MATH 567: Graph Theory (qual course) MATH 568: Enumerative Combinatorics (qual course) MATH 566: Discrete Optimization (no qual)
Applied Math	MATH 519: Methods of Applied Math I (qual course) MATH 520: Methods of Applied Math II (qual course) MATH 565: Continuous Optimization (no qual)
Numerical Analysis	MATH 561: Numerical Analysis I (qual course) MATH 562: Numerical Analysis II (qual course) MATH 517: Finite Difference Methods (no qual)

4.3.2 Grade Requirement

A grade of 3.00 (B) or better must be earned in each core course used to satisfy the requirements in this section. A deficiency may be made up by any one of the following methods:

- a) Retaking the course for credit and earning a 3.00 (B) or better;
- b) A pass on the associated qualifying examination, if such examination exists.

4.4 Graduate English Requirements

4.4.1 General Requirements

Graduate students whose native language is not English must meet the Graduate College English Requirement. See the Graduate College Handbook for details:

<https://www.grad-college.iastate.edu/handbook/>

4.4.2 MS Degree Students with Teaching Assistantships

Every teaching assistant must demonstrate an ability to teach effectively. To assure this, before the beginning of the 1st semester that they assume their duties, teaching assistants are required to give a short, prepared lecture to a panel of experienced teaching assistants and/or faculty that is suitable for an algebra, trigonometry, or similar class. In addition, each teaching assistant whose native language is not American English must take the SPEAK/TEACH test (the test administered by the University to screen applicants for classroom duties) unless such student is a native English speaker from Australia, Canada, Ireland, New Zealand, or the United Kingdom of Great Britain and Northern Ireland. They must pass it at the 1st or 2nd level before they are assigned a class or

recitation section, and they must pass it at the 1st or 2nd level within their 1st year of residence to guarantee continued financial support.

4.5 Program of Study and Committee (POSC)

Each MS student must officially file a Program of Study and Committee (POSC) with the Graduate College. This can be done via AccessPlus and must be completed at the beginning of the 2nd year in the MS program.

A MS student will complete, submit, and revise their POSC through AccessPlus. They will need to log in to AccessPlus, find the student tab in the upper right-hand corner, and then find the **MY POSC Form**.

4.5.1 Program of Study (POS)

The POS details all of the courses that will be used to cover the 30 credits required for graduation. This list of courses must meet all of the requirements as described in § 4.2. If the student takes additional courses beyond the required 30 credits, these courses **do not** need to be listed on the official POS, unless these additional credits are used to satisfy the requirements of a graduate minor in another program (see § 4.11).

4.5.2 Committee

The POS Committee for an MS student should consist of **3** members. A list of the duties of the POS Committee may be found in the Graduate College Handbook.

- The 1st member will be the major professor, who will serve as the chair of the committee. The appointment of a major professor is by mutual agreement of the student and designated faculty member, who must have graduate faculty status in the program in which the student is enrolled.
- The remaining **2** members will be selected by the student with the aid of the major professor. **1** of these **2** members must be from a research area different from the advisor and the MS student – this member must be officially designated as the outside member.
- Failure to select a major professor and the committee in a timely fashion impedes progress towards the degree and may lead to dismissal from the program.
- If for any reason the major professor resigns or is removed from their position, and the student is in good academic standing, then a new major professor must be selected and the corrected POSC must be resubmitted to the Graduate College.

4.6 MS Thesis Option

The MS Thesis is a written document that is the culmination of the MS student's research efforts. The MS Thesis Option requires 6 credits of MATH 699, which count towards the required 30 total credits. The MS Thesis must contain original research conducted by the MS student.

4.6.1 Basic Format

There is no specific length requirement for the thesis, but it should contain at least three general parts:

1. **Introduction:** This critically important portion of the thesis outlines the rationale and context for the MS student's research project. Somewhere in this part there should be a chapter, section, or subsection with a title similar to **Scope of This Work** that clearly explains in general terms what original research has been done as part of this work, why this work is important, and how it fits into the larger context of research being done in that field.
2. **Original Research Results:** This critically important portion of the thesis provides all the details (e.g., methods, data, theorems, proofs, computations, figures, and tables) of the original research conducted by the MS student. Unlike many refereed journal articles, there are no maximum page number requirements on the thesis, which allows the MS student to provide ample detail.
3. **Conclusions:** This critically important portion of the thesis provides the MS student with the space to properly summarize and draw conclusions from their research efforts. In this portion it is also advisable to briefly describe future avenues of research that could be conducted by the MS student or others in order to extend the current work.

