Ph.D. in Mathematics Degree Requirements

I.a. Ph.D. Qualifying Examinations (Ph.D. Qual Exams)

Each Ph.D. student is required to pass the Ph.D. Qual Exams within the first 24 months of beginning the graduate program.

The Ph.D. Qual Exams will be offered during the week before each Fall and Spring semester in the following five areas (as needed by student registration): Algebra, Analysis, Topology, Differential Equations, and Numerical Analysis. These five qual-examination areas are based on their corresponding MATH:5000-level course sequences, as listed below.

- **Algebra**: Abstract Algebra I-II (MATH:5000 - MATH:5010)
- **Analysis**: Introduction to Analysis I-II (MATH:5200 - MATH:5210)
- **Topology**: Fundamental Groups and Covering Spaces (MATH:5400) - Introduction to Smooth Manifolds (MATH:5410)
- **Differential Equations**: Nonlinear Dynamics with Numerical Methods (MATH:5600) - Introduction to Partial Differential Equations (MATH:5700)
- **Numerical Analysis**: Numerical Methods I-II (MATH:5800-MATH:5810)

A Ph.D. student must register for the Ph.D. Qual Exams by the announced deadline, usually about a month before the exam. A Ph.D. student cancelling his/her registration must do so at least one week prior to the Ph.D. Qual Exams session. After this date, any examination area not taken will be marked as "Fail".

For each of the examination areas, the Qual Exam is three hours. Each Ph.D. student will choose the examination areas they want to be tested on, and during which sessions they take each Qual Exam. For each examination area a student will receive a grade of "Ph.D. level pass", "Master's level pass", or "Fail". An honorific grade of "Ph.D. level pass with Distinction" will be given for exceptional performance.

To pass the Ph.D. Qual Exams a Ph.D. student must either:

- pass three different qual-examination areas with the mark of "Ph.D. level pass" within the first 24 months of beginning the graduate program, or
- pass two different qual-examination areas with the mark of "Ph.D. level pass" and additionally pass another distinct qual-examination area with the mark of "Master’s Pass" during the first 12 months of beginning the graduate program.
For a repeated examination area, the best result will count, i.e., a mark of "Fail" does not replace a mark of "Master's level pass".

It is not mandatory for a student to retake an examination area with a mark of "Fail" or "Master's level pass" in a subsequent session. Another area can be substituted.

**I.b. Sample Timelines:**
Some possible timelines for completing the Ph.D. Qual Exams requirement are below.

- Entering Ph.D. students with exceptional preparation have the opportunity to pass the Ph.D. Qual Exams at the start of their graduate study, and move directly to research related activities and complete the Ph.D. Comp Examination by the beginning of their second year;
- Entering Ph.D. students with very strong preparation have the opportunity to pass some of the area exams at the start of their graduate study, then concentrate on the remaining areas to pass the Ph.D. Qual Exams at the beginning of their second year of graduate study and thus again move quickly to research related activities as soon as their second year and complete the Ph.D. Comp Exam by the end of their second year;
- Entering students with adequate preparation have the opportunity to take three MATH:5000-level course sequences in the first year and pass the Ph.D. Qual Exams at the beginning of their second year and thus again move quickly to research related activities as soon as their second year and complete the Ph.D. Comp Exam during the beginning of their third year;
- Entering students with less preparation have the opportunity to take two MATH:5000-level course sequences in the first year and another in the second year they start on Ph.D. Comp Examination preparation to take the Ph.D. Comp Examination by the end of their third year.

The two-year timeframe also allows the flexibility for any Ph.D. student to switch the areas of the Ph.D. Qual. Examinations during their first two years.

**II. Ph.D. Comprehensive Examination (Ph.D. Comp Exam)**
Each Ph.D. student is required to submit to the DGS a Doctoral Plan of Study and a Proposal for Ph.D. Comp Exam for approval by the Graduate Committee, and then to pass the Ph.D. Comp Exam in his/her chosen area no later than August 31-st at the beginning of their fourth year of graduate study.

