

# Official Requirements and Guidelines for the Ph.D. in Mathematics

Approved by the Boston College Graduate Educational Policy Committee, October 26, 2009.

The requirements for the Ph.D. fall into five categories:

1. Residency
2. Coursework
3. Exams
4. Teaching
5. Dissertation

**1. RESIDENCY:** A student must be in residence in the Mathematics Department at Boston College for at least two consecutive semesters of one academic year with full-time registration. Full-time is 2 courses per semester. This is a Boston College GSA&S regulation.

**2. COURSEWORK:** Students must complete at least 50 credit hours at the graduate level, including all courses in Year 1 in the table below, and receive a grade of B- or higher in at least 44 of these. Typically, students will take 6,4,4 three-credit courses in years 1,2,3, respectively, as well as the one-credit seminars in teaching or research. Up to 18 credit hours of this requirement may be waived for students with prior graduate work, upon approval of the Graduate Vice Chair. Students with prior comparable course work may also be exempted from one or more of the first year graduate courses, upon approval of the Graduate Vice Chair.

## A typical course schedule

Year	Fall	Spring
1	Real Analysis Algebra I Geometry-Topology I Teaching Seminar	Complex Analysis Algebra II Geometry-Topology II Research Seminar
2	Number Theory I <i>or</i> Geometry-Topology III, Topics Teaching Seminar	Number Theory II <i>or</i> Geometry-Topology IV, Topics Research Seminar
3	Topics Guided Study Research Seminar	Topics Guided Study Research Seminar
4	Dissertation Research (1 credit) Research Seminar	Dissertation Research (1 credit) Research Seminar
5	Dissertation Research (1 credit) Research Seminar	Dissertation Research (1 credit) Research Seminar

## Course descriptions

**Real Analysis:** Measure Theory, Hilbert Space and Fourier Theory. Possible topics from: Lebesgue measure starting on  $\mathbb{R}$ , convergence and Fubini theorems, generalizing to locally compact spaces and groups.

**Complex Analysis:** Local and global theory of analytic functions of one variable.

**Algebra I, II:** Group Theory (Group actions, Sylow, Nilpotent/Solvable, simple groups, Jordan-Hölder series, presentations). Commutative algebra (uniqueness of factorization, Jordan decomposition, Dedekind rings, class groups, local rings, Spec), finite fields, algebraic numbers, Galois theory, Homological algebra, Semisimple algebras.

**Geometry-Topology I, II:** Point-set topology, fundamental group and covering spaces, smooth manifolds, smooth maps, partitions of unity, tangent and general vector bundles, (co)homology, tensors, differential forms, integration and Stokes' theorem, de Rham cohomology.

**Number Theory I, II:** Possible topics include: Factorization of ideals, local fields, local-vs-global Galois theory, Brauer group, adèles and idèles, class field theory, Dirichlet L-functions, Chebotarev density theorem, class number formula, Tate's thesis.

**Geometry-Topology III, IV:** Possible topics include: differential geometry, hyperbolic geometry, three dimensional manifolds, knot theory.

**Topics Courses:** Advanced topics in number theory and geometry-topology.

**Research Seminar:** The research seminar is an opportunity for students to present their own research or give lectures on advanced topics. Participation in the research seminar is encouraged by the department. A student may be required by their advisor to participate and/or speak in the research seminar.

**3. EXAMS:** There are three types of exams: Preliminary, Language and Comprehensive.

**Preliminary Exams:** All students must take preliminary exams in two of the three following subjects:

Real and Complex Analysis, Algebra, Geometry and Topology.

These exams cover the material in the core first year courses, and are typically taken at the end of May following the first year. They may also be taken at the start of the academic year and in mid-year. Preliminary exams are graded as follows: Ph.D. pass, M.A. pass, Fail. Students are strongly encouraged to complete two preliminary examinations at the Ph.D. pass level by the start of their second year.