All MS students are strongly urged to use the official thesis L^AT_EX style file as provided by the ISU Grad College:

https://www.grad-college.iastate.edu/thesis/thesis_template/

More information about how to format, organize, and submit your dissertation can be found here:

<https://www.grad-college.iastate.edu/thesis/>

Archived versions of past theses/dissertations can be found at the following link:

https://lib.dr.iastate.edu/math_etd/

NOTE: The MS Thesis must be submitted to the POS committee two weeks before the MS Final Exam.

4.6.2 Traditional vs. Journal Style Format

- **Traditional Format:** All your references and appendices are at the end of the thesis. See Overleaf Traditional Style Format.
- **Journal Style Format:** Use this style when you have published, have submitted, or will be submitting papers for publication. Each journal paper becomes a chapter complete with abstract, introduction, tables, figures, references, and appendices. References are put at the end of each chapter rather than at the end of the paper. The first chapter is Introduction. The last chapter is Conclusion. See Overleaf Journal Style Format.

4.7 MS Non-Thesis Option (Creative Component)

The MS Non-Thesis Option allows an MS student to obtain the MS degree without producing original research. Instead, the student must take 3 credits of Math 599, which count towards the required 30 total credits. During the semester that Math 599 is taken the student will be assigned some previously published research (either some journal articles, chapters out of a book, etc...), from which they will produce two items:

1. A written document referred to as the **Creative Component** that synthesizes some important aspects of the research documents read by the MS student; and
2. A suitable oral presentation that will be given as part of the MS Final Defense (see § 4.9).

Unlike the MS Thesis and the PhD Dissertation, the Creative Component has no specific required format. The formatting requirements are left up to the POS Committee. Archived versions of past Creative Components can be found at the following link:

https://lib.dr.iastate.edu/math_creativecomponents/

NOTE: The Creative Component must be submitted to the POS committee two weeks before the MS Final Exam.

4.8 Application for Graduation

Application for graduation should be made by the end of the 3rd week of the semester in which the student expects to receive the degree. Instructions for how to complete this form can be found here:

<https://www.grad-college.iastate.edu/student/forms/graduation-application/>

4.9 MS Final Defense

The MS Final Defense is an oral exam in which the MS student presents to their POS Committee either: (1) their original research as part of their MS Thesis; or (2) some POSC approved material as part of their Creative Component. The presentation is followed by a question and answer session with the POSC.

4.9.1 How to Setup and Take the Final Defense

The student with the approval of the POS Committee must find a room, a 2-hour time-slot, and date for their exam. Room requests can be obtained by emailing: mathoffice@iastate.edu. Once these have been established, the MS student must officially submit a Final Exam request from the Graduate College: <https://www.grad-college.iastate.edu/student/forms/>. The form requesting scheduling of the examination must be submitted to the Graduate College at least two weeks before the proposed date of the examination.

The total length of the exam **should not exceed 2 hours**. A typical exam would consist of the following three parts:

1. [(**30-40 minutes**)]: Oral presentation given by the MS student consisting of a description of their MS Thesis or Creative Component work.
2. [(**10-20 minutes**)]: Question and answer session with members of the audience who are not part of the POS Committee;
3. [(**≤ 60 minutes**)]: Question and answer session with members of the POS Committee. In this portion of the exam, only the POS committee and the candidate are present.

4.9.2 Possible Outcomes of the Final Defense

The “Report of the Final Oral Examination” form must be submitted to the Graduate College immediately after the examination. On this form the POS committee has four possible options:

1. The student passes and may be granted the degree sought.
2. The student must meet some conditions before the degree may be granted. These conditions are specified on the report form and will remain in effect until the major professor and/or committee, if specified, submits the “Preliminary or Final Oral Exam Conditions Met” form to the Graduate College. This form notifies the Graduate College that conditions have been satisfied and the degree may be granted.
3. The student has not passed, but the exam may be retaken. Two months must elapse before the exam may be retaken (a written explanation should be provided with the report form).
4. The student has not passed and the exam may not be retaken at a future date. The degree is denied (a written explanation should be provided with the report form).

In a final oral examination, if one member of the committee votes not to pass the candidate, each member of the committee must forward to the Dean of the Graduate College in writing a justification for their vote. If more than one member of the committee votes not to pass the student, the candidate does not pass the examination.

4.10 Satisfactory Progress

Students in the MS program should complete all requirements for the MS degree in two years. Under special circumstances, the student and their advisor may request an additional semester of support. A POS committee should be formed before the beginning of the 3rd semester in the MS program. The student must maintain a cumulative grade point average of at least 3.00 (B) in all course work, exclusive of research credit.

At the beginning of year 2 of the MS program, every MS student will receive a **progress memo** from the DOGE and the Graduate Committee. This memo will contain a brief assessment as to whether or not the MS student is making satisfactory progress in the MS program.