The preparation for the Ph.D. Comp Exam is under the supervision of a faculty. Typically the Ph.D. Comp Exam preparation would build on one of the MATH:6000-level sequences with additional readings from books and research papers. Each student must submit their Proposal for Ph.D. Comp Exam to the DGS for approval by the Graduate Committee at least one month before a presentation is scheduled. The proposal must list the examining committee consisting of at least four people including the chair and be first approved by
the chair of the examining committee. During the Ph.D. Comp Exam the student would give
an oral presentation of the material (usually about one hour) and be questioned over the
material by the examining committee. Note that the Ph.D. Comp Exam is not open to the
public (except for special requests made to the DGS).

Ph.D. students may submit to the DGS revised drafts of their Doctoral Plan of Study by
August 31-st of each subsequent year. Each revised plan should highlight any differences
between the current and the previous version of the document.

Modifications of rules for special circumstances may change time restrictions but may not
lessen content requirements.

III. Breadth Requirements

Important notice: The MATH:5000-level courses associated with the three qual-
examination areas which were used to satisfy the Ph.D. Qual Exam requirement in Section I
do not count for any of the breadth requirements below.

III.a. Hours Breadth Requirement:
A Ph.D. student must pass (grade of B- and higher or S or P) at least 27 credit hours of the
following graduate courses:

- Courses numbered from MATH:6000 to MATH:7900 with the exception of
  Seminars;
- MATH:5000-level courses that are not associated with the qual-examination
  areas used by the student to satisfy the requirements in Section I;
- Other graduate courses if they are central to the student’s research. Registration
  for such courses and their inclusion in the Doctoral Plan of Study require
  endorsement from the student’s thesis advisor prior to submission to DGS for
  approval by the Graduate Committee.

At least 18 (out of 27) credit hours must be from MATH:6000-level courses. Any exception
to this rule, as justified by the student’s Doctoral Plan of Study, must be approved by the
DGS.

III.b. Areas Breadth Requirement:
Among the following MATH courses, a Ph.D. student must pass (grade of B- and higher) at
least two courses from each of three areas chosen from the following six areas.

- **Algebra:** Abstract Algebra I-II (MATH:5000 - MATH:5010), Categories and
  Modules (MATH:6000), Comm Algebra and Rep Theory (MATH:6010);
  Homological Algebra (MATH:7000); Algebraic Number Theory (MATH:7020);
  Topics in Algebra (MATH:7030);
- **Analysis:** Introduction to Analysis I-II (MATH:5200 - MATH:5210), Analysis I-II
  (MATH:6200 - MATH:6210); Functional Analysis I-II (MATH:7200 - MATH:7210);
- **Topology**: Fundamental Groups and Covering Spaces (MATH:5400), Introduction to Smooth Manifolds (MATH:5410), Algebraic Topology (MATH:6400), Introduction to Differential Topology (MATH:6410), Differential Geometry I-II (MATH:6500 - MATH:6510); Current Geometry and Topology I-II (MATH:7400 – MATH:7450);
- **Differential Equations**: Nonlinear Dynamics with Numerical Methods (MATH:5600), Introduction to Partial Differential Equations (MATH:5700), Ordinary Differential Equations I-II (MATH:6600 - MATH:6610), Partial Differential Equations I-II (MATH:6700 - MATH:6710);
- **Numerical Analysis**: Numerical Methods I-II (MATH:5800-MATH:5810), Advanced Numerical Methods I-II (MATH:6850 - MATH:6860);
- **Biomathematics**: Mathematical Biology I-II (MATH:5750 - MATH:5760).

Graduate-level courses transferred from other universities may be used to satisfy part of the breadth requirements, subject to approval of the DGS and the Graduate Committee.