The following two rules apply. Students may re-take each preliminary exam once. Students must pass two preliminary examinations at the Ph.D. level by the middle of their second year in order to continue in the program after their second year. Exceptions to these two rules require the approval of the Chair, who will consult the Graduate Vice Chair and the student's instructors before arriving at a decision. Exceptions will be granted when there is clear evidence of potential to complete a degree in a timely way, or for special circumstances such as extended illness.

A student with advanced preparation may choose to take one or more of the preliminary examinations immediately upon entering Boston College. In such a case, the examination would not count as one of the

student's two attempts, and failure of the examination would have no negative consequences. Students who wish to take an examination upon entrance should notify the Graduate Vice Chair in writing by mid July that they intend to do so.

**Language Exam:** This exam consists in translating mathematics from French or German into English. The student will select, in consultation with a faculty member, a book or substantial article in the chosen language, and will be asked to translate passages from it with the aid of a dictionary.

**Doctoral Comprehensive Exam:** After passing the preliminary exams at the Ph.D. level, the student requests that a faculty member serve as their research advisor. Upon agreement of the faculty member, the student forms a Comprehensive Examination Committee, consisting of the research advisor and at least two other members, in consultation with the research advisor. Two members must be from Boston College; the chair must be a tenured or tenure-track member of the departmental faculty. Committee composition is subject to departmental approval.

The comprehensive exam can be taken any time after the Comprehensive Examination Committee has been chosen. We recommend that it be taken as soon as possible, to allow time for dissertation research.

The doctoral comprehensive exam consists of a research topic and one secondary topic, chosen by the student in consultation with the student's Committee. Typically these are based on topics courses or independent study completed by the student in the second and third years. The comprehensive exam has both a written and an oral component. In the written part the student is given a week to solve problems or answer questions in the chosen areas. The Committee then reads the student's work, and questions the student about it in the oral exam, which may range into related areas. After the oral exam the Committee grades the entire comprehensive exam as Pass with Distinction, Pass, or Fail. A student who fails the comprehensive exam may take it one additional time, but not sooner than the following semester.

**4. TEACHING:** In addition to their responsibilities as teaching assistants and teaching fellows, students participate in the required Teaching Seminar in the fall semester of their first two years. The first year teaching seminar is for teaching assistants, covering their responsibilities both to their students and their supervisors, and providing guidance on leading a classroom for the first time. The second year teaching seminar is for teaching fellows, providing guidance for teaching one's own class.

**5. DISSERTATION:** Upon satisfactory performance on the Language and Doctoral Comprehensive Examinations, the student is eligible to be admitted to candidacy for the Ph.D. To be admitted, the student formally constitutes a Dissertation Committee which is then approved by the Graduate Vice Chair. The Comprehensive Examination Committee will typically become the student's Dissertation Committee; any changes of membership require the department's approval. At this point the student begins research for the doctoral dissertation. The dissertation must consist of original scholarly work. The Dissertation Committee will read and evaluate the completed dissertation and conduct an oral examination, at which the dissertation is defended in a public meeting. The dissertation is accepted when endorsed on the official title page by the Dissertation Committee after the oral examination. After ensuring that the format of the accepted dissertation conforms to Boston College requirements, the student submits the dissertation to the University.

## **M.A. Degree**

Students enrolled in the Ph.D. program who receive at least an M.A. pass in two of the three preliminary exams and pass at least 30 credits of math graduate courses, including at least five semesters of the first-year graduate courses in Real and Complex Analysis, Algebra, and Topology, will receive an M.A. degree. Advanced undergraduate courses may count towards the 30 credits in meeting the M.A. requirement with the permission of the Graduate Vice Chair. Students who skip a first-year course because of advanced preparation may substitute more advanced courses in any area, with the permission of the Graduate Vice Chair. A student may receive an M.A. and continue on to a Ph.D. provided the student meets the Ph.D. requirements above.