4.10.1 Failure to Maintain Academic Standing

If a graduate student does not maintain a cumulative 3.00 (B) grade point average on all course work taken, exclusive of research credit, they will be placed on probation by the Dean of the Graduate

College. The Graduate College places a hold on future registrations by a student on probation; see the GCH for more details. Before a student on probation registers for each term, there must be a review of their record by the POS committee. Further registration will not then be permitted without recommendation in writing by the Graduate Committee to the Graduate College.

It is the purpose of the second year review to anticipate any problems that a student may have in making satisfactory progress toward a degree. Generally, failure to meet the time limits or maintain the grade point averages specified above is considered the main evidence of unsatisfactory academic progress. If the student fails to meet any of the time limits under extenuating circumstances, they may petition the Graduate Committee for extension of one or more of those limits.

Under certain circumstances it may be necessary to terminate a graduate student's enrollment in a program because of lack of satisfactory academic progress, or for other reasons as specified in the GCH. The procedures of dismissal are spelled out in the GCH.

4.10.2 Grievance Procedures

If dismissal is based on failure to make satisfactory progress, the graduate student may appeal to an ad hoc grievance committee that is appointed for this purpose by the Chair of the Department of Mathematics. Details of the constitution of the grievance committee, and the procedures it will follow, are given in the GCH.

4.11 Graduate Minor in Another Program

An MS student in Applied Mathematics has the option to get a **Graduate Minor** in another graduate program at ISU. The graduate minor can be declared on the POS form in AccessPlus. The MS student must add a graduate faculty member from this graduate program to their POS Committee (see § 4.5). Additionally, the MS student must take an additional 6 credits from this graduate program. **NOTE:** the specific requirements will vary by program and can be found by consulting the appropriate program-specific graduate handbook:

<https://www.grad-college.iastate.edu/program-handbook/>

4.12 Transferring from the MS Degree Program to PhD Program

By the beginning of the 3rd semester an MS student desiring to continue for a PhD should request admission into the PhD program. This request should be made in writing to the DOGE or the Graduate Committee. Transferring from the MS Degree Program to PhD Program is not automatic, and must be fully approved by the Graduate Committee.

Before requesting admission into the PhD program, an MS student must meet the following **minimum requirements:**

- They must have maintained a 3.33 or better grade point average on graduate level mathematics courses.
- They must have passed at least two written qualifying examinations. **NOTE:** MS students must first obtain permission from the Graduate Committee in order to even attempt a qualifying exam; the request to take a qualifying exam should be in writing and sent either to the DOGE or the Graduate Committee.

5 PhD Co-Major in Applied Mathematics

Well-qualified Iowa State University PhD students are encouraged to consider a PhD program having a co-major in Applied Mathematics and another PhD program outside of the Department of Mathematics. The procedure to propose a Co-Major is as follows:

- A co-major must be initiated with a written proposal from the student to the Department of Mathematics Graduate Committee. A draft POS must be submitted with this proposal. The proposal must contain an outline of how all requirements are to be met.
- The student must have two co-advisors, one from a graduate faculty member with a primary appointment in the Department of Mathematics and one from the other PhD program.
- Authorization by the Graduate Committee to embark on a co-major program will be based on this proposal and on the academic history of the student.
- The dissertation must have significant content in both fields.

Co-major programs are subject to the following minimum standards:

- Co-major PhD students are required to earn at least 24 credits in 500–600 level mathematics courses other than Math 590, 591, 592, 599 and 699.
- They are required to take a total of four courses from the mathematics core (see § 3.3) including at least one one-year sequence (Math 519–520 or Math 561–562).
- They are also required to pass two of the qualifying examinations described in § 3.5.
- Co-major PhD students are required to have two years of professional experience including at least one year of supervised teaching. The other year may be supervised research as a research assistant or associate.

6 Graduate Minor in Applied Mathematics

PhD and MS students from Iowa State University PhD programs that are outside the Department of Mathematics may declare a graduate minor in Applied Mathematics. The requirements are described below. The decision whether the minor is most appropriately declared in **Mathematics** or **Applied Mathematics** shall be left to the discretion of the POS Committee.

6.1 PhD Graduate Minor

PhD students who wish to obtain a Graduate Minor in Applied Mathematics are required to have:

- At least 12 credits in mathematics courses which are acceptable for non-major graduate credit (excluding Math 590, 591, 592, 599 and 699);
- At least 6 must be in 500–600 level mathematics courses.

6.2 MS Graduate Minor

MS students who wish to obtain a Graduate Minor in Applied Mathematics are required to have:

- At least 6 credits in mathematics courses which are acceptable for non-major graduate credit (excluding Math 590, 591, 592, 599 and 699) at the 400-level or above.