### III.c. Sample Timeline of Course to Ph.D.:
These are only recommended timelines. They will be adjusted to respond to the specific academic and research needs of the Ph.D. student.

<table>
<thead>
<tr>
<th>Year</th>
<th>Courses by Focus Area - Examples</th>
<th>Major Academic Goals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Topology</td>
<td>Analysis/Number Theory</td>
</tr>
<tr>
<td>5000-5010</td>
<td>5200-5210</td>
<td>5000-5010</td>
</tr>
<tr>
<td>5200-5210</td>
<td>5600-5700</td>
<td>5200-5210</td>
</tr>
<tr>
<td>1</td>
<td>5400-5410 (or 5800-5810)</td>
<td>5400-5410</td>
</tr>
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</table>

Attend MATH:5900 and AMCS:5900 (First Year Seminars)
<table>
<thead>
<tr>
<th>6400-6410</th>
<th>6200-6210</th>
<th>6000-6010</th>
<th>5750-5760</th>
<th>6850-6860</th>
<th>Match with an advisor</th>
</tr>
</thead>
<tbody>
<tr>
<td>6500-6510</td>
<td>7200-7210</td>
<td>7000-7020</td>
<td>Choose four: 6200, 6210, 6400, 6410, 6600, 6610, 6700, 6710</td>
<td>Choose four: 6200, 6210, 6400, 6410, 6600, 6610, 6700, 6710</td>
<td>Submit Plan of Study</td>
</tr>
<tr>
<td>Choose two: 6000, 6010, 6400, 6410, 6600, 6610, 6700, 6710</td>
<td>6400-6410</td>
<td>(or 6600, 6610, 6700, 6710)</td>
<td></td>
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<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Three other breadth and/or topics courses</th>
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<th>Three other breadth and/or topics courses</th>
<th>Choose two: 6850-6860 or other from IV.b</th>
<th>Other MATH:5000/6000-level courses</th>
<th>Pass Comp Exam</th>
</tr>
</thead>
<tbody>
<tr>
<td>Three other breadth and/or topics courses</td>
<td>Choose two: 6850-6860 or other from IV.b</td>
<td>Two other breadth/topics courses (see IV.a and IV.b) as recommended by advisor</td>
<td>Two other breadth/topics courses (see IV.a and IV.b) as recommended by advisor</td>
<td>Broader professional development / Conduct original research</td>
<td></td>
</tr>
</tbody>
</table>

Register for MATH:7990 Research/Independent Study and use short hours form

Goal of 27 breadth hours by the end of the year, Make sure 18 breadth hours are MATH:6000-level.

Register for MATH:7990 Research/Independent Study and use short hours form (or take other courses, per research interest)

Goal: At least 72 credit hours total

Register for MATH:7990 Research/Independent Study and use short hours form

Conduct original research
Participate in conferences

Write thesis
Obtain employment
IV. Academic Registration
Registration for any course that is not listed as a Ph.D. in Mathematics Degree Requirement according to Sections I-III, requires pre-approval by the DGS.

According to Section XII. Doctor's Degrees, C. Academic Registration Requirement of the Graduate College Manual of Rules and Regulations, all doctoral students must obtain a minimum of 72 semester hours of graduate work. Of those 72 semester hours, at least 39 must be earned while registered in The University of Iowa Graduate College. After completing 21 semester hours of graduate work under Graduate College registration and in compliance with the Graduate College policy for time limits on academic credit, i.e., courses ten years or older may not be counted toward the degree, students must complete an additional 18 semester hours to be taken as follows: (1) enrollment as a full-time student (9 semester hours minimum) in each of two semesters, or (2) enrollment for a minimum of 6 semester hours in each of three semesters. A student must be registered in the semester in which (s)he earns her/his degree. See also the College of Liberal Arts & Sciences Academic Policies Handbook.

V. Ph.D. Dissertation

VI. For information about Master of Science degree, see M.S. in Mathematics